



The aim of the animal welfare science update is to keep you informed of developments in animal welfare science relating to the work of the RSPCA. The update provides summaries of the most relevant scientific papers and reports received by the RSPCA Australia office in the past quarter. Email science@rspca.org.au to subscribe.

ANIMALS USED FOR SPORT, ENTERTAINMENT, RECREATION AND WORK

How round-pen, lunging, and high-speed liberty training may compromise horse welfare

Horse training techniques that use circular pens or lunge-lines have been increasing in popularity recently, and when well applied, the round-pen can be a classroom. However, when poorly applied and without an understanding of learning theory, training in the round-pen can pose significant risks to both horse welfare and handler safety. This Australian article reviews some of the common mistakes and misunderstandings that occur during round-pen training of horses.

With both lunging and round-pen work, the trainer stands in the centre of a circle and the horse moves around them. The trainer can increase or decrease the distance between themselves and the horse very easily with one or two steps, which is known as applying or decreasing 'pressure'. Horses will work to avoid this pressure, and so it can be used as a negative reinforcement to train horses to follow commands. That is, pressure can be applied to encourage the horse to perform the correct behaviour (e.g. accelerating, decelerating, turning). The pressure is removed as a reward for performing the correct behaviour. While professional horse trainers can appropriately use this technique successfully, there is a risk of poor horse

welfare if pressure is applied incorrectly. For example, 'chasing' the horse around the pen applies excessive amounts of pressure that can cause panic, stress and exhaustion in horses, with negative consequences for welfare.

Ambiguous training goals such as asserting dominance over the horse, gaining its respect, or becoming the herd leader, are highly unlikely to be understood by the horse and are likely to lead to fear, confusion and anxiety. One of the biggest risks to horse welfare occurs when training techniques encourage anthropomorphism, as this will make the trainer more likely to misinterpret their horse's behaviour and administer punishment. When training horses in round-pens, trainers should ensure that they have a clear training goal that can be easily understood by the horse, have a good understanding of how horses learn, and be able to apply an optimal amount of pressure that encourage learning without causing fear or panic in the horse.

Fenner K, Mclean AN, McGreevy PD (2019) Cutting to the chase: How round-pen, lunging, and high-speed liberty work may compromise horse welfare. *Journal of Veterinary Behavior* 29:88-94.



New Zealand media reporting of Thoroughbred jumps racing

Jumps racing is a form of horse racing that involves approximately 25 hurdles over a distance of 2900 – 4000m. This race distance is greater than flat racing (1200-1700m), and jumps racing is associated with a much greater risk of accident and fatality than flat racing. The wide accessibility of media, combined with alternate views regarding the place of animals in society, raises the question of the acceptability of the continuation of jumps racing. This study compared the quantity of media reporting of jumps racing in New Zealand and its association with horse casualties.

Racing data and media articles from Newztext and Google news search were collected for the 2016/2017 and 2017/2018 jumps racing seasons, during which the fatality rate was 5.8 per 1000 starters. Jumps racing articles comprised 3.4% of all race reporting, and the volume of discussion about jumps racing was minimal (2.9% of jumps race articles related to the continuation of jumps racing), short-lived and related to horse fatalities. Articles were categorised and analysed using rhetorical analysis to determine the main arguments.

Jumps racing generally elicited little interest from the mainstream New Zealand media. The Jumps racing generally elicited little interest from the mainstream

New Zealand media. The inherent risk posed by jumps racing to the horse was universally accepted and formed a basis for two argumentative positions. Proponents of jumps racing argued that the risks were reasonable, with risk minimisation measures best determined by expertise and care from within the racing industry, labelling opponents as naïve extremists. Deaths were argued to be singular aberrations in an otherwise regulated and controlled industry. Opponents of jumps racing used anthropomorphism of the horse to argue that any risk was unacceptable and jumps racing should be banned. Horses were attributed with rights, and from this perspective, the racing industry exploited horses for entertainment. Deaths were argued to be needless, horrific and tragic. Although there was a general acknowledgement that jumps racing poses inherent risks by both proponents and opponents, two different arguments were used to shape claims for and against the continuation of jumps racing, with the proponents accepting that the risks can be minimised, whilst opponents argue that the risks are unacceptable.

Legg KA, Breheny M, Gee EK et al (2019) Responding to risk: Regulation or prohibition? New Zealand media reporting of Thoroughbred jumps racing 2016-2018. *Animals* 9:276.

COMPANION ANIMALS

Attitudes of vets and vet students on improving cat and dog welfare in the clinic

The veterinary profession is an ambassador for the welfare of animals, but visiting a veterinary practice is in itself stressful for many animals. A multitude of recommendations on how to reduce stress during a visit to the veterinarian are available, but they are often not implemented in practice. Therefore, the aim of this study was to survey veterinarians and veterinary students regarding their attitudes toward recommendations to improve cat and dog welfare in veterinary practice.

Two online surveys were conducted in Austria, asking 342 veterinarians and 258 veterinary students to rate 20 statements about pet-friendly handling and practice environment and other measures to improve animal welfare on a scale ranging from 1 to 6 regarding their importance for animal welfare and their feasibility in practice. All questionnaire items were averaged to create an overall importance score and a feasibility score. These scores and single items were then compared between veterinarians and veterinary students.

In general, the rating of welfare importance was high and the overall score did not differ between veterinarians and veterinary students. The recommendations rated as most important were "Dog ward: possibility to urinate/defecate at least

3 times a day," "Separate cats from dogs during hospitalization," and "Cat ward: provide hiding possibility." Regarding feasibility, veterinarians had higher overall scores than students. The rating of 9 single items was higher than that of veterinary students. Higher feasibility ratings in students were only found for the items "Advise owner on how to reduce stress during transport," "Use muzzle training with dogs and advise owner on how to do it," and "Report animal abuse to the authorities." The items "Separate cats from dogs in the waiting room", "Exam table: let cats exit carrier on their own", "Separate cats from dogs during hospitalization" received the lowest feasibility ratings by veterinarians. In conclusion, the greatest barriers for the implementation of recommendations aiming to increase animal welfare in veterinary practice seem to be related to constructional aspects or perceived time constraints. Furthermore, veterinarians might have experienced low compliance of owners to their advice and might find reporting of suspected abuse cases challenging.

Arhant C, Hörschläger N, Troxler J (2019) Attitudes of veterinarians and veterinary students to recommendations on how to improve dog and cat welfare in veterinary practice. *Journal of Veterinary Behavior* 31:10-16.

