

CRC ONE HEALTH ONE WELFARE

One Welfare in Practice

The Role of the
Veterinarian

Edited by Tanya Stephens



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One Welfare in Practice

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One Welfare in Practice: The Role of the Veterinarian

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Foreword: One Welfare for the Veterinarian

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Mixed career as a veterinary practitioner, teacher and researcher. Assistant/Associate Professor, University of Alberta Canada, 1966–1970. Head, Energy Metabolism Section, Rowett Institute, Aberdeen 1970–1977. Appointed Professor of Animal Husbandry at the University of Bristol School of Veterinary Science 1977. Established the Bristol Unit for Study of Animal Welfare and Behaviour. Founder member of the UK Farm Animal Welfare Council (FAWC). First proponent of the ‘Five Freedoms’ concept of animal welfare, adopted by FAWC and now recognised as an international standard. Former President of the UK Nutrition Society and British Society for Animal Science.

The concept of One Health is now widely accepted within the medical professions in recognition of the fact (which should be self-evident) that humans are animals so human health can never be considered in isolation from animal health. This approach has been given fresh impetus by our need to manage the increasing threat from zoonotic infections within a global society, currently the arrival of the Covid pandemic. Less dramatically, the concept of one health has been central to medical research ever since medicine became a science. Studies using laboratory animals, and tissues from laboratory animals, have been critical to the development of our understanding of the aetiology and pathogenesis of almost all threats to human health, from infection, neoplasia, acute injury or general wear and tear. Clinical evidence from the management of, for example, pets with neoplasia can also benefit human medicine, not least because things progress faster in small animal so we can learn quicker. The concept of One Health comes naturally to members of the veterinary profession for the good reason that veterinary science has to be based on the application of first principles to compare and contrast the biology of health and disease across species. We are taught to think this way and it is natural to include the human species within our sphere of understanding. While this, very properly, does not permit us to carry out medical procedures on this single species of animal, it can give us the expertise to make significant contribution to the understanding and management of health problems at a population level.

One health is a big issue. One Welfare, of which one health is but a part, is as big as it gets. It is the principle that the wellbeing of all life, humans, animals, wild and domestic, and all else that constitutes the living environment, should be addressed holistically because all are inextricably linked within one biological and social ecosystem. In 2019 a group of veterinary professionals established 'Vet Sustain' whose aims are to motivate and inspire veterinary professionals across the globe to unite under a One Welfare umbrella and work towards a sustainable future for humans, animals and the environment, framed by six interconnected goals: 'Diverse and abundant wildlife; A Good Life for Animals; Net zero warming; Health and happiness; A no waste society; and Enough clean water for all'. These are all laudable ambitions. However, if they are to become more than a set of virtue signals, they have to lead to action: the identification of specific manageable objectives, detailed analysis of the problem and the implementation of strategies designed to achieve a fair compromise between the expressed and inexpressible needs of all life forms. Each specific issue will be difficult and complex. Strategies for effective action, fair to all parties, require input from individuals with a wide range of specific skills, coordinated and given the authority to act by those with the education and experience to identify the individual trees and the wisdom to visualise the wood.

The veterinary profession is well equipped to make a significant contribution to many specific strategies within the overall embrace of One Welfare. The newly graduated veterinarian, in receipt of an excellent education in comparative biology and medicine, has the potential to develop and contribute a wide range of relevant skills. While most are likely to specialise, especially within the lucrative trade of pet vetting, the range of opportunities available to the veterinarian within the broad embrace of One Welfare is legion. The contributors to this book bring together expertise and experience from a wide range of disciplines within the compass of veterinary science to provide a comprehensive introduction to the ways in which veterinarians may contribute to policy and to action.

The individual chapters within this book address the broad aims of the Vet Sustain group and illustrate a range of specific, practicable programmes within the compass of their mission statement. They may be grouped within three broad categories. Taken in no particular order, chapters within the first category are those in which animal welfare is the central issue: laboratory animals, working animals, animals in transit and fish. These are obviously, but not exclusively, veterinary matters. If we are to understand the impact of human actions on the emotional state of animals, it is necessary to seek input from others with specialist knowledge of topics such as animal behaviour, stress and motivation.

The second category deals with the humane application of population control measures in relation to wildlife management, pest control and disease control programmes for farm animals. A programme for the eradication of *Mycoplasma bovis* in New Zealand cattle provides a good specific example of the impact of rigid disease eradication procedures on the welfare of both cattle and farmers. Similar principles could well be applied to the unsuccessful programme for eradication of bovine tuberculosis in the UK, where the concerned parties are cattle,

farmers and wildlife, most notably, the badger. The chapter on rabies control in Indonesia provides an excellent example of the application of a One Health approach that brings the human, domestic animal and wildlife sectors together to address a complex problem that incorporates socio-cultural issues and political dimensions in addition to the technical component.

Chapters within the third category address the broad, environmental aims of Vet Sustain. They include topics as diverse as food security for humans in subsistence communities, the animal welfare implications of land clearance programmes and climate change. All of these big themes have a veterinary component: most subsistence farmers are critically dependent on their animals and when they suffer, they are likely to suffer together. The insatiable demand of the human population for food from animals is one of the greatest threats to the sustainability of the living environment. Clearing forests to make room for beef cattle has serious impacts on diversity and wildlife. Pollution from intensive livestock production systems threatens water courses. Emissions of greenhouse gases, especially methane from ruminants, are a significant contributor to global warming. In all these cases, the poison is in the dose. Farming animals for food was a sustainable practice for millennia. It is only in recent years that a huge increase in demand fuelled by parallel increases in the clearing of natural habitat to grow crops for livestock, and dependence on non-renewable resources like artificial fertilisers and fossil fuels, has supplanted sustainable livestock farming pursuits like managed grazing and the feeding of pig swill. If we are to address the six aims of one welfare, we have no option but to become less greedy. Pollan's maxim [1] 'Eat food, not too much, mostly plants' is a good place to start.

This is a valuable book that should give inspiration to many young idealistic veterinarians wanting to do 'the right thing'. There is no doubt that the veterinary profession has a lot to contribute to policy within the general aims of One Welfare. However, when we advocate the message of One Health, which is that responsibility for human health cannot be the exclusive province of the (human) medical profession, we must take great care not to assume that we are the prime custodians of One Welfare. We have a great deal to offer but we are not alone.

1. Pollan M. 2008. In defence of food: an eater's manifesto. Goodyear.



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Preface

Tanya Stephens, BVSc (USyd), MSc IAWEL (Uni Ed),
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In late 2019, I gave a presentation on Land Clearing at the One Welfare Conference in Sydney when I had an email from Alice Oven, of Taylor & Francis publishers with a proposal to edit a brand new book on *One Welfare: The Role of the Veterinarian*. I did at first wonder if this was a hoax call, never having considered myself ‘well known’. However, after a friendly online chat I determined that Alice was indeed ‘fair dinkum’, as they say in Australia, and I submitted a proposal.

I was absolutely delighted to have the proposal accepted as editing the book gave me the opportunity to bring together a long-standing interest in veterinary professional ethics, animal welfare, human wellbeing and the environment – an interest shared by contributors who enthusiastically agreed to submit chapters to collect, in one place, a practical guide to implementing a One Welfare agenda and a discussion on the limitations of the concept.

These are challenging times to produce a new book. However, a book on One Welfare, the interrelationship between animal welfare, human wellbeing and the environment, has never felt more relevant or more useful than at this time when the world continues to be in the grip of a zoonotic pandemic.

Although the book is aimed primarily at the veterinarian, I am most appreciative of the non-veterinary chapter authors with special expertise who have contributed to the book and have highlighted the importance of a collaborative approach to the One Welfare agenda. Chapters cover a dazzling array of topics which can serve as a basis for information, ideas for collaboration, inspiration and ongoing debate; not everyone will agree with some of the conclusions drawn and this is surely a good outcome. The book was always intended to stimulate discussion and serve as an impetus for action, and never meant to sit and gather dust on a bookshelf.

There has been an increasing societal interest in animal welfare as well as the environment over the past 60 years or so, and it is evident that animal welfare, the environment and human wellbeing cannot be conveniently compartmentalised. There is an urgency about protecting the planet and its inhabitants. Climate change, biodiversity loss and new and emerging pandemics present existential threats to humankind, and there needs to be a debate around balancing human needs and the environment, balancing animal health and welfare and food production to feed a burgeoning population.

Most importantly there need to be solutions – solutions that are practical and can be achieved soon, not later. This can only be achieved with prompt action and

collaboration between people with a common goal not only to make the world a better place in the short term but to ensure that long term there will be a world that is liveable. Veterinarians have always been concerned with more than the individual animal, and it is clear that veterinarians have an essential role to play in the One Welfare agenda.

Introduction

Tanya Stephens

The concept of One Welfare recognises the interconnections between animal welfare, human wellbeing and the environment, with an emphasis on the importance of interdisciplinary collaboration and solutions. In this book, contributors have been given free rein with the topic and they have brought a rich variety of writings, each with their own perception of benefits and limitations of the concept and the role of the veterinarian.

2020 was a challenging year for all of us and I'm extremely grateful that chapter writers have been so generous with their time and expertise in bringing this book to fruition. The Covid 19 pandemic created extra time for some writers and less time for others. We were all affected in some way or other and undoubtedly this pandemic cast a long shadow over all our lives.

At the time of writing, the world is still in turmoil due to the Covid 19 pandemic, which has arisen out of the close relationship between humans, animals and the environment. It therefore seems only fitting to have a book on One Welfare. In addition, climate change, other emerging diseases in humans and animals and the need to maintain a viable ecosystem whilst feeding the world presents new and urgent challenges and veterinarians need to be at the forefront of looking for solutions in which robust collaboration plays an essential role.

We live in a new geological epoch, the Anthropocene, in which a great acceleration of human activity has altered our planet, transforming as much as half of the world's tropical forest into agriculture and human settlements. Around one third of emerging diseases, including Covid 19, are the result of these rapid changes in land use which have led to humans increasingly coming into close contact with wildlife and their viruses, a situation that was once uncommon. Unfortunately, on the biodiversity front we are not doing well. The recent IPBES Global Assessment Report on Biodiversity and Ecosystem Services paints a grim picture of a rapid decline in ecosystem health associated with increased food production.

There is no doubt that the planet is in a perilous position and urgent action is required. In 2016 the World Health Organization declared climate change to be the greatest threat to global health in the 21st century. Worldwide, climate change impacts on agriculture and livestock production with a risk to food security and animal welfare. Climate change is truly a One Welfare issue and it is only fitting that it has a mention in many of the chapters.

Feeding the world without destroying the planet is a top priority for all of us, with veterinarians being able to provide expertise, leadership and genuine concern. Sustainability and One Welfare are inextricably linked, and it is particularly pleasing to see the emergence of the veterinary groups, the One Health

Commission, Vet Sustain and Vets for Climate Action, who have submitted chapters to this book. It is also heartening to learn that a 2019 survey of UK veterinarians by the British Veterinary Association found that 89% would like to play a more active role in the UK sustainability agenda.

Much of the literature relating to One Welfare to date has focused on areas such as human/animal abuse, which of course is of great importance and there is plenty of published work in this area. In this book, writers have addressed broader issues to do with concern for the environment, biodiversity, ecosystems and sustainability. Veterinarians cannot ignore the looming crisis and need to become involved, show leadership, demonstrate their expertise and be at the forefront.

One Welfare builds on the One Health initiative which has been used as a basis for collaborative efforts to control zoonotic diseases, antimicrobial resistance, food safety and natural disaster management and has moved on from being a concept to becoming a global movement. However, there is a need to continually reinvigorate and emphasise the concepts of One Health and One Welfare that have been fragmented by specialisation within the veterinary profession and to engage in holistic approaches to issues that affect animals, humans and ecosystems. Along with the concepts of One Health and One Welfare, the concept of Planetary Health has emerged. Planetary Health recognises that our civilisation depends on human health, flourishing natural systems and the wise stewardship of natural resources.

The concept of One Welfare is not new and a concern for ‘big picture’ issues is not a novel concept for veterinarians. The emergence of One Health and more recently One Welfare is in a way reinventing the wheel in response to fragmentation and specialisation within the profession.

Veterinarians routinely develop an understanding of their clients and their patients and the social contexts that influence their lives so that a veterinarian on a routine farm visit, for example, is likely able to notice, advise or pick up on something unrelated to the visit such as the state of the farm. Veterinarians, in a range of roles, have always needed to consider animal welfare broadly in the context of where the animals live or are kept and the human factors of the caregivers. Human factors may include knowledge, skills, ability to implement knowledge and skills, mental health, financial considerations and other stressors.

The aim and scope of this book are to present the role of the veterinarian in One Welfare and how veterinarians can and are contributing to improving animal and human welfare. Veterinary professionalism has at its core a concern for more than just treating an individual animal. Veterinary professional ethics ‘obliges’ veterinarians to be concerned with more than simply the animal in front of them. Indeed, professional ethics are essential in upholding the integrity of the profession, and the maintenance of a social contract with the public ensures that the veterinarian continues to be the primary authority on animal health and welfare. Maintenance of professional integrity is essential if veterinarians want to collaborate with other professionals under the One Welfare umbrella.

A social contract is said to be at the heart of the professional relationship, in that, in exchange for the statutory restriction of certain acts to the profession,

members of the profession must act in the interests of society and its members. Professionals owe a special duty of care to those they serve; they have special duties to other professionals and responsibilities to society in general. In essence veterinarians should have wide concerns and responsibilities regarding animal and human welfare ranging from a concern for, amongst others, biodiversity, sustainable agriculture, climate change and wild animal welfare. The OIE (World Organisation for Animal Health) has declared that veterinarians are a 'public good' because of their professional role with veterinary public health, epidemiology and disease control, animal welfare and their association with communities.

Veterinary ethics and legislation relating to veterinarians often describe a One Welfare concept. For example, the oath recited by graduates in Veterinary Science at the University of Sydney states that they will 'practise veterinary science ethically and conscientiously for the benefit of animal welfare, animal and human health, users of veterinary services and the community'.

The idea that veterinarians have a concern for more than their patients, but also for humanity, is longstanding. When Claude Bougelat, a French barrister and Commissioner-Inspector at the Stud Farm at Lyon in France, established the first veterinary school in Lyons in 1761, he intended that these new animal doctors be regarded alongside the other medical professions. His ideals regarding the veterinary profession were nobly stated in the 'Rules for the Royal Veterinary Schools' (1777)

The doors of our Schools are open to all those whose duty it is to ensure the conservation of humanity, and who, by the name they have made for themselves, have won the right to come and consult nature, seek out analogies and test ideas which when confirmed may be of service to the human species.

(Translation from Harris 2011)

The links between veterinary medicine and the service of humanity are as pertinent as ever, despite a number of key differences existing between Bougelat's world and the professional context in which the majority of veterinarians now practise. The 18th-century veterinarian was primarily concerned with the maintenance of the agricultural economy, while the 21st-century veterinarian has a much greater range of roles and responsibilities. A number of factors have added greater complexity to the profession, including the rise of intensive animal production, development of laboratory animal research, a growth in the status and economic value of companion animals and a growing appreciation of the human/animal bond.

Colonus and Earley (2013) proposed that the grounding ideals of One Welfare will help veterinarians foster not only animal welfare but also human and societal wellbeing, and that the separation between human, social and animal welfare is an artificial compartmentalisation and these depend on each other in an ecological context. This required interdisciplinary approach would create an exciting path for veterinary medicine in advancing human society and would address increasing welfare challenges and opportunities through a framework for action where decisions on welfare would not be made in isolated disciplines. There is a

growing need for veterinary leadership in new and rapidly emerging fields associated with public health, ecosystems and global ecology.

Similarly, Pinollis et al. (2018) suggested that integrating the concept of One Welfare in existing projects could provide a low cost platform for promoting interdisciplinary collaboration to help improve global standards of human and animal welfare. For example, this could be achieved by supporting food security and improving productivity within the farming sector. In the One Welfare arena, a number of areas have been highlighted to benefit or are already benefiting from a One Welfare approach. These include the link between human and animal abuse, improved animal welfare and human wellbeing, improved animal welfare and food safety, improved animal and farmer welfare through improved farming productivity and increased biodiversity leading to improved human wellbeing.

However, there are limitations to the One Welfare approach and finding solutions to complex problems may be difficult. A broad view is needed to ensure that improvements in animal welfare do not cause a decrease in human welfare or impacts on other animals. It is no easy task to incorporate animal welfare into the sustainability agenda and this is where the concept of One Welfare can fall short. Sometimes there are no easy solutions, and it is somewhat idealistic to assume that the One Welfare approach will make the world a better place for humans and animals. Clearly there needs to be an acknowledgement of conflicting interests and a critical examination of any limitations to this approach, for example, the conflict between wild animals and humans when humans encroach on habitat or conflicts between animals and humans in modern intensive animal production.

The connection between human and animal welfare involves compromises. For example, improvements in animal welfare may increase the cost of food in society and be detrimental to human wellbeing. Given the need to feed the world and increasing demand for animal source protein, this raises biodiversity and environmental concerns. In addition, we live in a global economy where animal welfare policy decisions in one part of the world can affect costs of food, wildlife habitats and energy consumption across multiple nations.

I trust this book, with its multiple fascinating approaches to One Welfare, will inform and inspire the reader to take a critical look at the concept. It will inform them of solutions to complex problems and, most importantly, help them find areas where collaborative action has most benefit. None of us can ignore a looming planetary crisis and it is clear that the veterinary profession has a responsibility to humanity as well as animal health and welfare.

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Tanya Stephens



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Editor



Tanya Stephens, BVSc (USyd), MSc IAWEL (Uni Ed), MANZCVS (Animal Welfare) FRCVS, was born and grew up in the Somerset countryside which inspired a lifelong love of animals and the natural world. She loved nothing more than paddling in streams, collecting tadpoles, talking to hedgehogs or spending time on Devon beaches with their wealth of rock pools. Her family moved to Australia when she was in her early teens, and it didn't take long for that interest to transfer to the Australian landscape. A passion for the environment and animals led her to study veterinary science and postgraduate work with native ani-

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Tanya established her own small animal practice in Haberfield, Sydney, and very much enjoys practice and its everyday challenges. As a practitioner she is particularly interested in professional ethics and promoting the use of evidence-based veterinary medicine. She is also a wildlife researcher with original research on galactosaemia in kangaroos and nutrition of orphan marsupials. Tanya's interests lie in animal welfare, professional ethics, the law, research, evidence-based practice, wildlife, the environment and sustainable agriculture. She is a regular presenter at Veterinary Conferences and Universities and published author on these topics.

Tanya holds leadership positions within the Australian Veterinary Association, the Australian and New Zealand College of Veterinary Scientists, and is Chair of the Australian Veterinary Association's Animal Welfare Trust. She is also a member of a number of Animal Ethics Committees, Honorary Veterinarian for the Children's Medical Research Institute and involved in management of kangaroos.

Tanya is a recipient of the Belle Bruce Reid Medal awarded by the University of Melbourne in 2006 to Australia's 100 most notable women veterinary science graduates and is a Fellow of the Royal College of Veterinary Surgeons.



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Ruth Clements, BSc (Hons), BVM&S (Edin), MRCVS, graduated as a Veterinary Surgeon from Edinburgh University in 2008 and has a degree in molecular biology. She began work in sustainable agriculture in 2002, joining FAI Farms in 2008 and continues to work for the Benchmark group to date. Ruth created and published a 5 Point Plan approach to tackle lameness in sheep, which is promoted by UK industry stakeholders as the national control strategy against this disease. The framework enables producers to reduce lameness prevalence levels and associated antibiotic use in their flocks. She now takes these principles across agriculture and aquaculture, looking towards tackling some of the most challenging disease-based and environmental blockers to sustainable production. Ruth has a strong interest in regenerative farming and holistic health management as drivers of more balanced food production for the future. Ruth has been a strong advocate for the veterinary profession's growing role in sustainability as professionals, citizens and as responsible human beings.

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Simon Doherty, BVMS, CertAqV, MRQA, CBiol, FRSB, ARAgS, FRCVS, holds a senior position at the Institute of Global Food Security, Queen's University Belfast. Prior to his presidency of the British Veterinary Association, he was the Animal Sciences and Aquaculture Specialist for the Department for International Trade. He currently sits on the UK Trade and Agriculture Commission Standards Working Group. A former Chair of the UK One Health Coordination Group,

Simon chairs the Federation of Veterinarians of Europe Food Safety and Sustainability Working Group and is an ad hoc expert to the World Veterinary Association One Health Strategic Focus Group. He is a past-president of the North of Ireland Veterinary Association and a Life Member of the Royal Ulster Agricultural Society. Simon is a director of Vet Sustain and is a trustee of sustainable development charity, Send a Cow, and the BVA Animal Welfare Foundation.

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Angela Frimberger, BS, VMD, Diplomate ACVIM (Oncology), is a parent, biologist, veterinary oncologist, small business owner and volunteer climate advocate/educator. Angela has always been interested in environmental concerns and in 2014 she was trained as a Climate Reality Leader by the Climate Reality Project and Australian Conservation Foundation. She founded ClimateVets, a global network of animal health professionals concerned about climate change, and is a founding board member of Veterinarians for Climate Action.

Locally, Angela is a member and Committee Member of the Energy Forever Project, and a member of the Hastings branch of Climate Change Australia and the Port Macquarie / Hastings Sustainability Network.

Ahmad Gozal, MMi, is a Veterinarian with 23 years' experience. He started his career working in the commercial poultry industry as a Veterinary Technical Services Representative. Later, he worked as a government veterinarian providing many public services for the animal health sector and supporting veterinary public health in East Java Province. From 2006, he worked with the Ministry of Agriculture (MoA) Participatory Disease Surveillance and Response (PDSR) project and supported development of the PDSR program as a PDSR Master Trainer. From 2010 he worked as a National Technical Advisor (NTA) at Food and Agriculture Organization Emergency Centre for Transboundary Animal Diseases (FAO ECTAD) Indonesia on poultry disease surveillance. He also worked closely on rabies control in Bali and Flores Provinces. Together with the MoA, he also provided training on rabies control for animal health workers in Vietnam and Singapore. Since 2016 he has been involved in One Health Capacity Building with FAO ECTAD to improve emerging infectious disease (EID) and zoonoses prevention and control.

Angenita (Nita) Harding, BVSc, MBA (Dist), MANZCVS (Animal Welfare), is a Veterinarian who has worked in a variety of roles covering animal health and welfare, disease control, and biosecurity in the New Zealand primary sector. Her most recent role was with DairyNZ, the industry organisation representing dairy farmers. Her work included liaison with government and working with other industry organisations and stakeholders within the primary sector, input into the development of resources and training for farmers and farm advisors, and technical advice for policy analysts.

Nita was appointed to the DairyNZ team working on the *Mycoplasma bovis* response in July 2017. During this time, she was involved in several technical working groups, along with MPI staff and representatives of other farming sector groups. Nita also delivered over 60 presentations and workshops to farmers on *Mycoplasma bovis* and on-farm biosecurity.

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Rob Howe, BVSc (Hons) MRCVS, works as a Farm Veterinarian in Lancashire, NW England, having founded and grown a practice over 11 years which is now part of a much bigger group. His interests are not limited to cattle health and production. Driving work at his practice, the group and beyond, he seeks to make

sustainability within the veterinary profession and farming an important focus. He believes strongly that farm vets have a pivotal role in knowledge exchange and driving change within agriculture to benefit animal, human and environmental health. He sees the change to farming subsidy in England as an opportunity to deliver this, if implemented well. Rob is currently undertaking a Nuffield Scholarship researching the role of farm vets within Regenerative Agriculture, and continues to work with Vet Sustain, Vet Partners and many other groups to progress this agenda.

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Wahid Fakhri Husein, DVM, is a Veterinarian who has been involved in a multisectoral cooperation between animal health and public health sectors in Indonesia on rabies prevention and control programmes for several years. He worked for the Global Alliance for Rabies Control (GARC) as a field coordinator of rabies prevention and control programmes in Nias Island, Indonesia from 2014 to 2016. As a national technical advisor for rabies control, he has been working for the FAO Emergency Centre for Transboundary Animal Diseases (ECTAD) programme in Indonesia from 2016 until now in a close collaboration with relevant sub-directorates of Indonesian Ministry of Agriculture, Ministry of Health, Ministry of Environment and Forestry, as well as other national authorities. In addition, he has responsibilities to provide technical support to the prevention control and programme, including detection and response for other zoonoses in Indonesia, such as avian influenza, anthrax and leptospirosis.

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Gretchen E. Kaufman, DVM, is a Wildlife Veterinarian and One Health educator. She is a cofounder of VIEW (Veterinary Initiative for Endangered Wildlife), a non-profit organization dedicated to building wildlife health capacity in countries that need it the most. Previous positions include Assistant Director for Global Health Education and Training at the Paul G. Allen School for Global Animal Health at Washington State University; and Director of the Tufts Center for Conservation Medicine at Tufts University, where she founded the Masters in Conservation Medicine Programme. She retains adjunct faculty positions at both

institutions. Dr. Kaufman's mission is to promote inclusion of wildlife health in conservation efforts and to seek sustainable solutions to global health challenges through a One Health approach. She strongly defends the protection of biodiversity as key to the health of the planet and continues to pursue and support the practice of conservation medicine.

Libby Kemkaran-Thompson, MA Cantab VetMB MRCVS, is a Behavioural Psychologist and Veterinarian who trained as a Climate Reality Leader with Al Gore. She is a Director of Vet Sustain and regularly speaks for them on the power of utilising behavioural change and understanding the Neural Mechanisms of Behaviour, which she studied at degree level at the University of Cambridge. Owner of The Mindset Vet and creator of 'TAME™ Your Brain' change management programme, Libby helps organisations and individuals effect the behavioural change needed for sustained success. Libby speaks on TEDx and at conferences and events worldwide.

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<https://kemkaran.com/>

Uttara Kennedy, BVSc, MSc IAWEL, MANCVS (Animal Welfare), has worked for 18 years as a small Animal Practitioner, Practice Manager and Mentor to young veterinarians across Australia and India. She is currently working as a shelter veterinarian at the RSPCA Queensland's largest city shelter. She has an MSc in International Animal Welfare, Ethics and Law and is a Member of the ANZVCS (Animal Welfare chapter). She has co-authored papers on cattle welfare in India and Australian invasive pest control strategies. She continues to conduct epidemiological research on shelter disease and spread, as part of her role at the RSPCA. She has volunteered in India with Vets Beyond Borders and presented her research into Indian cattle shelters at the ANZVCS Science Week Animal Welfare Stream in 2017.

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range of issues, including farm animal welfare, highlighting human stories and global issues through film, supporting the next generation of entrepreneurs in Africa and giving purpose to adults with learning disabilities and autism.

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Joann M. Lindenmayer, DVM, MPH, has taught and applied One Health in international, national, state and local venues since 1988. She is an adjunct Associate Professor of Public Health at Tufts University School of Medicine, an elected member of her town's Board of Health and Chair of the Leadership Council of Humane Society Veterinary Medical Association. Previous positions include Track Director, Tufts DVM-MPH Programme, co-Principal Investigator for the USAID-funded Tufts Emerging Pandemic Threats Programme, Principal Investigator for a Rockefeller Foundation-funded project to analyze educational barriers to intersectoral collaboration for HPAI prevention and control, Epidemic Intelligence Service fellow and U.S. Peace Corps volunteer. Her 7 years in Southeast Asia and West Africa has informed her appreciation for the contributions of national, cultural and religious values to One Health societal perspectives. In her professional and personal lives Dr. Lindenmayer ascribes to and practices a nontheological version of Dr. Albert Schweitzer's philosophy of Reverence for Life.

James McGrane, MVM, MSC, MRCVS, is a Veterinarian with 45 years' experience in the diagnosis, control and prevention of animal diseases and zoonoses in Africa, the Middle East, Latin America and Asia. He led the FAO Emergency Centre for Transboundary Animal Diseases (ECTAD) programme in Indonesia from 2006 to mid-2020. ECTAD supports the government to build capacity to prevent, diagnose and control zoonoses such as highly pathogenic avian influenza (HPAI), rabies and anthrax, as well as emerging pandemic threats like COVID-19. FAO has improved disease control through cross-sectoral coordination and collaboration with the public health and wildlife sectors using a One Health approach. ECTAD also supports local governments to reduce disease, decrease antimicrobial resistance and improve food safety along poultry value chains. FAO partnered with animal health laboratories to develop an Influenza Virus Monitoring (IVM) network and online platform to monitor and characterise circulating H5N1 HPAI viruses and develop a molecular surveillance system.

Clive J.C. Phillips, BSc, MA, PhD, was the Foundation Professor of Animal Welfare at the University of Queensland, where he directed the Centre for Animal Welfare and Ethics in the veterinary school. He previously taught and researched animal welfare to veterinary and agriculture students at the Universities of Cambridge and Wales in the United Kingdom. He has written widely on the welfare of captive animals, mainly farm animals but also zoo and companion animals. He is best known for his research on the welfare of livestock transported

by ship. His books include *Principles of Cattle Production*, *The Animal Trade* and *The Welfare of Animals – the Silent Majority*. He has also authored about 350 scientific journal articles. Clive chairs the Queensland Government's Animal Welfare Board and is editor-in-chief of the journal *Animals* and the *Animal Welfare Series* published by Springer. In 2012 Clive was awarded the Australian Museum prize for scientific research for the protection of animals.

Andrew Prentis, BVSc, MRCVS, after a 40-year career in clinical practice, now works almost exclusively on environmental projects with Vet Sustain, the 99% Organisation, in sustainable forestry and eco house design. Starting off in private practice, Andrew worked for the RSPCA as London hospital director before moving to Morocco for a development project building clinics for working animals and setting up an environmental education centre. Back in the UK he was appointed director of the first opinion teaching hospital at the Royal Veterinary College in London before moving on to set up his own multi-disciplinary clinic in central London. He has extensive media experience, having written book chapters, clinical training manuals, papers and articles, and has had numerous radio and television appearances. On a good day, he can also speak French.

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Elly Sawitri, MSc, is a Veterinarian with 42 years' experience in the control and prevention of animal diseases and zoonoses in Indonesia. She worked as a government official at the Directorate of Animal Health, Ministry of Agriculture for 30 years in the fields of disease control, veterinary drug control and animal biosecurity. Later, she led the Campaign Management Unit (CMU) for highly pathogenic avian influenza (HPAI) control from 2006 to 2009. Then she joined the FAO Emergency Centre for Transboundary Animal Diseases (ECTAD) programme in Indonesia as Senior National Veterinary Adviser from 2009 to mid-2020. ECTAD supports the government to build capacity to prevent, diagnose and control zoonoses such as HPAI, rabies and anthrax. She has experience in applying the One Health approach to disease control through cross-sectoral coordination and collaboration with the public health and wildlife sectors. She recently started working as a consultant with the Indonesian Veterinary Drug Association, advising on veterinary drug registration.

Luuk Schoonman, DVM, PhD, is a Veterinarian with a PhD in Veterinary Epidemiology with 33 years' experience in the diagnosis, control and prevention of animal diseases and zoonoses in Africa and Asia. He has been the Chief Technical Advisor of the FAO Emergency Centre for Transboundary Animal Diseases (ECTAD) programme in Indonesia from 2010 onwards. ECTAD supports the government to build capacity to prevent, diagnose and control zoonoses such as highly pathogenic avian influenza (HPAI), rabies and anthrax, as well as emerging pandemic threats like COVID-19. FAO has improved disease control through cross-sectoral coordination and collaboration with the public health and wildlife sectors using a One Health approach. ECTAD also supports local governments to reduce disease, decrease antimicrobial resistance and improve food safety along poultry value chains. FAO developed over the last years the Indonesian Field Epidemiology Training Programme for Veterinarians (FETPV) to strengthen the epidemiology capacity for disease control and prevention.

Becky Sedman, BVSc (Hons), MRCVS, is a recently graduated Veterinary Surgeon working in companion animal practice in York. She undertook a course on 'Business Sustainability Management' with the University of Cambridge and became an Associate Member of IEMA. Becky is on the Greener Veterinary Practice Working Group of Vet Sustain and works as a Referral Associate for Investors in the Environment. As well as trying to encourage local change in her own veterinary practice, she hopes to influence wider change in the veterinary sector through her work on the Vet Sustain Toolkit and by writing educational material.

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Arvind Sharma, BVSc & AH MVSc (Surgery and Radiology) PGDAEM PhD, recently completed his PhD (2020) at the School of Veterinary Science at the

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Ben Sturgeon, BSc, BVM&S, Cert E.P. Cert E.S.M BAEDT MRCVS, graduated from Edinburgh University in 1996. After completing an internship at Dublin University, and residency at Edinburgh University, he went on to lecture in Equine Practice & Medicine before moving into first opinion and referral work in England becoming head surgeon and director. During this time he produced several general publications and presented multiple peer-reviewed articles in scientific journals on a range of primarily equine conditions and investigative procedures. He left private practice to work for the international charity The Society for the Protection (SPANNA) as Veterinary Director, and now Services Director, overseeing strategic developments and delivery in veterinary programmes, education activities, community training, emergencies and advocacy. His key interests are in impact-driven Sustainable Development, through One Health principles, utilising veterinary expertise leading individual behavioural and national legislative change.

Pebi Purwo Suseno, DVM, is a Veterinarian with a 20-year experience in control and prevention of animal disease and zoonoses in Indonesia and also active in the same field and coordination mechanism in Asia, especially in the Southeast Asia. For the last 10 years, he has been actively involved in the national rabies control program including in the Island of Bali, where he, as the representative of the Ministry of Agriculture of Indonesia, works closely with the local government and developing partners including FAO in the development of integrated

bite cases management (IBCM) and training module for rabies vaccination team that also has been used in several countries in Southeast Asia. He is a member of OIE Ad Hoc Group related to rabies since 2019. He is also active in the one health capacities development in Indonesia and participated in the development of a series of resources documents for One Health in Indonesia.

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10 years spent working in animal welfare officer roles in Australia and in the UK, and a career-long membership of animal ethics committees. She has published over 40 scholarly articles on animal welfare and law.

Yuni Yupiana, MSc, PhD, is a Veterinarian at the Directorate of Animal Health (DAH), Ministry of Agriculture (MoA), Indonesia, focusing on the prevention and control of animal diseases and zoonoses. She graduated in veterinary medicine from Bogor Agriculture University, then completed her Master's degree at Erasmus University Rotterdam and just recently finished her doctoral degree from Massey University, New Zealand. Her work in the MoA included an assignment with the National Veterinary Drug Assay Laboratory (NVDAL) working on viral vaccine assay. After 7 years working at the NVDAL, she was promoted to the DAH headquarters, as head of section for animal disease eradication where she was involved in developing and implementing eradication programs for priority animal diseases and zoonoses. After returning from her PhD studies in September 2019, she is now actively involved in developing guidelines for African Swine Fever (ASF) and leptospirosis control and coordinating training of field officers in ASF control in Indonesia.

1 One Health and One Welfare

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Until the lions have their own historians the history of the hunt will always glorify the hunter.

African Proverb

INTRODUCTION

In this chapter, we will explore the connections between One Health and One Welfare and suggest how these two important and overlapping movements could benefit from each other and help us to work collaboratively towards common goals. Both concepts are based on the foundational idea that humans, other animals (wild and domestic) and the environment are interconnected and interdependent, and that these relationships are inescapable, inviolable and arise out of common origins and shared experiences.

The One Health concept requires us to recognize and appreciate the dynamic complexity of everything from minute ecosystems within cells to diverse populations that constitute macro-ecosystems. In doing so, we must move beyond the hundreds of years of training that has led us to think of health problems in simple reductionist terms of direct cause-and-effect relationships that can be studied and manipulated apart from the complex context in which they occur. One Health is not well served by this simplistic way of thinking, based on *normal science*, and would benefit from the more systemic approach offered by *post-normal science*, defined as a way of doing policy-related inquiry that is appropriate for complex cases where “facts are uncertain, values in dispute, stakes high and decisions urgent” that “does not pretend to be value free or ethically neutral” (Funtowicz and Ravetz, 1990, 1992). Our understanding of the world emerges not from isolated, linear lines of scientific inquiry but rather from multiple, sometimes conflicting perspectives, and varying historical, moral and ethical frameworks, *not all of which are based in science* (Bunch and Waltner-Toews, 2015).

Although One Health began with the recognition of interconnected, interdependent relationships, it has most often examined issues through a biased scientific lens of human health and human activities. Even as an ethical perspective of One Health is beginning to be explored, it is being applied mainly to people. But as Dr. Albert Schweitzer noted decades ago, “We need a boundless ethics that includes the animals also” (Schweitzer, 1998). We posit that a moral and ethical framework needs to be developed for One Health that considers more than human dimensions, applies as well to our relationship with other animals and the environment and assists us to reach beyond normal science. One Welfare, based on similar foundational ideas but also grounded in the ethical concepts of welfare and well-being, may serve as the basis for a much needed ethical framework to guide One Health.

One Welfare begins with the perspectives that are not all based in “normal” science, complementing One Health with an important value dimension. Taken together, One Health and One Welfare can give us a way to think about forging a healthier path away from the widespread destruction that *Homo sapiens* alone, of the more than 8 million known species on earth (Zimmer, 2011), has caused and that imperils not only our survival but that of all other living species. One Health and One Welfare together provide us with the opportunity to think about how we can “stitch a new garment. One that fits all of humanity and nature” (Sonya Renee Taylor, 2020). Accomplishing this will require applying not only the science of health, among others, but doing so within an ethical framework.