Predictive models of assistance dog training outcomes

Assistance dogs can greatly improve the lives of people with disabilities. However, a large proportion of dogs bred and trained for this purpose are deemed unable to successfully fulfil the behavioural demands of this role. Often, this determination is not finalised until weeks or even months into training, when the dog is close to 2 years old. Thus, there is an urgent need to develop objective selection protocols that can identify the dogs that are most and least likely to succeed, from early in the training process.

This study assessed the predictive validity of two tests used by Canine Companions for Independence (CCI), a national assistance dog organization based in California, USA. For more than a decade, CCI has collected data on their dogs using the Canine Behavioral Assessment and Research Questionnaire (C-BARQ) and a standardized temperament assessment known internally as the In-For-Training (IFT) test, which is conducted at the beginning of professional training. Three predictive models were developed that could predict success or release from the training program using C-BARQ scores (3,569 dogs), IFT scores (5,967 dogs), and a combination of scores from both tests (2,990 dogs).

All three final models performed well, with overall accuracies ranging from 64 to 68% correct predictions. The model predictions were most accurate for dogs predicted to have the lowest probability of success (ranging from 85 to 92% accurate for dogs in the lowest 10% of predicted probabilities), and moderately accurate for identifying the dogs most likely to succeed (ranging from 62 to 72% for dogs in the top 10% of predicted probabilities). Combining C-BARQ and IFT predictors into a single model did not improve overall accuracy, although it did improve accuracy for dogs in the lowest 20% of predicted probabilities. The study's results suggest that both types of assessments (C-BARQ and IFT) have the potential to be used as powerful screening tools, thereby allowing more efficient allocation of resources when selecting and training assistance dogs.

Bray EE, Levy KM, Kennedy BS (2019) Predictive models of assistance dog training outcomes using the Canine Behavioural Assessment and Research Questionnaire and a Standardized Temperament Evaluation. *Frontiers in Veterinary Science* 6:49.

Meet your Match – a personality test to match shelter cats with potential adopters

Regarding companion animals, personality assessments can promote successful adoptions by relying on more than just the subjects' physical appearance. The American Society for the Prevention of Cruelty to Animals (ASPCA) has implemented a program called Meet your Match® (MYM), which assesses the personality of shelter cats. It allows adopters to choose a cat that matches their expectations, the intention is to decrease relinquishment and return rates and improve the welfare and adaptation of the animals in their new homes. The study's objective was to check the validity of a modified version of the MYM when applied to a Brazilian cat shelter sample.

This study assessed 71 cats (32 male and 39 female) from 5 months to 12 years of age, all neutered, from an animal shelter in Brazil. The MYM personality assessment consists of 11 tests (or 'items') that are performed on the cat, and the cat's behavioural response to each item is scored. Examples of the behaviours scored were the cat's body posture while at rest in the shelter, and the cat's response to being approached and stroked by the researcher. Affiliative behaviours receives a positive score, while aggressive or fearful behaviours receives a negative

score. Combining the total score for each personality dimension indicates the cat's personality.

Three personality dimensions of cats were detected from this study: Agreeableness, Openness and Extraversion. The personalities of the cats in this study could be divided into two groups: one group had higher average values for agreeableness and extraversion, and the other with lower average values for agreeableness and extraversion. Openness did not differ significantly between these two groups. The modified MYM showed evidence of validity based on internal structure for personality traits in a sample of Brazilian shelter cats. This research sets in motion the validation of the modified MYM protocol for Brazilian shelter cats and allows the correct interpretation of the results of the MYM. In turn, this will contribute to enabling satisfied adopters, improved welfare of adopted cats and less return and relinquishment.

Fukimoto N, Howat-Rodrigues AB, Mendonça-Furtado O (2019) Modified Meet you Match® Feline-ality™ validity assessment: An exploratory factor analysis of a sample of domestic cats in a Brazilian shelter. *Applied Animal Behaviour Science* 215:61-67.

Engaging with socio-economically disadvantaged communities and their cats

The overpopulation of free-roaming domestic cats is fuelled by uncontrolled breeding of both owned and unowned populations, and has been identified as a particular problem in socio-economically deprived areas. Consequently, for sustainable change, it is recommended that Trap-Neuter-Return activities are linked with community engagement to encourage positive behaviours towards cats, such as reporting unowned cats for neutering. This paper assesses the acceptability and impact of a community-partnership program called "Bulwell Cat Watch" (BCW), set-up to control cat numbers in Bulwell, UK.

A series of surveys were developed to assess the impact of the BCW on human behaviour within the community, specifically the reporting of unowned cats for neutering. A cross-sectional survey was administered to 478 people to evaluate whether any change in behaviour towards unowned cats in the community was linked to awareness of BCW. A pre-post survey was administered to 21 people who had been previously surveyed in 2016 to evaluate the effects of direct engagement efforts by BCW on the knowledge and behaviour of individuals over time. A third questionnaire was administered to 34 residents

of Bulwell that were known to actively engage or volunteer with BCW to evaluate the individual benefits and outcomes of taking a more proactive role in BCW.

This study found significant associations between awareness of BCW and an increased likelihood of reporting unowned cats now when compared to previous years. Respondents reported increased self-efficacy and confidence to help cats. The pre-post study corroborated these findings with residents significantly more likely to report unowned cats compared to when surveyed pre-BCW. An indirect benefit to residents engaged with the program was the positive impact on confidence and self-esteem. Taken in combination these results show community partnerships can effectively engage often hard-to-reach populations and foster sustainable management by overcoming barriers to helping cats, alongside the potential for wider community benefits.

McDonald JL, Clements J (2019) Engaging with socio-economically disadvantaged communities and their cats: Human behaviour change for animal and human benefit. *Animals* 9:175.



Considering the relationship between domestic violence and pet abuse

This Australian review examines the literature regarding the relationship between domestic violence (DV) and pet abuse (PA), particularly in the veterinary clinical and educational contexts. Animal abuse can include, but is not limited to, wilful neglect, inflicting injury, pain or distress, or malicious killing of animals. This abuse can be directed toward pets, farm animals or wildlife. The review examines the significance of the relationship between DV and PA for the veterinary profession. This includes the veterinarian's role and associated legal and ethical obligations, and relevant current veterinary education standards, to identify future clinical and educational directions.

Pet abuse has been identified as a potential risk factor for DV, and DV perpetrators may harm or kill a pet to exert physical, psychological or emotional control over an intimate partner. Given that victims of DV often seek veterinary aid for their pets, veterinarians may act as frontline professionals in the recognition of the link between PA and DV. Veterinarians must assess individual cases for diagnostic indicators of non-accidental injury and consider demographic factors to identify suspected PA and DV. Despite existing legal and ethical obligations of the veterinarian relating to

suspected PA and victims of DV, there is uncertainty and unpreparedness addressing PA and DV in a clinical veterinary context. Many factors may contribute to the lack of veterinary intervention in suspected cases of PA and DV, including concern for animal welfare, confusion about the reporting process and uncertainty in differentiating accidental versus non-accidental injuries in pets.

Specific published guidelines regarding the recognition and reporting of PA and DV in the veterinary clinical context are required. Limited published evidence exists examining the implementation and success of veterinary training regarding the relationship between DV and PA. Ultimately, veterinary student education is needed to prepare veterinarians for their response to PA and DV in practice. Further research is required to examine the effects of the delivery of content regarding the link between PA and DV in the veterinary curriculum on veterinary student knowledge and attitudes.

Newland X, Boller M, Boller E (2019) Considering the relationship between domestic violence and pet abuse and its significance in the veterinary clinical and educational contexts. *New Zealand Veterinary Journal* 67:55-65.



Assessing the welfare of kennelled dogs

Around the world, dogs are kept in kennels for a variety of reasons. Abandoned and stray dogs may be kennel housed in shelters, and kennels form the standard housing for working, racing and laboratory dogs. Even pet dogs may be temporarily housed in kennels during holidays or quarantine periods. Despite there being hundreds of thousands of dogs housed in kennels worldwide, there are no standard protocols for assessing the welfare of dogs in these environments. Animal welfare science is focusing increasingly on the importance of animal-based measures for determining welfare states, and this UK article reviews the measures that have been used with kennelled dogs, with a particular focus on their validity and practicality.

The welfare of dogs in kennels can be assessed using physiological, behavioural and cognitive measures. In terms of physiological measurements, cortisol is one of the most commonly used indicators of stress, and can be measured invasively using plasma samples, or non-invasively using saliva, faeces, urine and even hair samples. The cortisol response of dogs to being placed in a kennel will depend on how they were housed previously. Dogs that had been experiencing unpleasant conditions before being kennelled (cold weather, being a stray) may show a reduction in

cortisol after kennelling, whereas dogs surrendered from a home may show increasing levels of cortisol. Other physiological measures used less commonly to assess dog welfare are heart rate variability, body temperature and immune function. Behavioural measures are also of great relevance when addressing canine welfare, thus studies on fear and anxiety behaviours, abnormal behaviours like stereotypies, as well as responses to strangers and novel objects are reviewed. Finally, a limited number of studies attempting to use cognitive bias and learning ability were located, although these methodologies need further refinement before they can be used to assess dog welfare.

The literature to date provides a strong background for which physiological and behavioural measures may be useful in determining the welfare of kennelled canines. However, more research is needed to further assess the value of using these methods, particularly in regard to the large degree of individual differences that exist between dogs.

Polgár Z, Blackwell EJ, Rooney NJ (2019) Assessing the welfare of kennelled dogs – A review of animal-based measures. *Applied Animal Behaviour Science* 213:1-13.

A retrospective analysis of complaints to the RSPCA about dog welfare

Animal neglect and cruelty are important welfare and social issues, and dogs are one of the most commonly reported species to have experienced both. Most previous studies related to canine cruelty and welfare focused on animal abuse and dog fighting. However, literature dealing with the often less severe but more common forms of animal welfare concern is limited. Therefore, this study aimed to understand the epidemiology of different types of canine welfare complaints over one decade, and to identify the risk factors and their roles in the different types of welfare complaints.

The retrospective study included 107,597 dog welfare complaints received by RSPCA Queensland, Australia, from July 2008 to June 2018. The risk factors considered were the age of dogs and the year of being reported. The number of complaints received each year increased by 6.2% per year. The most common complaints were poor dog body conformation, insufficient food and/or water, dogs receiving inadequate exercise, and dogs being confined or tethered. Increasing numbers were most evident for poor living conditions and leaving dogs in a hot

vehicle unattended, both of which may have resulted from increasing public awareness. The majority of complaints were neglect-related rather than related to deliberate cruelty. Compared with puppies, adult dogs were more likely to be reported to have been poisoned, left unattended in a hot car or abandoned, as well as to have had inadequate exercise and shelter. Reported puppies were more likely to be alleged to have experienced cruelty, lack of veterinary support, overcrowding, poor living and health conditions, and inappropriate surgery.

In conclusion, animal neglect was the most commonly reported welfare concern for dogs in Queensland. Due to an assumed increasing public awareness of some types of cruelty, the trends of reported concerns differed. Adult dogs and puppies were reported to be involved in different types of welfare concerns. Strategies to address cruelty to dogs can be informed by an understanding of risk factors and trends in types of cruelty.

Shih HY, Paterson MBA, Phillips CJC (2019) A retrospective analysis of complaints to RSPCA Queensland, Australia, about dog welfare. *Animals* 9:282.

Identification and treatment of pain in cats undergoing dental extractions

Periodontal disease is a common source of pain in cats, and is associated with inflammation, reduced feeding behaviour, weight loss and oral haemorrhage. This disease is commonly treated by removing severely affected teeth in the mouth, but it is not known how this oral treatment influences pain and the subsequent intake of soft and dry food in cats. This study investigated the pain scores, analgesic requirements, and food intake in cats before and after clinically recommended dental treatment.

Twenty-four cats were recruited from shelter facilities in Canada and equally divided into minimal (minimal dental treatment) or severe (multiple dental extractions) oral disease groups. They were admitted (day 0) and underwent oral examination/radiographs/treatment under general anaesthesia. Pain was scored using the Glasgow composite measure pain scale-feline before treatment and then regularly every day for 5 days after treatments. Rescue analgesia was administered if the pain scores indicated that the cats were still in pain, and the cat was re-scored after 30 minutes to ensure pain had been relieved. Dry and soft food intake (%) was measured during the 3 minutes

and 2 hours after feeding, and total daily soft food intake was calculated.

Pain scores were significantly increased in cats with severe disease when compared with baseline (up to day 4) and minimal disease (all postoperative time points). Prevalence of rescue analgesia was significantly higher in severe (91.7%) than minimal disease (0%); analgesics were required up to day 3. Pain scores and frequency of rescue analgesia were significantly correlated with the number of tooth extractions and disease severity. The prevalence of rescue analgesia was significantly correlated with the number of missing teeth, teeth extractions and gingival index. Dry and soft food intake during 3 minutes, and dry food intake during 2 hours were significantly lower in the severe than minimal disease group throughout the study. Long-term analgesia is required after dental extractions in cats with severe oral disease, and food intake is reduced with this condition.