We put forward that One Health and One Welfare together can establish a basic ethic of respect for other living and nonliving elements of our planet, provide a foundation for the science of One Health and replace exploitation and annihilation with stewardship and responsibility for our planet and all its life forms.

LESSONS FROM ONE HEALTH – A SHORT HISTORY

The concept of One Health has its roots in ancient civilizations that made no distinction between healers of people and healers of animals and, although it has nearly completely fallen out of current practice and fashion, remnants of this idea persist among certain indigenous peoples (Callicott, 1982; Loppie, 2008; Dockery, 2010; Tignino, 2018; Jack, Gonet, Mease, and Nowak, 2020). Not until Hebrew prophets and Greek philosophers was the distinction drawn between man and other animals with respect to their morals, behaviour and mental processes (Schwabe, 1984), thereby setting humans apart from and superior to other animal species. In the 19th century, the physician-pathologist Dr. Rudolph Virchow studied spontaneously occurring diseases of domestic animals with the objective of applying what he learned to diseases in people, and wrote in 1856 that “Between animal and human medicine, there is no dividing line – nor should there be. The object is different but the experience obtained constitutes the basis of all medicine” (Klauder, 1958). His work, and that of others at the time, laid the groundwork for the study of comparative pathology among animals of all species, humans included, and he is credited with conceiving the concept of one medicine. Against this backdrop of a common scientific understanding of diseases, the microbiological revolution arrived in the mid-20th century. Coupled with the subsequent influence of biotechnology in the 21st century, physicians became increasingly specialized and collaborative efforts with veterinarians waned (Kahn, Monath, Bokma, Gibbs, and Aguirre, 2012).

One Medicine, a term formally defined and elaborated by veterinarian Dr. Calvin Schwabe, refocused attention on the common scientific origins of human and veterinary medicine (Schwabe, 1984). In the 21st century, two key advances propelled One Health to where it is today. The field of medicine expanded from treatment alone to include prevention, thereby paving the way for the evolution of One Medicine to One Health (United States Public Health Service, 1979; Etheridge, 1992). And in 2004, health experts from around the world met at the One World, One Health symposium to discuss movements of diseases among human, domestic animal and wildlife populations, leading to the publication of the Manhattan Principles (Cook, Karesh, and Osofsky, 2004). These gave greater weight to the value of biodiversity and extended One Health to encompass the environment and the health of people and other animals in ecosystems.

One Health is a concept that affirms the health interdependency of people, other animals and the environment. It is an approach to understanding and solving complex, shared health challenges and, as such, requires engagement by representatives of multiple disciplines and communities. Finally, it is the implementation of One Health in policies and programmes designed to improve the health of

people, other animals and the environment. The most commonly applied definition of One Health states that it is “the integrative effort of multiple disciplines working locally, nationally, and globally to attain optimal health for people, animals, and the environment” (American Veterinary Medical Association, 2020b). A newer definition states that One Health is a “collaborative, multisectoral, and trans-disciplinary approach – working at local, regional, national, and global levels – to achieve optimal health and well-being outcomes, recognizing the inter-connections between people, animals, plants and their shared environment”(One Health Commission, 2020c).

One Health as we know it today was launched into prominence with the heightened recognition of threats to people posed by the emergence of animal diseases such as Highly Pathogenic Avian Influenza, which has the capacity to become pandemic and kill vast numbers of people (and poultry). For that reason, an early focus of One Health was dominated by concerns primarily for human health and secondarily for animal health as advanced by physicians, veterinarians and population health professionals, and was adopted by many as a strategy for achieving effective and economically efficient joint health outcomes that would not have been possible had there been no collaboration. This relationship was codified in 2010 in a Tripartite Agreement signed by the Food and Agriculture Organization of the United Nations (FAO), World Health Organization (WHO), and the World Organization for Animal Health (OIE) (World Health Organization, 2010). The agreement promotes cross-sectoral collaboration to address and reduce risks from zoonoses and other public health threats existing and emerging at the human-animal-ecosystems interface; similar collaborations were established in many other countries (Food and Agriculture Organization of the United Nations, 2020; Mbabu et al., 2014; Nigeria Centre for Disease Control, 2019; Pennsylvania State University, 2020). Because of these institutional arrangements at the highest levels, One Health in its most basic form has influenced investments, research funding and policy at international and national levels and is supported and recognized by many members of the international donor community (One Health European Joint Programme, 2020; United States Agency for International Development, 2018).

VISUALIZING ONE HEALTH

Of four common graphic representations of One Health, including the generic One Health Venn Diagram (Figure 1.1), the One Health Triad (Centers for Disease Control and Prevention, 2020), the One Health Umbrella (Lerner and Berg, 2015), and a suggested new One Health World graphic (Figure 1.2), a survey of One Health experts found strong preferences for either the Venn Diagram or the Triad (One Health Commission, 2016). However, the Venn diagram/triad images, while adequate in that they include the three domains of One Health (human health, other animal health, and environmental health), are flawed in a number of ways. While they emphasize that the area of overlap among human, animal and environmental health is the domain of One Health, they lead to troublesome

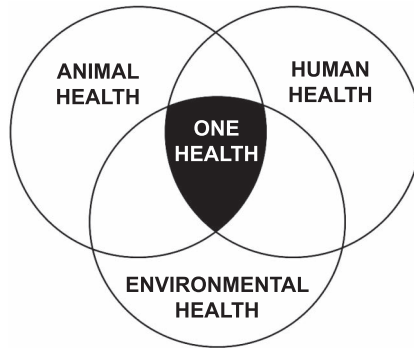


FIGURE 1.1 The One Health Venn diagram.

interpretations. The first of these is that humans and other animals are considered separate at a time when, through advances in our understanding of genetics and the neurological basis of behaviours, we humans increasingly recognize solidarity with other living beings (Rock and Degeling, 2015). The second is that humans and other animals exist independently of the environment, which, whether that environment is natural and/or built, is never true. The third is that there is equivalence among human, other animal and environmental domains with respect to the degree to which they are valued and the extent to which they are represented in One Health research and application (Barrett and Bouley, 2015), an idea of equity which should be supported but belies our overwhelming focus on human health. The fourth is that disciplinary expertise in the traditional health sciences alone, as practiced by physicians, veterinarians and environmental health professionals, is sufficient for a full understanding and application of One Health.

Extending Health and Well-being to Animals and Ecosystems – Lessons Learned and Missed Opportunities from One Health

The practical meaning of the word ‘health’ has evolved over time. Long used to refer to the absence of disease, in 1946 the World Health Organization expanded its meaning and defined health as “a state of complete physical, mental, and social well-being, and not merely the absence of disease or infirmity” (World Health Organization, 1946). This was extended in the 1970s to include disease prevention and health promotion (Etheridge, 1992; United States Public Health Service, 1979).

This broad interpretation of health is in widespread use for people today but the mental health and social well-being aspects of it have only recently been applied to other animals (Lerner and Berg, 2017) and rarely to the environment. Anthropocentrism, a view that informs our perspective of the world and our place in it, has, for centuries, led us to value human life over other forms of life (Waldau, 2002), and translated to health, and now One Health, it has favoured concern, funding, research and interventions that protect and promote human health over that of other living beings and ecosystems (Standley and Bogich,

2013). The separation of *Homo sapiens* from the rest of the natural world is a false separation that subverts the development of longer term, sustainable solutions to One Health challenges that would also benefit human health. As Rachel Carson, author of *Silent Spring* noted in an interview shortly before her death, “Man’s attitude toward nature is today critically important simply because we have now acquired a fateful power to alter and destroy nature, and his war against nature is inevitably a war against himself” (Central Broadcasting Corporation, 1963).

A corollary to our near-overwhelming concern for human health is that even now, we deny, undervalue or dismiss the mental and social well-being consequences to animals of our treatment of them. Even among many veterinarians, if an animal is not sick or injured then it is not suffering or in distress, and it “fares well,” even if it is deprived of space, environmental enrichment or opportunities for socializing with other members of its species. This is not only true for animals raised for food but also for animals kept for research and entertainment purposes, perhaps because for many of them, their lives are short and implementing changes to husbandry and housing would not translate to profits in sheer economic terms. That so much research, education and advocacy in the veterinary medical profession is subsidized by the corporate sector - agribusiness, pharmaceutical and feed companies, among others - raises inherent conflicts of interest as economics trumps a broader application of animal health and well-being (Dally, 2011; Dowers, Schoenfeld-Tacher, Hellyer, and Kogan, 2015). This influence also reinforces the idea that animals have value only insofar as they are useful to us.

Against this backdrop, however, the concordance of the human genome to that of chimpanzees (99%) and pigs (95%) suggests that we should view ourselves as slightly remodelled chimpanzee-like apes (Wildman, Uddin, Liu, Grossman, and Goodman, 2003), consider domesticated animals as closer relatives and treat our relationship with other animal species as part of a continuum across which pathogens can emerge and spread (Daszak, Cunningham, and Hyatt, 2000). Yet, it took the publication in 2012 of a text, *Zoobiquity: the Astonishing Connection between Human and Animal Health*, for many in the human medical community to recognize that the presentation of physical and mental health illnesses and conditions in animals bears striking resemblance to those same illnesses and conditions in people (Natterson-Horowitz and Bowers, 2013).

Finally, in one of the most exciting discoveries of the past few years, innovative research hints that even plants have the ability to acquire new behaviours that enhance foraging efficiency for light, form learned associations and communicate with other plants (Wong, 2020; Dicks, 2007; Gagliano, Vyazovskiy, Borbely, Grimonprez, and Depczynski, 2016). We have yet to fully explore what this means, if anything, with respect to health and well-being of plants or to broader ecosystems.

A search for the term “Environmental health” brings up the World Health Organization’s (WHO) definition of environment, as it relates to health, as “all the physical, chemical, and biological factors external to a person, and all the related factors impacting behaviors” (World Health Organization, 2020a). Environmental health consists of preventing or controlling disease, injury and disability related

to the interactions between people and their environment, but is not necessarily focused on the health of the environment itself. The environment, even in many One Health applications, is usually considered as a *context* for health issues involving humans or animals. Environmental health and “ecosystem health” are frequently used interchangeably and economic metrics are usually referred to as ecosystem services, a term that has many meanings but for public and policy audiences means “the benefits people obtain from ecosystems” (Millennium Ecosystem Assessment, 2005). Neither of these definitions fully represent what is meant by “environment” in One Health and this leads to confusion and misrepresentation because of the inherent human-centric bias. Rather than considering the three domains as separate but overlapping, in reality they constitute a hierarchical relationship or a continuum where humans are a subset of all animals, which are in turn a subset of the greater earth ecosystem. It is in this context that we should be treating the environment domain, discussing environmental or ecosystem health, and addressing environmental or ecosystem well-being and welfare.

Ecosystem health is a recognized discipline, largely based on foundational work by Costanza Norton and Haskell (1992) that strives to apply the idea of “health” to ecosystems. Considering the major impact humans have on ecosystems of all sizes, including the whole earth ecosystem, it is vital to be able to assess ecosystem health in order to assess our impact and devise more sustainable relationships with other living organisms and natural resources. There are many definitions that describe a healthy ecosystem in the literature, but most are similar to: “a healthy ecosystem...has the ability to maintain its structure (organization) and function (vigor) over time in the face of stress (resilience)” (Costanza and Mageau, 1999). Environmental or ecosystem health indicators have been developed and are continually being updated with the understanding that there cannot be a single rubric for evaluating health that applies to all ecosystems in all situations (Jorgensen, Xu, and Costanza, 2016).

Harkening back to the concept of One Health then, if we, as a matter of routine practice, apply a broad definition of health for people that includes well-being, it seems unreasonable and unjust not to apply the same interpretation to the other two dimensions of One Health, that is, other animals and the environment. This is not to ignore the fact that doing so is likely to be complicated and difficult. But in the past few decades, our growing awareness that features once thought to be unique to human beings are shared by other species should impart to us a greater sense of solidarity and concern for the physical and mental health and social well-being of other species and the planet as a whole (Rock and Degeling, 2015). Perhaps, as has been suggested, to be effective and ethical, we should reframe One Health as a common or universal good shared across species (Degeling, Lederman, and Rock, 2016).

FOCUS ON PEOPLE AND ZOOSES

As late as 2019, One Health focused largely on zoonotic disease, but a broader One Health agenda was beginning to be recognized that includes antimicrobial

resistance, food safety, health services delivery, the human animal bond, climate change, destruction and depletion of natural resources including loss of biodiversity, disaster management, chronic diseases and other health challenges that are shared by people and animals (Takashima and Day, 2014; Xie, 2017). The recent appearance of the novel coronavirus and its worldwide toll on human morbidity and mortality ensures that interest in and commitment to the prevention and control of zoonotic diseases will displace other One Health problems for years to come. But in the rush to protect people, we cannot ignore the fact that the virus likely emerged precisely because of our species' careless disregard for wildlife and wild places. Evidence points to the virus's origin in horseshoe bat populations (Hu et al., 2017) and its transmission to people via an intermediary species in wet markets in China, where captured wildlife species are crowded together in cruel and unsanitary conditions, offered for sale, bought and consumed (Carpenter and Song, 2016). Historically, our response to zoonotic diseases has been to protect or treat affected people and interdict the pathogen at its proximal source - an animal, often by culling (Degeling et al., 2016; Lederman, 2016; Newsome, van Eeden, Lazenby, and Dickman, 2017), rather than addressing ways to improve the health of animal populations or altering the human behaviours that created the opportunity for pathogen spillover to occur from one species to another (Johnson et al., 2020). A few recent publications note that we ought to take better care of animals or, at least, leave them undisturbed in their natural environments for their sake and the sake of the environment, not just for ourselves. Osofsky's 'behavioral distancing,' of people from wildlife, building on the practice of social distancing among people in the time of COVID-19, is one such example (Osofsky, 2020).

ENVIRONMENT: THE MISSING DIMENSION

Because of the overwhelming attention and amount of resources devoted to zoonotic diseases of direct significance to human health and their proximal causes - the animals that harbour and transmit them - the environmental component of One Health has usually been given limited consideration. We must also do a better job of evaluating the health of the environment in its own right and not only as a source or context for human and animal health problems. This dimension is inherently complex and addressing it in relation to health reinforces the need to move beyond a search for proximal causes of disease and the simple cause-and-effect relationship of "normal science," to adopt a systems approach to the health of people, other animals and the environment. This approach is referred to by some as a "social ecological systems" approach and further as "health in social ecological systems" (Lu et al., 2015; Zinsstag, Schelling, Waltner-Toews, and Tanner, 2011). We can learn much from the ecological community to help us better define what constitutes a healthy ecosystem. This, in turn, will permit the development of tools and metrics that allow us to reasonably assess health in the environment which is, by its dynamic nature, always a moving target. To fairly consider, the health of the environment will require defining better ecosystem health and well-being indicators (Lu et al., 2015; Prescott-Allen, 2001; Rapport,

Costanza, and McMichael, 1998) and recruiting environmental experts in the service of One Health.

RECONCILING EQUITY AND TRADE-OFFS

We uphold the idea of “equity” as a fundamental ethical standard to be applied across the three domains of One Health: the health of all three domains should be balanced for any given situation or problem. The idea of achieving “equity” across this spectrum is challenging, not least of all because animals and the environment cannot represent themselves at the table. Attempting to account for equitable treatment or consideration requires subjective and objective, if not quantifiable, metrics and patterns of argument that help to illuminate and reconcile trade-offs that inevitably have to be made.

The last element of the One Health definition – “optimal health” - deserves discussion in this context. In biology, ‘optimal’ “denote[s] a condition or a result that is favorable or best for a particular living entity.” (Biology Online Dictionary, 2020). In mathematical terms, an optimal solution is “a feasible solution where the objective function reaches its maximum (or minimum) value – for example, the most profit or the least cost,” and “A globally optimal solution is one where there are no other feasible solutions with better objective function values” (Solvers, 2020). In the case of One Health, the biological living entity is an ecosystem and ‘optimal’ refers *simultaneously* to the health of people, other animals and the environment. It follows then that the health of each of these domains – humans, other animals and the environment – cannot be maximized independently of the other two. This means that there are trade-offs to be made between and among these domains so that the health of all three may be optimized simultaneously.

As a biological and mathematical process, optimization often takes into account an individual’s or a community’s preferences for one option over another. Since only people can express in words their preferences for one option over another, we must make the best guess, using new-found understanding of our fundamental connections with other species, about what we believe other animals and even the environment would prefer. At the most basic level, however, individuals of all species seek to avoid pain and distress and mostly wish to live and not die. We can infer these choices in animals by observing their behaviours under stressful conditions and by measuring biological indicators such as oxytocin during relaxation or cortisol during stress. If we feel sufficient solidarity with animals, we may be able to project preferences upon them, although our best guesses will necessarily be imperfect. Similarly, we can project environmental preferences by striving to better assess, understand and appreciate what denotes health of an ecosystem and what factors contribute to an ecosystem’s drive towards homeostasis or dynamic equilibrium.

Trade-offs may pit short-term versus long-term benefit or harm. In the case of the environment, harm is often long-term and not within the scope of short-term goals or needs defined by a particular problem. For example, climate change and pollution are the result of an accumulation of actions that may meet short-term

needs, say of human development or agriculture, but which over time result in extreme harm to the environment that in turn affects the health and even the survival of all life. This trade-off is rarely considered when only short-term goals of a problem are assessed.

If we are to progress towards the actualization of One Health, we must also be able to measure the health of people, other animals, plant populations and ecosystems on various scales, or infer these states with some degree of certainty. But this is precisely where the most severe breakdown on the path to realizing One Health occurs.

Achieving One Health is an aspirational goal that is belied by our near overwhelming application of One Health to the health of human populations. Trade-offs that involve animals and environmental health often require acknowledging major gaps in our knowledge and understanding individual or population health status and preferences of other species, but should *not* lead to discounting or ignoring these factors.

Public health has developed objective and subjective indicators and methods to measure physical and emotional health and well-being of human populations (Centers for Disease Control and Prevention, 2018, October 31). We understand relatively less about the physical and mental health and well-being of other animals, particularly those that live in the wild, because we have directed so few resources towards surveillance and understanding of these populations. We are least able to measure the health and well-being of the environment (Vucetich and Nelson, 2013). While the most comprehensive catalogue of ecosystem health indicators can be found in the CRC manual (Jorgensen, Xu, and Costanza, 2016), and an attempt to measure ecosystem well-being has been described by Prescott-Allen (2001) and expanded upon by others, public health institutions such as the United Nations, World Health Organization and the Centers for Disease Control and Prevention have developed environmental health indicators that exist only in the context of how they impact the health of human populations. The same is true for ecosystem services, defined jointly in economic and ecological terms as “The outputs of ecosystems (whether natural, semi-natural or highly modified) that most directly affect the well-being of people...a fundamental characteristic is that they retain a connection to the underlying ecosystem functions, processes and structures that generate them” (Haines-Young and Potschin, 2013). This concept, similar to that of natural capital, is generally linear and unidirectional with respect to benefits to people. However, it does not yet adequately address situations where ecological benefits are indirect and, more importantly, when human activities are accompanied by side effects or consequences - externalities - that affect the well-being of non-human One Health stakeholders such as other animals, plants and environments. Progress in the science and application of ecosystem valuation is an important tool for assessing trade-offs but is still incomplete and must move towards a more social-ecological, integrated and non-linear process (Costanza et al., 2017). We hope that, as this science develops more fully, considerations beyond pure economic/monetary and societal benefit will be incorporated to ensure a measure of well-being of non-human components.

The complexity of ecosystems is difficult to comprehend without the benefit of mathematical models that solve problems by simultaneously accounting for multiple factors and processes, both quantitative and qualitative (Duboz et al., 2018), although models alone are insufficient towards this end. The same is true of One Health initiatives. The Network for the Evaluation of One Health (NEOH) has initiated efforts to address this complexity. NEOH's goal was to "develop standardized methodology for quantitative evaluation of One Health activities" and to apply that methodology so as to "enable future quantitative evaluations of One Health activities and to further the evidence base by developing and applying a science-based evaluation protocol in a community of experts" (Rüegg et al., 2018). Although frequently limited by a focus on the health of human populations and an emphasis on input by disciplinary experts and scientists, this effort represents the first and best attempt to date to measure the "One-Healthiness" of a One Health initiative.

Finally, assuming that we can, in specific circumstances, reach agreement on these matters, how can we even know when optimal health for all is achieved? Efforts to measure One Health will require considerably more work before what constitutes optimal health and well-being can be understood, measured, analysed and applied.

In summary, a scientific (and often economic) approach has been employed to demonstrate the benefits of a One Health approach to shared health challenges because scientific inquiry has dominated that approach and objective metrics are relatively easy to measure and understand (Roth et al., 2003; Schelling et al., 2007). However, the scientific approach without an underlying code of ethics as defined by community values means that One Health may elevate human health above all else, to the detriment of other animals, the environment, and longer term, even to human populations themselves (Lynn et al., 2019). One Health has only begun to be inclusive of contributions of community representatives who can represent community values (Duboz et al., 2018). Consequently, there have been few attempts devoted to defining the ethics of One Health (Capps et al., 2015; Coghlan and Coghlan, 2018; Degeling et al., 2015; Lederman, 2016).

In this section, we have made the case that One Health, as practiced today, has serious limitations and we have also justified the need for an ethical underpinning of One Health by pointing out that the focus on science and metrics to the exclusion of an ethical framework may be undermining our success in achieving One Health.

ENTER ONE WELFARE

As discussed above, and as it is currently practiced, One Health has been beholden to research and academic interests focused almost exclusively on prevention and control of zoonoses, their impact on human health and the proximal risk factors to people for transmission of zoonotic disease - the animals. With few exceptions, disciplinary experts who are funded or tasked with implementing One Health operate in organizations that are not set up to support true interdisciplinary

collaboration (Bunch and Waltner-Toews, 2015; Kahn et al., 2012; Ribeiro, van de Burgwal, and Regeer, 2019; Spencer et al., 2019) which, when done properly, is a thoughtful but long-term and challenging exercise that requires more than just getting a variety of disciplinary experts together (Mansilla, 2005; Mansilla, 2006; Mansilla, Duraisingh, Wolfe, and Haynes, 2009). With few exceptions, traditional “quantitative” scientists do not belong to professional networks that include social scientists who could raise important questions about the values and ethics of One Health (Lapinski, Funk, and Moccia, 2015; One Health Commission, 2020b; Wolf, 2015) and may not have the connections with community members who could impart local values to One Health plans and activities. For these reasons, quantitative disciplinary scientists rarely incorporate well-being, welfare and community values into their thinking and activities. In the absence of thoughtfully considered ethical guidelines and in spite of any well-meant intentions of One Health practitioners, efforts naturally tend to drift into familiar comfort zones that allow human health and well-being to dominate. Operationalizing One Health has moved forward without a well-defined moral or ethical framework that encompasses the well-being of all three domains, not just that of people. For this reason and others, a separate effort to incorporate an ethical framework is needed, along with a plan to integrate it with One Health (Pinillos et al., 2016).

Although the terms “well-being” and “welfare” are often cited as synonyms, the way in which they are applied to people makes clear the distinction between the two. Applied to people, the term “well-being” is defined as “the *state* of being happy, healthy, or prosperous” (Oxford University Press, 2020b). The term “welfare” on the other hand, is defined and used most often to denote a “statutory procedure or social *effort* designed to promote the basic physical and material well-being of people in need” (Oxford University Press, 2020a). Well-being is a state of being, whereas welfare is an action taken towards others, underpinned by the conviction that we have an individual moral and a societal ethical responsibility to consider the desires and needs of others.

Welfare, as applied to animals, appears to be a hybrid of the meanings of both terms. According to the American Veterinary Medical Association,

An animal is in a *good state of welfare* if (as indicated by scientific evidence) it is healthy, comfortable, well-nourished, safe, able to express innate behavior, and if it is not suffering from unpleasant states such as pain, fear, and distress.

(American Veterinary Medical Association, 2020a)

We may use animals for a variety of purposes, including companionship, food, fibre, recreation, work, education, exhibition and research conducted for the benefit of both humans and animals as long as we *provide them with good welfare*, meaning disease prevention and veterinary treatment, appropriate shelter, management, nutrition, humane handling and, when necessary, humane slaughter or euthanasia. As is abundantly clear, many if not most animals that are kept and maintained for human purposes, especially laboratory research, entertainment and food production cannot be said to have good welfare by this definition.

Nearly four decades of work has explored the concept of ecosystem health and devised tools and indicators to measure health of the environment (Costanza, Norton, and Haskell, 1992; Lu et al., 2015; Rapport, Costanza, and McMichael, 1998). In the context of ecosystem services which directly benefit human populations, it is clear that the inherent difficulty in devising metrics to measure the *well-being* of the environment has been a challenge and only rarely attempted. Some scientific publications and reports (Naiman and Dudgeon, 2011; Prescott-Allen, 2001) and essays (Tignino, 2018) have explored the ethical and legal rights of ecosystem elements such as rivers and mountains, as well as the well-being of entire national ecosystems. One such publication describes a new method of measuring both human and ecosystem well-being, and a methodology for combining the two. The Ecosystem Well-being Index (EWI) is a comprehensive measure of the quality of ecosystems, defined as their capacity to maintain themselves through cycles of growth, maturity, death and renewal; their productivity; and the chemical and physical integrity of soil, water and the atmosphere (Prescott-Allen, 2001).

In the *Well-being of Nations*, the author argues that to sustain their own well-being, people need to look after the well-being of the ecosystem: the system of land, water, air and living creatures that embraces and supports them. To that end, it becomes possible for people to adopt better ecosystem well-being as an achievable goal. Furthermore, although there are trade-offs between the needs of people and the needs of the ecosystem, they must be limited because human and ecosystem wellbeing are *equally* important (Prescott-Allen, 2001).

Less than a century ago, medical research conducted on people lacked a foundation of ethical principles. This was corrected with universal acceptance of the Nuremberg code, a set of research ethics principles that prescribe conduct for human subjects research (Moreno, Schmidt, and Joffe, 2017). Forging ahead with One Health without an ethical set of principles as “humans have overrun the world,” described by the historian Sir David Attenborough (The Guardian, 2020, January 15), risks destroying all that sustains human life and that of other species regardless of how tenuous and far-reaching is our relationship with each and every one.

In the spirit of the WHO definition of “health”, we argue that, where One Health is concerned, a broad concept of well-being should apply to all three dimensions of humans, other animals (wild and domestic) and the environment/ecosystem. One Welfare can provide the individual moral and societal ethical construct to guide One Health actions and ensure well-being as part of achieving optimal health. It could serve as a scribe for human behaviour and policy-making, based on acknowledgement and respect for our interdependence with other living beings and our mutual dependence on the planet’s natural resources.

One Welfare is an emerging concept or approach that “describes the interrelationships between animal welfare, human well-being and the physical and social environment” (Pinillos et al., 2016). It extends the idea of well-being, heretofore only applied to people, to animals, and is beginning to be addressed in scientific publications, but less so in treatises that explore the ethical underpinnings of One Health (Lysaght et al., 2017).

The need for an ethical framework is not a new idea. As Aldo Leopold envisioned, “All ethics so far evolved rest upon a single premise: that the individual is a member of a community of interdependent parts” (Leopold, 1949). Addressing the need for a land ethic decades ago Leopold noted, “Primacy of economics has undermined the notion of an ethic. A system of conservation based solely on economic self-interest is hopelessly lopsided” (Leopold, 1949). More recently, Goldberg and Patz asked, with respect to global health, “Might the recent proliferation of global health organizations in academia, government, and the private sector, tied to institutions driven by economic incentives, actually be impeding the development of a global health ethic?” (Goldberg and Patz, 2015). Until very recently, One Health has focused on quantifiable, scientific and economic metrics to the near exclusion, intended or not, of an ethical framework.

ILLUSTRATIVE EXAMPLES OF ONE HEALTH AND WELFARE CHALLENGES AND SUCCESSES

An example of a One Health challenge is the well-documented story of vultures and diclofenac on the Indian subcontinent. Populations of three Gyps vulture species declined mysteriously and rapidly, beginning in the 1990s and ending with their being classified as critically endangered in 2000. In 2004, renal failure secondary to diclofenac poisoning was identified as the cause of the decline in vulture populations. Diclofenac is an inexpensive non-steroidal anti-inflammatory agent used commonly to alleviate pain in people and animals. Out of concern for the welfare of their old, ailing cattle and bound by the Hindu practice of not killing or euthanizing cows, farmers in south Asia began applying diclofenac to alleviate the animals’ suffering until they died a natural death. In this setting, without other means of disposal, bodies of dead animals are left out in the open to be scavenged naturally by carnivores and birds of prey, including Gyps vultures which have been called ‘natural sanitary workers’. Where cattle were treated with diclofenac, vultures ingested doses of the drug that proved lethal, an unexpected and unintended consequence. As vultures disappeared, the primary role of scavenging and disposing of bodies was left to local carnivores, particularly free-roaming community dogs. With increased access to food sources in the absence of vultures, social interactions and competition among dogs increased at cattle carcass disposal sites, and the dog population exploded. In a country without effective rabies control, transmission of rabies increased among dogs, leading to a secondary increase in human rabies cases. Additional health risks, such as anthrax, brucellosis and runoff pollution from rotting carcasses have also been identified as a result of less efficient carcass disposal by dogs compared to vultures (Markandya et al., 2008).

Critical elements of this case include an initial welfare action, the catastrophic collapse of ecologically important species, the belated recognition of a critical connection between wild animals and carcass disposal, an increase in food sources supporting the expansion of dog populations, and increased transmission of rabies and other zoonotic diseases among dogs and, subsequently, to people.

The solution to this problem was to ban the veterinary use of diclofenac and offer a more expensive alternative (meloxicam) that appears to be less toxic for vultures. However, the effectiveness of this solution has been limited because of the prohibitive cost of meloxicam and the ongoing preference for diclofenac by some farmers.

The lack of appreciation for different cultural practices, the need for a better understanding of the ecological dynamics of carcass disposal, and variable concern for a wild animal species illustrate the need for an integrated One Health One Welfare approach to future such challenges. Twenty years later, the vulture population is slowly recovering because of intense efforts at captive breeding and release, the creation of drug-free vulture feeding sites, and widespread educational efforts (Bindra, 2018; Green et al., 2004; Markandya et al., 2008; Oaks et al., 2004).

A second example of a One Health challenge is the common use of culling to kill animal populations for a variety of reasons and in a number of venues. Culling campaigns in the interest of human health have targeted free-roaming dogs to control rabies (Morters et al., 2013), badgers to control spread of bovine tuberculosis (Lederman, 2016), and poultry in backyard flocks and intensive production facilities to control avian influenza (Scoones and Forster, 2008). Culling campaigns in the interest of livestock production have targeted cows and sheep to stem transmission of foot-and-mouth disease (Haydon, Kao, and Kitching, 2004) and pigs to stem transmission of African Swine Fever (Wang, Sun, and Qiu, 2018b). Widespread culling of free-roaming cats in Australia aims to eliminate an alleged threat to biodiversity (Aguirre, 2019).

In nearly all instances, the anticipated impact of culling on individual or aggregated human interests - health, livelihoods, livestock production and concerns for biodiversity - was elevated over interests of the animals and the environment. Where research into the outcomes of these campaigns was conducted, culling was determined to be ineffective, often counterproductive and not cost-effective (Lederman, 2016; Morters et al., 2013; Newsome et al., 2017). Furthermore, culling is typically met with strong and vocal opposition where it is viewed as being at odds with community values.

While the initial impulse to kill a pathogen's messenger – the animals – may be immediately satisfying, and culling may work in the short term, it raises difficult ethical issues and does little to arrest or control pathogen dynamics in the environment. More effective methods of control may be to address distal, structural factors that contribute upstream to a pathogen's emergence and maintenance in the environment (Wallace et al., 2015). As an example, some conservationists have advocated eliminating free-roaming cats from the environment *by any means necessary* (Marra and Santella, 2016) in the interests of biodiversity and survival of endangered wildlife species. This call has been met with intense resistance from community members and animal welfare advocates. Other structural methods to address the presence of free-roaming cats in the landscape are advocated by the National Association of Public Health Veterinarians, and these include educating cat owners to keep their pets indoors, strengthening community

commitments to trap-neuter-[vaccinate]-release programmes, and advocating for greater public support for animal shelters (Lynn et al., 2019). Although these solutions are more complicated and likely involve a greater overall expenditure of public and private funds, they are likely in the end to yield better results and be met with greater acceptance.

Examples of One Health initiatives that simultaneously address the health of people, other animals and the environment do exist. The ethical foundations of these programmes are generally implied by their organization's mission statements. One example of the thoughtful scientific, economic and ethical application of One Health is Conservation through Public Health (Conservation through Public Health, 2019) founded by veterinarian Dr. Gladys Kalema-Zikusoka in Uganda. Out of concern for the survival of endangered mountain gorillas, CTPH promotes biodiversity conservation by supporting the coexistence of people, gorillas and livestock in and around Africa's protected areas. Recognizing that survival of this species was linked to the survival of poor local communities whose behaviours encroached upon the animals' habitats, competed with them for food, and served as points of origin and destination for diseases transmissible among human, wildlife and livestock species, CTPH organized Village Health and Conservation Teams (VHCTs) under the Ugandan Ministry of Health. VHCTs promote health, conservation and community livelihoods by delivering integrated community-based public health services that promote good health-seeking behaviour, hygiene practices, infectious disease prevention and control, family planning, nutrition, and conservation education to individual households. VHCT networks are sustained through group income-generating projects, which are reinvested into Village Saving and Loan Associations that have a special focus on women as the primary influencers of household health.

Another example of a conservation, community and health-centred programme is Health in Harmony (HIH), founded by physician Dr. Kinari Webb (Health in Harmony, 2020). HIH supports communities that abut forest ecosystems in Borneo and Madagascar that are threatened by agricultural practices and extractive industries such as logging. The programme offers incentives to protect the forest and seeks alternative livelihoods and behaviours that lead to economic stability and more sustainable and healthy lifestyles. HIH has paired access to highly valued health care with rewards for forest conservation. For example, people accrue "green credits" if they reduce illegal logging in their communities and these in turn can be used for healthcare discounts at local medical clinics. People are also allowed to pay for services with sustainable non-monetary commodities such as seedlings, manure or handicrafts. Farmers have been provided with training in efficient and eco-friendly organic farming methods that have increased their crop production without requiring more land clearing or the use of chemical fertilizers. Other programmes help to support and bring dignity to marginalized members of the community, such as a Goats for Widows program, provide a source of income, nutrition, animal care and contact for widows who would not otherwise have a means of support. Programme recipients donate goat kids back to support other widows, thereby making this programme self-sustaining. HIH's

programmes utilize “radical listening” to ensure that activities and training are focused directly on community needs, thereby utilizing local knowledge and cultural practices.

COVID-19 AND A GLOBAL PANDEMIC OF OUR OWN MAKING

The need for One Health and Welfare is no better illustrated than through the example of our current COVID-19 pandemic. At the time of writing this chapter, the facts surrounding its emergence and global impact are not yet completely understood, however, the story is not a new one and its lessons are clear. The spillover and likely mutation of this terrible virus, from an innocent wild species to one capable of causing a lethal human pandemic, was an inevitable event and long predicted by many scientists studying recent emerging diseases (Afelt, Frutos, and Devaux, 2018; Allen et al., 2017; Jones et al., 2008; Ross, Olveda, and Yuesheng, 2014; Wolfe, Daszak, Kilpatrick, and Burke, 2005). Despite these warnings, society has been unwilling or incapable of changing critical human activities that underlie the threat, or devoting sufficient resources to fully understand and prevent it. Now we are paying a price.

It has been shown that the links between “exploitation, as well as anthropogenic activities that have caused losses in wildlife habitat quality, have increased opportunities for animal–human interactions and facilitated zoonotic disease transmission” (Johnson et al., 2020). Previous emerging disease events, arguably less lethal but no less preventable, have demonstrated how this happens and the roles that human activity played: HIV emerging from apes and producing the global AIDS epidemic, 38 million people living with HIV in 2020, and 690,000 deaths from AIDS in 2010, decreased from 1.7 million in 2004 (UNAIDS, 2020); H5N1 avian influenza emerging in intensive poultry markets in China, 445 deaths since 2003 (World Health Organization, 2020b); SARS-CoV emerging from a wet market in China with mixed live wildlife species, 775 deaths (Wang et al., 2006); Nipah virus emerging from bats through pigs to humans in Malaysia, Bangladesh and India, 373 deaths (Chattu, Kumar, Kumary, Kajal, and David, 2018); Ebola virus emerging from bats, through apes to humans, 13,308 deaths since 1976 (Centers for Disease Control and Prevention, 2019); MERS-CoV, another coronavirus originating in bats and jumping through camels to humans, 858 deaths (World Health Organization, 2020c). All of these emerging diseases originating in wildlife evolved to spread rapidly from human to human and arose in contexts where humans encroached on or manipulated natural environments. The impact of these pathogens was amplified by human travel and modern lifestyles, and all have threatened to become the event we see today.