Watanabe R, Doodnaught G, Proulx C et al (2019) A multidisciplinary study of pain in cats undergoing dental extractions: A prospective, blinded, clinical trial. PLoS ONE 14: e0213195.



FARM ANIMALS

The effects of early separation on dairy cow and calf health

On dairy farms, dairy cows are stimulated to produce milk by giving birth to a calf, which is usually removed from the cow within 24hrs of birth. Early separation of the cow and calf increases the amount of saleable milk that can be collected, and is considered preferable to separating the calf at an older age when the maternal bond has grown stronger and the separation is more stressful. A third reason used to support early cow-calf separation is the perceived health benefits for the calf, however there is a lack of consensus about the benefits and risks of this practice. On one hand, neonatal calves have poor immune function and are exposed to pathogens from the cow, while on the other hand prolonged cow-calf contact allows calves to receive immunoglobulins from colostrum and reduces mortality rates. To help clarify this topic, this Canadian article reviews the health implications of cow-calf contact versus artificial rearing.

A systematic review of the scientific literature relating to cow-calf contact produced 125 related articles, which were reduced to 70 articles using a four-stage selection process. This selection process ensured that the review only included peer-reviewed research that experimentally compared the effects of cow-calf contact

or suckling on calf health. The final 70 articles were used to examine calf health associated with cow-calf contact in the following areas: scours and enteric pathogens, Johne's disease, respiratory health, immunity and mortality. The effects of cow-calf contact on mastitis rates in the cows was also examined.

This review highlighted that there was substantial variation in the literature in terms of study design, and often it was difficult to compare different studies accurately. However, in conclusion, the evidence presented in this review does not support the recommendation of immediate separation of cows and calves to promote calf health. Early separation is not advantageous in terms of calf immunity, mortality, scours, or pneumonia, and there is an absence of literature supporting early separation to prevent the transmission of Johne's disease. This review also indicates that suckling is protective against mastitis in the cows.

Beaver A, Meagher RK, von Keyserlingk MAG et al (2019) Invited review: A systematic review of the effects of early separation on dairy cow and calf health. *Journal of Dairy Science* 102(7):5784-5810.

Lame cows on Australian dairy farms

On Australian dairy farms, cattle often walk several kilometres to be milked, and lameness has the potential to severely impact cow welfare. The Australian and New Zealand dairy industries encourage farmers to regularly score their herds to ensure that lameness is systematically identified, but uptake of this practice is low. However, previous research shows that farmers underestimate the prevalence of lameness in their herds when not inspecting them systematically. This study examined the accuracy of farmer-identified lameness rates when compared to lameness rates identified by a cattle veterinarian.

This extensive study was conducted by an experienced cattle veterinarian who examined over 19,000 dairy cows from 50 herds in Australia. Each farmer provided a list of the cattle that were receiving treatment for lameness to indicate the rate of farmer-identified lameness in each herd. Each cow from that herd was then examined by the researcher as it left the milking parlour to assess the presence and severity of lameness. The prevalence of lameness identified by the researcher was then compared to the rate that was identified by the farmer. The order that the cows

left the milking parlour in was also compared to their lameness score.

The overall average rate of lameness of all 50 herds was 3.8% (ranging from 0–11.4%), which is lower than reported in previous research. All farmers had successfully identified all severely lame cows but had only identified 24% of the total lame cows in the herd. There was no relationship between herd size and lameness prevalence. Only 60% of the lame cows were in the last third of the herd to be milked. This was unexpected, as it was assumed that the lame cows would walk more slowly to the milking parlour and thus be the last to be milked. The authors conclude that the entire herd should be systematically assessed for lameness at regular intervals to ensure an accurate diagnosis, but that scoring the last third of the herd to be milked might be useful as a screening test to identify herds with high rates of lameness.

Beggs DS, Jongman EC, Hemsworth PE et al (2019) Lame cows on Australian dairy farms: A comparison of farmer-identified lameness and formal lameness scoring, and the position of lame cows within the milking order. *Journal of Dairy Science* 102:1522-1529.

How best to improve farm animal welfare? Four main approaches viewed from an economic perspective

Historically, farm animal welfare has been protected by legislation that dictates the minimum standards for animal care, and 94% of European citizens surveyed agreed that animal welfare should be protected. In the EU, the interest in regulating animal welfare through legislation is decreasing, and there is an increasing focus on improving welfare through market-driven change such as welfare-friendly product labels. This Danish review examines how economics and social sciences can play a role in designing and implementing improvements to farm animal welfare.

The authors examine the following four approaches to improving animal welfare: producer-driven change, legislation, labelling for consumer choice, and retailer-driven change. Producer-driven improvements arise when producers voluntarily improve the welfare of their animals to receive benefits such as improved profit, reputation and job satisfaction. Developing and enforcing minimum standards of welfare through legislation adds additional cost to animal products, and is at risk of driving consumers to cheaper products sourced from other countries with poorer welfare standards, leading to no net improvements in animal welfare. Economic analysis can guide the form and extent of animal welfare legislation. Labelling animal

products can be used to improve animal welfare by attracting a premium for welfare-friendly farming practices. However, animal welfare is not important to all consumers, and many consumers would prefer to pay a small increase in price for moderate welfare improvements rather than the large increase in price for premium welfare. Retailer-driven change occurs when retailers dictate the level of animal welfare that is required for the products to be sold by that retailer. This corporate social responsibility can arise from ethical concerns, or out of self-interest (e.g. by increasing the desirability of their product). Retailer-driven strategies have the real potential to raise the standards of animal welfare, but only if they result in real improvements to animal welfare rather than just greenwashing their products to make consumers feel better about consuming animal products.

In conclusion, a combination of all four approaches is needed to achieve the best possible outcome for farm animal welfare. Economic analyses have an important role to play in designing and optimising these different approaches.

Christensen T, Denver S, Sandøe P (2019) How best to improve farm animal welfare? Four main approaches viewed from an economic perspective. *Animal Welfare* 28:95-106.



Animal welfare as preventative medicine

Due to the positive relationship between good animal welfare and good immune function, this article reviews the novel idea that promoting good animal welfare could be used to improve disease resistance in farm animals and reduce our reliance on antimicrobials in farming. Antimicrobial resistance is now recognised as a major threat to human health across the planet, and extensive use of antimicrobials given to farm animals has been a major contributor to this problem. Consequently, there have been calls for reduced antibiotic use on farm animals, but their use continues to rise due to the inability to prevent disease without them under current farming practices. To reduce the risk of antimicrobial resistance, antimicrobials should only be used when necessary to treat actual infections, rather than being used routinely and prophylactically (i.e. to prevent infection). A second important step is to reduce the risk of infection in the first place.

The immune system is a complex range of defence mechanisms that are used by the body to detect and destroy pathogens. The immune response occurs in two stages. The first stage is called the innate response and acts as a kind of non-specific emergency response,

producing bacteria-destroying granulocytes, releasing cytokines, and causing local inflammation and general signs of illness. The innate response requires a lot of energy and nutrients to maintain, and is very costly to the body. The second stage of the immune response involves targeted antigens that will target and destroy specific pathogens. This response is much less costly in terms of energy and nutrients to maintain.

Animals that experience stress and poor welfare also tend to have poorer immune function, leaving them more susceptible to disease. Evidence in humans and animals shows that better welfare is associated with better immune function and resistance to infection, and providing higher standards of animal welfare may be able to act as a method of preventative medicine in farm animals. Research is urgently needed into the relationship between animal welfare, immunity, gut microbiota and disease and we are not yet in a position to claim that improving welfare will definitely improve resistance to disease.

Dawkins MS (2019) Animal welfare as preventive medicine. *Animal Welfare* 28:137-141.

Do broiler chickens with different growth rates use perches and grids differently?

At night, chickens will roost in elevated positions to avoid predation. In addition, access to perches is associated with improved bone strength and better foot health in broiler chickens. Previous research has shown that broilers prefer to roost on platforms rather than perches, and the use of elevated structures can vary with height, time of day and growth rate. This study investigated whether the growth rate of broiler chickens influenced their preferences for platforms and perches at different heights.

This study was conducted at a research institute in Germany using three strains of chicken: a fast growing strain (Ross), a medium-growing dual purpose strain (Dual), and a slow growing strain (LB). At one-day old, 200 chickens from each strain were divided into groups of 50 and placed into pens of the same strain, and grown to market weight. In each pen was a structure consisting of three levels (10cm, 30cm, 50cm), with three perches on one side, three platforms on the other side, and a ramp in between to allow easy access to the perching sites. The use of the perches during the day and night was monitored using

video cameras, and the general activity levels of the chickens was monitored using transponders attached to their legs. The behaviour of the chickens and their preference for the different structures was compared between the three strains.

The elevated structures were used by all three strains of chicken, and the fast-growing Ross strain used the elevated structures less than the slower-growing strains. This was attributed to their reduced locomotor ability and potentially poor leg health. All three strains preferred to use the grids over the perches, although the LB chickens used the perches more often. There was a high level of activity on the structures at dawn rather than at night, which was unexpected, as chickens often use elevated positions to roost during the night. The chickens that did roost at night preferred to roost on the highest level of the structure. In conclusion, broiler chickens are motivated to use high, stable structures such as raised grids.

Malchow J, Berk J, Puppe B et al (2019) Perches or grids? What do rearing chickens differing in growth performance prefer for roosting. *Poultry Science* 98:29-38.

Public attitudes towards genetically modified polled cattle

Recent developments in the field of genetics provide greater control over gene modifications in animals, allowing humans to precisely add or remove genetic material from embryos in the very early stages of development. One application of this technology is to insert a single gene into cattle that prevents them from growing horns, thus creating polled cattle. Genetically modifying the Polled gene would increase the number of polled cattle much faster than using traditional breeding techniques, negating the need for these cattle to undergo painful disbudding or dehorning procedures, and improving the safety of farm workers. Previous research has shown that the public is generally opposed to genetic modification of animals, however there has been little work looking at public attitudes to modifications that may benefit the animal. This study surveyed public attitudes towards the use of gene modification to produce polled cattle to improve animal welfare.

An online survey was created to collect data on participant demographics, familiarity with the topic, attitudes toward genetically modifying cattle to be hornless, attitudes toward consuming food products from these animals, and measures of social desirability bias. The survey was disseminated through

the Mechanical Turk platform, and received 598 responses from US citizens. Of these, 434 responses were useable. The responses were then examined for relationships between the different variables, and recurring themes in the open-ended responses.

When positioned from the perspective that a specific genetic modification could be used to eliminate the need for painful disbudding procedure in cattle, the respondents of this survey expressed positive attitudes toward the modification. The most commonly expressed reason for these attitudes was the improvement in cow welfare, with many respondent displaying nuanced reasoning when considering the benefits and risks of the modification. In conclusion, the majority of participants reported positive attitudes toward genetically modified cattle and would be willing to consume products from these animals. These results suggest that people may be more likely to support genetic modification technologies if they are perceived to benefit animal welfare.

McConnachie E, Hotzel MJ, Robbins JA et al (2019) Public attitudes towards genetically modified polled cattle. *PLoS One* 14(5): e0216542.

The effects of prolonged cow-calf contact on behaviour, welfare and productivity

On dairy farms, calves are often removed from their mothers within hours or days of birth. This practice is performed to increase the amount of saleable milk from the cow, control the amount of colostrum fed to the calf, improve milk let down in the cow during milking, and to minimise separation distress by preventing a strong bond forming between the cow and calf. However, there is significant concern from the members of the public that are aware of this practice regarding its impact on animal welfare. To help resolve the different stakeholder views regarding early cow-calf separation, this Canadian article reviews the impacts of this practice on the behaviour, welfare and productivity of the cows and calves.

A systematic review of the scientific literature relating to cow-calf contact produced 283 related articles, which were reduced to 53 articles using a four-stage selection process. These final articles were used to compare the effects of early cow-calf separation with an extended period of cow-calf contact on short and long-term responses of calves, including behaviour, stress responsiveness and growth, as well as milk yield in the cows. Relatively few studies measured long-term effects on cows and calves, collected data on a variety

of welfare indicators, or used consistent experimental designs, which limited the strength of the conclusions that could be drawn from this review.

Contrary to the expectations of some stakeholders, while allowing cows to nurse calves generally decreased the volume of milk for sale during the nursing period, suckling often did not reduce saleable milk yield when measured over the long term. Early separation (within 24h postpartum) was found to reduce acute distress responses in cows and calves, however longer cow-calf contact typically had positive longer-term effects on calves, promoting more normal social behaviour, reducing abnormal behaviour, and sometimes reducing responses to stressors. Allowing a prolonged period of nursing increased calf weight gain during the nursing period. In summary, prolonged cow-calf contact aggravates the acute distress experienced at separation, but can have positive effects on calf behaviour and weight gain.