Based on genetic analysis, it is currently believed that the COVID-19 virus, technically named SARS-CoV-2, originated naturally in bats (horseshoe bats, *Rhinolophus affinis*) and was either passed directly to humans or through other animals to humans in a heavily human-dominated situation. While the exact conditions for emergence may never be known, two possible scenarios are that it jumped in a rural village setting – perhaps several times – as communities cleared

land, built farms and came in repeated contact with bats (Li et al., 2020; Wang et al., 2018a), or that it jumped from bats to another wild species such as pangolins (*Manis javanica*), a species that is traded illegally in China and crowded in captivity in close, unsanitary quarters for the purpose of sale (Andersen, Rambaut, Lipkin, Holmes, and Garry, 2020). The latter scenario is similar to the way SARS-CoV emerged nearly 20 years ago.

Both scenarios raise serious animal welfare issues. Unfettered human development and demands for housing, food and livelihoods lead to unprecedented environmental destruction and bring people and wildlife into unusually close levels of contact. It also induces stress in the animals, either because it disrupts their survival and species sustainability through habitat disruption, creates novel situations that expose them to diseases of people and domestic animals, or because they are trapped, traded, transported (often great distances in unimaginable conditions), sold and slaughtered. Some highly prized species have been traded so extensively that they are on the brink of extinction (pangolin, elephant, tiger and others (Traffic, 2020)). There is no worse example of bad welfare or lack of ethics than that seen in the practice of illegal wildlife trade. In fact, many animals handled in this way die in the process and never make it to markets where profit is generated (Baker et al., 2013; Goodall, 2020; Rosen and Smith, 2010). This is unacceptable under any circumstances and for any reasons.

In spite of the warning shot delivered by the well-documented first SARS-CoV emergence (Wang et al., 2006), nearly the very same scenario has played out yet again, producing SARS-CoV-2 and a rapidly developing global pandemic. This tragedy has been fed by human behaviours that devalue wildlife and other people, particularly those who are poor and powerless, as well as by our collective lack of readiness. Eminent scientists and humanitarians have made it clear that human societies themselves are endangered because of our careless exploitation of the natural environment (Goodall, 2020; Johnson et al., 2020; Kwong, 2020; Quammen, 2020; Vidal, 2020; Watts, 2020).

Allowing human greed and development to proceed unfettered and at the expense of other life on earth has instead increased the risk to our own health and threatens the sustainability of human populations. We have yet to fully experience the full impact of this disaster. We need One Health and One Welfare now more than ever.

ONE HEALTH AND ONE WELFARE AS PARTNERS

How can the One Health movement and the One Welfare movement support each other going forward? We have argued that One Health needs a robust ethical framework and its current stakeholders may not be well positioned to create such a framework. The One Welfare movement acknowledges that health is a significant component of good welfare and good/optimal health that includes well-being as a shared goal. Both concepts share a broad perspective that includes people, animals (domestic and wild) and the global environment and recognizes the essential

interconnectedness among these domains. While there are some differences in focus and emphasis, we believe that neither One Health nor One Welfare should be subsumed by the other and that a lateral collaborative relationship would best serve both enterprises in these early stages. With sufficient foundational support, a merged “One Health and Welfare” concept should be possible in the future. The suggestions that follow might help this process move forward and result in a more equitable and sustainable One Health world.

Initially, an international conference involving a diverse group of One Health and One Welfare stakeholders could launch a dynamic and ongoing relationship focused on identifying overlapping interests and drafting ethical guidelines for One Health practice. Involving experts with broad backgrounds in ethics would help to create balance, identify common ground and draft a pathway to developing a *One Health Code of Ethics*. We suggest using the model of the process that led to the development of the Nuremberg Code as a starting point. After an initial gathering and securing commitments by participants to goals and objectives, working groups comprising a broad range of stakeholders, including the public, could be established to draft a strategic plan that includes benchmarks similar to the United Nations’ Sustainable Development Goals (United Nations, 2020). It might also offer incentives to the One Health and One Welfare communities that would serve to guide ethical human behaviours. The One Health Code of Ethics would be a “living” document with a mechanism for review and adjustment over time as it is applied, tested and reviewed in One Health programmes and in real time. This kind of high-profile meeting could be repeated at regular intervals.

We also suggest that one or more networks, similar to those that were created for One Health in Southeast Asia (SEAOHUN, 2011) and Africa (AFROHUN, 2020), but more inclusive of social scientists and community stakeholders, be created. These would make a broad range of social scientists available to work on existing or proposed One Health activities, thereby providing cultural, ethical and well-being/welfare input. This effort should be extended to public and private sector organizations and entities with significant One Health activities. It would bring welfare issues into focus in agencies that may never have considered them previously, raising the level of awareness and understanding of the need to consider welfare and well-being across the three domains of One Health.

A major theme of the One Health Commission is extending an ethic of respect for all living things through broad educational initiatives aimed at transforming public attitudes about humans’ relationship with the natural world (One Health Commission, 2020a). Education needs to happen at all levels, especially among younger children where formative attitudes towards nature are developed that last a lifetime. One Health education promotes attitudes and behaviours that extend beyond typical public health themes of washing hands and eating right. Newly developed curricula incorporate concepts of interdependence and complexity, emphasize responsibility for personal and societal impacts on people and other living things, and reinforce positive human values of stewardship, respect,

empathy and humility. This is encouraged through early hands-on environmental experiences, curriculum enhancements to existing programming and themes that focus on the most urgent issues such as climate change, water and air pollution, plastic pollution, habitat destruction, depletion of natural resources and loss of biodiversity. All of these initiatives could and should include elements of welfare and well-being. A One Health and One Welfare education working group could help to ensure that welfare ethics are being taught alongside existing and new One Health educational programming from K-12 through higher education, and build a stronger value-driven ethic for sustainability (One Health Commission, 2020a).

Educational efforts also need to include community-level engagement so that formal educational initiatives find an outlet to transform attitudes in families and communities for maximal impact. Ethical arguments can be very powerful in this context as outreach programmes influence social media and networks, utilize peer pressure and support local-based activities that raise the profile of One Health among members of the general public. The best example of this is the remarkable, global impact a single Swedish teenager and environmental activist, Greta Thunberg, has had on promoting the view that humanity is facing an existential crisis arising from climate change.

Complementing One Health activities with One Welfare perspectives may also lead to greater funding successes and help establish equity more securely among the three domains of One Health. Applying an ethical framework in combination with traditional cause-and-effect models could attract new funding partners that are likewise interested in welfare and well-being. At the same time, it could enlighten traditional funders of the need to embrace broader problem-solving approaches (post-normal science) and more inclusive and equitable rubrics that ensure balanced consideration for all three One Health domains.

Finally, as we consider new ethical frameworks and broader audiences for One Health and One Welfare, it seems like a good time to revise the visual representation of One Health and make its use universal. As discussed above, existing graphical representations of One Health, while useful as the movement has evolved within academic circles, are in need of reimagining so that they reflect more accurately the true relationships among constituents of the three One Health domains. A novel visualization of One Health, as pictured below, places humans in a more dependent and humble position with respect to the rest of the planet. We suggest that the concept and practice of One Health must arise from this understanding of our relationship with the planet.

A more accurate representation of One Health that sets humans squarely within the animal kingdom and both within the environment (Figure 1.2) helps us to rethink our relationships with both. It also leads us to consider different approaches to research on One Health, which have been dominated by epidemiological studies of the impact on people of diseases transmitted from other animals, often without reference to the environment, and to recognize that the environment not only contributes to our health but is eminently worthy of consideration in its own right. Our survival, and that of other living species, depends on it.



FIGURE 1.2 The One Health World. (Art Credit Amy Kaufman, 2020. Copyright of Joann M. Lindenmayer and Gretchen E. Kaufman.)

CONCLUSIONS

One Health together with One Welfare provides us opportunities to extend Schweitzer's Reverence for Life (Schweitzer, 1936) beyond humans and other animals to the environment, incorporate new knowledge and understanding of health and well-being across the spectrum of life on earth, reassess our impact on health in the earth's ecosystems and give us novel tools to better protect and sustainably support good health and well-being in the broadest sense as we move forward in time.

ONE HEALTH AND ONE WELFARE STRUCTURED ACADEMIC CONTROVERSY MODEL AND A ONE WELFARE APPROACH

Apply the questions below to one of the following scenarios:

1. The origin and evolution of the COVID-19 pandemic;
2. The wildfire disasters on the West Coast of the USA, Australia or the Amazon;
3. Consider a more locally relevant scenario in your area (e.g. earthquake, flood, disease emergency).

BACKGROUND INFORMATION FOR STUDENTS

This Chapter

Animal Well-Being

1. Identify nonhuman animals, domestic and wild, which are likely to be impacted by the scenario.
2. Identify potential health, welfare and well-being impacts of the event on each of these species.
3. What stakeholder groups should be involved in developing potential actions/responses?
4. Propose potential actions/responses that could be considered in order to minimize the impact on health and well-being of these species.
5. What ethical principles underlie your potential actions/responses?

Environmental Well-Being

1. Identify key environmental components (renewable and non-renewable) that are likely to be impacted by the scenario (consider micro and macro-levels, including global levels where appropriate).
2. Identify potential environmental well-being impacts of the event on each of these components.
3. Propose potential actions/responses that could be considered in order to minimize the impact on environmental well-being of these components.
4. What stakeholder groups should be involved in developing potential actions/responses?
5. What ethical principles underlie your potential actions/responses?

Human Well-Being

1. Identify social, ethnic, racial, economic, cultural and/or religious groups that are likely to be impacted by the scenario.
2. Identify potential welfare and well-being impacts of the event on these groups.
3. What stakeholder groups should be involved in developing potential actions/responses?
4. Propose potential actions/responses that could be considered in order to minimize the impact on health and well-being of these groups.
5. What ethical principles underlie your potential actions/responses?

Synthesis

1. Consider how you might use an interdisciplinary process to *integrate* various actions/responses that you've listed above for the three domains.
2. List various trade-offs that might have to be made, how you might assign value and how you would resolve them.

3. Suggest a set of actions that would optimize One Health and One Welfare of the three domains collectively.
4. Identify a set of ethical principles to guide implementation of your recommended actions.

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2 Sustainability

The Role of Veterinarians in Aligning Animal, Human and Environmental Well-Being

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INTRODUCTION

Our planet is currently facing a growing number of interconnected challenges (World Economic Forum 2020), and as such, radical changes are needed in order to move towards a sustainable state for ourselves, our domestic animals, our wild-life and our planet. We are in a position to channel our professional strengths, and influence in areas which go beyond veterinarians simply being ‘guardians of animal welfare’. There is a need for us to engage as citizens, so that we make informed decisions ourselves and bring others with us. The veterinary profession is trusted by the public (RCVS 2019) – more so than many professions, and it is incumbent upon us to utilise that trust for the greater good of all.

Vet Sustain was established in October 2019 by a group of veterinary professionals, to use our voice to leverage change towards a more sustainable future. Our mission is to enable and inspire veterinary professionals to work to secure the well-being of animals, people and the natural world, and to act as drivers of change where possible. Our mission is underpinned by six interconnected goals (Table 2.1), each of which are linked to several of the 17 United Nation’s Sustainable Development Goals (UNSDGs) (UN 2020). The UNSDGs support a blueprint for human and planetary peace and prosperity.

As a group, Vet Sustain instigated a petition to call on the profession to recognise a Climate Emergency (<https://www.vetsustain.org/vets-declare-emergency>). In addition, Vet Sustain has created working groups covering areas such as the development of toolkits for veterinary practices; food and farming; and incorporating sustainability within veterinary school curricula.

Defining what sustainability looks like is challenging, and perhaps, in the first instance, it is simpler to define what sustainability is not. As examples, sustainability is not: supporting food production systems that degrade land and seas, compromise both human and animal health and welfare, lead to biodiversity loss, and rely on artificial inputs; utilising veterinary medicines without regard for

TABLE 2.1
The Six Veterinary Sustainability Goals, as Defined by Vet Sustain 2020, with Corresponding Associated UN Sustainable Development Goals (UN 2020)

Vet Sustain Goal Number	Description	Associated United Nations Sustainability Development Goals
1	Diverse and abundant wildlife	2,14,15,17
2	A good life for animals	2,3,14,15,16,17
3	Net zero warming	1,7,8,11,13,14,15,17
4	Health and happiness	1,2,3,4,5,8,10,11,12,16,17
5	A no-waste society	9,12,17
6	Enough clean water for all	6,14,15,17

human, and environmental impact; breeding animals for traits that are incompatible with optimal health and welfare; or practising veterinary medicine with little regard for our own planetary footprint.

The chapter is written through a One Welfare lens (García Pinillos et al. 2016) – integrating the health and welfare of animals, humans and the wider environment, building on and complementing now well-established principles of a One Health approach (WHO 2017). A One Welfare approach highlights the importance of animal, human and environmental *well-being*, reinforcing that health and welfare (good or poor) are not separate entities.

One Welfare outcomes can be achieved through actions that show ‘respect for all living things’. To do this requires a ‘systems thinking approach’, a holistic perspective, and a broadening of scope, such that it is the optimal functionality of the system, rather than that of the individual components within it, that leads to positive outcomes for humans, animals and the environment.

In this chapter, we review two key areas: food systems in the broadest sense, and our varied work as veterinary professionals, exploring how our voice can educate, inform and actually drive movement towards achieving these interconnected goals.

A third section ‘What Should I Feed My Pet? Student Learning Exercise’ comprises a Structured Academic Controversy Model to assist with student learning, using the question ‘What should I feed my pet?’ as an exercise that can be undertaken with a One Welfare approach. Utilising the model, small groups of students address a complex problem through guided research, consideration and presentation of alternative perspectives, and engage in shared decision-making.

SUSTAINABLE FOOD SYSTEMS

CONTEXT

Veterinarians have an undisputed duty-of-care for the health and welfare of all animals in agriculture and aquaculture. Veterinarians in most countries

swear an oath (often mandatory), on completion of their studies. Oaths vary in length, content and scope, but not surprisingly, animal welfare is a core element (Bones and Yeates 2012). In the UK veterinarians swear their oath on admission to the Royal College of Veterinary Surgeons as follows (RCVS 2012):

I promise and solemnly declare that I will pursue the work of my profession with integrity and accept my responsibilities to the public, my clients, the profession and the Royal College of Veterinary Surgeons, and that, ABOVE ALL, my constant endeavour will be to ensure the health and welfare of animals committed to my care.

On a wider scale, veterinarians, as citizens and trusted professionals (RCVS 2019), have a role to play in advancing greater understanding of how food systems impact human, animal and environmental health, and applying that understanding to improve food production practices, and drive better decision-making by ourselves and indeed all consumers. Veterinarians have, for example, a duty to champion animal welfare more broadly across society – beyond the bounds of animals under their direct care – and to challenge activities that compromise animal welfare (BVA and RCVS 2015, AVMA-CVMA-FVE 2020). Interestingly, the Canadian veterinary oath (non-mandatory) includes concerns for human and environmental health in addition to animal health and welfare, as follows (CVMA 2018):

As a member of the veterinary medical profession, I solemnly swear that I will use my scientific knowledge and skills for the benefit of society. I will strive to promote animal health and welfare, prevent and relieve animal suffering, protect the health of the public and the environment, and advance comparative medical knowledge. I will perform my professional duties conscientiously, with dignity, and in keeping with the principles of veterinary medical ethics. I will strive continuously to improve my professional knowledge and competence and to maintain the highest professional and ethical standards for myself and the profession.

Reviewing our veterinary role in promoting optimal animal welfare in food-production systems contributes to achieving ‘A Good Life for Animals’, our Veterinary Sustainability Goal 2 (Table 2.1). Additionally, exploring what best practice food systems might look like, and why they are important in terms of humans and the environment contributes to Veterinary Sustainability Goals 1,3,4,5 and 6 (Table 2.1), thus illustrating the enormity of the influence our food systems have on all aspects of sustainability.

ANIMAL WELFARE IN FOOD PRODUCTION SYSTEMS

The Challenge

Globally, numbers of both terrestrial and aquatic animals reared for food production have increased rapidly since the 1950s, in line with an increasing human population and increased animal protein consumption per capita at a global level (Mateo-Sagasta and Turrall 2018).

Our significant challenge as veterinarians in this production animal arena is to safeguard the welfare of these animals, which play an important role in feeding the human population, and to do so in a way which protects and enhances the environment. The second Veterinary Sustainability Goal (Table 2.1) is 'A Good Life for Animals'. To assist us in achieving this, we suggest using a relatively simple framework focussed on two key goals: 'keeping animals healthy' and 'giving them what they want' (Dawkins 2017). Such an approach avoids the need to endlessly debate the relative degrees of consciousness in different animal species, but is of course potentially constrained by the limits of our understanding of what animals want. The Good Life framework promotes opportunities for positive welfare outcomes, such as comfort, pleasure, interest and confidence, alongside excellent health outcomes (FAWC 2009). We recognise that safeguarding welfare will not be possible without a multi-disciplinary approach engaging with academic and applied researchers, producers, customers and consumers alike. As veterinarians, we are inherently well-placed to assist with bridging between these stakeholders, but it is incumbent upon us to strive to do so more effectively.

Within any production system, there is potential for compromised animal health and welfare in association with many inter-related factors, such as infectious and non-infectious disease, behavioural restriction, mutilations, transportation and slaughter. In this section, we select several examples to illustrate animal welfare accomplishments that veterinarians have contributed to historically, in addition to challenges that lie ahead.

Infectious Disease

There are some good examples of disease challenges where a relatively one-dimensional approach with veterinary involvement can be successful, such as: vaccination against both clostridial disease and leptospirosis in cattle (Scott 2010a, b); a combination of vaccination with 'test and remove' to eradicate brucellosis (Zhang et al. 2018); and genetic selection against infectious pancreatic necrosis (IPN) virus in farmed salmon (Guy et al. 2009).

Many endemic and often intractable disease-related problems will however require integrated thinking and multi-disciplinary approaches, requiring us to engage more proactively with those stakeholders involved in animal-based research and animal production systems. Example strategies might include more health-orientated genetic selection, optimal nutrition and immune support to build the 'resilience' of a population, whilst simultaneously considering surveillance, biosecurity, optimised husbandry and the judicious use of treatments to control disease challenge. As veterinarians, with our broad knowledge of all these elements, and our trusted relationships with both the scientific and farming communities, we are well positioned to drive the development and implementation of such approaches.

An example where a multi-faceted programme has achieved success is the international trans-border collaboration in surveillance and vaccination, to tackle Rinderpest in ruminants across 170 countries, resulting in the global eradication of the disease in 2011, saving countless animals and their associated human

livelihoods (Morens et al. 2011). Secondly, in the UK, a coordinated programme involving veterinarians, farmers and the pharmaceutical industry to control foot-rot in sheep entitled the '5 Point Plan' has seen the industry align around a practical approach which is helping producers gain control of this endemic disease and move from an estimated prevalence of 10% in 2004, towards a suggested target of <2% lameness by 2021 (FAWC 2011).

Genetic selection has long been used in production animals to drive productivity, but more recently the focus has rightly shifted towards more balanced health as well as productivity traits. In dairy cattle, genetic selection increased milk yields rapidly until the 1970s, but more recent genetic focus has turned to encompass traits for health, longevity, fertility, and calving ease (Miglior et al. 2017). This shift was driven in part by animal welfare concerns, as high levels of metabolic disease and endemic health problems such as lameness, together with reduced longevity, created challenges for the dairy industry. The focus for the future lies with further addressing the balance of available health and welfare traits together with a strong focus on environmental sustainability.

In farmed salmon production, a similar but more recent focus on balanced health and productivity traits has emerged as producers can now choose to buy salmon eggs which have an increased genetic resistance against several viral diseases including (IPN), pancreas disease (PD), cardiomyopathy syndrome (CMS), and the disease syndrome caused by parasitic sea lice (Houston and Macqueen 2019).

Looking to the future, it is a matter of duty that veterinarians challenge 'positions of acceptance' of certain infectious and non-infectious endemic diseases where these exist, in all our varied roles as clinical practitioners, researchers, policy advisers and consultants to the wider food industry as examples. It is of note that the increasing awareness of antimicrobial resistance (AMR) as a threat to human health (O'Neill 2016) has highlighted the use, misuse and overuse of antibiotics in some food-production systems (in 'Veterinarians in Practice' we discuss in more depth our role as custodians of veterinary medicines). Addressing AMR, together with the increase in parasiticide resistance in food-production animals (Sangster 2001), presents an opportunity for veterinarians to work more closely with producers and other stakeholders to examine food animal production systems, and move towards more preventative and holistic strategies, minimising the necessity for antimicrobial or parasiticide use without compromising animal welfare.

Behavioural Restriction

Some farming systems have intrinsically led to welfare challenges associated with restriction of an animal's ability to perform natural and often high-motivation behaviours, specific to their species.

Examples of such behavioural restriction have been observed with sow stalls and farrowing crates, veal crates, high stocking densities in laying hen cages and inadequate environmental enrichment. In response to these issues, there has been

progress, which veterinary voices have contributed to, working alongside animal welfare scientists and NGOs.

In the EU, a lengthy phasing out of sow stalls to group housed systems has led to improved welfare. Where this has extended to include the farrowing period, this has enabled important mothering behaviour (SRUC 2014). In laying hens, widespread replacement of traditional cages with more free range or barn systems has improved both movement opportunities, and the ability to perform high-motivation behaviours such as foraging and dust bathing (Weeks and Nicol 2006). In 2006, a ban on the use of traditional veal crates across the EU improved the welfare of many calves allowing them to move around and interact more normally (McKenna 2011). Despite these improvements, however, many global challenges remain.

Mutilations

Mutilations, such as castration of male animals, tail docking of lambs and pigs, beak-trimming of laying hens, and disbudding and de-horning of cattle, present an additional welfare challenge in production systems. Mutilations may be carried out for several reasons: castration for the avoidance of unwanted breeding, or for safer handling; tail docking in sheep to help control fly strike, and in pigs to control tail biting; beak-trimming to control feather-pecking in laying hens; and de-horning cattle for handling safety.

In our trusted role as veterinarians, it is vital that we engage widely across disciplines in two main areas: to advise how and why mutilations can be avoided in the first instance; and secondly to ensure that appropriate anaesthesia and/or analgesia is deployed if mutilations are deemed necessary.

Avoidance of mutilations negates the need for potentially painful or uncomfortable interventions, but in addition, by addressing underlying causal factors that lead to mutilations being deemed necessary, significant animal health and welfare benefits can accrue. For example, a lack of environmental enrichment is considered one of the most important underlying causal factors of tail biting in pigs. Through the provision of effective ingestible, chewable and destructible enrichment, tail docking should not be considered necessary, and psychological well-being of pigs will also be improved (Temple et al. 2014).

As an example of engagement activities, the British Veterinary Association (BVA), in its policy position Statement on Sustainable Animal Agriculture, advises that veterinarians take the following approach:

- A '3Rs' (Replacement, Reduction and Refinement) approach, when advising on mutilations, aiming to prevent the need for procedures and using modern analgesia protocols when the procedures are absolutely necessary (BVA 2019a).

Many animals globally are, however, still exposed to sub-optimal practices and much more focus is needed to further break down barriers to change, and address underlying reasons for ongoing practices.

Transport

Transportation of livestock is an intrinsic part of the food production system, and species-specific approaches are required in order to minimise negative welfare effects (EFSA 2011). Successful implementation of optimal practices (addressing transport infrastructure, journey times and staff training as examples) that minimise negative welfare impacts during transit is extremely challenging at a global scale, with levels of regulation, and legal powers of veterinarians varying widely. It is important, however, that veterinarians remain central to ensuring animal welfare during transit, through advocacy, training, monitoring and enacting legal powers where possible (FVE 2008, BVA 2019b).

Slaughter

No discussion on the welfare of farmed livestock would be complete without addressing humane slaughter. Linking to the issue of transport, the BVA recommend that “wherever possible, and paying due regard to scientific evidence regarding the relationship between journey times and welfare outcomes, animals to be slaughtered for food should be slaughtered as close to the point of production as possible” (BVA 2019b). In terms of the slaughter process itself, much work has been done by individuals such as the American animal scientist Temple Grandin who pioneered the design of improved cattle handling systems in abattoirs, and did much to raise awareness of the importance of calm, and species-appropriate handling of animals both on farm and importantly at abattoirs (Grandin 2003). At a global scale, welfare at slaughter will vary widely, and methods will be influenced by socio-cultural elements, but this should not prevent us using our veterinary voice in advising and educating the public. Indeed, Welfare at Slaughter is identified as a UK Priority Animal Welfare issue (BVA 2016), based on the BVA Animal Welfare Strategy.

HUMAN AND PLANETARY WELFARE IN ASSOCIATION WITH FOOD PRODUCTION SYSTEMS

The Challenge

From a planetary perspective, large elements of our current food systems are arguably unsustainable, with biodiversity losses, deforestation, water scarcity, soil degradation, malnutrition, poverty and poor human health all contributing to an unprecedented impending crisis (FAO 2014, IPBES 2019).

We, as veterinary professionals, can act to influence discussions about how we produce, harvest and distribute food. We can educate ourselves and others about alternative techniques that reverse, halt or at least slow the degeneration of land, seas and ecosystems, about production methods that care for humans involved in those systems, and about production methods that enhance the nutritional value of our food.

One approach to taking better care of our land is the ‘land-sparing’ concept, in which we leave designated areas untouched, allowing recovery. However, it

is becoming apparent that this approach alone is insufficient to halt or reverse marine or terrestrial biodiversity losses – likely due to a host of factors such as: lack of connectivity between protected areas; areas being too small; budget constraints; and lack of enforcement (Mora and Sale 2011). Consequentially, where land is used for food production, there is an ever-increasing need to co-exist harmoniously with the natural world through a land-sharing approach. This is an area in which we, as veterinarians with trusted relationships with farming communities and the public, can play a positive role.

Such co-existence requires a rethink of how we position ourselves in our ecosystem and how potential human-wildlife conflicts have to be addressed. Such conflicts include predation of livestock; crop damage; and feed consumption and spoilage. It is apparent that human-wildlife conflicts are rarely considered in the literature base surrounding land-sharing and land-sparing, perhaps because a truly inter-disciplinary approach is required to tackle what is an inherently challenging subject area (Crespin and Simonetti 2019). In their review, the authors suggest using Conflict Transformation, a technique that views disputes and problems as opportunities to bring about social change, creating problem-solving dynamics. This is achieved by applying a systemic approach, moving from an antagonistic mentality to a collaborative ‘one-team’ mentality. It is striking that this is very much in line with a One Welfare approach, in which true sustainability cannot be achieved unless human, animal and environmental well-being are assured. Notably, it is not the individual techniques to address the conflicts that are key here, rather it is the mindset of the humans in the system that brings about reconciliation.

Human Health Impacts of Food-Production Systems

Our food systems influence human health directly and indirectly in a number of ways: the mental and physical health of those involved in food production from farms right through to end-product consumption; the cultural roles food systems play in respective societies; the nutritional value of the food consumed by us; and the risk of zoonotic disease transmission.

From a mental health perspective, a recent systematic review paper (Yazd et al. 2019) reported on several factors that likely affect farmer mental health, including pesticide exposure, concerns over climate instability, physical health and safety concerns, social isolation, and financial worries. At the Ethical Farming Conference in Scotland in 2019, dairy herdsmen spoke out about their experiences of mental health being negatively impacted by working in an intensive dairy production system, in contrast to the positive effects they experienced in a dairy cow-with-calf, lower intensity production system (Ellet and Davies 2019).

Culturally, it is important to be aware that food production plays a strong societal role (FAO 2019) – and any changes to systems will have societal impacts. The ‘campesino a campesino’ movement in Latin America connects hundreds of thousands of small-scale producers, sharing knowledge and practices around regenerative production. This approach recognises and indeed champions the

importance of the social and cultural settings in which food production is embedded (Holt-Giménez 2002).

From a nutritional perspective, malnutrition, which includes both insufficient calories and unhealthy unbalanced diets, alone or in combination, is one of the greatest challenges facing humanity (FAO and WHO 2018). Unpicking this subject in depth is an enormous task and falls largely beyond the remit of this chapter, the purpose of which is to explore the role of veterinarians. It is important to realise, however, that much of this malnutrition is related to our food systems in their entirety, and it therefore makes sense for us to examine those systems more critically and more fully through a One Welfare lens.

Finally, no discussion on human health and food systems would be complete without reference to zoonotic disease, arising from poor food safety and livestock and/or wildlife transmission. History is littered with examples of zoonotic disease transmission from our livestock, and as our production systems have intensified and our encroachment into wildlife habitats has increased, more opportunities for cross-species transmission exist. Examples include influenza viruses, such as H5N1, coronaviruses, such as Sars, Nipah and Hendra viruses (Kingsley 2016). The most recent example is of course, the coronavirus causing Covid-19, which probably originated in wild bats. Human transmission most likely arose through an intermediate wildlife host species, as a consequence of the mixing of many captive wildlife species destined for human consumption and sold in live animal markets (Li et al. 2020).

Environmental Impacts of Food-Production Systems

Terrestrial agriculture uses roughly 38% of the world's surface (UNCCD 2017). In addition, fish products from our marine environment are a major source of the world's protein (GRID-Arendal and UNEP 2016). As such, our food systems have potential for a significant impact on planetary health. On the land, increasing use of technology and mechanisation, and increasing use of agrochemicals have increased productivity at the expense of soil health, water quality and biodiversity (IPBES 2018). In our seas, over-fishing and pollution have led to degraded marine ecosystems (GRID-Arendal and UNEP (2016).

Notably, the World Economic Forum's Global Risk Report (2020) has biodiversity and ecosystem collapse in its top five risks. Food production from the land relies on the health of that land, and the cycling of sunlight energy into plant growth, as well as effective and optimal cycling of water and nutrients. Sustainable harvesting of marine products and aquaculture in turn rely on healthy functioning of the marine and coastal ecosystems. If our ecosystems collapse, our food systems collapse too.

The Solutions

The questions are therefore what can we do, how should we go about it, and how, as veterinarians can we help?

From a food-safety perspective, we can act to maximise health in our livestock and promote better hygiene practices. However, the remaining issues can appear so overwhelmingly complex, with a myriad of different food types and production

systems across the globe, a massive population to feed, and an ever-increasing array of literature about the greenhouse gas emissions and nutritional value of differing food types and production systems. We suggest a way forward is to take a step back, and view the situation as a whole; through the lens of the planet, the human and the animal, at a localised scale.

Agroecology represents such an approach to land-based food systems; integrating ecological and social concepts and principles to food systems. In this way, it optimises the interactions between plants, animals, humans and the environment – and permits us to move towards a truly sustainable food system. An accompanying change to our dietary choice (in the developed world) to eat less, but better, animal protein in terms of both its production foot print and nutritional quality (De Boer et al. 2014, Eating Better 2019), combined with increasing the diversity of food types in our diets (IPBES 2019) may be key components for transitioning to agroecological systems.

The Food and Agriculture Organisation of the United Nations published and approved a set of Ten Elements of Agroecology in 2019, which provide a very useful blueprint and point of reference (FAO 2019). There are many techniques and tools that can be used in agroecological systems, all of which are highly context-specific, and we cannot possibly review them all here. One widely applied approach, however, is that of regenerative grazing with livestock. In a regenerative grazing system, ruminant livestock, which are of appropriate genetics well-adapted to their environment, are managed in ways that mimic historic natural grazing by wild herbivores in the presence of predation threats. When grazing is managed in this way, grassland plants are neither over- or under-grazed, and they have sufficient rest periods to recover from the roots up. Over time, this process leads to greater biodiversity below and above ground, enhanced nutrient, carbon, water and energy cycling without the need for external chemical or mechanical inputs (Teague 2018).

Well-managed ruminant livestock in these systems benefit from the enhanced nutritional profile of a diverse sward (Provenza et al. 2019), in contrast to the detrimental health effects of a grain-based diet. In addition, there are social, cultural and nutritional human benefits. These systems reconnect farmers, (and consumers if they also choose to engage with the source of their food) back to the land, the livestock and the soil, because of greater farmer time spent with their livestock, observing the effects of planned grazing on the life and biology present both above and below the ground. The resulting nutritional profile of both meat and milk from regeneratively grazed livestock is biochemically richer than that of more conventionally grazed livestock on grass monocultures combined with grain (Provenza et al. 2019), and it is this biochemical richness (or diversity) that is believed to be of greater nutritional benefit than individual components of the meat or milk per se (Provenza et al. 2019).

Regenerative approaches, where system development takes a holistic view of the human, animal and environmental impacts, are also being developed and championed for aquaculture. Of note, there appears to be increasing evidence that bi-valve shellfish and seaweed production, when managed appropriately in the right geographical areas, have the potential to regenerate coastal ecosystems, and support local economies in social and economic terms (Theuerkauf et al. 2019).

Such innovative and restorative techniques have the added benefit of reducing the pressure on wild species – allowing space and time for marine ecosystems to also recover and rebuild (Duarte et al. 2020).

At farm, producer and consumer levels, changing to agroecological/regenerative systems presents a significant challenge. Barriers include innate human resistance to change (Jost 2015), combined with the difficulties of keeping farmers, their families and employees financially afloat during transition. Since there are wider societal and environmental benefits of regenerative approaches to food production systems, support frameworks may be an option, particularly in wealthier economies. At the time of writing this chapter, the Department for the Environment Food and Rural Affairs (Defra) were developing the Environmental Land Management Scheme (ELM) for England. The authors hope that components of the scheme will support the transition to more sustainable farming systems.

As an example of how to start the process of transition, one of the authors of this chapter is using the practice newsletter to engage with farm clients about the environmental impacts of parasiticides in livestock (Wall and Strong 1987, Sanderson et al. 2007, Brinke et al. 2010, Verdú et al. 2017). In addition, a veterinary group here in the UK is engaging with their farm clients about the use of parasiticides in livestock, and their negative environmental impact (Wall and Strong 1987, Sanderson et al. 2007, Brinke et al. 2010, Verdú et al. 2017). This story is showcased in Case Study 2.1.

Case Study 2.1 Rob Howe

In the UK, it is common for farmers to source anthelmintics from outlets other than veterinary practices, who often cannot compete on pricing. Free advice may, therefore, be sought elsewhere, resulting in veterinarians not being involved in farm parasite control practices.

Our veterinary group decided to undertake a pilot enrolling approximately 20 dairy and beef farms. We offered our time for free, in order to embed our veterinary advice, even if not selling products, into our farmer practices, as we felt significant cost savings, animal health and environmental gains were attainable for our farms.

A questionnaire was undertaken at the outset to understand current parasite control strategies on farm. None of the farms were performing any faecal egg counts, but almost all (88%) were using a prophylactic strategy. Of those, 94% were using macrocyclic lactones, known to be highly toxic to broad range of insect species, both terrestrial and water-based (Weaving et al. 2020). The farms in the pilot study had been using their current control regime for an average of 10.1 years.

The hidden costs of this approach, as outlined below were discussed with the farmers in the study:

1. An increase likelihood of resistance arising (Taylor et al. 2007);
2. Potentially unnecessary non-targeted treatments that incur both product purchase costs, and time costs in terms of stock gathering and treating;

3. Preventing parasite exposure in youngstock can impair the development of immunity and lead to adult losses and/or disease (Taylor et al. 2007);
4. The decimation of beneficial insect populations arising from the non-selective lethal and sub-lethal effects of drug residues in dung (Weaving et al. 2020).

Based on this understanding of the costs, it was then a natural step to explore the benefits of more integrated veterinary-led approaches using for example, regular and targeted faecal egg counts, and more considered product selection, with the pilot farms.

A key factor for positive farmer engagement has been highlighting the role of the keystone and charismatic dung beetle, as a tool to drive understanding of agroecology. Dung beetles provide many ecosystem services, for example, seed dispersal, nutrient cycling and parasite suppression (Nichols et al. 2008), yet they are in decline, in part in association with the use of livestock parasiticides, and in particular, macrocyclic lactones and synthetic pyrethroids (Sands and Wall 2018, Weaving et al. 2020).

Veterinarians and veterinary technicians in our group have been performing basic dung beetle surveys for our farmers and the engagement of all has been incredible to witness. Visualisation of the ‘life in the dung’ has proved to be a very powerful tool, enabling our farmers and the veterinary team alike to begin to realise the importance of biodiversity (Figure 2.1).

Following such a successful trial, our aim is to enrol all our clients into this approach. This represents an enormous opportunity for farm veterinarians anywhere to demonstrate value to their farm clients by providing better, more



FIGURE 2.1 *Onthophagus vacca* with Parasitidae mites. These mites ‘hitch-hike’ as dung beetles fly between dung pats, predating fly maggots, and further reducing the need for fly control treatments. (Photo credit: Darren J Mann.)

integrated approaches to parasite control, with benefits to livestock, farm productivity, biodiversity, public health and veterinary practices themselves.

These approaches may also be new to our own profession. To that end, Vet Sustain has created a Food and Farming Working Group. Its objectives are to develop and deliver a suite of products (e.g. assessment tools, educational materials, training modules, on-farm events) tailored to livestock veterinarians, veterinary technicians, veterinary students and livestock producers, that successfully drives effective change to more sustainable food production practices, by appealing to the motivation(s) of both veterinarians and farmers. Readers can find up-to-date resources on the Vet Sustain website (<https://vetsustain.org/>).