Meagher RK, Beaver A, Weary DM et al (2019) Invited review: A systematic review of the effects of prolonged cow-calf contact on behaviour, welfare, and productivity. *Journal of Dairy Science* 102(7):5765-5783.

A comparison of gene editing vs conventional breeding to increase the number of polled dairy cattle in the US

Horns on dairy cattle pose a safety risk to farmers and other cattle, and 94% of dairy cattle producers in the US routinely dehorn or disbud their cattle to avoid this issue. Both dehorning and disbudding are painful procedures that have received public scrutiny as an animal welfare issue. A solution to this welfare problem is to genetically select cattle to be hornless (polled), however the frequency of polled sires to breed with in the US is very low (1% for Holsteins, 2% for Jerseys). The genetic quality of these sires is also low, making them an unattractive option for cattle breeders. Gene editing is one method of introducing the polled gene to good quality sires without causing detrimental effects to the population genetics. This study compared the effectiveness of gene editing in comparison to a conventional breeding program for increasing the frequency of polled cattle in the US.

A computer simulation was used to test the effects of four different mating schemes on the frequency of polled cattle over a 20yr period. The first scheme only selected sires with a high genetic value irrespective of horn status, which acted as the baseline model. The following two schemes used polled sires that

had either one copy of the polled gene (half of the offspring would be polled) or two copies of the polled gene (all offspring would be polled). The number of offspring produced from each bull was limited to 5000 to avoid inbreeding. The final scheme used polled sires with no offspring limit. These mating schemes were then replicated using gene-editing technology instead of conventional breeding, resulting in 7 simulations. The frequency of polled cattle, the degree of inbreeding, the rate of genetic gain, and the number of sires used were then compared between the different scenarios.

This study found that using conventional breeding methods to select for polled cattle will increase inbreeding and slow genetic improvement in dairy cattle. In comparison, gene editing could be used to rapidly increase the frequency of polled cattle while maintaining genetic gain and reducing inbreeding.

Mueller ML, Cole JB, Sonstegard TS et al (2019) Comparison of gene editing versus conventional breeding to introgress the POLLED allele into the US dairy cattle population. *Journal of Dairy Science* 102: 4215-4226.

Should animal welfare regulations be more restrictive?

Intensive farming practices are causing increasing societal concern for animal welfare, and the degree of concern experienced by an individual is related to their level of knowledge about the topic. Several studies have also shown that animal welfare attitudes can vary across countries and cultures, and in relation to the type of animal in question. Individuals can be categorised as either consumers or citizens when expressing their opinions on animal welfare. Consumers are meat-eaters that express their animal welfare values in relation to their purchase and consumption of animal-based products. Citizens are vegetarians and vegans who base their values on ethical and altruistic concerns rather than economic and consumption-based themes. This European study investigated the attitudes and knowledge of European consumers and citizens in relation to farm animal welfare.

A semi-structured questionnaire was administered to 3860 people across eight European countries. The survey methodology ensured that there was an even representation of gender, ages and country location, and respondents were classified as consumers or citizens. Consumers were classified as someone who had purchased and consumed meat in the last week.

Citizens were classified as non-consumers of meat products. The survey assessed opinions on whether animal welfare laws should become more restrictive (yes or no), and various factors that may have affected this decision such as respondent knowledge of animal welfare, their perception of current welfare standards, and socioeconomic characteristics.

The results showed that citizens were more likely than consumers to support animal welfare regulations becoming more restrictive. Respondents from northern European countries (Poland and Sweden) were more likely to support regulations that are more restrictive than respondents from southern European countries (Spain and Italy). Respondents with a higher level of subjective knowledge on animal welfare, women, and those who rely on the internet for information were supportive of more restrictive regulations on animal welfare. These results suggest that increasing knowledge of animal welfare is related to effective information campaigns that use the internet to endorse the current animal welfare legislation.

Pejman N, Kallas Z, Dalmau A et al (2019) Should animal welfare regulations be more restrictive? A case study in eight European Union countries. *Animals* 9:195.

Sow and piglet behaviour in group lactation housing from 7 or 14 days post-partum

There is growing societal concern for the welfare of sows that are confined in farrowing crates due to the barren and restrictive nature of this environment. One method of addressing these concerns is by housing the sows and their piglets in groups during lactation. Two-stage group lactation systems involve the sows farrowing in standard farrowing crates to reduce early piglet mortality, and then moving the sows and their litters to a group at around 14 days post-partum to allow greater behavioural freedom. Under natural conditions, sows and their piglets abandon the nest and return to the herd between 7-14 days post-partum, and moving the sows to group lactation at 7 days would reduce their period of confinement. This study compared the effects of transferring sows to group lactation pens at 7 and 14 days on their aggression and nursing behaviour.

This experiment was conducted at a large Australian piggery, using 112 pregnant sows. All sows farrowed in standard farrowing crates, and at 7 days post-partum, 48 sows and their litters were transferred to group-lactation housing and remained there until weaning. This housing consisted of large pens that

could hold 5-7 sows, with two piglet creep areas and enrichment such as hay and litter. At 14 days post-partum, another 48 sows and their litters were transferred to group-lactation housing. The remaining 16 sows and their litters remained in the farrowing crate throughout lactation. All piglets were weaned at 26 days old. The behaviour of the sows and piglets was recorded using video cameras for 1hr after entering the group lactation pens, the day after mixing and the day prior to weaning.

Mixing sows and their litters into group lactation pens induced behavioural changes in sows and piglets compared to housing them in farrowing crates during lactation. Group-lactated sows were more active, exploratory and interactive with their piglets, but experienced more disrupted nursing behaviour and cross suckling by the piglets. There were few differences between grouping at 7 or 14 days postpartum on behaviour.

Verdon M, Morrison RS, Rault J-L (2019) Sow and piglet behaviour in group lactation housing from 7 or 14 days post-partum. *Applied Animal Behaviour Science* 214:25-33.



HUMANE KILLING

Effectiveness of a non-penetrating captive bolt device for killing layer chickens

In the poultry industry, it is sometimes necessary to kill birds to prevent suffering in sick or injured birds, to control the spread of disease, or for managing the number of birds in the laying house. The most common method used is mechanical cervical dislocation, however this is unpleasant for stockpeople to perform, and may not result in immediate loss of consciousness in the birds. Recent developments in the availability of commercially produced non-penetrating captive bolt (NPCB) devices may provide an alternative method of humane killing of poultry on-farm. This study compared the effectiveness and humaneness of three commercially available NPCB devices for killing layer chickens.