CONCLUSIONS

As veterinarians, we are in a position to apply our understanding of ‘good welfare’ not only to the animals under our care, but to ourselves, our veterinary businesses and the wider environment – all of which are equally affected by our food production systems. It is therefore incumbent on us to continue to strive for better health and welfare in our farmed livestock, and to educate ourselves and others in context-specific regenerative and restorative food production systems. Such systems have the potential to provide us with more nutritionally dense food, ensure better farmer welfare, and restore our degraded terrestrial and marine ecosystems. It may be that we have to accompany these changes with a dietary shift to less, but higher quality, animal protein. The avenues open to us include our work on farm, in pure and applied research, in policy and legislation development and implementation, in professional and public education, and in advocacy.

VETERINARIANS IN PRACTICE

CONTEXT

This section illustrates the breadth and diversity of the roles of practising veterinary professionals, and the positive effects we can have in driving our societies in a more sustainable direction, in addition to our involvement in food production systems. We will explore, as examples of how we can effect positive change, the following issues through a One Welfare lens: antimicrobial usage and resistance; parasiticide use in companion animals; sustainable pet ownership; conservation; our own planetary footprint; and engaging as citizens.

ANTIMICROBIAL RESISTANCE

The Challenge

Antimicrobial resistance (AMR) is amongst the most significant health threats facing human society. It is currently responsible for an estimated 700,000 human

deaths per year, predicted to rise to 10 million by 2050, with a cumulative cost to global economic output of 100 trillion USD (O'Neill 2016). These impacts are due to a decline in the efficacy of antimicrobial drugs, threatening our ability to prevent and treat bacterial infections using the products that we have come to rely on in modern medicine.

Antibiotic use is a key driver of antimicrobial resistance. By using antibiotic drugs, we apply a selection pressure that kills susceptible microbes but provides the surviving drug-resistant bacteria with a competitive advantage and potential to cause untreatable disease in their human or animal hosts. Drug-resistant, multi-drug-resistant and pan-resistant bacteria are causing human disease across the world, resulting in serious illness and mortality. Although antibiotic use in people is implicated as the primary driver, it is now widely acknowledged that the use of antibiotics in animals contributes to the global health burden of AMR.

This understanding is based on evidence supporting the steps in the causal pathway: (1) the emergence of resistant bacteria or genetic determinants resulting from the use of antibiotics in animals; (2) the subsequent transmission of resistant bacteria or genetic determinants from animals to humans and vice versa via direct contact, the food chain and the environment; (3) the colonisation of people by bacteria with resistance genes of animal origin; and (4) clinical impact on human health due to bacteria with resistance genes of animal origin. These clinical impacts include for example increased incidence and severity of bloodstream infections, treatment failures, prolonged duration of illness and mortality (Heuer et al. 2009).

There is a small but growing evidence base of landmark reviews that link antibiotic use in animals to human disease (ECDC, EFSA and EMA 2017, Tang et al. 2017), and these studies underline the public health imperative to ensure responsible use of antibiotics in all animals, with a focus on reducing use from currently high levels in certain regions, species and production systems. It is understood that in some countries, antibiotic use in livestock accounts for 70% of all medically important antibiotic use (O'Neill 2015). A global overview of by the World Organisation for Animal Health, OIE, reports total usage (correcting for animal biomass in each region) ranging from 39 mg/kg in Africa to 237 mg/kg for Asia, Far East and Oceania (OIE 2020).

There is evidence that the level of public health risk of AMR arising from antibiotic use is dependent on the drug-bacteria combination in question, which has resulted in a particular focus on reducing the use of the fluoroquinolones, third- and fourth-generation cephalosporins, macrolides and colistin – named as the ‘highest priority critically important antibiotics’ by the World Health Organization (WHO 2019). However, there is also a need to view the challenge through an ecological lens, recognising that bacteria of different species can acquire a range of new resistance genes from the environmental ‘resistome’ that support their evolutionary success. It is therefore responsible to mitigate veterinary use of *all* antibiotics where possible to reduce selection pressure, whilst protecting animal health and welfare.

The Solutions

Most members of the veterinary profession have a clear understanding of their role in One Welfare and the need to manage and mitigate antibiotic use, to protect animal and human health and welfare in the future. There are, however, several constraints to driving progress. These include paucity of consistent data surrounding usage patterns and indications; dependence on medical sales for revenue; defensive prescribing; and husbandry systems reliant on antibiotics.

The lack of harmonised data collection and reporting systems to establish baseline use and enable monitoring of progress is a significant problem. Some countries and sectors have developed effective data capture systems, but these differ in terms of the data they collect and metrics they use. Veterinary surgeons and businesses have a role in establishing robust data collection systems that enable them to track their own progress and remain accountable to their clients and to the regulatory bodies that may request this.

The challenge of dependence on antimicrobial sales is, in many countries, a real and significant one. There is an ongoing need to ensure that financial outcomes do not influence antibiotic prescribing behaviours, which may necessitate a shift in business models towards an emphasis on selling services and diagnostic testing before treatment. Some countries such as Denmark have gone further by prohibiting medicine sales by veterinarians, by decoupling medicine prescriptions and sales (Høg et al. 2019).

‘Defensive prescribing’ is defined in the human health field as a “physician’s deviation from what is considered to be good practice to prevent complaints from patients or their families” (Toker et al. 2004). There is also a perceived client expectation of receiving a product from a veterinarian, which can drive certain prescribing behaviours. Both of these social drivers can be addressed by better understanding client expectation, managing these expectations through education, effectively communicating with our client base and the public, having confidence in the inherent value of our veterinary services and advice, and charging appropriately for our time.

Some incidences of antibiotic use in animals are the result of management or husbandry practices that predispose to stress and disease. FAO (2020) states that “in recent decades, the intensification of animal production due to the increasing demand for products of animal origin has led to an increasing overall use of antimicrobials”. It is necessary for veterinarians to work with animal owners and keepers to reduce usage of antibiotics where possible and where necessary by not only ensuring judicious use when antibiotics are needed, but to critically evaluate husbandry methods and systems that may be predisposing to stress, disease, poor welfare outcomes and ultimately antibiotic use in our patients.

Veterinarians are amongst very few healthcare professionals that have the authority to prescribe antibiotics in many jurisdictions, which represents a considerable responsibility to ensure judicious use and minimise public health risk. Veterinary surgeons occupy an extraordinary niche at the human-animal-environment interface, and arguably of all professions, have the most acute

theoretical and practical understanding of the importance of One Welfare. Antimicrobial resistance is the quintessential One Welfare challenge, with human, animal and environmental dimensions to the risk factors, impacts and solutions to the problem. Despite the challenges, there is an opportunity for veterinarians in this space to deploy all the tools available to help farmers select, breed and manage animals in healthier systems, requiring fewer interventions.

A number of frameworks have been adopted for antibiotic stewardship policies in the veterinary sector. However, the '3Rs' framework – Reduce, Replace and Refine – has been used in recent years in the UK agriculture industry, adopted by FAI (2014), RUMA (2016) and numerous food businesses. The 3Rs was originally devised by Russell and Burch (1959) for the purposes of reducing, replacing and refining the use of animals in research. Repurposing this framework has been useful to structure the necessary actions and behaviours around judicious medicine use in animals, and can be a useful way for veterinary surgeons and veterinary businesses to structure their approaches and policies.

Here, we present the '3Rs' goals of antibiotic stewardship, in animal agriculture as an example (From FAI no date):

1. REDUCE the annual usage of antibiotic agents in animal agriculture/aquaculture, per unit of livestock produced, whilst preserving animal health and welfare.

Example of implementation: Usage data should be monitored in terms of livestock species and antimicrobial classes. The routine use of prophylactic treatments should be discontinued. The use of medicines classified by WHO (2019) as 'highest priority critically important' to human health should not be used unless supported by diagnostic test results.

2. REPLACE the use of antibiotic agents in animal agriculture/aquaculture where possible, with sustainable solutions to prevent diseases such as vaccination and improved husbandry practices, to protect animal health and welfare.

Example of implementation: Proactive herd/flock health planning and analysis of medicine records should support the identification and control of prevalent diseases on farm, with a view to replacing antibiotic use with sustainable alternatives such as vaccines, biosecurity policies, improved husbandry practices and application of novel technologies.

3. REFINE the use of antibiotic agents in animal agriculture/aquaculture, by ensuring the responsible and informed selection and administration of products to animals that have a clinical indication for treatment.

Example of implementation: Responsible medicine dispensation and communication on correct medicine use (including handling, storage and disposal) by vets to farmers, for animals that have a therapeutic or metaphylactic need for treatment. Support the appropriate use of diagnostic testing, and the training of farm staff involved in animal care on responsible medicine use.

ECTOPARASITICIDE USE IN COMPANION ANIMALS

The Challenge

There are many endo- and ectoparasite veterinary products available for animal treatment, the purpose of which is to control and prevent parasitic burdens, thereby protecting the health and welfare of treated individuals. There are, however, potential environmental effects on non-target species. In Section ‘Sustainable Food Systems’, we highlighted the environmental impact of routine use of macrocyclic lactones in livestock (Wall and Strong 1987, Sanderson et al. 2007, Brinke et al. 2010, Verdú et al. 2017). In this section, we examine the use of parasiticides in companion animals, and for simplification, since there are so many products available, we focus on neo-nicotinoids, in particular imidacloprid.

Imidacloprid is used in companion animals for the prevention and treatment of flea infestations, but its direct and indirect lethal and sub-lethal effects extend to non-target invertebrate and vertebrate species (Gibbons et al. 2015, Pisa et al. 2015, Wood and Goulson 2017, Yamamuro et al. 2019). Historically imidacloprid has also been widely used as an agricultural seed treatment (Wood and Goulson 2017). All neonicotinoids are water soluble and can persist in soil – highlighting the potential for both terrestrial and aquatic contamination (Wood and Goulson 2017). In a US study of waterways contamination, imidacloprid was found in urban streams, but the degree to which this contamination might be related to use in pets is not possible to quantify since imidacloprid is widely used in garden insecticides in the USA (Hladik and Kolpin 2015).

Insects are in decline globally, of which pollinators are of particular concern (Hallmann et al. 2017, IPBES 2017). In addition, insectivorous birds are also declining (Hallmann et al. 2014). Despite polarised debates on the underlying causes of these declines, the European Food Safety Authority, EFSA, concluded in 2018 that neonicotinoid use represented a threat to wild bees (EFSA 2018). Since then there has been a ban on the outdoor use of imidacloprid (EC 2020). Imidacloprid is however still widely available as a spot-on treatment for companion animals. Veterinary concerns over its widespread use in dogs and cats in the UK have recently been voiced (Loeb 2018, Powell et al. 2018, Little and Boxall 2020, Perkins 2020).

As veterinarians adopting a One Welfare approach, there is a clear need for us to question the routine administration of imidacloprid (and other parasiticides) in our companion animals. Even if the risks to non-target species and wider biodiversity cannot be quantified, the size of the global pet population, estimated at over 800 million dogs and cats in 2018 (Statista 2020), raises concerns over the amount of imidacloprid likely being administered. A search of the EU veterinary medicines database revealed 36 products containing imidacloprid (EU 2020), and data from 13 of Europe’s leading manufacturers of animal medicines shows parasiticide sales representing just under 28% of total veterinary product sales in 2019 (vaccines 33%; antimicrobials 12%; ‘other’ 27%) (Animal Health Europe 2019).

The Solutions

A One Welfare approach to the use of ectoparasiticides in companion animals should enable us to protect the health and welfare of our client’s pets, without causing undue harm to the wider environment.

Risk-based assessments at the individual level should replace the routine and regular use of ectoparasiticides, reviewing the necessity for treatment in the light of potential environmental risks.

In addition, a multi-disciplinary step-wise review of ectoparasite-related problems in companion animals in different geographical settings should be undertaken (Figure 2.2). Stage 1 defines the scale of the problem requiring an understanding of both direct host effects of individual ectoparasites, and indirect effects where ectoparasites are vectors of potential pathogens, building on materials already published, for example, European Scientific Counsel Companion Animal Parasites Guidelines (see <https://www.esccap.org/>). Stage 2 documents current advice from within the veterinary profession and from wider sources such as animal health companies or companion animal societies, followed by an assessment of the actual levels of routine treatment, based for example on a combination of veterinary practice sales, and owner questionnaires. The final stages assess animal health and welfare benefits of routine treatments, alongside negative consequences for target and non-target species and the wider environment. The entire process could provide a platform from which an alternative set of protocols could be developed, which incorporate environmental health more fully.

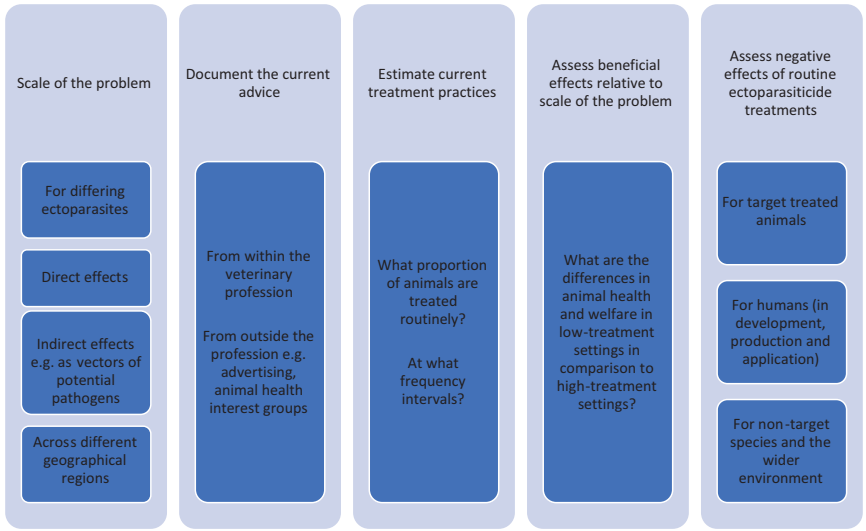


FIGURE 2.2 A framework for evaluating current ectoparasiticide application practices in companion animals using a One Welfare approach.

SUSTAINABLE COMPANION ANIMAL OWNERSHIP

The Challenge

Humans have kept animals as companions for thousands of years (Amniot et al. 2016). There are well-documented human benefits of these relationships in terms of physical and psychological health – and companion animals are often considered family members (Amniot et al. 2016). In settings where companion animals are ‘healthy’ and ‘have what they want’ (refer to ‘Sustainable Food Systems’ section – relating to animal welfare), there is a mutuality of welfare benefits. Animal welfare may, however, be compromised, for example when housing conditions are inappropriate, or human attention to animal needs is inadequate. In addition, transmission of zoonotic disease and/or antibiotic resistant bacteria may compromise human welfare.

In planetary terms, there is also an ecological footprint of keeping companion animals (Martens et al. 2018). Much of this footprint will be associated with feeding, but other inputs such as specialist housing requirements, or extra veterinary care requirements, for example, may all add to that footprint. In addition, there are specific issues relating to the keeping of more exotic pets such as reptiles and amphibians. The human, animal and planetary impacts and regulatory constraints in differing countries could form an entire book chapter of its own (see Pasmans et al. 2017).

Individual human decision-making about companion animal ownership in the first instance is an ethical choice, where input from the veterinary profession is part of a much wider debate around personal decision-making. We can add our voice, advising current and prospective clients, and the wider public about balancing human, animal and planetary welfare relating to companion animal ownership. However, where we as veterinary professionals have a more well-defined role, is in the particular choice of companion animal, both at species and breed level.

The Solutions

Any advice we give to clients, or educational material and opinion pieces that we disseminate should be through a One Welfare lens, ensuring that we align human, animal and planetary interests.

In the case of companion animal ownership, this could take the form of a sequential assessment, with a first step to determine ‘species of companion animal’, for example, horse, dog, cat, rabbit or ferret, followed by a second assessment to select the optimal ‘breed of companion animal’, matching owners to pets, and maximising the likelihood that pet health and welfare can be guaranteed in the home setting. Primary assessments should address owners’ circumstances realistically, in terms of time, space and finance available for example. An example of this approach in practice is the People’s Dispensary for Sick Animals (PDSA) ‘Get Pet Wise’ information, advising potential owners to focus on ‘P-E-T-S’: Place, Exercise, Time and Spend that

they have available to them, when choosing a pet (see <https://www.pdsa.org.uk/taking-care-of-your-pet/choosing-a-pet>).

As veterinarians, it is important that we take a stance on advising against selection of species or breeds that have inherent problems, particularly relating to animal health and welfare. This is a key to fulfilling our professional oaths and is our second Veterinary Sustainability Goal – ‘A Good Life for Animals’ (see Table 2.1). The BVA Priority Animal Welfare Problems for companion animals include ‘exaggerated conformation’ for dogs, cats and rabbits (BVA 2016). For dogs, this might include breeds predisposed to brachycephalic obstructive airway syndrome or intervertebral disc disease as examples. Other considerations could include positive selection of breeds with the ability to reproduce without intervention, or of individual animals from breeders active in schemes to minimise inherited diseases.

VETERINARIANS IN CONSERVATION

Veterinarians are often involved in multi-disciplinary conservation projects – but there may be a perception that their only contribution relates to safeguarding the welfare of any captive or free-living wildlife that are central to the project. However, consistent with the One Welfare theme of this chapter, we suggest that the veterinary role goes much further than this.

An example of this is when a disease risk analysis, DRA, is undertaken for a conservation translocation. Translocations may be part of re-introduction or population reinforcement programmes and may involve captive-to-wild or wild-to-wild animal movements. Regardless of the precise nature of the translocation, each time a wild animal is moved from one location to another, the health risks to that individual, its conspecifics, other species (wild and domesticated), humans and the wider environment should be taken into consideration. This approach is clearly consistent with One Welfare. The disease risks that may arise from translocations include the following: direct translocation of infectious agents accompanying the wildlife species of interest – that may affect wildlife, domesticated animals and/or humans; exposure of the translocated wildlife species to novel infectious and non-infectious agents at or *en route* to the destination; alterations in host response in association with translocation stress; and ecological changes associated with the presence or increase in numbers of the wildlife species being translocated. All of these possibilities, alone or in combination have the capacity to compromise human, animal and environmental health and welfare.

There are now well-established International Union for the Conservation of Nature (IUCN) Guidelines for undertaking a DRA that follow this line of thinking (Jakob-Hoff et al. 2014), and a number of DRAs have been published (see Sainsbury and Vaughan-Higgins 2012, Lewis et al. 2019).

In addition, veterinary professionals can follow alternative pathways to exert their influence and disseminate One Welfare messages within the conservation arena. One such example is that of veterinarian Cal Major – whose story we present here – Case Study 2.2. <https://www.calmajor.com/>.

Case Study 2.2 Cal Major

My love affair with the ocean began when I was 18. I travelled to Australia to learn to scuba dive on the Great Barrier Reef, and from my first breath underwater I was hooked. I'd never felt such peaceful joy or love for a place and the animals in it. I knew from that moment that I'd dedicate my life to protecting this wild place that I loved so much.

My role as a veterinarian in marine conservation may be quite different to how you expect. I focus on public engagement, aiming to drive change through education and inspiration. As a veterinarian I feel I have a shortcut to the public's trust, able to refer to environmental challenges from an animal and scientific viewpoint. I regularly refer to the One Health concept in my campaigns, and feel that the passion and skills I have acquired through veterinary training and my years in practice, have stood me in very good stead to lead campaigns and inspire positive change. I occasionally do work hands on with animals in the field, but more often than not am educating and hoping to inspire hope, positivity and action through my expeditions and adventures, often using film and media. People often ask 'are you still a veterinarian' on account of having been out of small animal clinical practice for a couple of years. The answer is a resounding 'yes' - all the passion I have to preserve life, help people and animals and protect ecosystems, encapsulated perfectly in the One Health model, that characterised my role as a clinical practitioner also drives my passion to protect the wild animals at large and the precious marine ecosystems that are so vital for their survival.

I strongly believe that human mental health and environmentalism are intrinsically connected. They are linked through a connection to our natural world. As humans, we have not evolved to be as separate from it as our lives have become. It's scientifically proven that time in nature is enormously beneficial for mental health, and I believe that time spent in our natural world is also imperative for driving people to appreciate it and care enough about the environment to want to protect it. People protect what they love, but they only love what they know. Why do people love these wild places? Because of how it makes them feel; the improvement to their mental health. Just like how I fell in love with the ocean - the sense of peace, wonder, joy and love at being somewhere wild and natural. We are all physically connected to the oceans in a number of ways, not least that they produce over half the oxygen we breathe, but feeling a personal, meaningful connection to them is not only beneficial for our mental health, but essential in driving us to want to protect them, and the animals within them.

ENVIRONMENTAL FOOTPRINT OF CLINICAL VETERINARY PRACTICE

Veterinarians have a responsibility to lead and engage with their teams to evaluate and mitigate the planetary footprint of their practice. Health care has a significant environmental impact (Eckelman and Sherman 2016, Rizan et al. 2020b) but within the veterinary sector this has not been quantified. Engagement with environmental sustainability has a moral value, and compliance with legislation where it exists, is necessary. However, beyond this, engagement with sustainability has the potential to accrue further benefits, such as increased staff well-being, improved team recruitment and retention, enhanced local reputation by leading

and demonstrating best practice, and economic saving. Sustainability is essential for business resilience (Quintos 2020).

The major environmental impacts of practice are due to energy consumption, procurement, waste management and anaesthesia (Jones and West 2019). Important issues also include single-use plastics, prescribing practices and antibiotic stewardship. Travel to work and out-of-clinic visits also have an impact, along with client visits to the practice.

Below we outline how a ‘Greener Veterinary Practice’ check-list might look for a UK-based veterinary practice.

1. Plan and audit environmental policies:
 - a. Publish an environmental policy with named responsible staff;
 - b. Create an environmental management plan;
 - c. Estimate your organisation’s carbon footprint using an online-tool;
 - d. Nominate team members to track progress – and consider nominating ‘Sustainability Champions’ within the practice.
2. Engage with your stakeholders:
 - a. Communicate the sustainability vision with staff and clients;
 - b. Provide advice for clients on sustainable animal ownership, for example, consider pet-food protein-source (Okin 2017), recycle food packaging, use biodegradable poo-bags;
 - c. Consider the value of environmental accreditations for your organisation;
 - d. Use existing training in sustainability principles and policies to upskill your team, for example, on climate awareness and literacy;
 - e. Demand sustainable products/services from wholesalers and suppliers.
3. Practise responsible resource use:
 - a. Reduce fossil-fuel use (energy and heating), save energy and/or switch to renewable energy;
 - b. Make sustainable choices when purchasing equipment or consumables;
 - c. Segregate and dispose of waste appropriately and in accordance with legislation, reducing, reusing and recycling where possible;
 - d. Reduce disposable materials usage, including single-use plastics (Rizan et al. 2020a);
 - e. Ensure responsible paper sourcing, use and disposal;
 - f. Put water-saving measures in place.
4. Be sustainable in your operation:
 - a. Include eco-principles in building design or adaptations, for example, by integrating energy saving features;
 - b. Ensure environmental legislation compliance;
 - c. Use evidence-based infection control measures and minimise use of ecotoxic chemicals;
 - d. Minimise the greenhouse gas impacts of anaesthetic agents e.g. avoid nitrous oxide, choose anaesthetic protocols carefully and use low-flow techniques;

- e. Comply with RCVS Practice Standards Scheme sustainability goals;
 - f. Enhance on-site green spaces and promote biodiversity;
 - g. Promote animal welfare;
 - h. Support sustainable welfare-friendly agriculture when advising farming clients;
 - i. Create a travel policy to reduce emissions from business travel, commuting and freight;
 - j. Support walking, cycling or public transport use by staff and clients;
 - k. Consider where tele-medicine can reduce travel to the clinic;
 - l. Reduce carbon emissions from conferencing/education;
 - m. Utilise paper-free management systems wherever possible.
5. Use medicines responsibly:
- a. Practise responsible antimicrobial stewardship (including antiparasitics), mitigating resistance;
 - b. Avoid drug wastage through good stock management;
 - c. Dispose of drugs correctly (minimising ecotoxicity);
 - d. Utilise preventative healthcare and herd health plans.
6. Sustain the team:
- a. Support staff well-being and development, for example, through sustainability education and projects, and encourage formation of a 'green group';
 - b. Recognise that good health and well-being supports all aspects of practice operations, including physical, emotional, psychological and social well-being.

VETERINARIANS AS ACTIVE CITIZENS

Veterinarians have the knowledge, facility and responsibility to act as active citizens. Through professional global oaths and association declarations, we have primary leadership and advocacy roles in aspects of animal health and welfare. These roles extend into the triumvirate of animals, people and environment that encompass One Welfare. Veterinarians also have a growing responsibility towards global food security for all, in a food system that allows production and distribution in an equitable and sustainable manner, while protecting and enhancing the environment.

By the nature of veterinarians' professional status, there will be a popular assumption of active citizenship and an expectation that we will accept this responsibility. The professional esteem and acumen that is bestowed upon us gives them the privileged obligation to act as active citizens for the benefit of One Welfare with a primary role as advocates of animal welfare.

As active citizens, veterinarians must influence this narrative and take action. We must vigorously seek access to good quality information, which allows us to challenge the state and other actors and influence decisions. We must be the collective source of evidence-based trusted information, and the focus of education of, and influence on animal owners, keepers and others involved in animal

contact. The result will be a positive influence on the behaviour and actions of all citizens by providing an evidence-based and sustainable way that has a positive impact on animal welfare and One Welfare.

While professional acumen and societal influence is important, veterinarians also have a role to agitate for positive change. This is a collective and personal responsibility that should be pursued. Collectively veterinary associations and professional bodies can speak with one voice to lobby the state and other actors for evidence-based positive change; we can act as credible influencers, provide solutions and show leadership. As individuals, our behaviour as citizens should reflect our profession obligations, manifesting in many ways including how we act as consumers. As a profession, we must continue and progress our ability to provide societal leadership, and challenge conventional practice. We must be leaders in sustainability both through our work and our actions as citizens.

The ‘Citizen Shift’ encompasses the concept that we not only have the freedom to choose how we behave and what we consume, but that we also play an active role in shaping what are the options we are offered. This brings a greater agency and responsibility for which we must be better informed and proactive. No longer are we *only* capable of judging what is best for ourselves as individuals, but we must have a say in what is best for society as a whole.

As veterinarians on this journey within our profession, we are not simply participants, but active influencers, embracing the wider purpose. We must be prepared to shape, create and collaborate in new and diverse ways.

Case Study 2.3: Jen Gale, Founder of Sustainable(ish) and veterinarian. <https://www.asustainablelife.co.uk/>

I always thought we were pretty green (we did our recycling...) until I slightly randomly decided that we should spend a year buying nothing new as a family (me, my husband and our two sons who were then aged 4 and 1). Up until that point I'd never really thought that much about the things we were buying, other than where we might be able to get them cheapest, but the experience changed my life – not only where and how I shop, but how I see my place in the world too. Having to find the things we wanted or needed secondhand meant we slowed down our consumption of ‘stuff’, and also forced me to confront lots of issues that I'd previously known about but chosen somehow to look away from: fast fashion, the climate crisis, resource depletion, habitat destruction and so much more.

I learned lots of practical skills during the year, but the biggest lesson was that I can make a difference. Even as just one person, just one family. All of our choices, the choices we make every day, often without a huge amount of thought, have a consequence. And we all have the capacity to make better choices more of the time.

I set up a blog to document our year buying nothing new, and I now run a social enterprise called Sustainable(ish), where I write, speak, podcast and coach about easy sustainable living for non-greenies. I think it's so important that we break down many of the stereotypes that exist around sustainability and sustainable

living – that we make it feel do-able for everyone, and that people feel inspired and empowered to just make a start and take imperfect action. None of us is perfectly sustainable (I’m certainly not!) but I really do believe that we can all be sustainable(ish) and we can all make a difference, without having to turn our lives upside down in the process.

WHAT SHOULD I FEED MY PET? STUDENT LEARNING EXERCISE

For student learning purposes, we have included a Question ‘What Should I Feed My Pet?’ to work through using the *Structured Academic Controversy Model and a One Welfare Approach*.

BACKGROUND INFORMATION FOR STUDENTS

Animal Well-Being

Consider the following:

1. Physiological dietary needs for cat/dog
2. Taste, variety in diet, enjoyment etc.
3. Optimising *health* – not just existing

Environmental Well-Being

Consider planetary footprint of the following:

1. Base ingredient production methods
2. Production of pet food – combining base ingredients
3. Transport/packaging etc.
4. Waste – from production and following animal consumption

Human Well-Being

Consider the following:

1. Owner’s own ‘ethical’ views on food sources
2. Owner’s responsibility for health and welfare of their pet
3. Farmer health and welfare in the production chain
4. Food manufacturers’, distributors’ health and welfare in the production chain.

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3 Climate Change as an Animal Welfare Problem

The Role of the Veterinarian

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Although we face numerous important problems in today's complex world, many people feel that climate change logically tops the list, since it affects every other issue. The current COVID-19 pandemic is certainly a more *urgent* problem at the moment; however difficult as it may be to imagine, the *magnitude* of the crisis that would stem from climate change under a "business as usual" scenario would dwarf the current crisis. Moreover, the pandemic has exposed the vulnerability of many of our societal frameworks to exceptional stressors in a way that foreshadows many of the concerns raised over climate change.

But, although we may acknowledge that, even now, climate change is an important problem, is it a veterinary problem? This chapter explores this question by reviewing the current science of climate change, its effects and potential solutions; and concludes that yes, climate change is a veterinary problem with substantial one welfare impacts and veterinarians have a professional duty to take and encourage stronger action to mitigate it.

Climate change is a multi-faceted problem that stems from increased heat energy trapped in the earth's atmosphere. This obviously leads to increased temperatures, which is a problem in itself; but the situation and its consequences are more complex than *simply* warmer weather.

Climate change does not directly cause bushfires, droughts, floods or cyclones; but it does clearly set the stage for each of these types of events to be more frequent and more severe. Until recently, it was possible to say that the overall risk of extreme weather events was increased by the background of climate change but not to attribute specific events or proportions of events to climate change. Now, however, event attribution is one of the most rapidly expanding areas of research within climate science (Committee on Extreme Weather Events and Climate Change Attribution; Board on Atmospheric Sciences and Climate; Division

on Earth and Life Studies; National Academies of Sciences, Engineering, and Medicine 2016).

It is important to state clearly at the outset that the science on the main points surrounding climate change is indeed settled and that there is no realistic question of belief – similar to, for example, tobacco smoke being the primary risk factor for lung cancer. The bottom-line facts of climate science have in fact been in place for decades now, and the consensus on anthropogenic global warming among publishing scientists is above 97%, verging on unanimity (Powell 2016). There is certainly much to be discussed and decided surrounding societal choices, priorities and responses to the problem we have arrived at. However, the remaining questions about the science of climate change are about details such as the likely severity of predicted effects and the important question of tipping points; not whether or not it is real, happening now, serious, important and urgent. If anything, empirically observed changes are now outstripping predictions, not the other way around. This means that when we hear talk about unsettled science or belief/nonbelief in the media, we are hearing people speaking in the public space about this issue who are either uninformed, which is irresponsible, or intentionally spreading misinformation, which is worse than irresponsible. An important step towards progress on climate change would be to move beyond the false “debate” about the reality of climate change and advance any debate towards solutions.

Before proceeding further into the discussion, it may be worth exploring some terminology surrounding climate change. *Weather* is the atmospheric conditions over a short period of time, and *climate* is the background condition to weather: how the atmosphere “behaves” over relatively long periods of time. We live in a Mediterranean climate. The weather today was cloudy.

The terms “global warming” or “global heating” and “climate change” are sometimes used interchangeably, but strictly they refer to slightly different things. For purposes of conversation we can use them interchangeably, but it is worth clarifying this point because sometimes people get the mistaken impression that the difference in terminology means climate scientists don’t really know what is happening, which is not the case. Global warming or heating refers only to the Earth’s rising surface temperature; while climate change includes warming and the “side effects” of warming, such as melting glaciers, heavier rainstorms or more frequent drought. Said another way, global warming is one symptom of the much larger phenomenon of climate change. Although the earth has cooled and warmed before, and the climate has changed before, the terms “global warming”, “global heating” and “climate change” in general use now usually mean the specific human-caused phenomenon being discussed here, otherwise known as anthropogenic (caused by humans) global warming (AGW).

Although the basics of climate change are well settled among climate scientists, it is a science in itself and there are many complexities. However, non-climatologists can understand the basic mechanisms. In short, the effect is caused by the accumulation of “greenhouse gasses” in the earth’s atmosphere; and while carbon dioxide, or CO₂, is certainly not the only greenhouse gas, it is a major player. CO₂ is now commonly referred to as just “carbon” although

chemically what is being discussed is not the element carbon but rather the compound carbon dioxide. Figure 3.1 shows the monthly average atmospheric concentration of CO₂ at the observatory at Mauna Loa, Hawaii since 1958, showing the long-term increase superimposed upon the annual cycle in CO₂ concentration (which reflects the large northern hemisphere forests taking up more CO₂ in the northern summer).

The greenhouse effect of CO₂ was initially advanced in 1856 by Eunice Foote (Ortiz and Jackson 2020), who reported to *The American Journal of Science and Arts* the results of experiments with jars filled with CO₂, water vapour and air, finding that the CO₂-filled jar became much hotter in the sun and took much longer to cool afterwards. She speculated that higher concentrations of CO₂ in the

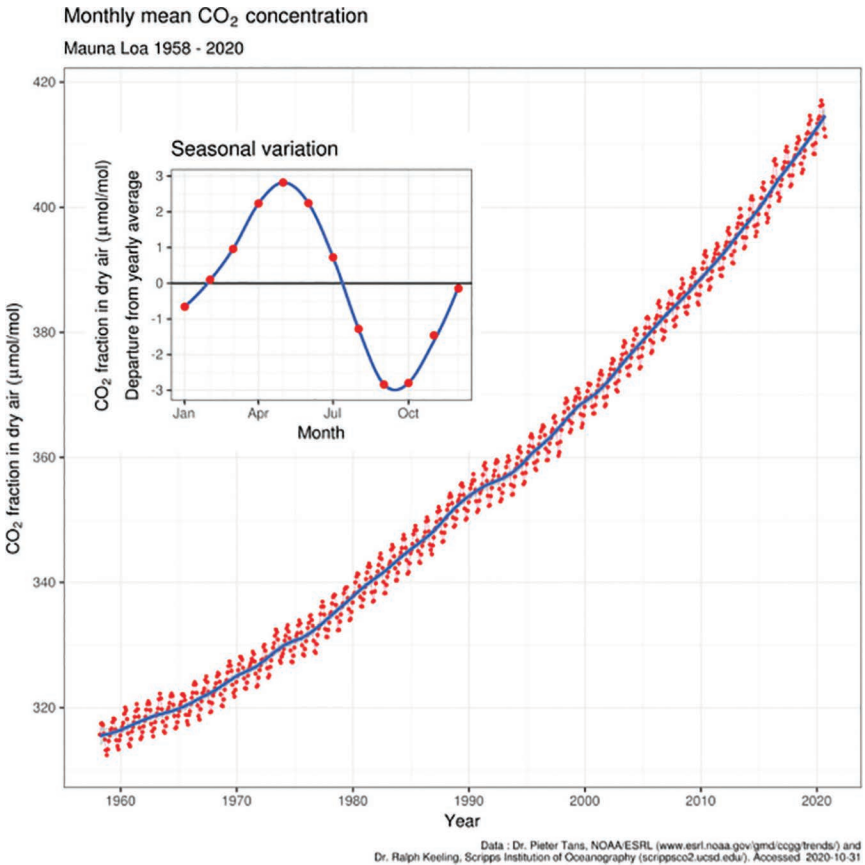


FIGURE 3.1 Monthly average atmospheric concentration of CO₂ recorded at Mauna Loa, Hawaii since 1958. The long-term increase can be easily seen over and above the annual cycle (which reflects northern hemisphere forests taking up more CO₂ in the northern summer). (Image credit: Delorme - Own work. Data from Dr. Pieter Tans, NOAA/ESRL and Dr. Ralph Keeling, Scripps Institution of Oceanography., CC BY-SA 4.0, <https://commons.wikimedia.org/w/index.php?curid=40636957>)

atmosphere would give the earth a higher temperature. In 1859, John Tyndall separately reported more extensive and quantitative experiments into infrared energy absorption by different gasses including CO₂ to the Royal Society of London (Tyndall 1859). Thereafter, Svante Arrhenius (Uppenbrink 1996) suggested in 1896 that there was a relationship between atmospheric CO₂ concentrations and global temperature, and that fossil fuel burning could cause accumulation of heat energy in the earth's atmosphere. Working with Thomas Chamberlin, he calculated that a doubling of atmospheric carbon dioxide concentration would lead to a 5°C rise in global average temperature (strikingly accurate: A July 2020 report of a major international assessment (Sherwood et al. 2020) of this question found that the likely range in this scenario is probably between 2.3°C and 4.5°C) – the historical baseline from 10,000 years ago to the start of the Industrial Revolution is taken to be 280 ppm, and the current level is approximately 415 ppm. This proposed effect of CO₂ as an infrared energy absorbent was confirmed in the 1940s thanks to advances in infrared spectroscopy; and in 1955 Gilbert Plass published the conclusion that increasing atmospheric CO₂ concentration would result in increased global temperatures.

In the 1980s, global temperature curves started to rise significantly, leading to greater awareness that the “greenhouse effect” might be a serious problem. In the late 1980s, the Intergovernmental Panel on Climate Change (IPCC) was formed by the United Nations, and is still ongoing. The IPCC is considered the largest peer-reviewed scientific cooperation project in human history and works with over 2,500 experts in diverse fields related to climate change, including ecology, oceanography, economics and of course, climatology (<https://www.ipcc.ch/about/history/>).