This study was conducted at a university research unit in Canada. The three NPCB devices tested were the Zephyr-E, Zephyr-EXL, and the Turkey Euthanasia Device (TED). These devices are based on modified nail guns that deliver a concussive blow to the skull. Each device was tested on approximately 25 layer chickens (male and female) at four different ages (10-11wks, 19-20wks, 30-35wks and 60-70wks), resulting in a total of 279 chickens used. Each bird received a single application of the device at a standard location on the

head, and the time to insensibility and death were recorded. Each bird was then examined immediately after death to determine the degree of tissue damage caused to the skull and brain. The measures of insensibility, death and tissue damage were then compared between the three devices and four age groups of chickens.

The brain trauma caused by all three NPCB devices was sufficient to rapidly render the birds insensible, leading to irreversible brain death in all age groups of layer chickens. To ensure the humaneness and effectiveness of these devices, it is vital that the correct air pressure is used to drive the captive bolt. For stockpeople using these devices on farm, it is vital that they are able to determine whether a bird has been successfully killed. Based on the results of this study, the onset of tonic convulsions, the last movement and final cloacal relaxations are good indicators of clinical death in layer chickens in the field.

Mudliyananselage R, Bandara AS, Torrey S et al (2019) Anatomical pathology, behavioural, and physiological responses induced by application of non-penetrating captive bolt devices in layer chickens. *Frontiers in Veterinary Science* 6:89.

MISCELLANEOUS

Characteristics of animal hoarding cases referred to the RSPCA

Animal hoarding is a source of both human and animal suffering, and is characterised by the following criteria: owning many animals; failing to provide minimum care for these animals; being unable to recognise the inability to care for the animals, and persistently accumulating animals despite the inability to care for them. Hoarding often results in overcrowding and the spread of disease, and is a significant animal welfare concern. Attempts at resolving these cases are costly and often involve veterinary, legal, housing, animal control, sanitation, public health and social service agencies. This study reports the characteristics of animal hoarders in terms of their demographics and reasons for hoarding.

In collaboration with psychiatric researchers, a standardised data collection form was developed for use by RSPCA inspectors when investigating cases of animal hoarding. The inspectors were required to complete the form for all cases of hoarding that were reported to the RSPCA in NSW, Australia, during 2013-15. The inspectors were asked to categorise each animal hoarder according to the following categories: overwhelmed caregiver, rescue hoarder, exploiter hoarder, incipient hoarder and breeder hoarder. Inspectors also rated the apparent mental health of the animal hoarder, details of their

home, the housing conditions of the animals, and the numbers of each species of animal kept. These data were then summarised to describe the characteristics of animal hoarding.

Similar to previous research on animal hoarding, the majority of animal hoarders were middle-aged to elderly females. The median number of animals hoarded was 35, and the most commonly hoarded animal was cats, followed by dogs. 50% of cases involved single-species hoarding. The accumulation of animals was most commonly attributed to unplanned breeding (60%), but also commonly resulted from collecting strays (38%) and animal rescue networks (19%). There is good evidence from this and other studies that many people who accumulate too many animals and then fail to look after them properly have psychological or mental health problems. The authors advocate for the involvement of mental health professionals in services run by animal inspectorates, which may help to alleviate human and animal distress associated with animal hoarding.

Elliott R, Snowden J, Halliday G et al (2019) Characteristics of animal hoarding cases referred to the RSPCA in New South Wales, Australia. *Australian Veterinary Journal* 97:149-156.

RESEARCH ANIMALS

Non-animal models for acute toxicity testing of chemicals

Approximately 90% of consumer products contain chemicals that lack toxicity information, but it is unfeasible to test this number of products using animal models. One method is read-across, in which the toxicity information from known compounds is used to estimate the toxicity of untested compounds with similar structures. Another alternative is low-cost, high-throughput *in vitro* bioassays. However, incorporating *in vitro* bioassays into chemical toxicity evaluations such as read-across requires significant data curation and analysis based on knowledge of relevant toxicity mechanisms, lowering the enthusiasm of using the massive amount of unstructured public data. This American study aimed to develop a computational method to automatically extract useful bioassay data from a public repository (i.e., PubChem) and assess its ability to predict animal toxicity using a novel bioprofile-based read-across approach.

A training database containing 7,385 compounds with diverse rat acute oral toxicity data was searched against PubChem to establish *in vitro* bioprofiles. Bioassay groups that may inform on relevant toxicity mechanisms underlying acute oral toxicity were identified. These bioassays groups were used to predict animal acute oral toxicity using read-across, and an external test set of over 600 new compounds was used to validate the resulting model predictivity.

For complex animal toxicity end points, such as acute oral toxicity, the complete replacement of animal testing is still not feasible. However, efforts to prioritize potentially hazardous chemicals by leveraging reliable and sufficient bioassay data that can be linked to specific toxicity mechanism(s) can significantly reduce the number of animals used, save great resources in chemical toxicology studies, and facilitate hazard assessment of high-priority chemicals. The data-driven profiling strategy presented in this study provides a novel way of extracting pertinent information from a daily updated, unstructured public resource. In contrast to previous studies, our method not only predicts acute oral toxicity classification but also infers biological mechanism information, offering novel insights into mechanisms of acute oral toxicity as well as *in vitro* bioassays and their utility for predicting *in vivo* toxicity. Furthermore, this method can easily be expanded to develop non-animal models to evaluate other complex animal toxicities beyond acute oral systemic toxicity.

Russo DP, Strickland J, Karmaus AL et al (2019) Nonanimal models for acute toxicity evaluations: Applying data-driven profiling and read-across. *Environmental Health Perspectives* 127(4):47001.



WILD ANIMALS

Animal welfare and the killing of wildlife by captive bolt in Australia

People may be called upon to kill wild animals in a range of scenarios, such as for population management or road accidents, and it is vital that the animal to be killed experiences an instantaneous death, or is rendered insensible until death occurs. However, access to firearms and euthanasia drugs for these purposes can be limited by remoteness, drug restrictions and human safety. One alternative method for killing wildlife is the penetrating captive bolt. While these devices are commonly used on farm animals, there is very little information on their humane use with wildlife. This article reviews the animal, operational and equipment factors that may influence the animal welfare outcomes for Australian wildlife that is killed by captive bolt.