As said above, climate change results from increased heat energy trapped in the earth's atmosphere; however, this energy is not evenly distributed over the globe. Ninety percent of the excess heat energy is absorbed by the ocean (Dahlman and Lindsey 2020), resulting in significantly increased average ocean temperatures both globally and in our region. Warmer water is less dense, so a warmer ocean contributes to sea level rise; and this is also exacerbated by melting of glaciers and polar icepacks, as discussed in greater detail below.

The model of the water cycle conceptualises that the overall amount of water in the earth's system is fairly stable, a proportion of it is locked away as ice and the rest moves around by evaporation, precipitation and flowing back to sea. However, a net increase of energy in the atmosphere increases the magnitude of the cycle, as well as adding more liquid water to the system by unlocking previously frozen water that wasn't cycling. Thus, increased evaporation leads to increased water vapour in the atmosphere. Increased water vapour and heat energy lead to more intense storms; and more super-storm (typhoon/cyclone/hurricane) events have been charted in recent years, forming over areas of ocean heat anomalies. Even aside from these “super-storms”, extreme precipitation events have produced more rain and become more common since the 1950s (Madsen and Willcox 2012) in many regions around the world; and the extreme rainfall events are four times more common globally now than they were in 1980 (Nelson 2018).

It may be difficult at first to understand how global warming can be blamed for causing more precipitation and flooding, and at the same time, more drought. As the climate changes, precipitation patterns also change, leaving some areas with less rainfall than before, and long established, relatively predictable annual patterns starting to deteriorate and becoming less predictable (NASA 2020b). In addition, in areas where precipitation does not occur the increased heat causes greater evaporation from the soil.

Lastly, it is now well understood that when fires occur, their severity depends on the preceding and prevailing weather conditions; so with hotter, drier conditions, fires that occur will be hotter, more severe and harder to control (Binskin, Bennett and Macintosh 2020; Mullins, Bradshaw and Pearce 2020). Moreover, earlier springs mean the fire season is lengthened, and increased heat energy leads to an increase in lightning strikes (Thompson 2014). Lastly, the shortened winters and increased frequency of high risk weather conditions mean that authorities are less able to conduct hazard reduction activities (Binskin, Bennett and Macintosh 2020; Mullins, Bradshaw and Pearce 2020).

Many people find it difficult to conceptualise how human activity can significantly influence the composition of our planet's atmosphere, since a planet seems so large. The image in Figure 3.2 is illustrative on this point; it is essentially a cross-section of our atmosphere, showing the surface of the earth, with the relatively small distance to the top of the stratosphere. The lowest layer of the atmosphere where our weather occurs is the troposphere. Viewed in this way, most people find it easier to understand that the atmosphere is smaller than we usually tend to think of it when we look up at the sky.

So, why do these greenhouse gasses heat the earth up? Much of the heat energy in the troposphere comes from solar radiation, warming the planet,



FIGURE 3.2 The thin line of Earth's atmosphere and the setting sun. Image photographed by the crew of the International Space Station while space shuttle Atlantis on the STS-129 mission was docked with the station. (Image attribution: By NASA - NASA Image of the Day, Public Domain, <https://commons.wikimedia.org/w/index.php?curid=8563878>.)

which is favourable. Some of the infrared radiation reflects off the surface of the earth back into space, and the earth itself produces some infrared energy; and some of that reflected and produced heat energy is trapped by gasses in the atmosphere which are partially “opaque” to infrared. Again, this is favourable, and is the reason that the earth is warmer than the moon, even though both are about the same distance from the sun (without this natural greenhouse effect, the earth’s temperature would be approximately -18°C). However, if we increase the amount of these infrared-blocking components – or greenhouse gasses – in the atmosphere, by for example emitting CO_2 faster than it is absorbed by natural processes like plant growth, then we will have more trapping of heat energy within the atmosphere, causing a net increase of energy in the system, which becomes unfavourable.

But how can all this be true, when on some days our senses tell us it is cooler than expected? It is a matter of statistical likelihoods. Every day the temperature is either average or cooler than average, or warmer than average. Compared to weather records in the past, we do still have cooler than average days, just fewer of them, and we have more days that are warmer than average; and more days that are hot. Figure 3.3 illustrates this. The first box shows the global summer temperature distribution during the three decades 1951–1980, forming a bell-shaped normal distribution curve, and this serves as the baseline. The second box shows the temperature distribution in the decade 1981–1991, compared to the baseline set in the preceding three decades, and although the bell-shaped curve persists, it has shifted to the right, with the emergence of occasional “extremely hot” days. The third box shows the temperature distribution for the 1990s, compared to the same baseline; and the curve continues to shift further to the right. The fourth box shows the first decade of this century, showing the curve both spreading laterally and shifting even further to the right, with more “warmer than average” days in that decade than “average” days, and “extremely hot” days becoming increasingly common; although “cooler than average” days still occur. This is why occasional

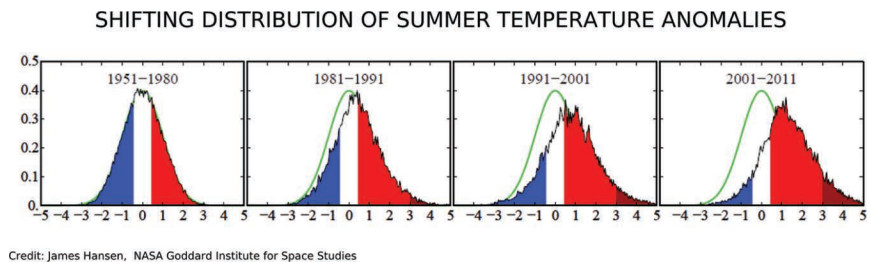


FIGURE 3.3 Frequency of occurrence (vertical axis) of local June-July-August temperature anomalies (relative to 1951–1980 mean) for Northern Hemisphere land in units of local standard deviation (horizontal axis). Temperature anomalies in the period 1951–1980 match closely the normal distribution (“bell curve”, shown in green), which is used to define cold (blue), typical (white) and hot (red) seasons, each with probability 33.3%. (Wikimedia Commons, images created by NASA are in the public domain.)

cooler than expected weather does not disprove the science of climate change (NASA 2020a).

The discussion up until now has largely assumed that the rate of climate change is more or less linear in relation to greenhouse gas concentrations in the atmosphere. However, this is probably not an accurate assumption and one major unanswered question in climate science is the concern of tipping points. Tipping points are abrupt non-linear irreversible changes in the climate system – in other words, when a particular threshold is crossed, the climate system may suddenly “tip” from one state to another in a relatively short time (Schneider 2002; Steffen et al. 2018; Lenton et al. 2019). Looking at this from a veterinary perspective, we can understand how systems can “compensate” in the face of suboptimal conditions up to a certain point and then decompensate, leading to the clinical appearance of a sudden severe illness when in fact the pathophysiology has been developing subclinically for much longer.

Some of these potential climate tipping points involve feedback loops, and while this is an area where knowledge is still developing, there is a possibility that some tipping point events could be triggered in the range of 2°C of average warming. For example, one positive feedback loop involves the Greenland ice sheet, where ice at lower elevations melts more quickly because the temperature is warmer; and more melting at these lower elevations reduces the overall elevation of the ice sheet, putting more ice in the warmer range. Likewise, ice cover loss results in less reflectivity (albedo) and more absorption of heat (because the surface colour would now be dark, not white), leading to more melting. Irreversible melting of either the Greenland or Antarctic ice sheets would lead to accelerated sea level rise; and the release of fresh water from Greenland ice sheet melting could disrupt the Atlantic thermohaline circulation that is an important global heat transporter. Another example of a positive feedback loop is permafrost melting, which releases substantial quantities of methane (another potent, greenhouse gas), leading to a more potent greenhouse effect (Schneider 2002; Steffen et al. 2018; Lenton et al. 2019).

Vegetation and soils typically act as a carbon sink, storing CO₂ that is absorbed through photosynthesis. When the land is disturbed, the stored CO₂ - along with methane and nitrous oxide - is emitted, re-entering the atmosphere. Land clearing can result in soil degradation, erosion, and the leaching of nutrients, which can also possibly reduce the soil’s ability to act as a carbon sink. This can result in additional CO₂ remaining in the atmosphere, thereby increasing the total amount of greenhouse gases. Globally, CO₂ emissions from land use changes represent an estimated 18% of total annual emissions (Ritchie and Roser 2020). (In addition, deforestation directly impacts on individual animals in cleared areas and impacts populations through loss of habitat.) Another potential regional tipping point can occur if deforestation eventually triggers breakdown of the forest ecosystem as a whole.

Importantly, tipping points may cascade (the results of crossing one tipping point may trigger another, and so on). Examples of this would include the above-mentioned disruption of Atlantic thermohaline circulation triggering regional

temperature changes that lead to dieback of forests, resulting in reduced sequestration of CO₂, leading to higher global temperatures, and so forth. Again, while the body of knowledge regarding potential climate tipping points and exactly when which point would be triggered is still developing; it is acknowledged that these points are a real risk whose consequences would be unacceptable and every effort should be made to avoid them. While on the one hand comforting that these dramatic effects are not a certainty, it is also concerning that they are a possibility and their thresholds are not clearly defined. This underscores the urgency of the climate change problem and the need to make strong action on mitigation (below) a top priority.

As a result of these processes to date, global surface temperatures have risen significantly. Nineteen of the 20 hottest years ever measured with instruments have been in the last 21 years, and the 5 hottest years of all have been the last 5 years (Lindsey and Dahlman 2020). The likelihood and severity of heatwaves in Australia have been greatly increased due to human activity (Steffen, Hughes and Perkins, 2014).

As a result of this, in the last few years, Australia has seen animal tragedies unfold both underwater, with repeated severe global coral bleaching events hitting the Great Barrier Reef and massive loss of Tasmanian kelp forest, and on land, with heatwaves, drought and fires causing massive impacts on the welfare and survival of both domestic and wild animals.

Veterinarians have a duty to use their scientific knowledge and skills for the protection of animal health and welfare, the prevention and relief of animal suffering, and the promotion of public health. Multiple aspects of climate change impact on that responsibility.

In the 2009 “Black Saturday” bushfires, more than 1,000,000 animals were killed, including nearly 12,000 helpless livestock (National Museum of Australia 2020). In the recent 2019–2020 Australian bushfire event, more than 3,000,000,000 wild vertebrate animals were killed or left homeless (WWF 2020), in addition to 100,000s of livestock killed (in fact, one of the most pressing needs for assistance from the Australian Defence Force when deployed was to help bury dead livestock in mass graves to prevent a biosecurity crisis) (9News 2020). In the 2019 Townsville floods, more than half a million cattle died (Major 2019).

It is important to also consider not only the numeric magnitude of these losses but the animal welfare considerations – fear and pain - of death in fire, flood or other natural disasters. In addition, many more animals that did not die in the immediate event suffered habitat loss and resultant stress, loss of breeding opportunities, predation and/or starvation. Figure 3.4 shows two reptiles that emerged from a fireground approximately two months after the event; both had obviously survived the fire but subsequently suffered from malnutrition (both recovered with supportive care and were released in alternate locations).

In addition to the impact on individual animals, the massive geographic scale of the most recent Australian fire season has resulted in pressure on entire



FIGURE 3.4 Two reptiles (a, b land mullet; c, red-bellied black snake) that emerged from a fire ground in the months following the fire, showing signs of dehydration and cachexia. (Image: author.)

species, such as the Kangaroo Island dunnart and glossy black cockatoo, and local populations of already-stressed species such as koalas. In January 2020, an analysis by the Australian Government Department of Agriculture, Water and Environment indicated that 49 listed threatened species had more than 80% of modelled likely or known distribution within the fire extent (Richards, Brew and Smith 2020).

Underwater heatwaves in past years have dramatically impacted on both the Great Barrier Reef and Tasmanian giant kelp forests. These are not conventionally thought of as veterinary issues, but both ecosystems are important habitats and nurseries for millions of animals and their loss would be devastating to biodiversity.

The giant kelp forests of Tasmania represent a highly diverse ecosystem which has been decimated in recent years, attributed clearly to ocean warming associated with climate change. The East Australian Current has extended further south in recent decades resulting in much more rapid warming along Tasmania's East coast than the average global ocean temperature. The impacts of this on the giant kelp are threefold: the higher temperature itself is stressful, the warm water being carried south is poor in nitrogen and the temperature is now high enough for spawning of long-spined sea urchin (which it was not previously), leading to plague proportions of the urchins which graze on the kelp. Taken together, these impacts result in the kelp being unable to regenerate after storm losses. For these reasons, approximately 95% of giant kelp has been lost. Likewise, in Western Australia, 100km of kelp forest was killed during an underwater heatwave

between 2010 and 2013 (Bennett, Santana-Garcon and Wernberg 2016). As of 2016, giant kelp was considered locally extinct along a 250-km stretch of the east coast of Tasmania (University of Tasmania 2018).

Australia's tropical coral reefs are beautiful, iconic and economically important to the tourism industry. They are also extremely important wildlife habitats, with one in four fish relying on a coral reef during at least some stage in its life cycle. There are many threats to tropical coral reefs, but coral scientists agree that the single greatest threat is climate change. Coral bleaching is a state of extreme stress of coral polyps – the minute invertebrate animals whose colonies form what is typically thought of as “a coral” - resulting from excess water temperature. If conditions improve, the polyps can potentially recover, but mortality begins if the temperature remains high for more than 8 weeks (Figure 3.5). Bleaching has been observed on the Great Barrier Reef since 1982, with severe bleaching events occurring in the summers of 1998, 2002, 2006 and 2016–2018. In June 2016, the Great Barrier Reef Marine Park Authority (GBRMPA) reported mortality from the previous summer's bleaching event, ranging from full recovery in the southern extent of the reef to 50% mortality in the north. A second mass bleaching occurred the following summer, resulting in a further 20% mortality. Another mass bleaching event in the 2019–2020 summer appears likely to be very widespread (Great Barrier Reef Marine Park Authority 2020). In 2019, the GBRMPA's 5 yearly outlook report found that the condition of the Reef was very poor, with widespread habitat loss affecting fish, turtles and seabirds, and called for the “strongest and fastest possible action” to reduce CO₂ emissions (Great Barrier Reef Marine Park Authority 2019).



FIGURE 3.5 Bleached branching coral (*Acropora* sp.) at Heron Island, Great Barrier Reef, 21 January 2005. (Image Source: Creative Commons. Author: J. Roff.)

In 2019, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) issued a report predicting that 1,000,000 species are at risk of extinction and that

The rate of global change in nature during the past 50 years is unprecedented in human history. The direct drivers of change in nature with the largest global impact have been (starting with those with most impact): changes in land and sea use; direct exploitation of organisms; climate change; pollution; and invasion of alien species

(Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) 2019).

As just one example, the Bramble Cay melomys, *Melomys rubicola* (or mosaic-tailed rat) (Figure 3.6) was declared extinct in 2016; considered the first extinction of a mammal species specifically due to anthropogenic climate change, its habitat was inundated by rising sea levels (Fulton 2017). Importantly, the IPBES report noted “... it is not too late to make a difference, but only if we start now at every level from local to global...”

Other impacts of climate change on animals and human health include heat stress (a major killer in itself), changes in the distribution of infectious diseases and insect vectors; and food shortages and drought. Economic stress to animal owners also impacts their ability to provide proper husbandry and veterinary care for their animals.

Taken together, this information leads to the conclusion that climate change is a serious and urgent problem; and it can well be considered an animal health and welfare emergency. Thus, what can be done; and more specifically what can veterinarians do to help the problem?

As ever, understanding the sources of the problem allows us to focus our efforts to combat it. CO₂ is a major greenhouse gas but it is not the only one; others include methane and water vapour, so the primary emphasis on CO₂ emissions



FIGURE 3.6 Bramble cay melomys, extinct. (Creative Commons. Attribution: State of Queensland.)

can be confusing. Recall also that not all greenhouse effect is negative and the natural baseline greenhouse effect is in fact vital to life on earth. However, the reasons for the emphasis on CO₂ in the discussion around climate change are that CO₂ is the greenhouse gas whose concentration has changed the most since the Industrial Revolution (i.e. it is the main greenhouse gas produced by human activity), it contributes a major proportion to warming, and it is also the greenhouse gas most likely to be controllable with reasonable regulations. And while there are other sources of CO₂ emissions, the biggest by far is the production and burning of fossil fuels (Ritchie and Roser n.d.).

Fossil fuels still provide the majority of the world's energy. Their use - and emissions - has gone up dramatically since World War II and has contributed greatly to the social progress and standard of living that characterized the second half of the 20th century. However, this benefit was not without adverse effects – unknown initially but now understood for several decades. Considering Australia's fossil fuel emissions by source, electricity is the largest; the second largest is mining, industry and heating and then transportation (Bourne et al. 2018). Fortunately, there are good alternatives now available, especially for the largest sources.

There are two main categories of response – adaptation and mitigation. Adaptation means accepting some change and learning how to manage with it, and mitigation means taking steps to minimize the amount of change that will occur. Adaptation (now often termed “resilience”) includes activities such as building seawalls and switching agricultural production to more heat-resistant strains. Mitigation focusses around reducing the causes of the problem – primarily greenhouse gas emissions, especially CO₂. From a veterinary perspective, mitigation is much more important, because adaptation mainly centres around the needs of humans and largely does not solve the problem for other species. Moreover, mitigation is much less costly than adaptation. However, some adaptation will be necessary, because the greenhouse gas levels already emitted commit the world to some warming, and current efforts centre around attempting to limit warming to 1.5°C.

In addition, because of the recognised importance of limiting warming to avoid triggering tipping point events, the amount of greenhouse gasses already emitted and the delay in initiating the transition to a low-carbon economy, the concept of “drawdown” or “negative emissions” has become important. This refers to not just reducing emissions but actively removing CO₂ from the atmosphere. The simplest form of “drawdown” is revegetation or reforestation. The impact of deforestation as one of the causes of climate change was mentioned above, but reforestation can to an extent remediate the damage. By removing CO₂ from the air through photosynthesis, forests function as terrestrial carbon sinks. At any time, forests account for as much as double the amount of carbon in the atmosphere. Forests remove approximately three billion tons of CO₂ every year, or about 30% of anthropogenic emissions (Canadell 2008). So an increase in the overall forest cover around the world would be highly valuable mitigating step. It is of course better to avoid deforestation in the first place than to allow for deforestation and subsequently reforest, as the former leads to irreversible effects

in terms of biodiversity loss and soil degradation – it is not a simple one-for-one replacement - however in areas already deforested, it is better to reforest than to leave them in the degraded state.

Likewise, agriculture in its current form is a major source of CO₂ emissions (after fossil fuel use) (Ritchie and Roser 2020). However, agriculture is also a potential champion by being one of the most effective and least costly sources of CO₂ drawdown with substantial side benefits. Regenerative agriculture is a large and important topic and a full treatment of it is well outside the scope of this chapter. Briefly, it is a system of farming principles and practices that seeks to rehabilitate and enhance the entire ecosystem of the farm by placing a heavy premium on soil health with attention also paid to water management, fertilizer use, and others – resulting in greater carbon sequestration in the soil as well as being more productive and less polluting in other ways. Some of the key techniques include low- or no-till practices, increasing plant diversity in fields, the use of crop rotation and cover crops, and using fertilisers and other soil amendments sparingly (Project Drawdown 2014–2020a, 2014–2020b).

Other negative-emissions or “drawdown” technologies, such as carbon capture and storage (CCS) and direct air capture and storage have not yet proven cost and energy effective on a large scale (Sgouridis et al. 2019).

Efforts to reduce emissions in the past have emphasized individuals and businesses minimizing their personal “carbon footprint” – switching off lights, cycling instead of driving, etc. This is important and should continue, but it is not adequate in the face of industrial-scale extraction and emissions. Moreover, it shifts responsibility onto consumers, when the necessity for these changes is so clear that individual choices should not be the major force driving them. An effort of the magnitude needed must come from government, industry and finance; and it is beginning to happen.

The finance sector is progressing quickly, recognizing the economic risks of climate change and old technologies. Many scientific and financial experts now agree that doing nothing about climate change is already becoming more costly than taking action; and that moreover, a change will be a win-win, and the polarization of environment versus the economy no longer accurate. At the time of writing, the RE100 initiative has partnered with 230 global major corporations committed to source 100% of their global electricity from renewable sources as soon as possible (by 2050 at the latest) (there100.org). The Powering Past Coal Alliance is an alliance of national and sub-national governments, business and organization committed to accelerating the transition from coal to clean energy, whose 97 members currently include 33 countries and 27 sub-national governments, including Sydney, Melbourne and the ACT (<https://poweringpastcoal.org/>). Australia’s states and territories have made strong commitments.

Both solar and wind energy have dramatically surpassed predicted potential, with installations and the energy produced from them increasing and costs dropping rapidly, and Australia has the best solar resource of any nation in the world (Australia 2020). Electricity from wind and solar are now cheaper than electricity from new coal plants or new natural gas plants (Kretchmer 2020). There are

over 26,000 renewable energy jobs in Australia (Australian Bureau of Statistics 2020), and statistics from the US showed that the fastest-growing job category through 2029 is forecast to be “wind turbine service technician”, followed by “solar installer” in third place (after nurse practitioners) (US Bureau of Labor Statistics 2020).

A particular benefit of renewable energy sources for developing countries is that many renewables can be less centralized than fossil fuel-fired electricity. In many areas affected by energy poverty, the problem is actually lack of grid access, not lack of coal. However in areas with no universal electricity grid, consumers and businesses can access electricity by small-scale solar installations (Figure 3.7). Thus, local economies can be supported at the same time as progressing towards climate solutions.

Reliability is a frequently cited concern with renewables; but while sun and wind are variable, they are predictable, and coupled with batteries, hydroelectric dams and smarter grids, the “intermittency problem” is surmountable. The Hornsdale Power Reserve, South Australia’s “big battery” which was grid-connected on 1 December 2017, helped to stabilise the power grid when a unit at the Loy Yang coal-fired power station tripped on 14 December 2017, before the Gladstone Power Station was able to respond; (Parkinson 2017) and in its first 2 years of operation is estimated to have saved consumers over \$150 million (Hornsdale Power Reserve 2020).

Thus, a transition to a low-carbon economy is not only necessary and feasible but has the potential to be associated with a better economic outcome for Australia than not transitioning. Certainly, the transition will require resolution, care and attention to justice; but the technical resources are ready, and “responsible” transition should not be a euphemism for delay. Rather, considering the scale and the urgency of the problem, the responsible approach is to make the strongest possible effort at emission reduction, at the fastest possible pace.

Thus, because of the widespread impact on animal health and welfare, animal suffering and public health, climate change undoubtedly is a veterinary problem. Some veterinarians are even experiencing personal grief as a result of these impacts. However, at this time, there is no collective course of action available



FIGURE 3.7 (a and b) Small-scale solar economy in Madagascar, 2017. (Image: author.)

that can entirely avoid any kind of change; and there will be both climate change and change in energy sources, industries and patterns of consumption. The choice of path will influence the relative extent of the different types of change.

Veterinarians are well educated to understand the problem and the urgent need to mitigate it. However, the pressures of veterinary work, combined with family and community responsibilities mean that most veterinarians are too busy to take substantial action personally; and end up feeling disempowered. Several not-for-profit organizations and networks exist that can help to act as sounding boards, communities of support, and amplifiers for veterinarians concerned about climate change and its impact on animals. *Climate Vets* is a global network of animal health professionals concerned about climate change and other environmental problems (climatevets.net). *Veterinarians Concerned About Climate Science Denial* is an Australian-based Facebook group (<https://www.facebook.com/groups/1390813204416169>). *Veterinarians for Climate Action* (vfca.org.au) is a new organization formed in Australia in 2019 to help empower veterinarians to take action on climate change on behalf of animals. Veterinarians for Climate Action aim to inspire the veterinary profession to advocate for and achieve climate action both within and beyond our industry. Veterinarians for Climate Action's founders believe that by organising and engaging veterinarians to advocate together, the organisation can help to influence the industry, the public and the government towards stronger climate action.

Veterinarians are empathetic and caring and are generally trusted and well-connected within their communities; and at the same time are scientific, knowledgeable and well-practiced at communicating scientific information to laypeople. Therefore, veterinarians are well positioned to positively influence public understanding and government policy regarding climate change.

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4 Animal Welfare Aspects of Land Clearing

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WHAT IS THE WELFARE PROBLEM WITH LAND CLEARING?

DEFINITIONS AND INTRODUCTION

Land clearing consists of the destruction of the above ground biomass of native vegetation and its substantial replacement by non-local species or by human artefacts.

(Cogger et al. 2003)

Animal welfare means the physical and mental state of an animal in relation to the conditions in which it lives and dies.

(World Organisation for Animal Health 2019)

This chapter discusses the scientific concepts of animal welfare developed internationally over the last 40 years and applies them to the welfare of animals affected by land clearing. The examples are drawn from the Australian experience but the principles apply generally (Figure 4.1).

The process of land clearing describes a spectrum of practices that modify the vegetation from minor clearing for infrastructure and urban development to complete removal of the native vegetation for irrigated agriculture, cropping and introduced pastures. The animal welfare and biological consequences also follow a continuum from minimal impact to complete loss of the native biota and irreversible change. The historic sequence that occurs can take place over decades where sequential expansion gnaws away at the native vegetation edge, with each small increment seeming inconsequential, yet the total effect over years can be the complete loss of bioregions. An example would be the Blue Gum High Forest bioregion of the Sydney Basin, which is a critically endangered ecological community (Environment Protection and Biodiversity Conservation 1999). It is now limited to a few isolated hectares, despite being identified as a threatened ecosystem in 2005. Broad-area land clearing, historically driven by government-backed development projects, like the Brigalow Scheme 1962–1978, had a more rapid and transforming effect on bioregions. This variation in clearing practice changes the intensity of the animal welfare impact but not the ultimate effect.

ANIMAL WELFARE

Social Licence

The animal welfare problem created by clearing mature vegetated landscapes is that most animals in those landscapes die, either immediately or subsequently (Cogger et al. 2003). The animal welfare consequence of the decision to clear is, or should be, known at the time (Finn and Stephens 2017) as many studies have documented the outcome (Hannah et al. 2007; Woinarski, Burbidge, and Harrison 2015). A social license exists within our community to tolerate animal welfare shortcomings when the human benefit exceeds the welfare infraction (Sharp and Saunders 2011). This social licence also

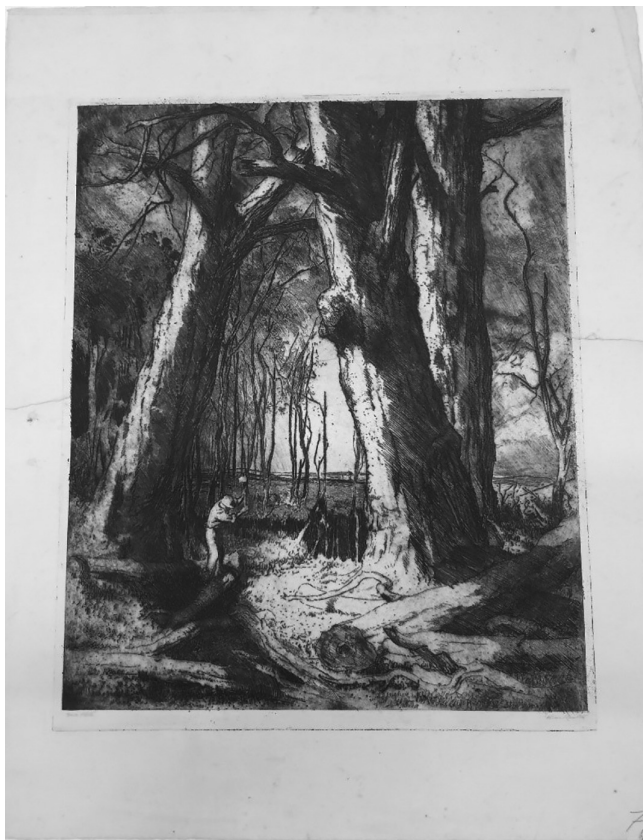


FIGURE 4.1 Red Gums. Henri van Raalte 1917–1919. Etching printed in brown ink. (Reprinted with permission of the National Gallery of Australia, Canberra, Australia.)

underpins our relationship with trading partners who expects that food production and development occur in a regulated and a sustainable framework which respects animal welfare (Broom 2010). Without achieving acceptable welfare outcomes markets and community acceptance can be eroded. In the Australian context, the on-going animal welfare concern about live animal exports and the culling of feral horses (brumbies) would be two cases in point where considerable gaps exist between community expectations and outcomes and a diversity of views. Yet, in the case of land clearing, the regulatory protections of animal welfare and transparent assessment of humaneness we would expect have not been developed. The approved clearing of land generally carries with it an exemption against prosecution for the harm caused to animals which would, in other circumstances, lead to prosecution (Finn and Stephens 2017). Some protections exist for threatened species and particular iconic species like the Koala.

Impact and Scale

Free-living animals (wild animals), both native and introduced, depend solely on their native or human-modified habitat to survive. Any disturbance in the total area or the quality of that habitat will have consequences for their survival to be reflected in a change in their abundance or a change in the mix of species present. This includes changes caused by variations in the weather cycles, climate change, fire events, introduced species and other causes. The development of land to a new commercial purpose carries with it the inevitability that the animals living there will be affected. It is rare that adjacent vegetation is available for the displaced animals to occupy given that available resources present will generally be occupied. Not only will the disturbance affect the displaced animals but will also affect the resident animals as they compete for nesting space, food or behavioural stress as new individuals or species move into their environment. The consequence of these displacements is well documented and widely accepted. Typically less than 10% of the original taxa will survive and the number of species (diversity) is between 5% and 20% of the pre-cleared number (Cogger et al. 2003; McAlpine, Frensham, and Demple-Smith 2002). This affects all animals, to varying degrees, whether arboreal or terrestrial, notwithstanding that mobile species have more opportunity to escape the immediate impacts.

Quantifying the welfare impacts of land clearing on free-living animals can be broadly done in two ways, by determining the number of animals affected and assessing the “humaneness” of the way in which they died (Kirkwood, Sainsbury, and Bennet 1994). The history of settlement in Australia has determined the sequence of clearing which originated in the South Eastern regions and extended West and North as the most productive and most accessible land was developed first. The areas selected for more detailed discussion in this chapter are from mostly from Queensland because it reflects this temporal sequence and because good science is available which describes the impacts. The maximal rate of land clearing in Australia was the 70s and 80s and most of that occurred in Queensland (Evans 2016). Although the rate has now slowed, the process shows signs of extending further North to the Northern Australian Tropical Savannah (Figure 4.2).

Land clearing occurs primarily for improved pasture for grazing animals representing typically over time 85%–90% of area cleared Australia wide, with a smaller proportion used for cropping and irrigation (Evans 2016). Recent figures for Queensland have been at the upper end of this range: pasture 91%, forestry 5.4%, cropping 1.7%, mining 1.1%, settlement 0.7% and infrastructure 0.3% (Neldner 2017). Although the proportion cleared for urban expansion and infrastructure is small, most is located in coastal zones of higher rainfall and high biodiversity (Figure 4.3).

The number of animals affected by land clearing can be estimated from the density of individuals of each species affected, multiplied by the area cleared. These figures are then used to assess the loss, year on year, according to the area of land cleared. Cogger et al. (2003) used this methodology with The Database

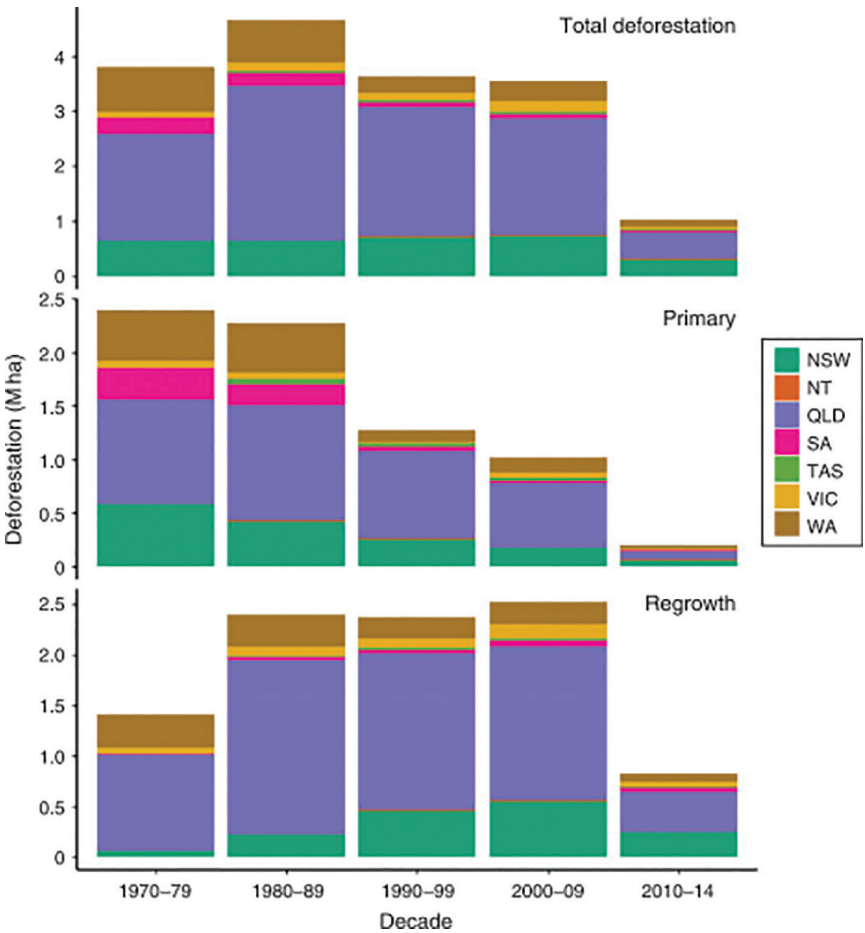


FIGURE 4.2 Amount of deforestation (total, primary and regrowth) per decade from 1972 to 2014 for all Australian states and territories (excluding Australian Capital Territory). (Reproduced from Evans (2016) with permission from CSIRO Publishing.)

of Abundance of Australian Mammals compiled by Dr Chris Johnson, which contains data of 62 species. Only animals for which density data were available were included, thus the number of animals affected is likely to be underestimated. Animals not considered vulnerable to land clearing, like red kangaroos and rock wallabies, were also excluded from the study.

The number of mammals killed or displaced by land clearing in Queensland for the period 1997–1999 was 2.1 million individuals per year most of which (60%) occurred in the Brigalow Belt. By species, these estimates included 233,000 macropods, 342,000 possums and gliders, over 7,500 Echidnas, 19,000 Koalas, 29,000 bandicoots and 1.4 million small carnivorous marsupials and native rodents. The

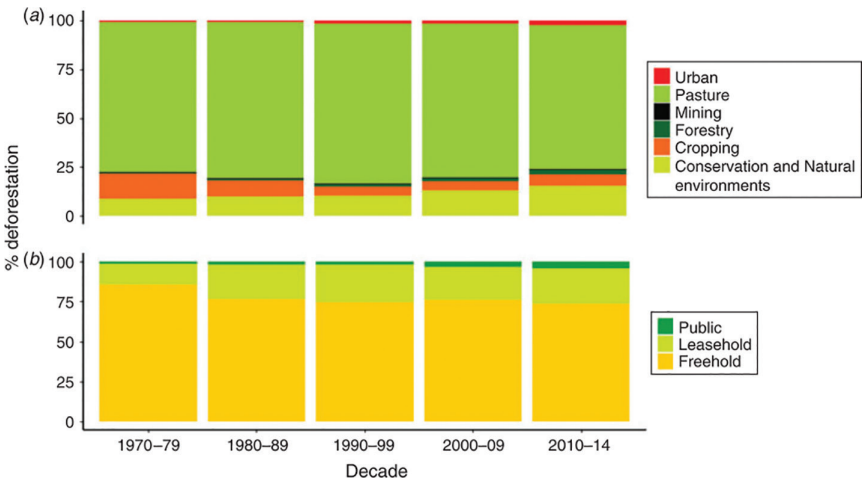


FIGURE 4.3 Proportion of total deforestation in each decade, by (a) land use (as of 2005–2006, above) and (b) land tenure (as of 1993, below). (Reproduced from Evans (2016) with permission from CSIRO Publishing.)

TABLE 4.1
Number of Selected Mammals Killed Annually in Queensland – 1997–1999

Mammal Type	Total Number Killed
Koalas	19,000
Possums and gliders	342,000
Echidnas	Over 7,500
Macropods (kangaroos, wallabies and rat-kangaroos)	233,000
Bandicoots	29,000
Small carnivorous marsupials (dunnarts antechinuses and others)	1,250,000
Rodents (native rats)	196,000

Source: Data from Cogger et al. (2003) Table 2.

years 1997–1999 represented a recent peak in the rate of clearing remnant vegetation which has now fallen to 74,492 ha in 2017/2018 but the rate of regrowth has increased and remains at high levels (317,994 ha 2017/2018). The animal welfare impacts of clearing regrowth are likely to be less than remnant vegetation but will depend on its maturity (Bruton, McAlpine, and Maron 2013) (Table 4.1).

An alternative measure, on a smaller scale, is available from studies derived from fauna abundance assessments prior to land clearing as part of faunal rescue programs when land is cleared for urban and mining developments (Thompson and Thompson 2015). In their study from Western Australia, spotter-catchers were used to locate and move animals affected in two clearing projects. Of those

animals detected 39% of mammals, reptiles and frogs died during clearing. The proportion of animals detected by fauna spotters during clearing is typically low. In a comparative study, by the same researchers, of pre-clearing and clearing spotter success, more than three times the number of animals were detected pre-clearing (17 animals per hectare) than were detected while clearing was underway. These projects did not survey bird numbers and did not assess long-term survival of animals relocated to adjacent suitable habitat. Many of which will not survive (Menkhorst, Clemann, and Sumner 2016). The welfare implications are of significant concern notwithstanding the significant effort that was made to meliorate the consequences. A crucial consideration remains the survival of native animals translocated under such circumstances to adjacent habitat.

Extinction Debt

The welfare and survival implications of land clearing can be both acute and protracted even with minor interventions. Grazing herbivores and tree thinning can tip the balance which affects the population's ability to survive long term and sets them on a trajectory of decline or local extinction (McAlpine et al. 2002). This "extinction debt" can lead to the future loss of species locally or globally as a consequence of past actions (Kuussaari et al. 2009). The studies of McAlpine et al. (2002) from Central Queensland showed that 30% reductions in remnant vegetation lead to vertebrate fauna loss of between 25% and 35% with the expectation that the full impact may not be felt for 50–100 years. The impacts can affect animals absent at the time of clearing, for example migratory or seasonal visitors, like birds and bats, who return to an area to find it changed with food or nesting opportunities reduced or obliterated. Alternatively, the effects are only felt later when infrequent extreme seasonal events cause excessive erosion, sedimentation or facilitate the introduction of feral plant or animal species. Such disturbances can lead to changed fire events and genetic isolation of species. These effects, in general, cannot be reversed because it may be impossible to rehabilitate cleared land as it was in its native state. Particularly in complex wooded environments which contain interdependent age structures, in some cases hundreds of years old. Therefore, it is crucial to consider the potential consequences, prior to altering land management practice (Figure 4.4).

Humaneness Score

The second way to assess the animal welfare impact on these animals is to consider the "humaneness" of their deaths. Human activity that impacts with lethal effect on free-living animals occurs in a number of situations. It is revealing to compare what welfare considerations have been put in for these animals. The lethal control of feral animals and killing of excessive numbers of localized native animals (kangaroos, flying foxes and dingoes) remain as an unfortunate necessity in Australia. Extensive debate, legislative control and regulatory supervision have been applied in these situations. Science and community consultation has been used to determine the animal welfare cost/human benefit balance to determine a point acceptable to the wider community (Mellor and Littin 2004).

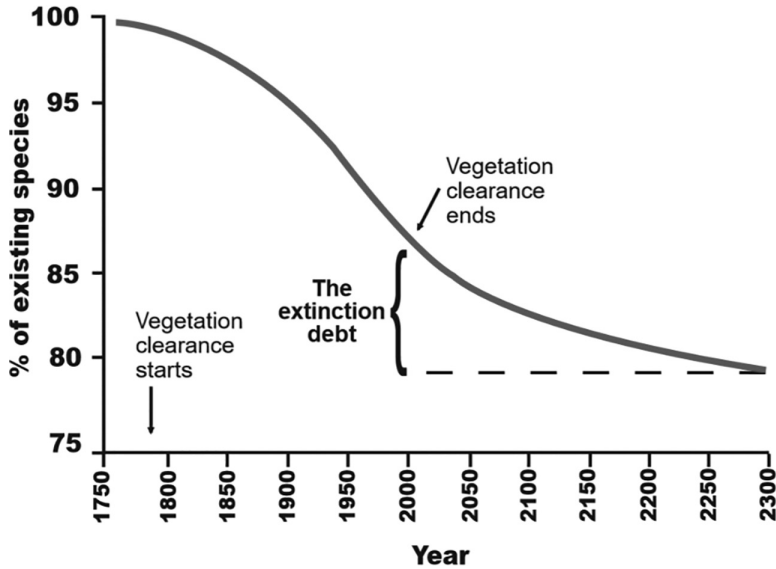


FIGURE 4.4 Extinction debt. (Reproduced from Cogger et al. 2003 with permission from WWF.)

The humaneness matrix model (Sharp and Saunders 2011) is being used to help select the most humane methods for lethal control of feral cats, wild dogs, feral pigs, rabbits and feral horses.

This approach is based on the work of Mellor and Reid (1994) and (Mellor and Littin 2004), assessing five domains to assess welfare being:

- Domain 1. Water and food deprivation
- Domain 2. Environmental challenge
- Domain 3. Disease, injury and functional impairment
- Domain 4. Behavioural and social restrictions
- Domain 5. Anxiety, fear pain and distress

Three ethical principles underly the foundation of the humaneness score (Sharp and Saunders 2011). The first is the “benefit of the doubt” where, in the absence of knowledge or where knowledge is inadequate, it is assumed that the animal will suffer. The second is the “worst case” where, in the absence of information to the contrary, it should be assumed the suffering is severe. The third is that “equal weight” is applied to the different dimensions of suffering, like pain, illness and stress.

Using the structure outlined above, Sharp and Saunders developed a two-part assessment process for lethal control methods for feral animals. Part A assesses the overall welfare impact based on the five domains and Part B assesses the killing method, based on the time to insensitivity, the intensity and duration of suffering. These are combined to provide a Humaneness Score.

While this procedure has not been developed for the assessment of animal welfare impacts of land clearing, the general principles apply. Some model examples of the application of this assessment method, as they apply to the land clearing scenario, are presented here. They provide a comparison of the Humaneness Score of animals killed by land clearing compared with those killed for approved feral animal control. The modelling should be reviewed with field data and expert panel assessment. A panel approach accommodates a variety of interpretations and judgements of parameters, which do not allow precise measurement. This would provide “A transparent reasoning process that can be understood by all stakeholders and also helps to generate consensus” as outlined by Sharp and Saunders (2011). Modelling is frequently used to gain insight into situations where the acquisition of field data is complex or impossible.

Making humaneness assessments scores in the land clearing context will produce a number of outcomes because of the diversity of clearing methods used, the number of species involved, the variety of topography and vegetation. The nature of the injuries suffered by individual animals during clearing have been described (Hanger, and Nottidge 2012; Finn and Stephens 2017). They include injuries ranging from crushing, fractures, abrasions, burns, psychological trauma (stress), separation from groups and nursing young and suffocation when sealed within burrows. These assessments are typically only made for larger mammal and avian species taken to wildlife rescue centres and veterinary clinics. The full assessment of the animal welfare implications of land clearing on free-living animals requires a ‘reach’ not part of previous assessments of the welfare implications of human pressures on free-living animals. These include the individual impacts as well as the extensive third-party impacts. They are detailed in the following ‘text box’. The spatial spread of animal welfare impacts is wider than first anticipated because it will include, the resident animals, neighbouring animals, migratory species, and distant effects caused by runoff of sediments and changes to hydrological and evapotranspiration cycles.

Perhaps for these reasons, a systematic evaluation and comparison of the relative humaneness of different clearing practices has not been done but the need is

EXTENDED ANIMAL WELFARE EFFECTS

- a. Individual animals
- b. Dependent offspring
- c. Populations
- d. Third-party – predator/prey and trophic
- e. Competing species
- f. Recipient populations
- g. Geographically distant effects – sediments, water quality, climate
- h. Unborn generation effects – sub-functional populations and genetic isolation

urgent. This would allow practices to be compared, codes of practice, and standard operating procedures to be introduced both to meliorate suffering of the animals affected but importantly for procedure to operate within an accepted social licence and therefore be sustainable (Broom, 2010). This suggests that much scope exists to improve the animal welfare outcomes by focusing on measures that operate at each stage; pre-clearing, clearing and post-clearing. These improved methods can then be incorporated into existing draft code of practice like those prepared by Hanger and Nottidge (2012).

Three model assessments are included in this chapter to demonstrate the relative animal welfare impact that can be anticipated when animals are impacted by land clearing. Three ‘model cases’ are presented to outline possible scenarios affecting a Koala, a group of Black-striped Wallaby and a Greater glider. The model case for the Black-striped wallaby is included in the text below and the other two in the Appendix 4.1.

MODEL CASE HUMANENESS ASSESSMENT SCORE – BLACK-STRIPED WALLABY (*MACROPUS DORSALIS*)

This modelled humaneness assessment is a theoretical but realistic case study using the scoring methodology of Sharp and Saunders (2011). The locations and environments chosen are representative of those in which these animals live and are summarized in documents like The Action Plan for Australian Mammals 2012 (Woinarski, Burbidge, and Harrison 2012). The scenarios are drawn together from knowledge of animals, farms, environments, veterinary science, and literature sources.

Species: Black-striped wallaby

Location: Clarence River, NSW

Sequence: land clearing for development of a small holding.

Animals: at the time of development the following mammals were known to be present in the area: Greater glider, Koala, Eastern Grey kangaroos, Echidnas, Black-striped wallaby (*Macropus dorsalis*)

Case Study Animal Impact

An area of 20 ha in heavily vegetated forest was progressively cleared over 5 years as part of the development of a hobby farm. The block was adjacent to a national park and located in the Clarence River valley. A number of large trees were removed to permit the construction of a small bungalow and garage and a fire-break of 50m surrounding buildings. Tracks were pushed into the bush, and the ground cover was extensively thinned to remove fuel load. One cow and one horse were introduced and owned as companion animals. The block was re-fenced securely, whereas before the fences had been derelict and not stock proof.

The area had been core habitat for a group of approximately 8 Black-striped wallaby which were gradually displaced by the encroachment. Over a period of 3 years, they moved deeper into the adjacent forest area but had difficulty competing with existing pockets of macropods and the lack of accessible marginal

grasslands. The area contained a number of large predators and raptors including wild dogs, dingoes and eagles. The group diminished in size and some individuals intermingled with existing populations. The case study follows a mature non-dominant male aged 5 years. He lost condition over a period of 12 months and was unable to establish a breeding group. In his weakened state, he was attacked by a group of three wild dogs. The attack took place at the edge of the forest area and lasted about 5 minutes before the wallaby was brought to ground and a further 15 minutes until it died as a result of haemorrhage and vascular shock. The wallaby did not move and appeared insensible in the last 5 minutes. Extensive skin and deep lacerations were inflicted in the neck and jugular region and around the hindquarters and tail region. The redeveloped site was regularly inhabited by the human owners and they also had two mixed breed dogs, which while disciplined could explore the surrounding bushland.

Summary

Young 5yo male Black-striped wallaby, non-dominant.

Displaced from stable habitat as a result of rural redevelopment.

Killed by wild dogs over a 20-minute attack of which it seemed insensible for the last 5 minutes.

Part A: assessment of overall welfare impact

The selected severity is indicated with tick ✓. Where more than one selection two categories may apply both are selected.

Domain 1 Water or food restriction, malnutrition

No impact	Mild impact	Moderate impact ✓	Severe impact	Extreme impact

Domain 2 Environmental challenge

No impact	Mild impact	Moderate impact ✓	Severe impact	Extreme impact

Domain 3 Disease, injury, functional impairment

No impact	Mild impact ✓	Moderate impact ✓	Severe impact	Extreme impact

Domain 4 Behavioural or interactive restriction

No impact	Mild impact	Moderate impact ✓	Severe impact	Extreme impact

Domain 5 Anxiety, fear, pain, distress, thirst, hunger

Score of Part A: 7

Overall Impact: The Overall welfare impact was moderate but persisted until the animal's death.

Duration of Impact:

Immediate to seconds	Minutes	Hours	Days	Weeks ✓

Part B: assessment of mode of death
Time to insensibility (minus any lag time)

Immediate to seconds	Minutes ✓	Hours	Days	Weeks

Level of suffering (after application of the method that causes death but before insensibility)

No suffering	Mild suffering	Moderate suffering	Severe suffering ✓	Extreme suffering

Score of Part B: E
Overall Humaneness Score: 7E

Summary of evidence: young 5yo male Black-striped wallaby, non-dominant. Displaced from stable habitat as a result of rural redevelopment.

Killed by wild dogs over a 20-minute attack of which it seemed insensible for the last 5 minutes.

Duration – 12 months
Suffering – Moderate to Severe

The same method has been used also to model the deaths of a Koala and Greater glider the details of which are presented in the Appendix 4.1. Figure 4.5 shows the summary results for the three modelled assessments alongside two data points assessed for feral animal control. Data points in the green zone are relatively more humane than those present in the orange zone. A key element in the assessment method is the time, which passes from intervention to death. The longer the period of suffering, the worse the humaneness score. This is clearly seen in the comparative case of a feral pig, killed by a head shot, where the length of time would be measured in seconds. A feral rabbit killed by the introduced bio-cide, Rabbit Haemorrhagic Disease Virus 1 has a much slower death reflected in its higher Mode of Death (Part B) score ranging from E to G (Centre for Invasive Species Solutions 2019).

The actual methods used for land clearing are chosen to suit the scale and terrain, which in turn determines the machinery used. Commonly bulldozers for broadacre clearing sometimes used in tandem with a ball and chain and a variety of other machinery including diggers, backhoes for smaller plots. The machinery used and the protocols followed by individual operators have an effect on the immediate morbidity and mortality rate (Thompson and Thompson 2015). Wildlife affected by land clearing generally die immediately through the direct impact from machinery or disturbance of vegetation. Others may survive for some time prior to succumbing to malnutrition, predation, incineration or other consequences (Cogger et al. 2003). A common and misleading notion that mobile species can move away to safe localities, and re-establish in the new location, is unusual (Cogger et al. 2003). This misnomer and hope that translocated animals survive provides a human psychological escape detaching us from our animal welfare responsibilities. Many mammal species have high levels of site attachment and will return, or attempt

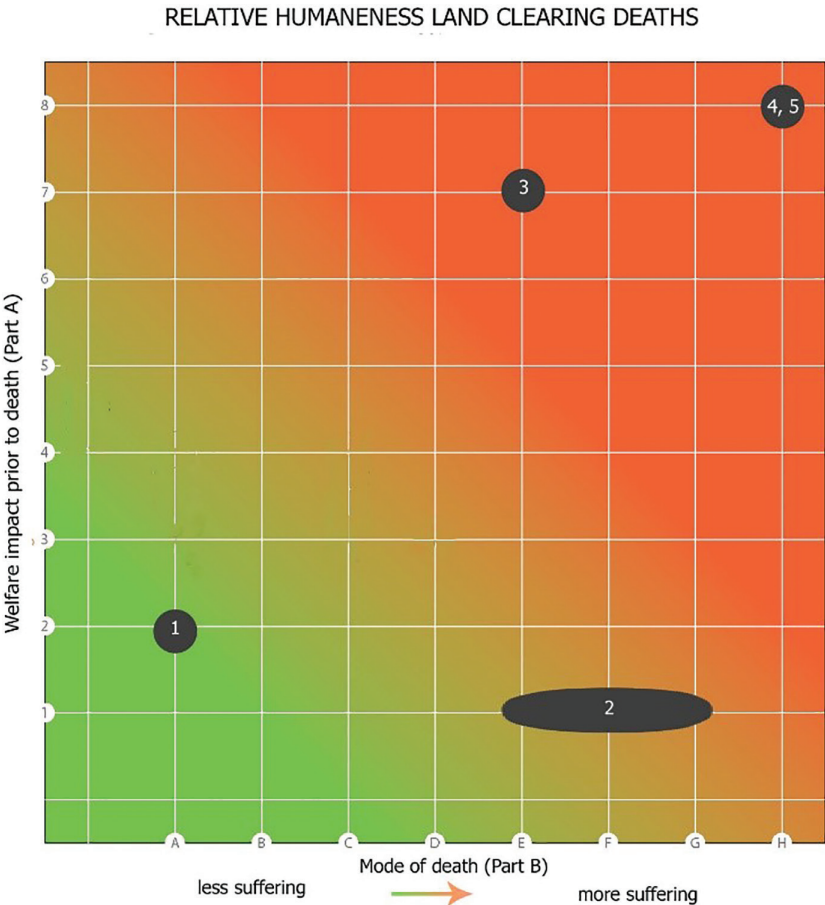


FIGURE 4.5 Model relative humaneness matrix of animals killed during land clearing compared with lethal feral animal control. Key 1. Feral pig ground shooting – head (2A), 2. Rabid bait delivery Rabbit Haemorrhagic Disease Virus-1 (1E-1G), 3. Black-Stripe Wallaby killed by land clearing (modelled), 4. Koala killed by land clearing (modelled), 5. Greater glider killed by land clearing (modelled). (The protocol followed is that of Sharp and Saunders 2011. The assessments for humaneness score for feral pigs and rabbit are taken from panel assessments (PestSmart). The model format has been adapted with permission of the authors.)

to return, to the destroyed area sometimes through fire to a devastated environment only to succumb later.

The rigor and scrutiny which have been applied to minimize trauma with lethal killing methods in abattoirs and for feral animal control, have not been applied wildlife affected by land clearing. Many options exist to mitigate the poor animal welfare outcomes and the sooner dialogue between stakeholders progresses the better for the animals and commercial sustainability of the livestock industries.

This will be developed in Section “What balances are in place to regulate land clearing?”

BIODIVERSITY & SUSTAINABILITY

How does biodiversity link with animal welfare? Good welfare for free-living animals depends on functional ecosystems with high biodiversity. These underpin sustainability (Steffen et al. 2015). The complex, natural interrelatedness of ecosystems is necessary to ensure that the ecosystem services are available for the animals in the environment as much as for sustainable animal production. Landscapes in which biodiversity has been compromised, even to a small degree, can place endangered native animals on an extinction spiral and carry obvious adverse animal welfare impacts. It has been suggested that 30%–90% of pre-industrial biodiversity needs to be retained to remain within functional ecosystem and safe planetary boundaries (McAlpine et al. 2002; Steffen et al. 2015). In developed and modified bioregions, like the Brigalow belt in Queensland, the preserved intact areas amount to less than 5% of the pre-clearing areas. The Brigalow Scheme, which predated understanding of the need to maintain biodiversity, was conceived and implemented without preserving the areas needed to maintain adequate ecosystem services (Administration Commission Department of Lands 1968). The policy difficulty is that the impacts fall on different groups, the farmer, or property developer, who may benefit from the economic gains while the community and future generations carry the costs of biodiversity loss, climate effects and land degradation. Some of these indirect costs are shared by both groups, for example the negative impacts of climate change including reduced precipitation and adverse weather events (Rolfe 2002).

Knowledge, which has accumulated since the single focus “development at any cost” era of the years 1948–1970, as discussed in detail by J.D Kelly in his report on Beef in Northern Australia (Kelly 1971), has laid bare the implications of landscape scale developments. Now it is understood that even small-scale effects from erosion from tracks and roads and grazing impacts on the understory all have the potential to bring about major change. Woinarski and Catterall, in McAlpine et al. (2002), recounted that even with 63% of original woody timber remained but only 5% of the softwood understory left, the local bird extinction rate was 1.97 species per decade on the property “Coomooboolaroo” in Central Queensland, largely as a result of grazing pressure alone, with little clearing taking place in the years 1873–1933. The fragility of ecosystems demonstrated by these observations highlight the danger of heavy-handed, one-species focus agendas, like the recent management of the brumbies in the Snowy Mountains and the destructive impact that one species can exert at the cost of other species. These matters are made worse by political and emotive priorities given priority against scientific advice (Day 2018). This scenario is repeated with water management, native vegetation management, threatened species management and climate change priorities in Australia. Policy decisions must be made within the consensus window tested by the peer-reviewed science and policy.

Natural environments exist in a dynamic state determined by soils, weather cycles, topography, location, land use histories and fire events (Kerle 2005; Seabrook, McAlpine, and Fensham 2006). Human activities now dominate this process. Accepting that a significant proportion of the available land must be maintained for food and forest products, the question then becomes, what balance of land-use practice will preserve sufficient biodiversity as discussed in “Increase Food Production Without Expanding Agricultural Land.” (Searchinger 2018). Free-living animal welfare hardly gets considered in determining this balance, which is weighted heavily by farm efficiency, return on investment and not infrequently economic survival of the farm enterprise. Small clumps of vegetation or individual paddock trees are frequently removed to extract the greatest farm efficiency.

A quotation from Cogger et al. (2003) p. 103 outlines the reality observed in their Brigalow study, “Yet despite the threat to so many species, only two per cent of the region had been set aside in reserves – an area not much larger than that cleared during each and every year of the previous decade.” Unfortunately, this story is repeated frequently, on different scales and different classes of natural resources but with similar outcomes and in many parts of Australia, to list just two: overexploitation of Australia’s water resources and clearing of Koala habitat in the 28% in population numbers in three generations (Woinarski et al. 2012).

STEWARDSHIP, CONTEMPORARY ATTITUDES AND INTERGENERATIONAL EQUITY

Land ‘ownership’ and land ‘title’ are central to the welfare issues that continue in the rural and peri-urban contexts. The property rights reside in three groups, private (including corporate) community and indigenous, recognizing that community-ownership includes Commonwealth, State and Municipal Governments. The Aboriginal concept of custodianship of the Australian landscape is the key to intergenerational equity for all Australians. It is beyond the scope of this chapter to discuss this in detail but it is reflective to consider how current ‘ownership’ of the land and the inferred or legal property rights, are at the heart of the issues which generate the animal welfare and sustainability issues. Decisions made by settlers and property managers (past, present and future) have impacted on Australia’s landscapes in some cases with devastating results, which are irreversible. For example, the inability to remove introduced feral animal and plant species, which have changed the landscape and have been the greatest single cause of Australia’s mammal extinctions (Woinarski et al. 2015). These decisions and the legislative framework in which they have been made needs very deliberate and cautious amendment to avoid future damage and the loss of intergenerational equity. A condition not easy to meet in our short political cycles.

Self-interest, not meant in a pejorative sense, has been a key driver in Australia’s development since white settlement and mimicked in most Western countries. From the early colonial days, squatters, settlers, miners and entrepreneurs have

pushed hard to unlock wealth, driven by personal and corporate commercial gain and delivering community prosperity and growth (Cochrane 2006). Governments, “the Crown”, were the original custodian of all the assets, including land, water, minerals and wildlife (including vegetation). But these assets, except for precious metals, were not seen as precious at all but rather something to be crudely exploited for the immediate commercial gain they might bring. A fact so wistfully captured in the title of the first legislation to regulate and facilitate settlement in the new colony, the “Waste Lands Act, 1842”.

Governments have, since the very beginning, struggled to keep up with the commercial push to unlock these resources. The surveying of squatters’ blocks usually lagged settlement and any concept that the government acted as a knowing custodian, aware of its role and in the mould of a grand plan, is a misunderstanding of the historic and chaotic process of development in this country (Cochrane 2006). There was little thought to preserve natural assets in balance with development goals. The urgency to develop and a lack of awareness of the fragility of these natural resources held sway. It has been only in the last 30 years or so, when mapping and cataloguing of natural resources has been completed in some states, that ‘big picture’ natural development has become possible. For example, the recent publication of Queensland’s biodiversity inventory and planning framework has completed a task which has been more than 30 years in the making (Neldner, Butler, and Guymer 2019). Similar inventories and mapping models do not exist or have not been completed and made publicly available for all states or the Commonwealth. For example, NSW’s Native Vegetation Regulatory Map (NSW Department of Planning Industry and Environment 2020) and the regular reporting of land clearing areas remains incomplete and not publicly accessible. State and Commonwealth governments are still in the same position as their colonial forebears, being under-resourced and unable to keep up with the well-resourced and focused push from businesses managing their assets closely. But now, at a time when development is well advanced in the populated SE and SW areas of Australia and when threatened species and ecosystems are at crisis point, it is time for governments, representing the wider community interests to be rebalanced. The phase of national development has changed in the last 30 years and policy that has been mainstream and dominated by “development at all cost” must be critically reviewed. The “Let it rip” planning model, which might have been excused in the early development phase, is now totally inappropriate, given current knowledge and is incompatible with the planetary boundaries (Steffen et al. 2015; Stockholm Resilience Centre 2019; Searchinger 2018).

The ownership of land can be visualised as an ownership-pyramid where a small number of owners (mostly governments) own a large number of assets and where a large number of owners own as small number of assets. This produces a management disequilibrium, where assets in individual and corporate hands can be managed more aggressively, given the detailed attention only possible with a closely managed asset. This is at the heart of the land use conflict between property owners and governments where one party understands their own issues in detail and is not interested in the big picture issues, whereas governments are

responsible for the big picture issues but are unable, or under-resourced, to cope with the detail of individual assets. This conflict was evident during the land grab of the 1840s–1880s (Cochrane 2006) and remains so today. It could not be addressed in the 19th century because knowledge was rudimentary. It could be addressed today given better knowledge of national resource management but requires political will.

The other issue of property ownership, whether it be lease hold or freehold, is the expectation that landowners should be expected to act as unpaid custodians for vegetation and wildlife still the property of the government. This establishes a conflict between their commercial interests and custodianship of wildlife. With land development programs like the Brigalow scheme (1962–1978) (Land Administration Commission Department of Lands 1968), the government encouraged, and in many cases required, farmers to clear their land and did not include a requirement to protect areas from development or that the property owner was expected to act as custodian for wildlife and key habitats. This includes wildlife and vegetation on freehold and leasehold lands. Publications like, “Beef in Northern Australia” (Kelly 1971) and “The Australian Environment” (Commonwealth Scientific and Industrial Research Organization 1960) provide a context to these matters and convey the urgency and unquestioned priority of development.

LACK OF LEGAL PROTECTIONS

Community concern about animal welfare has advanced significantly in the last century particularly in the West. These advances have focused on domestic animals (companion, food producing and racing), animals used in research and teaching and hunting of free-living animals. Today, the use of these animals operates within legislative frameworks supported by the social license necessary for their continued use (Broom 2010; Pinillos et al. 2016). Without this license, their use is put in jeopardy or banned, for example, the banning of greyhound racing in the Australian Capital Territory (ACT Government 2017) and the ongoing discussion of the humaneness of live animal exports from Australia to the Middle East (Parliament of Australia 2020).

The animal welfare legislation that exists in all Australian states to protect against cruelty to animals is generally underpinned by Codes of Practice and Standard Operating Systems. These extend from the ‘humane’ killing of live-stock for human consumption to the killing of feral pest species in situations of local overabundance. By contrast, a satisfactory legal framework does not exist in Australia to ensure that free-living animals affected by land clearing for agriculture or peri-urban development are protected and to ensure that an enforceable duty of care exists (Finn 2019). This includes an assessment of the welfare cost/human benefit ratio, against the harm caused to wild animals and by extension, the environment in which they live. The principle of minimization of harm, which is present in animal welfare legislation for domestic animals, has not been extended to wildlife affected by clearing. Nor have transparent objective assessments been made of the Humaneness Scores for these animals as has been applied to animals

slaughtered for human consumption or the control of feral pest species (Sharp and Saunders 2011). Further, Codes of Practice for the welfare of animals affected by land clearing while available (Hanger and Nottidge 2012) have no legal standing and are not required to be followed. Free-living animals affected by land clearing remains the final area without legislative controls and supervision of animal welfare standards apply (Table 4.2). This anomaly needs urgent attention to provide appropriate legislative frameworks, codes of practice and to ensure that clearing operations, when they do occur, are conducted with the appropriate duty of care which is enforceable.

While legislative protections do exist in all states for wildlife in the care of person, these are exempt when authorised land clearing is conducted and the injury or death is not foreseeable. An example to demonstrate the specific exemption from prosecution is section 2.1 (2) of the Biodiversity Conservation Act 2016 No 63 (NSW), which exempts a person who harms threatened species, threatened ecological communities and protected animals if they are clearing land on category-1 land under Part 5A of the Local Land Services Act 2013 (NSW). However, this exemption is qualified by the assumption that the operator was not aware that such clearing activity would be likely to harm wild animals. Given that there has been extensive media discussion (Paull et al. 2019; HSI et al.

TABLE 4.2**Animal Welfare Protections – Legislation and Oversight**

Sector	Legislation	Oversight	Animals Assessed
Free living animals – hunting	Yes	Committee or group	Individual
Captive animals zoos	Yes	Committee or group	Individual
Animals used for research and teaching	Yes	Animal ethics committee	Individual
Domestic animals – companions	Yes	Committee or group	Individual
Domestic food producing animals	Yes	Committee or group	Individual
Domestic animals – sporting – horses, greyhounds	Yes	Committee or group	Individual
Fish and aquaculture	Yes	Committee or group	Individual
Free-living animals – feral pest species	Yes	Committee or group	Individual
Free-living animals – land clearing – selected species (Koala & threatened species)	Yes, some	No oversight	Individual
Free-living animals – land clearing	No, exemption	No	Population and Individual

2019) and literature depicting the animal welfare consequences of land clearing, ignorance of the outcome would seem to be a weak defence. In addition to the individual animal welfare assessment, the population welfare assessment only exists via legislation to protect threatened species and bioregions, as with at the Commonwealth level EPBC Act 1999 and at the state level legislation like the Biodiversity Conservation Act 2019 (NSW) and Nature Conservation Act 1992 (Qld). These acts that provide mechanisms for the protection of threatened species have proven inadequate in practice, with threatened species and environments taking years to be listed and when listed lacking effective and resourced plans to ensure recovery.

The Commonwealth and States' governments are, under property law, nature's guardian, and we would expect them to exercise their responsibility fully to balance the commercial pressures on natural resources. This responsibility is not being exercised effectively. Of 7.7 million ha of potential threatened habitat cleared between 2000 and 2017, 93% of this was done without referral to the Federal Government for assessment under the EPBC Act 1999 (Ward et al. 2019).

WHAT DRIVES LAND CLEARING?

A brief review of the drivers of land clearing and the historic sequence as it occurred in Australia helps us to understand the current situation. It also helps to put in context where we are on the development deforestation profile.

HISTORICAL DRIVERS

The requirement for food, water and natural materials has always been the underlying driver for human societies to use and modify the land. Until the pressure and scale of an expanding human population accelerated from the 1960s, this was achieved largely, at a local scale, without creating self-destructive feedback loops where, land-use change also contributed to environmental degradation beyond the immediate area cleared (Jia et al. 2019). Hunter-gatherer peoples acting at small scale, relative to the abundance of nature, caused restricted damage but, nonetheless, were noted by astute biologists like Alexander von Humboldt in 1800 (Wulf 2015). The local consequences were enough to destroy local civilizations. Examples include the Anasazi Indians, the people of Easter Island and Mesopotamia which have been discussed in detail (Diamond 2005). In recent times, increases, in consumption per head in concert with human population numbers, are the main drivers of habitat loss (Menkhorst et al. 2016).

In Australia, the initial precarious struggle of the colony to survive was dependent on shipments of food from elsewhere until more extensive and productive agricultural lands were discovered and settled. This occurred following the discovery of a western route over the Blue Mountains in 1813, and from 1803 the settlement of Hobart, Launceston, Port Phillip and Adelaide. The grab for

land that followed quickly became for wealth creation rather than sustenance. Squatters of independent means or financed by British investors were keen to secure land quickly to capitalize on the wool boom, driven by the textile industries in Britain. The early governors, Lachlan Macquarie, Thomas Brisbane, Ralph Darling, Richard Bourne and George Gipps, struggled to contain the land rush, the advancing front proceeding ahead of law and order, and beyond the then proscribed limits of settlement and before the land was surveyed. Squatters occupied the best land they could find (Cochrane 2006), and no thought was given to preserving significant tracts of land which represented precious natural assets or rich in biodiversity. Even today, the surveying of Australia's natural assets is incomplete but has reached a point, in the last decade, where sufficient details are known to describe the diversity and extent of our complex ecoregions (Neldner, Butler, and Guymer 2019). At the time when most of Australia's agricultural settlement and land clearing was in progress in the South East, the data and framework to direct its advance in an ecologically sustainable way did not exist and this included water resources.

In the 19th century, land clearing with hand tools or grazing impacts were small in scale and extended at a slow pace. Trees ringbarked and left to die provided the opportunity for wild animals to adapt over months to years. Extensive surrounding native vegetation provided opportunities for animals to move notwithstanding the fact that those displaced would face competition. The animal density and species composition would adjust over time. These historic pressures of land clearing have set the scene for conflict between development and the broader community interest in natural resource management. The commercial decisions made on an enterprise-by-enterprise basis can be appropriate and financially rewarding individually but when aggregated across larger areas, carry with them other external costs and implications. For example, increased drought, lower rainfall, soil degradation, loss of biodiversity and the ingress of invasive species. The cost of these is mostly borne collectively. Because these matters are only evident when areas are aggregated, they are not the responsibility of individual landowners. Their resolution requires wider stakeholder discussion, including the guidance and knowledge provided by well-resourced and independent agricultural advisory sectors like the CSIRO and university-based research. In the last 30 years, more rapid change has occurred (Figure 4.2) at the same time that government funding to such groups has been reduced. Now, just when information for optimal sustainability and production are required, they are limited. There is now an urgent need to accelerate research and extension to address these matters.

The continuing and in some cases rapid decline of wildlife numbers, including iconic population like the Koala, are linked to habitat loss (Woinarski et al. 2012) but not neglecting the crucial impacts of feral predators, particularly the cat and fox (Woinarski et al. 2015). This suggests that the current quantity of habitat contained in national parks or reserves is insufficient to prevent species decline (Neldner 2017) and, therefore, reliance on habitat existing on private land

becomes critical (Paull et al. 2019). Having wildlife dependent on the largess of farmers to preserve critical habitats remains a crucial political impasse, which requires national leadership to address. Given many of these species exist across state borders, national coordination and resolution is necessary, whether they are on endangered lists or not. This is a situation generated in the first place by the historic failure of governments to exercise its responsibility as custodian and the lack of knowledge at the time to preserve natural resource for wildlife and to ensure sustainability for future generations. The conflict and security for threatened species cannot be settled and secured until significant steps are taken to address this issue.

CURRENT AND FUTURE DRIVERS INCLUDING CLIMATE CHANGE

The game has changed, “For decades, the livestock debate has focused on how to produce more from less to feed 9.8 billion people by 2050” (FAO 2018) but now the process needs to be achieved within sustainable boundaries (Searchinger 2018). The scope must include all agricultural products, the goal now to: reduce growth in demand, increase food production without expanding agricultural land and protecting and restoring natural ecosystems (Searchinger 2018). Australia is a signatory to the Sustainability Development Goals and Biodiversity objectives, which recognise that each bioregion needs to retain a significant proportion of its area to ensure the retention of biodiversity and meet the provision of the necessary ecosystem services. This is articulated in international documents at a protected proportion of 17% of the land area. This proportion, while arbitrary provides, a benchmark. At the regional level, the proportion will vary, reflecting diverse soil, rainfall and land-use zones. Work by the CSIRO (McAlpine et al. 2002) suggests that for the Brigalow region, this proportion of the land area uncleared should be between 30% and 50%.

We have, at least in theory, progressed our knowledge and awareness of the welfare and ecological cost of land clearing to a point where decisions made now are, or should be, made in the knowledge of the consequence. If they are not, the issue then becomes one of wilful political or commercial ignorance of the scientific evidence for commercial or political gain and against the national, international and intergenerational interest; simply living beyond our means for short-term profit. The events surrounding the global financial crisis and the collapse of very large institutions like Lehman Brothers make the point, that singular commercial interest can carry with it a heavy public cost and that vested interests can be propped up until the point of collapse (Letts 2018).

Analyses of food demand are frequently conducted on the assumption that underlying variables are likely to be constant (Linehan et al. 2012; Harris-Adams et al. 2012; Townsend, Phil; Lawson 2012). Such reports serve an important purpose, but it is difficult to present to paying clients a report not supporting the status quo when the client needs to maintain their position at all cost. They have

TABLE 4.3
Requirement Actions for Sustainable Food Security

- 1. Reduce growth in demand for food and other agricultural products
- 2. Increase food production without expanding agricultural land
- 3. Protect and restore natural ecosystems and limit agricultural land-shifting
- 4. Increase fish supply
- 5. Reduce greenhouse gas emissions from agricultural production

Source: Adapted from Searchinger (2018).

large ongoing projects, debts and expectations. It is in their interest and that of their constituents (shareholders) to “hold the line”. At the same time, there is widespread realization that these assumptions need to be challenged and the period 2020–2050 is an era when many major biophysical and social forces reach a peak. The expansive and environmentally destructive model cannot continue. Markets that encourage unsustainable unhealthy eating patterns in the Western world, while 1bn people worldwide are malnourished, may make economic sense to some but cannot be sustainable (Table 4.3).

While knowledge exists to navigate to a sustainable future (Searchinger 2018), it requires the cooperation of multiple, independent industries co-operating in a transnational way which, at the same time responds to market forces. Achieving this, in a timely manner is unlikely without strong international cooperation. This has not happened with the carbon market (Garnaut 2019) or reaching for climate change targets. The rate at which change must take place is a significant hurdle. There is recognition within the scientific and institutional literature (UN, IPBES, IPCC) of the need for “transitional” policy reform to achieve these goals. There is consensus. But it is sobering to realise that the First World Climate Congress occurred in 1997 and 23 years later change has been grossly inadequate. Atmospheric carbon concentration and mean surface temperature are trending to the upper limits of the earlier predictions and at an accelerating rate.