Captive bolt devices are used to induce death or insensibility by firing a retractable projectile (bolt) into (penetrating) or against (non-penetrating) an animal's cranium. Penetrating captive bolts (PCB) are currently used to kill some wildlife species in Australia, such as joeys during annual kangaroo culls, but more information on their use is needed. For example, the type of bolt and the powerload needed to cause

instantaneous death will vary between different species and sizes of animals. For example, PCB are capable of killing pouch young instantaneously but may not be suitable for large ungulates such as water buffalo.

Factors that can influence animal welfare outcomes when using captive bolts are the degree of capture and restraint stress, whether the animal can be restrained appropriately, skull anatomy, correct maintenance and placement of the captive bolt device, and the correct use of the captive bolt device and cartridge combination. Depending on the circumstances, captive bolts may or may not be an appropriate killing method for wildlife in Australia. Wildlife are so diverse and may be encountered in such a wide variety of settings that the selected method of killing will depend on a range of variables. More research is needed to develop standard operating procedures that ensure humaneness when using captive bolts for killing wildlife.

Hing S, Hampton JO, Gibson TJ (in press) Animal welfare and the killing of wildlife by captive bolt in Australia. *Australian Zoologist*.

Tasmanian wildlife – influence of habitat suitability and live abundance to road mortality

Tasmania has been called the roadkill capital of Australia. However, little is known about the population-level impact of vehicle mortality on native mammals in the island state. Three marsupial species that are locally common in Tasmania and are frequently killed on the roads are the Tasmanian pademelon, Bennett's wallaby and the bare-nosed wombat. This study investigated the predictability of roadkill on a given route, based on models of species distribution and live animal abundance for these three marsupial species in Tasmania, and to assess the possibility of predicting the magnitude of state-wide road mortality based on live animal abundance.

Road mortality of the three species was measured on eight 15-km road segments in south-eastern Tasmania, during 16 weeks over the period 2016–17. The selected road segments were intentionally chosen to be homogenous to reduce the influence of road features on roadkill. Climate suitability was predicted using state-wide geographical location records, using species distribution models, and actual counts of these species based on 190 spotlight surveys that were conducted along the road segments.

In total, 869 roadkills were found for the three target species, with the Tasmanian pademelons being the most frequently killed (648 pademelons, 178 wallabies, 43 wombats). The present study has shown that live-animal abundance cannot explain the rate of road mortality of the three Tasmanian marsupials studied. Instead, a combination of general climate similarity and differences in microhabitat conditions and road characteristics seem to be the predominant influence of wildlife roadkill rates. A substantial amount of basic ecological, life-history, habitat and behavioural knowledge remains to be gathered before consistently effective measures can be recommended. Regular and continuous surveys, similar to the annual spotlight surveys that are conducted and used in the present study, need to be encouraged and need to link explicitly to road mortality. As such, future work should seek to use fine-scale spatial data on other road features, and map their relationship to the local frequency of roadkill to underpin appropriate mitigation methods.

Nguyen HKD, Fielding MW, Buettel JC et al (2019) Habitat suitability, live abundance and their link to road mortality of Tasmanian wildlife. *Wildlife Research* 46:236-246

Social identity shapes support for management of wildlife and pests

Public attitudes are important in shaping wildlife management decisions. However, the public is not homogeneous, and conflicting perceptions and attitudes often create barriers to achieving conservation outcomes. For example, social identity theory states that individuals will align themselves with groups that have similar interests to themselves, such as farmers, conservationists, and animal rights activists. These groups then stereotype the members of other 'out-groups' creating an 'us or them' mentality that dismisses the opinions of out-group members and hinders conflict resolution. In this study, a social identity approach was used to analyse public acceptance of different options for managing wild animals in Australia.

An online survey was developed to assess the participant's acceptance of the use of different management methods for four wild animal species in Australia (kangaroos, wild horses, dingoes, red foxes). The management methods included a range of both lethal (shooting, trapping, baiting) and non-lethal interventions (fencing, fertility control, translocation). The survey was distributed online by a market research company and received 793 responses.

This study found that the respondents' social identities were useful predictors and means of exploring acceptance of different options for wild animal management and conservation in Australia. Analyses indicate 11% of respondents strongly identified as animal rights activists, 19% as wildlife conservationists, and 19% as farmers. On average, all identity groups supported nonlethal management for all species and reintroduction or maintenance of dingoes to suppress kangaroos and red foxes. All identity groups except farmers were generally unsupportive of lethal control, but there was less consensus among responses within groups compared with support for nonlethal methods. Results suggest that policies which prioritise nonlethal management over lethal control (where effective) will be less controversial than those that use lethal management. Likewise, incorporating predator conservation into ecosystem restoration seems well supported across constituencies typically interested in wildlife conservation.

Van Eeden LM, Newsome TM, Crowther MS et al (2019) Social identity shapes support for management of wildlife and pests. *Biological Conservation* 231:167-173.

A zoo animal's neighbourhood: how conspecific neighbours impact welfare

While the zoological community strives to provide the best possible living environment for non-human animals, space limitations constrain where zoos can house particular species. Therefore, an individual may live in proximity to animals that impact its behaviour, physiology, reproductive function or overall welfare status. The impact of predators and prey species living in close proximity has received a considerable amount of research, but the impact of forced proximity to members of the same species has received little attention. This article examines how solitary and social species living in managed settings are positively and negatively affected by conspecific neighbours.

The factors that influence how neighbouring conspecifics can impact on an individual are species characteristics (e.g. social vs solitary), individual characteristics (e.g. gender) and environmental characteristics (e.g. enclosure enrichment). Housing social species alone but in visual contact with conspecifics can be beneficial or detrimental, depending on the species. Housing social species in unrelated groups, or housing different groups in close proximity can increase territorial behaviour and stress. Similarly, housing solitary species in close proximity to conspecifics is a source of stress that can increase the

rate of stereotypical behaviour and decrease fertility.

In summary, a zoo's quest to improve the welfare of individual animals must include an assessment of the effects of forced proximity to conspecifics. When making housing decisions, zoos should follow husbandry recommendations outlined by zoo associations, integrate natural history information and attempt to view the environment from the perspective of the species of interest. Furthermore, researchers can collect survey, behavioural and physiological data to examine how variables, such as density, distance between neighbours, the age/sex of conspecifics and types/amount of exposure to others influence welfare. Ultimately, zoos should consider the needs of individuals and investigate whether welfare can be enhanced by modifying enclosures, husbandry routines, enrichment schedules or access to conspecifics. A zoo's willingness to alter an animal's exposure to conspecifics may have a substantial impact on physical, mental and emotional health.

Whitham JC, Miller LJ (2019) A zoo animal's neighbourhood: how conspecific neighbours impact welfare. *Animal Welfare* 28:127-136.

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