The threat of the deadly emerging diseases, like Hendra virus, Ebola virus, SARS, novel coronavirus (Covid 19) and lyssavirus, owe their occurrence to the extent of disruption of natural habitats and the displacement of forest animals into close contact with humans (Plowright et al. 2014). The cost of emerging disease control and its impact on world trade are costs indirectly linked to the destruction of habitat. Reversing this trend has reasoned support to minimize the likelihood of recurrent and novel disease outbreaks. This move will contribute to positive animal welfare outcomes (OneWelfare) and positive human health outcomes (OneHealth). These ambitions depend on collaboration between animal production, public health, commerce and governance encapsulated in OneHealth (FAO 2018).

One senses that, within the Australian economic and political setting, the necessary shift in thinking to a sustainable future is only superficial and established industries will retard change for as long as political leverage can hold. Constant

pressure for population growth, the need to secure jobs for the expanding population and the legacy of endless development, mask the reality of a new world, pressed against biophysical Planetary Boundaries (Steffen et al. 2015).

WHAT BALANCES ARE IN PLACE TO REGULATE LAND CLEARING?

LEGISLATION, EDUCATION, ECONOMICS & BALANCED OUTCOMES

Economic drivers of food production, with some regulatory control, are not delivering a balanced and sustainable human health and animal welfare outcome. Malnutrition affects approximately 3bn people, 1bn with under nutrition both in calories and micronutrients and 2bn with over nutrition (obesity) (Lucas and Horton 2019). The largest areas of land cleared, both in Australia and internationally, are for pasture improvement mostly for beef production (Figure 4.3). Cattle, sheep and goats provide an essential source of animal protein and micronutrients. They can also utilize vegetation that is of little use directly for human nutrition. But large areas of wooded habitat, which are valuable for biodiversity, ecosystem services, are still being cleared to increase beef production to markets or to grow markets with create human health issues (Godfray et al. 2018; Willett et al. 2019). Rolfe (2002) has discussed that ‘marginal analysis’ where decisions to clear land based on the returns anticipated, change with time and locality, marginal land being more problematic. As the value of preserving remnant vegetation increases, calculations that were favourable in decades past may no longer be so. The value of each declining hectare of habitat has greater value than the preceding hectare. The societal acceptance also changes with time albeit following the trend by many years. These issues have been discussed for many years but integrated action by governments has been limited and shows no sign of awakening. Interestingly governments have acted quickly to respond to immediate human-health issues, like Covid 19, SARS and tuberculosis. The response to issues with prolonged consequences like smoking, alcohol, pollution and high red meat consumption has been slow and contested. The transformative change needed in the 21st century to address these problems is our planet’s moment of truth (Lucas and Horton, 2019).

MITIGATION

The “three R’s” of animal welfare in research and teaching: “replacement” of animals with non-animal tests, “reduction” in the number of animals used and “refinement” in the protocols and procedures, were developed by Russell and Burch (1959) to improve welfare outcomes for laboratory animals. They can be adapted to clearing vegetation and providing a valid framework to explore avenues for improvements (Table 4.4).

TABLE 4.4
Mitigation Opportunities to Lessen the Animal Welfare Impact of Land Clearing

Action	Options
Reduce the area cleared	Intensification of agriculture Dietary change Legislative and Regulatory Land management and alternative land use Carbon farming
Minimise clearing impact	Vegetation mapping and preservation of key habitat
Restorative and Regenerative Agriculture	Preserve key habitat Reforestation and revegetation Carbon Farming
Wildlife salvage	Translocations Wildlife Rescue Vegetation Offsets

“Reducing” the total area, or the intensity of land clearing, is the most successful and least costly animal welfare and biodiversity mitigation strategy. Landscapes once disturbed are disturbed forever and the costs of reclamation and reforestation are substantial. Intensification of agriculture is one way to achieve this (Searchinger 2018). Not clearing land where the marginal and long-term returns are small will also help (Radford et al. 2007). However, the current economic model applied at the farm-level does not permit assessment of public good benefit, including ecosystem services, climate change effects, siltation and tourism.

“Refinement” in this context can mean the optimization of the land clearing practice to minimise its impact on biodiversity, being the degree to which areas are cleared, the methods used at the time of clearing and the application of a farm-based vegetation map planning to retain diverse selected habitat. A recent example is the collaboration between the Australian Wildlife Conservancy and Bulloo Downs in Northern Territory, where productive agricultural land is used for that purpose while areas rich in biodiversity and landform are used for tourism and treated with separate management objectives.

Wildlife salvage represents a disaster management strategy and its overall benefit, except for humane and welfare reasons, is contested (Menkhorst et al. 2016). The proportion of wildlife directly impacted by land clearing and seen by animal rescue is unfortunately low. Improving these rescue facilities, while contributing to individual animal welfare, will have little impact on the ‘hidden’ welfare cost of land clearing. Only a fraction of wildlife that arrive at animal rescue are returned to the wild and of those, only a small proportion are successfully re-established in the wild (Taylor-Brown et al. 2019). “Of Koalas admitted

to hospital with fractures, for example, only 2% could be released back into the wild” (Henning et al. 2014).

Unfortunately, faunal rescue also provides an opportunity to sidestep moral responsibility by allowing clearing proponents and the community to rationalise that the animals so affected are being cared for. The reality is that most animals displaced from their habitat will die. Nonetheless, there is the potential for faunal rescue to be helpful for some animals depending on the species, their threatened species status, and is locality and scale-dependent. In situations of high-value real estate development, the significant cost of faunal rescue programs can be absorbed in the value of the development while with broad acre clearing these opportunities are lost in the large scale and the smaller economic margins. These issues have been explored repeatedly and have been well expressed by Thompson and Thompson (2015) and Menkhorst et al. (2016).

WHO HAVE PUSHED FOR CHANGE?

Which institutions and groups have raised concerns about the impacts of land clearing and particularly the animal welfare aspects? The recognition of human impact on nature became institutionalised around the world many years ago, and it was not without thought that the esteemed science journal *Nature*, first published in 1869, chose that name. The foundation of several groups followed, included the National Audubon Society in 1905 in the USA, the International Union for Conservation of Nature and Natural Resources (IUCN) in 1948, and the World Wildlife Fund for Nature (WWF) in 1948. In the early 1970s, a leading conservationist H.R.H. Prince Bernhard of the Netherlands, who was one of the founders of the IUCN and the WWF, reflected that, “For many years there have been voices crying from the wilderness – not the wild wilderness of nature (of which all too little is left to cry from!), but the wilderness of ignorance and apathy” (HRH Prince Philip and Fisher 1970).

The initial research in Australia investigating the impacts of land clearing came from institutions such as the CSIRO, University of Queensland, the Queensland Herbarium Environment Protection Agency, the Australian Museum, James Cook University of Queensland, University of New England, University Departments of Ecology, notably Tasmania, and Curtin University. A more recent focus has been the recognition of the animal welfare by Dr Hal Cogger Professor Hugh Ford, Dr Christopher Johnson, James Holman, Don Butler in 2003 (Cogger et al. 2003) professional herpetologists, ecologists and ornithologists.

Subsequently advocacy groups, such as the WWF Australia, Human Society International Australia, the RSPCA, Animals Australia, Australian Conservation Foundation, National Parks Association of NSW and the Wilderness Society, articulated these findings. The Australian Veterinary Association ratified its Native Animal Welfare (Habitat Clearing) policy in 2021 (Australian Veterinary Association 2021). It articulates the need to minimize the area of native or remnant habitat cleared; protect where possible

the welfare of the animals affected; consider the impacts on biodiversity and sustainable development. This policy is to be welcomed. A professional animal welfare body should articulate concerns factually and without fear being disrespectful of all stakeholders' positions but anchored to strong welfare principles and scientific evidence. A choice not to speak can be more damaging than articulating a factual and moral position.

PRACTICAL ACTIONS?

Progress to improve the balance between animal welfare, conservation and land clearing has been glacial, because of policy dissonance (Reside et al. 2017) and political alignments. Despite the expansion of knowledge and scientific consensus (Ecological Society of Australia 2019), decisions are being made with increasing frequency in disregard of balanced objectives and not based on science (Day 2018; Ward et al. 2019). The need for a coherent dialogue guided by continuity of policy over timescales appropriate to landscapes is clear but the political and commercial frameworks are not conducive. The long-term solutions, it seems, will await a monumental environmental change to bring this about. It will conceivably arrive at a time when the opportunities for meaningful action have largely passed, for example after the extinction of species, after the passage of climatic tipping points and after the increased rates of emerging diseases. Too many people and groups in positions of power have not realised that the time has arrived. We are standing in it right now.

BY GROUPS

The veterinary profession in Australia has not been driving improvements for animal welfare affected by land clearing. Some notable individuals excepted who have worked for decades on these problems. In Australia, the peak rate of clearing activity was in the 1970s and 1980s. It passed without a word said by veterinary groups. When ecologists and zoologists raised the alarm in the early 2000s (Cogger et al. 2003), there was still no recognition that vets could and should be playing a supportive role to encourage dialogue and push for more balanced outcomes.

By contrast, the veterinary profession is working actively with others to improve OneHealth and OneWelfare outcomes in areas, like biosecurity, feral animal management, exotic disease preparedness, antimicrobial resistance and the monitoring of animal welfare. Invasion of exotic plant and feral animal species interacts with land use change, fragmentation and biodiversity, exacerbating the negative animal welfare impacts of land clearing when it occurs. The introduction of exotic wildlife diseases, like West Nile Virus in birds and mammals, Parrot bornavirus and Pacheco's disease in parrots and white nose disease in bats, has the potential to further unbalance the equilibrium on the remaining fragile remnants of native vegetation. The control of feral pest species like feral cats,

pigs and deer are crucial supports for native species under pressure. Feral cats are likely to have been the main cause of 27 of the 47 extinctions in Australia of birds, reptiles and mammals since European settlement and contributed to another 7 species (Woinarski, Legge, and Dickman 2019, p. 136). Veterinarians in biosecurity positions at all levels, including laboratory research, diagnostic pathology and field diagnosis, are contributing directly to conservation biology and protecting potential animal welfare impacts sometimes without recognizing their role or influence.

Beyond the direct professional fee-for-service activities, significant opportunity exists to influence good outcomes for animal welfare and sustainability. Veterinarians generally are recognised as a respected professional group within the community and as such they have an opportunity, or perhaps an obligation, to use their position to contribute to community wellbeing. Comments and attitudes passed in general conversation can carry significant weight and influence. Conversely words not said, and practices not challenged, are equally damaging and allow attitudes which are no longer relevant, to continue unquestioned. In the words of the former Australian Chief of the Defence Force, David Hurley, “the standard you walk past is the standard you accept”. In recent years, smaller responsive groups like Vet Sustain (UK) and Veterinarians for Climate Action (Australia) have emerged to fill policy areas left vacant or insufficiently occupied by larger parent professional bodies.

By INDIVIDUALS

Codes of Practice and Stand Operating Procedures which are incorporated in animal welfare legislation form an integral part for the legislation and enforcement package. They set out acceptable standards and can support the basis on which regulations are tested. They have an important potential role to improve animal welfare for animals impacted by land clearing. None however have been successfully introduced in any Australian state, despite significant work done to develop such codes in Queensland (Hanger and Nottidge 2012). The lack of uptake appears to be political and bureaucratic. Individual veterinarians well versed in the broader importance of vegetation have a significant role to play, providing on-farm advice regarding issues like; shade for stock, the ability of vegetation to mitigate temperature extremes and its contribution to climate stability and rainfall. These issues link with grazing management alternatives for higher long-term production (Hall et al. 2011).

WHAT WILL CHANGE THE STATUS QUO?

GENDER

Significant changes have occurred in the gender balance of the veterinary profession in the last 30 years. The 2018 Australian Veterinary Workplace Survey

determined 67% of respondents were female with an age-related bias towards those of younger age ("Australian Veterinary Association 2019). The proportion of women working in the agricultural sector globally and in Australia is approximately 43%, but the proportion with equity in land and at senior management levels is small, typically less than 10% (National Farmers Federation 2019; Alston, Clarke, and Whittenbury 2018). Given that women's attitudes to caring and sustainability are strong, this has the potential to reset the importance of animal welfare and sustainable farming practice. The continued growth of regenerative agricultural practices and the uptake of Landcare programs suggests that there is a drive to rebalance a biodiverse and environment friendly landscape.

HUMAN POPULATION GROWTH AND CONSUMPTION

Increasing food supply to a world population projected to be 9.8bn by 2050, requiring a doubling of food calories, has the potential to encroach on the remaining forested areas, particularly the tropical rainforests. This would have very damaging consequences. An expansive agricultural model, clearing vegetation and extending pastoral lands is not compatible with keeping global average temperatures increase to below 1.5°C of pre-industrial temperatures. There is now a recognition that at this point in human history, a rapid transitional in our use of fossil fuels, methods of land use and dietary practice is required (Steffen et al. 2015; Cogger et al. 2003; Garnaut 2019). Given that the economic model underpinning our global economy has evolved incrementally and painfully, over 250 years, is it likely that we can achieve a transformational in here also? The timeframe needed is short, say 10–50 years, and there is no convincing evidence that demonstrates these changes have commenced? In the author's judgment, this is unlikely to be achieved on a global scale. Likewise, there has been consistent and building scientific research to raise concerns about biodiversity loss and sustainability for more than 30 years and while the rates of clearing have decreased, deforestation continues relentlessly albeit at a slower rate.

The more flexible option will be for local action. Region by region some areas will choose a sustainable course. There is evidence that this can happen locally as evidenced by interest in regenerative agriculture, state legislatures pursuing independently carbon-neutral strategies and localised reforestation and uptake of Landcare programs. On the global scale, the rapid transborder movement of funds and the transborder ownership of assets makes short-term global transformation seem an unimaginable challenge.

CLIMATE CHANGE

Atmospheric carbon dioxide concentration has now passed 400ppm and the increase is accelerating at a rate 100 times faster than 20 years ago, mean monthly surface temperature is now +1.0°C on pre-industrial levels (Allen et al. 2018) and government continue to present mixed messages on land management and reducing the use of fossil fuels. Learned bodies and thoughtful individuals carry

a responsibility, as never before, to engage and speak out. The irony appears that the economics of the low carbon economy has now tipped the balance, coupling profit with a low carbon future and reforestation. We must hope these powerful forces align to provide the drive to a sustainable future.

“If not now when” Book Title, Primo Livì

APPENDIX 4.1

MODELLED HUMANENESS ASSESSMENT SCORE – KOALA (*PHASCOLARCTOS CINEREUS*)

This modelled humaneness assessment is a theoretical but realistic case study using the scoring methodology of Sharp and Saunders (2012), which has been widely used to assess the humaneness of the killing methods used for other free-living animals particularly feral animals. The locations and environments chosen are representative of those in which these animals live and are summarized in documents like The Action Plan for Australian Mammals 2012 (Woinarski et al. 2012). The scenarios are drawn together from knowledge of animals, farms, environments, veterinary science and literature sources describing land clearing practice and the activities of spotter catches.

Species: Koala

Location: Central Queensland, Brigalow Region

Sequence: An area of 500ha of Brigalow was cleared following self-assessment by the property owner on land zoned X (exempt of clearing restrictions) under the Vegetation Management Act 1999 and amendment Vegetation Management and Other Legislation Amendment Bill 2018. The area was a mixture of remnant (uncleared) and regrowth eucalypt woodland. The surrounding areas on the same property and adjoining properties had been extensively cleared over the previous 25 years and were now improved pasture use for cattle. The area contained sparse paddock trees and some larger clumps of uncleared vegetation ranging in size from 10 to 50ha in which the ground story had been extensively thinned by grazing. The vegetation was cleared mechanically with bulldozers equipped with blades. Vegetation within 50m of water-courses were not cleared but these comprised only two strips through the area which was otherwise flat to slightly undulating. The vegetation was cleared completely keeping only occasional clumps of paddock trees. The surrounding area had been cleared previously and there was limited mature woody vegetation within a 2km perimeter of the area to be cleared. The woody vegetation was cleared over a period of 6 months in successive and irregular blocks as time and weather permitted.

Animals: the following mammals were known to be present in this area: Greater Glider, Koala, Eastern Grey kangaroos, Echidnas, Black-striped wallaby (*Macropus dorsalis*)

Case Study Animal Impact

A mature female Koala (6 years) with no dependent young was impacted by clearing in a clump of mature vegetation. The animal was not noted during the clearing process as it was obscured by vegetation. The tree to which it clung was pushed

over by the blade and the animal crashed to the ground and was caught up within fallen and moving timber debris sustaining a fracture to its left elbow. The fracture prevented the animal climbing or moving freely along the ground. The vegetation was piled into a stack but the area where the Koala was, was not moved far by the blade. The work continued nearby completing the operation.

There was no remaining tall or protected vegetation within 500m and the Koala remained within the leaf and timber debris. It browsed some ground level foliage over the next 7 days but it provided inadequate nutrition and moisture. The Koala died within the pile on day 10. Death was caused by malnutrition and dehydration. Its mobility was affected immediately by the accident and its general activity levels decreased over time. In the last 48 hours, the animal did not eat at all and became comatose 12 hours before death.

Summary

Left elbow fracture, unable to climb or move actively across the ground

No residual standing vegetation within 500m

Cause of death malnutrition and dehydration

Time to insensibility 8 days

Time from insensibility to death 2 days

Total time impacted 10 days

Part A: assessment of overall welfare impact

The selected severity is indicated with tick ✓. Where more than one selection two categories may apply.

Domain 1 Water or food restriction, malnutrition

No impact	Mild impact	Moderate impact	Severe impact ✓	Extreme impact

Unable to move to standing suitable vegetation

Domain 2 Environmental challenge

No impact	Mild impact	Moderate impact	Severe impact ✓	Extreme impact

Complete and immediate change of life-threatening proportion

Domain 3 Disease, injury, functional impairment

No impact	Mild impact	Moderate impact	Severe impact ✓	Extreme impact

Left elbow fracture causing pain, morbidity, blood loss (internal and external).
High stress high cortisol

Domain 4 Behavioural or interactive restriction

No impact	Mild impact	Moderate impact	Severe impact	Extreme impact ✓

Domain 5 Anxiety, fear, pain, distress, thirst, hunger

Score of Part A: 8

Overall Impact: Severe

Duration of Impact: 10 days

Immediate to seconds	Minutes	Hours	Days	Weeks ✓

Part B: assessment of mode of death

Time to insensibility (minus any lag time)

Immediate to seconds	Minutes	Hours	Days	Weeks ✓

Level of suffering (after application of the method that causes death but before insensibility)

No suffering	Mild suffering	Moderate suffering ✓	Severe suffering ✓	Extreme suffering

Score of Part B: H

Overall Humaneness Score: 8H

Summary of evidence

Duration – Total time to insensibility was 10–2 days=8 days. The dehydration and malnutrition cause progressive weakness and finally loss of consciousness. The course would have been exacerbated by blood loss and pain and stress from the elbow fracture.

Suffering – from the moment the animal was dislodged from the tree and fractured its elbow there was little chance of rescue without intensive human intervention. The level of stress, anxiety and pain would have been severe.

M. Banyard 24/02/2020

MODELLLED HUMANENESS ASSESSMENT SCORE – GREATER GLIDER (*PETAUROIDES VOLANS VOLANS*)

This modelled humaneness assessment is a theoretical but realistic case study using the scoring methodology of Sharp and Saunders (2012), which has been widely used to assess the humaneness of the killing methods used for other free-living animals particularly feral animals. The locations and environments chosen are representative of those in which these animals live and are summarized in documents like The Action Plan for Australian Mammals 2012 (Woinarski et al. 2012). The scenarios are drawn together from knowledge of animals, farms, environments, veterinary science and literature sources describing land clearing practice and the activities of spotter catches.

Species: Greater Glider (*Petauroides volans volans*)

Location: SE Queensland

Sequence: Land clearing of an area of 250ha involving the thinning of trees and opening up of the understory for pasture improvement of grazing land for beef cattle. Many large old Eucalypts and all vegetation except selected shade and riverine trees were removed. All but the largest stumps were dug out and the area was ploughed and seeded with improved pasture. Most of the land surrounding the area to be cleared had been cleared in the last 15 years although a small connecting corridor

was present linking to a nearby commercial forestry reserve. This had been extensively logged over the last 60 years and few large old growth Eucalypts remained.

Animals: the following mammals were known to be present in this area: Greater Glider, Koala, Eastern Grey kangaroos, Echidnas, Black-Striped Wallaby (*Macropus dorsalis*)

Case Study Animal Impact

The area had been used for beef production over a period of 50 years, but the grazing pressure had been light and no large timber had been removed. It was previously owned by an older couple who loved the naturalness of the area. No intense fire activity had been recorded in the last 25 years. Greater Gliders were known to be part of the vegetation particularly inhabiting the denser stands of old eucalypts many of which contained hollows and much fallen timber. The new owners cleared the area in the late autumn over a period of 6 months. The area, at the time of clearing, was assessed by ecologists to contain approximately 125 Greater Gliders. The area and adjacent forest were reassessed 2 years after clearing and no gliders were found. Surveys of gliders in the adjacent forest area were conducted before the clearing and 2 years after. The density of gliders in the connected forest area was unchanged. Studies of similar displacement have established that most of the displaced animals would not survive because of unsuitable alternative habitat or the habitat was already occupied by individuals and species in the receiving forest. It is estimated that most of the population would have succumbed as a result of malnutrition, competition and predation over a period of 1–2 years.

Summary

A group of 125 Greater Gliders were displaced from cleared forest. None remained 2 years later. Assessment of nearby connected forest showed no increased density of gliders, contributing to the conclusion that the net effect was the loss of 125 gliders from the region.

Part A: assessment of overall welfare impact

The selected severity is indicated with tick ✓. Where more than one selection two categories may apply.

Domain 1 Water or food restriction, malnutrition

No impact	Mild impact	Moderate impact	Severe impact	Extreme impact ✓

Domain 2 Environmental challenge

No impact	Mild impact	Moderate impact	Severe impact ✓	Extreme impact ✓

Domain 3 Disease, injury, functional impairment

No impact	Mild impact	Moderate impact	Severe impact ✓	Extreme impact

Domain 4 Behavioural or interactive restriction

No impact	Mild impact	Moderate impact	Severe impact ✓	Extreme impact

Domain 5 Anxiety, fear, pain, distress, thirst, hunger

Score of Part A: 8

Overall Impact:

The impact on the animals that survived the immediate clearing was assessed to be Severe to Extreme and lasted for weeks to months.

Duration of Impact:

Immediate to seconds	Minutes	Hours	Days	Weeks ✓

Part B: assessment of mode of death

Because the assessment is for a group of animals the mode of death can only be assessed generally. It is anticipated that death would have resulted from a combination of events involving, malnutrition, predation, competition, exposure and poor breeding success with the animals being unable to exhibit normal behaviour for their remaining life. A few dominant and strong individuals from the displaced population may have outcompeted individual members of the receiving population but either way, the net death rate remains approximately 100%.

Time to insensibility (minus any lag time)

Difficult to assess the lag time but as the welfare impacts started immediately after clearing the lag period could be considered to be short.

Immediate to seconds	Minutes	Hours	Days	Weeks ✓

Level of suffering (after application of the method that causes death but before insensibility)

No suffering	Mild suffering	Moderate suffering ✓	Severe suffering ✓	Extreme suffering

Score of Part B: H

Overall Humaneness Score: 8H

The level of suffering up until death is assessed as moderate to severe. The time to insensibility would be very variable but except for those animals killed immediately by the clearing process we can anticipate it would have been Days to Weeks to Months.

Summary of evidence

125 Greater Gliders were displaced from their forest location by land clearing and the net number of animals in the location and surrounding location decreased by the same approximate number.

The duration of the loss was not assessed serially but was complete by 2 years.

Duration – complete by 2 years

Suffering – Moderate to Severe

M. Banyard 24/02/2020

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5 Wildlife Utilisation and One Welfare

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Wild animals and their products are used and traded for many reasons, and wildlife trade may be legal or illegal depending on the local and international regulatory protections afforded to the species and products in question. The Convention on the International Trade in Endangered Species (CITES) aims to limit the trade of protected species. CITES offers three levels of protection: Appendix I which includes species threatened with extinction where trade is allowed only in exceptional circumstances. Appendix II includes species which are not in immediate threat of extinction but their trade must be controlled in order to prevent unsustainable utilisation. Appendix III lists species protected in at least one country which has requested that CITES assists in controlling trade (<https://cites.org/>). However as a voluntary agreement which countries sign up to, CITES has limited powers of enforcement or sanction, and breaches to the convention do occur – I had personal experience of this when visiting a zoo in China exhibiting two juvenile chimpanzees. I was told that the chimps had been imported with CITES permits from a breeding facility in Guinea. There are no chimpanzee breeding facilities in Guinea, and the juvenile ages and obvious abnormal behaviours displayed by the chimps indicated that these chimps had likely been taken from

their natal wild troop and had likely experienced extreme trauma. Usually taking young chimps from the wild results in the extermination of the entire group. In such cases there is little to be done, as regardless of the reality of the situation, the paperwork is 'in order'.

The market for wildlife trade may be either domestic – where animals are taken from rural settings in their range countries and sold at local markets or cities, or international where wild animals are taken from biodiversity-rich countries and traded internationally, often through organised crime networks to high-income countries. Wild animals and their products have many uses including medicinal products, food, clothing and luxury goods, for sport, as pets and for public display, and as ornaments, and furnishings, and these uses often drive the trade. Similarly, some aspects of the wildlife trade may be driven by personal motivations and preferences – for example the desire to own a specific exotic pet, or to see or touch a particularly charismatic animal. These motivations are often inspired by the way wildlife species are presented in popular culture and media. Once the perception of a particular use of a wildlife species becomes 'culturally normal', its use in a particular way is less likely to be challenged – for example: the keeping of large exotic wildlife species by private collectors in the USA, the wild harvesting of coral reef fish to supply marine aquaria, or the extermination of large numbers of 'pest' species in conservation projects.

In this chapter, we will use the five sections of the One Welfare framework (<https://www.onewelfareworld.org/>) to evaluate the relationships between the use and trade in wildlife animals and their products, veterinarians, and one welfare.

THE CONNECTIONS BETWEEN ANIMAL AND HUMAN ABUSE AND NEGLECT

The trade in wild animals and their parts is founded on the ethical viewpoint that the traded animal is valued as a commodity, rather than as a sentient being. This is the case both in domestic wildlife trade where animals and their products may be taken from rural areas and sold locally, and also in the illegal transnational wildlife trade. The transnational trade often involves endemic corruption of the legal protection conferred to wild animal species, and which may involve networks that also participate in illegal activities detrimental to human well-being, such as human trafficking, drug or weapons trades. Wildlife trade involves a range of people at different levels, including poachers, middlemen, processors, transporters, traders and market sellers, and consumers, and in many cases people involved in trading wildlife may be at risk of human health or welfare problems. For example, fishing of wild fish stocks for the domestic food chain may create a number of conservation and fish welfare problems, but may also expose the people involved in the supply chain to health and safety problems and even modern slavery practices such as bonded labour, forced labour and child labour. Such practice occurs even in 'developed' countries. For example as recently as February 2004, 38 Chinese illegal immigrants were collecting cockles (*Cerastoderma edule*) in Morecambe Bay in the UK, when they were

cut off by the incoming tide, resulting in 23 deaths. This case led to a cascade of UK legislative changes on the issue of modern slavery, but such legislative protections are not universal, and in many countries, the connections between modern slavery practices and wild food industries remain a concern that impact many apparently benign consumer purchases. In other situations, the connection between abuse and neglect of animals and people is more overt - emotional, physical and sexual abuse of people and animals may be committed by the same group of perpetrators. Such abuse may be conducted against a range of species including exotic and wild animals. Recent media cases such as that of 'Joe Exotic', sensationalised in the Netflix docu-series 'Tiger King', highlight the interplay between the trade and abuse of an endangered species – the tiger - and chaotic, abusive, and criminal human activities.

The well-known 'MacDonald triad' describes worrying behaviour including animal cruelty, fire setting and bed wetting in childhood that may be indicative of later aggressive and violent behaviour in adults. Whilst the validity of this 'triad' of behaviours has been challenged, there is empirical evidence that animal cruelty in children can be a warning sign for later abusive behaviour as an adult.

On a more positive note, the resonance between the abuse that may be experienced by both humans and wildlife species does offer opportunities for positive action, development of empathy and education about this connection. Research indicates that positive human-animal relationships may help with the development of empathy, compassion and prosocial behaviours in children. This approach has been adopted by charities such as Fostering Compassion (<https://www.fostering-compassion.org/>) which partners with a local zoos and rescue centres housing companion animals, bears and lions rescued from abusive and neglectful situations. By exploring the life experiences of the animals – neglect, abuse, rescue and rehabilitation – the charity supports abused and neglected children, including those affected by the Chernobyl nuclear disaster, to explore their own experiences and traumas, and to develop empathy and compassion towards animals, thus breaking the cycle of abuse. The caregiver of one adopted child, a victim of previous emotional abuse and neglect, who benefitted from this programme described his response:

Feeding the bears, seeing their arrival photos, 12-month-after photos and hearing the bears' life story impacted him and triggered his empathy and reflection. Right down to the need to flee to the trees close by and observe before returning to the group and asking some detailed and thoughtful questions of the bear keepers. He understood the parallels of his personal life story with that of the bears and asked the keepers one-to-one if he could tell them his story. On a one-to-one basis he explained about coming from somewhere different, told them his birth mother's name and that he hadn't had a safe place like the bears but does now.

Such case studies highlight the importance of recognising the connection between human and animal abuse, both because of the importance of tackling suffering and neglect, and criminal behaviour, but also because of the potential for

promoting evidence-based rehabilitation strategies that may positively impact the lives of both people and animals. As veterinarians, our skills and behaviour can have a positive impact, not just on wildlife rehabilitation but also on generating compassion in individuals, communities and society as a whole.

THE SOCIAL IMPLICATIONS OF IMPROVED ANIMAL WELFARE

The way wild animals are treated in society has implications for how that society may be viewed, and in particular, societal acceptance of practices that are abusive to animals often results in criticism of communities and people. Increasingly, evidence supports the position that negative attitudes and actions towards animals including wildlife species are often connected with negative attitudes and actions towards vulnerable people, and that activities which support positive attitudes and behaviours towards animals may also result in positive attitudes and behaviours towards other people. As described in the previous section, promotion of empathy and positive affect towards animals may promote the development of compassion, empathy and other prosocial behaviours more widely. The growing awareness of this connectivity has driven movements such as ‘compassionate conservation’, a movement rooted in virtue ethics that emphasises the importance of compassion and positive animal-welfare outcomes in conservation practices. In a move away from the traditional anthropocentric utilisation of wildlife, compassionate conservation is influencing and changing traditional conservation practices and there is growing acceptance of the importance of collaboration between animal welfare experts and field conservationists.

Prosocial behaviours such as wildlife rescue and rehabilitation may have wider benefits than simply improving wild animal welfare, as research indicates both positive (inspiration, hope) and negative (compassion fatigue) impacts on people working in wildlife rehabilitation. Similarly, the awareness of animal welfare issues in wildlife tourism activities have led to both positive (improved welfare practices) and negative (increased ethical stress) societal implications. If we recognise that humans have the capacity and knowledge to manage wildlife populations ethically, this capability then confers a level of responsibility upon society to fulfil this duty of care. Failure to do so may invoke criticism or be a source of moral stress. Such dilemmas occur frequently in society as very few societies agree universal principles of wildlife management. In particular, for activities where traditional wildlife utilisation aligns with cultural identity, any attempts to improve standards of animal welfare, or reduce wildlife consumption, may be perceived as an attack on cultural values. Such activities may include hunting (fox hunting in the UK, whaling in Japan and Norway), traditional medicine (the use of bear bile, tiger bone or rhino horn in traditional Asian medicine) and cultural practices (dancing bears in India/Nepal or Eastern Europe). Thus, efforts to improve wildlife welfare may inadvertently reinforce social, ethnic or class distinctions. Conversely, the rise on societal concerns over animal welfare may reduce social support for some wildlife consumption

industries – examples include the Australian Kangaroo harvest and the Canadian Harp seal hunt, both of which have seen a reduction in social license over recent years. ‘Social license’ or ‘social license to operate’ is an extension of the concept of corporate-social responsibility and is the unwritten consent or support to operate given by a community or society for a societally legitimate corporate activity. Whilst a social license is not a regulatory requirement, loss of social license can be quickly followed by increasing regulatory challenges as societal ethics influence policy and legislation around societally acceptable animal use. Thus, wildlife use industries, particularly those that rely upon consumption of wildlife, and which are thus more likely to be ethically controversial are at risk from increasing social concerns over the ethical use of wildlife. An international consensus on the ethical control of wildlife has been suggested and this comprises seven principles:

1. Modify human practices
2. Justify with evidence
3. Ensure objectives are clear and achievable
4. Prioritise animal welfare
5. Ensure social acceptability
6. Conduct systematic planning
7. Make decisions based on specifics not labels (<https://www.wildcru.org/wp-content/uploads/2018/05/Dubois-et-al-2017-Ethical-wildlife-control-infographic.pdf>)

Understanding the relationships between people and wildlife has driven research and strategies to improve animal welfare by empowering people to make informed decisions about which forms of wildlife utilisation they wish to engage in. Wildlife is commonly used in a variety of tourism activities from animal performances to elephant rides to wildlife viewings and direct interactions. Many of these activities highlight a conflict between tourists’ beliefs and actions – for example tourists that engage in a captive swimming with dolphin activity, may express a belief that they do not agree with dolphins in captivity, but still choose to engage in that activity due to the personal enjoyment it brings them. These attitude-behaviour gaps can arise either from genuine ignorance of the moral significance of our actions, or from a level of self-deception or cognitive dissonance about the impact of our own actions. Ethical decisions often involve a trade-off between personal desires, and moral principles, and by providing information that increases awareness of the impact of human behaviour on animal welfare, it may be possible to influence the choices made by tourist interested in visiting wildlife attractions.

As veterinary professionals have a professional duty to act as ambassadors for good animal welfare, it is especially important that we consider the impact of our own behaviours and actions out of work as well as in it – are we fully informed about the impacts of the choices we make when we visit animal attractions? Are we supporting those that provide good standards of animal welfare and humane

education? If we work with wildlife or exotic animal species, are we providing them with the best level of care? Do we challenge outdated husbandry practices? Do we promote and practice evidence-based, low-stress husbandry and handling techniques? Are we meeting our professional and societal expectations?

Veterinarians are, and must continually strive to be, the leading advocates for animal welfare in a continually evolving society.

ANIMAL HEALTH AND WELFARE, HUMAN WELL-BEING, FOOD SECURITY AND SUSTAINABILITY

Food insecurity is highly correlated with wildlife consumption, as communities that have no reliable sustainable food sources are more likely to depend on the hunting and harvesting of wildlife food sources to sustain themselves. This has implications not just for animal welfare, and for the health and welfare of human communities, but also for global health and well-being. The majority of recently emerged infectious diseases are zoonotic, and over 70% of these diseases have emerged from wildlife populations, so increasing the wildlife-human interface through increased wildlife utilisation, trade, hunting, and harvesting significantly increases the potential for the exposure of human populations to zoonotic diseases. Examples of such diseases include: avian flu, Ebola virus disease, influenza, leprosy, lassa fever, rabies, Sudden acute respiratory syndrome (SARS), smallpox, tuberculosis and Zika fever as well as many others.

There remain many regions of sub-Saharan Africa where bushmeat (such as forest antelope, nonhuman primates and bats), provides an important protein source to human communities. However, the need for protein is not the only driver of bushmeat consumption. Even when bushmeat is known to be potentially dangerous such as during the 2014 West African Ebola crisis, its consumption persisted. Whilst bushmeat consumption was reduced, this reduction was more marked in poorer households than richer households, indicating the importance of bushmeat culturally and socially, and the willingness of people to continue to pay for it despite the potential zoonotic risks. In Asia, the drivers of wildlife consumption are also complex and relate just as much if not more, to a desire for novel or culturally valuable meats than to a need for a protein source. This can be seen in popular wildlife markets in regional hubs such as Jakarta, or Guangzhou where multiple wildlife species taken from the wild are trafficked and traded for the restaurant trade. Such activities pose a great threat to global health and human well-being, as the increasing interaction between humans and stressed, disease-carrying wildlife increases the opportunity for zoonotic disease transmission. The potential for wildlife emerging infectious diseases (EIDs) to have an impact on the health of both humans and domesticated animals is well documented. Paramyxoviruses such as the Nipah and Hendra viruses, which circulate in bats across South-East Asia, sporadically infect humans, pigs and horses, and can cause human deaths such as those reported in Australia in 1994 and 2009. More recently, emerging coronaviruses

have jumped from civets - small nocturnal Asian carnivores - to people at the Guangzhou wildlife market resulting in an outbreak of a disease known as Sudden Acute Respiratory Syndrome (SARS). Similarly, dromedary camels in the Middle East transmit a coronavirus causing Middle-Eastern respiratory syndrome to people, and even more recently SARS-CoV2 virus has emerged - likely from an unknown wildlife reservoir in, China, and triggered the 2020–2021 global pandemic.

The emergence of such catastrophic EIDs and the impacts they can have on both animal and human health highlight the importance of a one-health, one-welfare approach to wildlife utilisation activities. Any situation that involves the harvesting, social disruption, chronic stress and poor welfare of wild animals is going to predispose those animals to experiencing an increase in the pathogen burden that they may naturally be carrying, and to shedding those pathogens during interactions with people.

Another area where wild animal health, welfare and human well-being intersect is that of traditional medicine safety and security. Many wildlife species have been used in traditional medicines across all continents for generations. This practice, known as zootherapy, is often described as ‘folk medicine’ or ‘traditional medicine’. Many taxonomic groups are utilised in medicine from marine and terrestrial invertebrates to larger, charismatic mammals. Examples from Latin America include the use of the common iguana for earache and female reproductive disorders, and the use of the Amazon river dolphin for asthma and athletes foot. It has been suggested that biodiversity loss may actually be depriving human communities of effective bioresources and therapeutic compounds before they are even discovered. Several such compounds have been adopted into mainstream medicine – for example compounds from poison dart frogs are routinely used as part of anaesthetic protocols in humans. However, there are potential problems with the use of zootherapeutics – unsustainable harvesting may create biodiversity loss and conservation concerns, and often the hunting and harvesting of traditional medicine components are associated with significant and detrimental impacts on wild populations, as has been the case with Asian and African pangolins, tigers and rhinos. The cruelty of the wildlife trade for traditional medicine is particularly difficult to justify when the traditional remedies derived from these species have no evidence base to support their use such as with the species mentioned. Thus, the trade raises ethical questions over the welfare and conservation impacts of this trade, and also of the negative public health impact, as the general public may be unwittingly duped into purchasing ineffective remedies. As well as the public health implications of consuming ineffective remedies, it has been shown that traditional remedies may also be sources of heavy metal contamination, or zoonotic pathogens such as salmonella or rabies. However as with bushmeat consumption, the cultural and personal drivers of traditional medicine practices are often strong, and so addressing the animal welfare, conservation and human health concerns generated by the trade is complex and multifactorial.

ASSISTED INTERVENTIONS INVOLVING ANIMALS, HUMANS AND THE ENVIRONMENT, REHABILITATION AND MANAGED ANIMAL REHOMING PROGRAMMES

There are a wide variety of sanctuary, rescue and rehabilitation programmes involving wildlife species around the world, each fulfils a slightly different role. The global federation of animal sanctuaries (GFAS <https://www.sanctuaryfederation.org/>) describes a sanctuaries, rescue centres and rehabilitation facilities as follows:

Sanctuaries provide *lifetime care* for animals that have been abused, injured, abandoned, or are otherwise in need. These animals often come from private owners, research laboratories, government authorities, the entertainment industry, and zoos.

Rescue centres *temporarily care* for animals with the goal of placing them in permanent ownership/foster care with approved members of the public, or with accredited or verified sanctuaries. Rescue Center animals often include domestic equines, farmed animals, birds, and reptiles.

Rehabilitation centres *temporarily care* for wildlife so that they can be returned back to their native environments. This includes facilities that provide transitional support as part of a reintroduction protocol, which serves as an important conservation tool.

In reality, there can be crossovers between these activities within a single facility depending on the species and individual situation. There are many situations where wildlife may be in need of human support and intervention. Often anthropogenic activities may have a negative impact on wildlife health and welfare, for example: habitat loss due to logging or mining, injury or social disruption due to hunting or snaring, or injury and disease due to the wildlife trade. It may be argued that in such cases, humans have an ethical duty of care to rectify the damage caused by their activities. In many of these cases, veterinary support and expertise is valuable, both in terms of addressing physical and psychological trauma that may be experienced by animals in these situations, and in terms of minimising any wider risks such as the potential for disease spread during reintroduction programmes. There is also the potential for staff working in such facilities to be put at risk of EIDs, as they work closely with highly stressed wildlife species, and also to experience compassion fatigue as the mortality rate for highly stressed species with specific ecological needs that enter rescue centres and sanctuaries is often high. In many cases, an ethical decision must be made as to the value of attempted rehabilitation, both to the individual and to the population.

In parts of Northern India and Nepal, the native Qalandar (Kalandar) people have taken the cubs of sloth bears from their wild mothers for generations. These young cubs experience maternal separation, and both physical and mental trauma as their teeth are smashed and their muzzles pierced to allow a rope to be inserted, maximising control of the bears head. Pulling on the rope forces the bear up on his hindlimbs and ‘dancing’ is achieved by pulling the rope through the bear’s muzzle in time to musical accompaniment. Similar ‘dancing bear’ activities were prevalent across Asia and Europe for centuries. Since 1995, Indian charity,

Wildlife SOS (<https://wildlifesos.org/>) has focussed on rescuing and rehabilitating wildlife in distress, and preserving India's natural heritage. A key component of this work has been their groundbreaking approach to eradicating the cruel dancing bear tradition from the streets of India. They've done this primarily by creating alternative livelihoods for the Qalandar communities that depended on the exploitation of the bears, and by rescuing Sloth bears from the dancing trade, providing extensive veterinary and behavioural rehabilitation, and housing the bears in rescue centres across India. This lifetime sanctuary approach, and the provision of alternative livelihoods, has resulted in enormous success and the eradication of the dancing bear trade across India. However, such an approach only works because of the resilient nature and ecology of bears that allows them to respond well both to the veterinary and behavioural rehabilitation offered, and to a lifetime in sanctuary. For other species, a lifetime in captivity may be less tolerable, particularly if they have grown up in the wild rather than under human care, and so the cost-benefit should be assessed in each case.

In terms of reintroduction, there are ethical considerations both for the species being reintroduced, and for other species that may be living in the reintroduction area. To address these issues, the International Union for the Conservation of Nature has developed 'Guidelines for reintroductions and other conservation translocations' (<https://www.iucn.org/content/guidelines-reintroductions-and-other-conservation-translocations>). An example of such considerations is illustrated by the release of trafficked, rescued and rehabilitated slow lorises from International Animal Rescue's Ciapus Primate Centre in Indonesia (<https://www.internationalanimalrescue.org/slow-loris-sanctuary>). Whilst more than 85% of the lorises rescued are not suitable for release, and so are offered lifetime sanctuary, the Centre has focussed on evidence-based rehabilitation and release. Sadly out of 23 lorises reintroduced to the wild and monitored, 48% died within a few months of release, but 22% were still alive and being monitored 226 days later, with the remaining lorises either missing or recaptured. The very variable outcomes from rescue and rehabilitation efforts like this emphasise the necessity of post-release monitoring in order to make informed decision about the ethical and welfare costs and benefits of reintroduction practices.

An alternative example is the reintroduction of White-tailed sea eagles to the Scottish island of Canna. Whilst the reintroduction of the eagles themselves has been a success with successful breeding and chick-rearing occurring after reintroduction, preparing the island for the safe reintroduction of the eagle generated ethical and welfare concerns. Initially, over 10,000 rats were exterminated from the island due to their role as nest predators. This activity, whilst securing the safety of sea eagle eggs and chicks, also created the consequence of removing one of the main predators of rabbit kits from the island, and leading to a subsequent explosion in the island rabbit population. To date, over 21,000 rabbits have been culled from Canna. This experience highlights the relative value we place on different species, depending on their roles in our society. From a purely welfare point of view, it is difficult to reconcile the value of the lives of four breeding eagles versus the lives of thousands of rats and rabbits. However, the conservation

value of breeding an endangered species balanced against the ‘pest/vermin’ role of rats and rabbits, does affect our ethical decision-making and how we balance the relative ‘value’ of each individual life. In different cultural and ethical circumstances, the value placed on the role of the animal may differ. For example, Buddhist ethics confer benefit to the instigator of an act regardless of the outcome of that act, for example, ‘mercy release’ confers benefit to the releaser regardless of outcome. Mercy release can involve the large-scale, ritualized release of animals, which are actually caught and traded from the wild, specifically to be sold for this unmanaged release. This practice may have a number of unintended negative environmental consequences such as the invasion of non-native species into an ecosystem or the introduction of disease from the traded and released animal into a naïve wild population, but is done because it is thought to confer ‘good karma’ upon the releaser.

The cultural and regional differences in making ethical decisions is important to acknowledge – particularly when working with rescued or rehabilitated animals, where there is often a level of personal or emotional connection. In these cases, making ethical decisions can sometimes be challenging. An example of this for me was working in Rwanda on a primate conservation project where two different species of captive monkey had managed to mate through the bars of their enclosures, resulting in a baby hybrid monkey. As a hybrid, the young primate could never be released into the wild as it could genetically alter local primate populations, releasing a neutered primate created the risk of social exclusion by wild primates, and overall the costs of rehabilitating, introducing, and monitoring a captive-bred hybrid into a wild population were thought to be too high. The conservation organisation I worked for did not house animals in captivity long-term, and there were no appropriate zoo or sanctuary facilities due to Rwanda’s continuing economic reconstruction after the genocide of 1994. We veterinarians discussed the option of euthanasia as a preferable alternative to a solitary life in substandard captive conditions. Whilst this decision was emotionally challenging, it was ethically justifiable to the Western vets. However, the local Rwandan vets expressed discomfort – this was interesting as they were not opposed to euthanasia in other circumstances. Further discussion elucidated that the primary concerns of the Rwandan vets related not to the welfare or ethics of euthanasing this individual monkey, but to the messaging that euthanasia of a hybrid animal might send to the local community – comprised of both Tutsis and Hutus, the two ethnic groups who had experienced violent conflict during the 1994 genocide. Within the local community were children of mixed Tutsi-Hutu heritage, conceived during and since the conflict. The local vets raised valid concerns about the message euthanizing this hybrid primate might send to the community as to the perceived value of mixed-heritage children, in a community that was still recovering from such recent trauma. This experience emphasised to me the danger of assumption, the privilege of my own position as a Western-trained vet concerned primarily with animal health and welfare rather than community leadership, and the absolute importance of talking, listening, and understanding an ethical problem, in order to avoid inadvertent consequences. Understanding the

motivation for, and ethical values placed upon particular human-wildlife interventions is important in order to ensure that good intentions do actually result in good welfare outcomes for the animals, and the people, involved.

SUSTAINABILITY: CONNECTIONS BETWEEN BIODIVERSITY, THE ENVIRONMENT, ANIMAL WELFARE AND HUMAN WELL-BEING

Approximately one-third of the world's bird species and thousands of reptile and mammal species are involved in international trade. Relatively few of these species are protected – for example only 2 out of 14 declining Indonesian bird species involved in the pet trade are listed as vulnerable with the International Union for the Conservation of Nature (IUCN). The trade in CITES Appendix 5.2 wild caught and captive bred reptiles has decreased (70% and 40% respectively). Whilst this sounds positive, ensuring the ethical origins of non-traditional companion animals (NTCA) or exotic pets is challenging, and it is reported that there has been a 50-fold increase in 'ranched' reptiles, especially royal pythons and turtle species. Recent reports have suggested that Asian reptile ranches are in fact exporting many more reptiles than they actually keep, indicating that the captive-breeding ranches may actually be masking illegal and unregulated poaching of reptiles from the wild for the pet trade. Thus, people who buy ranched reptiles in an effort to safeguard wild populations may inadvertently be supporting the trade in wild-caught animals. The illegal and unregulated trade in wild animals for the pet trade generates numerous welfare and conservation concerns including the depletion of wild population, the stress of capture, transport and sale, social disruption and nutritional and thermal challenges. This lack of traceability in the origin, transport and sale of non-traditional companion animals is a significant threat to animal welfare and potential solutions such as identification and registration of non-traditional pets have been proposed.

The international wildlife trade affects all taxonomic groups, and an example of a trade where welfare, conservation and sustainability are challenged is that of marine aquaria. Between 1.5 and 2 million people keep marine aquaria and the annual trade comprises 25–30 million fish (US\$800 million–30 billion) with an estimated 99% being wild-caught - primarily from the coral reefs of the Philippines and Indonesia (70%). Marine reef fish are primarily sold to private collectors and public aquariums in the USA (64%), Europe (14%) and Japan (7%). Both abundant and rare species are targeted, and there is often unsustainable harvesting of species with critical roles in the reef ecosystem, for example, cleaner fish. In the UK, concerns have been raised as to the lack of documentation that may accompany marine fishes sold for aquaria. Selective harvesting of small species and juveniles may affect breeding and thus sustainability of wild populations. Longer lived species such as sharks, eels and groupers are often sought for public aquaria.

The trade in marine fish generates several conservation concerns: Firstly, the conservation status of the majority (64%) of fish in the trade has not been assessed,

making it impossible to determine the impact of harvesting on these populations. Whilst vulnerability listings for coral reef fish have been proposed, such listings are not yet part of regulatory restrictions on harvesting, and the diversity of fish species involved in the trade continues to increase. Coral reefs support >4,000 species of fish (1/3 of the world's marine fish species), and yet nearly 3/4 of the world's coral reefs are classified as severely threatened by the IUCN. Destructive fishing methods are not only a welfare concern for individual fish but they also put whole ecosystems at risk by causing coral damage. Despite being outlawed several years ago, sodium cyanide squirting (to stun fish for capture) remains common in Philippines and Indonesia as a method to increase catch. Cyanide not only increases post-catch mortality rates but may kill 50% or more of non-target species, including corals. Despite a ban on cyanide fishing being implemented in range countries over recent years, up to 15% of fish in European marine aquaria show signs of cyanide catching. It has been suggested that between 5% and 75% of fish die within hours of capture, and a further 10%–40% die in the days following capture. Such mortality levels are indicative of severe welfare problems in the trade, including poor capture and handling methods, inadequate husbandry practices, improper facilities and transportation methods, and the harvesting of species that are unsuitable for trade. These factors trigger severe stress, injuries and pain in captured fish, which has significant consequences for their welfare. Captive breeding initiatives and certification schemes exist, but as yet remain a small part of the global trade. The harvesting of marine reef fish has consequences for human welfare too. Whilst the trade can provide important economic support for rural coastal communities, the use of hazardous harvesting methods such as cyanide fishing is dangerous and illegal for fisherman. Lengthy supply chains in Philippines and Indonesia often result in the catcher earning a very small percentage of the final sale price of the fish. For marine fish that are traded for display in zoos and aquaria, there is a difficult ethical dilemma of how organisations, which aim to conserve and educate, can genuinely do so when they are reliant on trade and catching methods that persist in harvesting fishes from the wild using illegal techniques that cause long-term ecosystem damage and high mortality rates.

A more hopeful example of the positive and sustainable interplay between animal welfare, human well-being and biodiversity conservation is that of the mountain gorilla (*Gorilla beringei beringei*). Mountain gorillas inhabit the Virungas National park (Rwanda, Uganda and Democratic Republic of Congo) and the Bwindi impenetrable forest (Uganda). There are no mountain gorillas held in captivity, and their conservation has always focussed on *in situ* protection. This protection has taken a transboundary approach at both government and park ranger level, with the gorilla habitat being managed according to unified and agreed standards regardless of the National jurisdiction. Since Dian Fossey first documented the Virunga gorilla groups in 1966, the Mountain gorilla population has been closely studied. In a region torn apart by conflict and habitat degradation, the national parks of central Africa, and their increasing mountain gorilla populations, remain a testament to the impact of coordinated and well-funded conservation activities. Individual conservation and welfare issues do arise due to instability, for example, in 2007 in

the Mikeno sector of the national park (DRC), ten gorillas were killed by rebels to disrupt income from gorilla viewing. In addition to enjoying good welfare with any anthropogenic illnesses or injuries treated by a team of highly experienced 'gorilla doctors', the Mountain gorillas are a valuable source of ecotourism revenue for the national governments. The ecotourism activities are highly regulated - habituated gorilla groups are visited by a maximum of one group of six tourists per day. Tourists must leave all bags and food in a forest area away from the gorilla group before proceeding to the group. To reduce the risk of reverse zoonoses to the gorillas, tourists must not approach closer than 7 m (however, gorilla movements are difficult to control and this rule may be broken by them!), and of course there are occasional problems. For example a reverse zoonosis, human metapneumonia virus, was diagnosed in two gorillas that died in 2009. Whilst such challenges are ongoing, they remain intermittent, and the veterinary team takes responsibility for safeguarding gorilla health through a complex and interdisciplinary approach that includes not just responsive treatment of anthropogenic injuries or illnesses, but also employee health screening and management of domestic animal populations to reduce disease risks. The approach has been successful - in 2016, the Mountain gorilla population was reported as 1,063 individuals, up from 620 individuals in 1989.

SUMMARY

This chapter has outlined real-life examples where the One Welfare intersections of animal welfare, human well-being and ecosystem health may be either challenged or enhanced by veterinary interventions and human activities. In some cases, such as sloth bear rescue in India, this activity may confer benefits by providing alternative livelihoods for the local population, educating visiting tourists, supporting sloth bear conservation and research, and protection of wild bear populations and the ecosystems in which they live. In other examples such as trade in wildlife animals for meat, medicine or for pets or exhibition, the welfare problems inherent in the trade are clear, and the lack of regulation, and often inherent corruption, makes safeguarding welfare or minimising biodiversity impacts a global challenge. As veterinary professionals, we have a personal and professional duty to safeguard animal welfare and health. In many of these examples, the role of the veterinarian as a direct actor is unclear, except perhaps for the role as a rehabilitator, rescuer or clinician. However, veterinarians work in many of these animal-use industries, and it may be argued that we have a duty of care to be informed when acting within industries such as wild food, zoological, aquarium or exotic pet medicine to understand and influence the ethical practices within these industries. Similarly for veterinarians involved in wildlife rescue, rehabilitation or sanctuary, it is important that instead of relying on good intentions, we employ our skills in clinical auditing to evaluate our successes, and our failures, and take an evidence-based rather than sentimental approach to making decisions about animal welfare. Whilst compassion is a key part of our role and duty, what matters to an animal is not what we think or feel, but what we do; for it is our actions that ultimately affect the welfare of the wildlife for which we are responsible.

ETHICAL CASE EXAMPLE: BEAR BILE FARMING

Background

The harvesting of bile from live bears is a legal industry in China and Korea, and illegal but ongoing in Vietnam. There are an estimated 10,000 captive bears farmed in intensive conditions in China. Originally used to treat cholestatic disease due to high ursodeoxycholic acid (UDCA) levels, bear bile is now added to a range of common products. Natural bear bile is high in UDCA, which is pharmacologically active and effective in some liver and cardiac diseases, but over 50 herbal alternatives exist along with synthetic products. Bear bile is commonly sold directly from bile farms as bile salts and may also be sold as a 'pure' liquid.

Asiatic black bears (*Ursus thibetanus*) are primarily used in the bile industry, they are CITES listed (Appendix 2), and the IUCN classify them as vulnerable. Captive bear population numbers on farms in China are estimated at 7,000–10,000. Illegal international trade in bears and bear products is massive, and a large driving force for commercial bear bile production. Chinese products containing bear bile can be found in the UK, USA, Australia, South Korea, Vietnam and Japan. In addition to creating significant welfare issues for bears on farms, the large market for bear bile is exerting further pressure on the wild bear population both within China and elsewhere. Wild Asiatic black bear population numbers in China are unknown, all estimates are unsubstantiated and vary between 15,000 and 46,500 and are thought to be declining.

Bears on bile farms are housed in small barren cages or concrete pens. Bile is extracted from a surgical fistula created between their gall bladder and abdominal wall. Due to unsanitary conditions and the acidic bile, this fistula is commonly inflamed and infected. Teeth and claws may be surgically or traumatically removed. The diet of the bears is primarily rice-based and provides inadequate nutrition. Bears commonly experience a range of skin, dental, liver, gall bladder, eye, and cardiac diseases, likely due to a combination of nutritional deficiencies and infectious diseases. Bears are usually highly stereotypic, displaying invariant behaviour, indicative of chronic stress and frustration. Despite these many health problems, bears rescued from the bile trade demonstrate resilience in rehabilitation, and adapt well to sanctuary environments so long as they are provided with an appropriate standard of care (www.animalsasia.org). The trade in bear bile generates conservation, welfare and public health concerns, which are outlined below:

Positions

Conservation – Consider the Following

- Bear bile farming was initiated in the 1980s with a view to conserving wild bear populations that may be affected by poaching for bile – has it been effective at achieving this or has the commercialisation of bile farms increased the market demand?
- What do you think are the main drivers of wild bear population decline in Asia?

- Should legal protection be extended to wild Asiatic black bear habitat through an expanded reserve system similar to that already used for Giant Pandas?
- What measures could be put in place to reduce both the legal and illegal trade in bears and bear products?

Animal Welfare– Consider the Following

- What do you think are the physical welfare problems the bears experience on farms?
- What do you think are the psychological welfare problems the bears experience on farms?
- Do you think there is a way that welfare problems on bear farms could be addressed or improved? Should this industry be outlawed or merely regulated?

Societal Position – Consider the Following

- What is the evidence for and against bear bile as an effective medicine?
- Consider the health status and chronic infections suffered by bears on farms – how might this impact on the medicinal properties of their bile?
- Bear bile is often sold direct from farms to the public – what public health concerns does this raise?
- Bear bile is also added to a variety of commercial toiletries and medicines e.g. toothpaste – do you think most consumers buying such products are aware of the ethical issues surrounding bear bile production?

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6 One Welfare and the Management of Vertebrate Pest Animals

A Complex Problem Needing an Interdisciplinary Approach

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INTRODUCTION

It is people who decide whether an animal becomes a pest either by moving it physically, by modifying habitats or land uses or by altering their own perceptions. It is people who decide whether an animal stays a pest either by managing it or by softening their perception of it. It is people who decide how, when and where to

manage a pest; and people who determine whether a management program will be successful.

(Olsen 1998, p10)

It is also people that largely determine if pest animal management is done in a humane manner. The selection of control technique to be used, how it is applied, and the knowledge, skill and attitude of the operator will all have considerable effects on the animal welfare outcomes.

Despite this significant role, the ‘people aspect’ of pest animal management is an area, that is, yet to be fully embraced, especially in Australia. The One Welfare concept recognises the interconnections between animal welfare, human well-being and environmental sustainability (Pinillos et al. 2016; Pinillos 2018) and promotes a multidisciplinary approach to achieving common goals in these areas.

This chapter outlines areas of pest animal management where application of the One Welfare framework could lead to improvements in animal welfare, along with positive consequences for people and the environment. It also presents a case study - the commercial harvesting of kangaroos - that demonstrates how a holistic, interdisciplinary approach can be used to understand and address a contentious wildlife management issue.

Vertebrate pests are animals that conflict with human interests and cause damage to a valued resource (Olsen 1998). They can include animals that have been deliberately introduced to a new country or area, for example, as a food source (e.g. rabbits), for hunting (e.g. foxes) or for biological control (e.g. cane toads). They can also include domestic animals that have escaped and then established feral populations (e.g. camel, pigs, goats and cats) and in some situations even native animals (e.g. kangaroos and parrots) have become pests. In this chapter, I use the term ‘pest animal’ to describe any vertebrate animal (including native animals) that has a negative impact on, or causes damage to, a valued resource, such as the environment, agriculture, industry, people or communities (Braysher 2017).

The management of pest animals is not easy, and it is often viewed as a ‘wicked problem’ – a challenge, that is, complex, contentious and not easily resolved (Bridger et al. 2019). Some of the factors that present a challenge related to the technical aspects of management, such as what are the impacts of pests, how can they be measured, how can we reduce the impacts, what control methods should we use, etc. Determining the suitability of a control technique will involve examining criteria such as efficacy (will it produce the desired outcomes and is it suitable for the target species?), target specificity (will it affect other animals e.g. companion animals, dependent young, predators and livestock?), cost (can it be done within the available budget?), practicality (are resources available to perform the method?), regulation (is it legally approved?), safety (is it safe to use?) and environmental impacts (will there be adverse effects on the environment?) (Sharp and Saunders 2011).

Another challenging issue relates to the effects of management on animal welfare – what are the impacts on animals and how can we use the most humane

methods. Note that the term humane, in this sense, and the sense used throughout this chapter means avoiding or minimising pain, suffering and distress to maximise an animal's welfare state (Broom 1999; Gillespie 2003; Jones 2003; Sharp and Saunders 2011; Hadidian, Unti, and Griffin 2014). Management of pest animals often involves lethal control methods such as shooting, trapping and poisoning but non-lethal methods are also used, for example, habitat manipulation, exclusion, and capture and removal. Regardless of whether they kill or not, all the techniques will have a negative effect on animal welfare and with some, the impacts for targeted (and also non-target) animals can be severe.

The number and diversity of people involved, all with differing aims, attitudes and perceptions also contributes to the complexity of pest animal management. These are the stakeholders, that is, the individuals or groups that significantly affect or are significantly affected by pest animal management (Decker, Riley, and Siemer 2012). They include the people that have the problem with pests (e.g. farmers or other land managers, etc.), the people who apply the control methods, researchers who measure the problems and come up with solutions, animal protection groups (and concerned individuals) that want to minimise or prevent animal suffering, conservationists who want to protect the environment from harm and also government agencies who prescribe what must be done and also regulate the use of control methods, such as poisons.

Given these factors, an 'ideal' pest animal control method would therefore be humane, target specific, efficient, cost-effective, practical, legal, safe for humans and the environment and acceptable to the public and other stakeholders. No such control method exists; however, we are more likely to get closer to this ideal by taking a collaborative and interdisciplinary approach whereby we consider everyone's views and aims, and try to reach agreement on what should be done and how to do it.

This chapter presents an interpretation of a One Welfare approach to the management of pest animals and suggests four areas that would benefit from the expertise and knowledge of groups and individuals across a variety of disciplines. These are; justifying management, understanding and addressing community concerns, developing best practice management and adopting best practice. Ecologists, natural resource managers, animal welfare scientists, behavioural scientists and social psychologists, extension and communications specialists, landholders and land managers, animal welfare organisations and veterinarians should all be providing input into pest animal management. Such a holistic approach could lead to improvements in both animal welfare and human well-being and thus more effective pest management. Reduced pest impacts will then lead to increased food safety, food biosecurity and sustainability and have positive outcomes for biodiversity and the environment.

JUSTIFYING MANAGEMENT

An important aspect of pest animal management is that it is carried out for a good reason. It's often stated that before undertaking pest animal management, it is

important to determine if control is *necessary* and if it can be *justified*. Necessary means that management is carried out for a legitimate purpose and justified means that the potential harms and risks have been considered and the benefits of management will outweigh the harms.

Pest management, that is, both necessary and justified is viewed as more ethical by a variety of stakeholders and is likely to be more widely accepted than management that is not justified. Several authors have emphasised the importance of justifying pest animal management. For example, Littin et al. (2004) outline six principles to guide the design and execution of ethically sound vertebrate pest control programmes. These are: (1) the aims or benefits and the harms of each control programme must be clear; (2) control must only be undertaken if the aims can be achieved; (3) the methods that most effectively achieve the aims of the control programme must be used; (4) the methods must be applied in the best possible way; (5) whether or not each control programme actually achieved its precise aim must be assessed; and (6) once the desired aims or benefits have been achieved, steps must be taken to maintain the beneficial state. They argue that we have an ethical obligation to ensure that all the anticipated positive impacts of control are maximised and that all the anticipated negative impacts are minimised as far as can be feasibly achieved.

A working group of stakeholder representatives have also outlined a set of key implementation principles to guide the design and execution of pest animal management programmes in Australia that included: (1) the aims or benefits and the harms of each control programme must be clear - control should only be undertaken if the benefits outweigh the harms; and (2) control should only be undertaken if there is a likelihood that the aims can be achieved (Humane Vertebrate Pest Control Working Group 2004). In addition, RSPCA Australia recognise the importance of justification when taking an ethical approach to management. They accept that in certain circumstances it is necessary to reduce some populations of introduced and native animals - when they have adverse impacts on human activities, health and well-being or the environment - but maintain that programmes and strategies, which prescribe the management of wild animals must be justified, supported by scientific evidence and have clearly stated aims (RSPCA Australia 2019).

Furthermore, the first set of international consensus principles for ethical wildlife control, developed in 2015, include 'justification for control' and state that evidence needs to be provided that substantial harm is being caused to people, property, livelihoods, ecosystems and/or other animals (Dubois et al. 2017). The seriousness of the perceived problem should be considered and an objective evaluation of the effects of no control actions being undertaken should be conducted.

The importance of justification is also highlighted in the 'strategic approach' to pest management developed in the early 1990s. With this approach, the focus is on achieving the desired outcome (i.e. reducing the damage being caused by pests to an acceptable level) rather than killing pests (Braysher 1993, 2017). The key first step of this approach is to identify and define the problem in terms of the results desired. Measurable goals and objectives then need to be set, and a

cost-benefit assessment undertaken before the management plan is implemented. Progress of the management plan needs to be monitored and results evaluated against the stated objectives.

However, despite the significance of justification - especially to stakeholders that are concerned about an ethical approach to management - and having clear principles and processes for identifying impacts caused by pests, there are still several issues with justifying management. Firstly, there can be problems with understanding or measuring pest impacts. In 1995, Bomford and O'Brien (1995, p251) stated that "we have few reliable, quantitative measurements for agricultural or environmental damage inflicted by vertebrate pests" and that "most information on damage is qualitative, correlative, or anecdotal, making benefit-cost analysis difficult" and for the most part, this still holds true 25 years later. Secondly, even when there is good evidence of impact, there is a high degree of subjectivity involved with assessing the costs and benefits of management programmes.

So, if we are to be guided by the 2015 international consensus principles (Dubois et al. 2017), how do we then determine what constitutes a 'substantial' harm and how 'serious' should the problem be before action is taken? Surely, a landholder with a wild dog predation problem would evaluate the costs and benefits of an aerial 1,080 baiting programme very differently to a dingo conservationist? This is also one of the reasons why rabbit management may fail – some landholders evaluate the impacts of rabbits as too serious to ignore so they implement a control programme, while others are not as concerned and, therefore, don't take any action. The problem is, if they are neighbours then there is a high likelihood that rabbits will simply recolonise from the properties where rabbits weren't controlled (Parer and Milkovits 1994).

Furthermore, effective communication between the people that have the pest problem, the scientists that identify and measure the problems and concerned stakeholders (such as animal protection groups and conservationists) is often lacking. To illustrate, let's examine a pest problem where the impact may be perceived rather than real. Foxes are often blamed for poor lambing success due to predation, when other factors such as poor ram management, ram infertility or infertile pasture are the major causes (Olsen 1998). A review of a number of studies revealed that fox predation accounted for only around 3% of lambs born (McLeod and Saunders 2014). Foxes can take lambs, but most of these have already died and are scavenged or would have died from other causes such as difficult birth, exposure to cold, poor mothering or low birth weight. Thus, these researchers concluded that "it may be more profitable to invest in addressing other causes of lamb mortality such as improved husbandry practices or ewe nutrition rather than invest in fox control" (McLeod and Saunders 2014, p8). So why are landholders still conducting 1080 baiting of foxes to protect lambs from predation? Has there been a breakdown in communication between scientists and landholders? Or do landholders perceive that the benefits of 1080 (a very small reduction in lamb mortality) outweigh the costs (time, money and effort required for baiting, harms to foxes)? Stakeholders who advocate for ethical pest management and are

concerned about the use of 1080 baiting are more likely to argue that costs to the welfare of foxes outweigh any benefits in this situation.

Unfortunately, these issues can be seen repeated across a range of pest management scenarios. For further examples, see Box 6.1 later in this chapter. This is not to say that pest management is not always justified, in many cases pests are of real concern and can have serious impacts. For example, feral pigs take as many as 40% of lambs born in the lamb production areas of western New South Wales, and rabbits, even at densities of less than 1/ ha, can prevent the regeneration of some native plants (Olsen 1998). Nevertheless, there are situations when there is a perception of pest impact without evidence and there are also problems with communicating about why pests need to be managed, and demonstrating that an evidence-based approach has been taken to balance the costs and benefits.

For pest management to be accepted by a wide range of stakeholders there needs to be more effective communication between them. This includes talking and listening to those that experience the impacts and researchers providing clear, consistent and evidence-based information on how to deal with the impacts.

UNDERSTANDING COMMUNITY CONCERNS AND ATTITUDES

One important stakeholder group that has received little scientific attention in the past is the general public. Policies and decisions regarding the management of pest animals are often made with the views and perspectives of the public in mind, however, in many cases we don't know what the public actually thinks. We try to predict public attitudes and positions especially on contentious or emerging management issues but don't always seek the objective data to support these predictions. Rather, we make unfounded assumptions or derive our understanding of public attitudes from a small number of motivated individuals or special interest groups that tend to have polarised views.

A good example to demonstrate this issue was the wild horse management programme conducted by the NSW National Parks and Wildlife Service in Guy Fawkes River National Park, eastern NSW in October 2000. A total of 606 wild horses were culled using helicopter-based shooting because dry conditions and bushfires had severely limited resources for the animals (Nimmo and Miller 2007).

After the cull there was considerable media attention and public outcry, mostly condemning the shooting operation but there was also support from landholders who had suffered horse incursions onto their land, ecologists and conservationists (Chapple 2005). An independent inquiry into the shooting operation was initiated and concluded that, despite one horse being wounded but not killed, the cull was carried out humanely under approved protocols, and was the most appropriate course of action given the circumstances of drought and the inevitable suffering of the horses from starvation had they not been shot (English 2000; Chapple 2005).

BOX 6.1 COMMUNITY TRAPPING OF THE COMMON MYNA BIRD IN AUSTRALIA

SPECIES

The common myna (*Acridotheres tristis*) (also known as the Indian myna) (Figure 6.1) is a broad ranging avian invasive bird found in association with urban landscapes that provide artificial nesting cavities (Cohen et al. 2019).



FIGURE 6.1 Common myna (*Acridotheres tristis*). (Rebecca Citroni / Alamy Stock Photo.)

THE PROBLEM

High levels of community concern about the negative impacts of common mynas led to pressure to reduce their numbers. It was believed that common mynas aggressively displaced native birds and competed with them for food and nest sites resources. In 2005, the Australian community voted the common myna as the top ‘pest problem that needs more control’ (cited in Lowe, Taylor, and Major 2011; Invasive Animals Cooperative Research Centre 2012).

MANAGEMENT UNDERTAKEN

With the high expectation that common mynas should be managed, a number of local councils and interest groups devote considerable resources to trap and kill common myna birds in an effort to reduce populations (e.g. Linley, Paton, and Weston 2017; Nicholls and Lamond 2018). Over the last two decades tens of thousands of mynas have been trapped and then killed

using gassing with either car exhaust fumes or carbon dioxide, or by cervical dislocation (Canberra Indian Myna Action Group Inc. 2018). In 2012, it was reported that the Canberra Indian Myna Action Group (CIMAG), with over 1,300 members, had culled more than 42,000 mynas since trapping began in 2006 (Invasive Animals Cooperative Research Centre 2012) and by June 2019 the number culled had increased to over 70,000 (Canberra Indian Myna Action Group Inc. 2019).

EVIDENCE FOR IMPACT OF COMMON MYNAS?

Empirical studies that rigorously establish the negative effects of common mynas on native fauna are few (Dhami and Nagle 2009). One study conducted in Canberra, ACT reported that the common myna has had a negative impact on the long-term abundance of some cavity-nesting bird species and some small bird species (Grarock et al. 2012). However, these findings have been disputed by Taylor (2012) who argues that although there was a negative correlation between the presence of mynas and the abundance of native birds this does not demonstrate that mynas were a cause of their decline.

Another study conducted in Sydney, NSW found that the common myna does not have a significant competitive impact on native bird species (Lowe, Taylor, and Major 2011). The researchers found that the high level of inter-specific aggression, that is, often attributed to the common myna was not evident during their observations, though the reputed behavioural dominance of another species, the native noisy miner was clearly detected. They argued that a case of mistaken identity with the noisy miner, with similarities in appearance and name, is likely to have contributed to the negative perceptions of the common myna.

EFFECTIVENESS OF CONTROL?

Community-led culling is capable of reducing the *local* abundance of the common myna, however, individuals are soon replaced by natural reproduction, survival and/or immigration (Grarock et al. 2014), thus the significant amount of effort and resources directed to trapping programmes is unlikely to achieve the desired result of reducing broad scale abundance.

Scientists recommend that creating or restoring native habitat (e.g. by planting trees) and making urbanised areas less suitable for pest species is a much more effective way of protecting native species than attempting to reduce numbers of mynas (Grarock 2012; Lowe, Taylor, and Major 2011).

WHAT WAS LEARNT?

This example demonstrates the need for more effective communication between scientists and stakeholders (including local and state governments, community action groups and the general public) that perceive mynas as significant pests and take actions into their own hands. Despite the scientific judgement that trapping and killing of myna birds is unlikely to have any effects, culling is still being conducted - and in many instances - using a method (i.e. gassing with car exhaust fumes) that, despite being effective (Tidemann and King 2009), is not considered acceptable due to animal welfare concerns (Sharp 2012; RSPCA Australia 2017).

Following the controversy and contrary to the recommendations of the inquiry, a ban on aerial culling of horses in NSW was imposed in 2002 by the then NSW Minister for the Environment “in keeping with broad community expectations” (NSW Hansard, 2002 cited in Ballard 2005). However, no poll, survey or other study of community knowledge of horse impact or expectations of management had been undertaken to understand the issues. The ban on aerial shooting was based on an assumption that the general public opposed the method, even though the media had presented members of the public arguing both for and against the cull (Ballard 2005).

If more had been known about the public’s views of wild horses, including knowledge about horse impact, levels of acceptability for different control methods and preferences for horse management, park managers may have been able to prevent stakeholder conflict by using effective communication techniques targeted to specific groups. Information about public views and attitudes could also be used to defend management actions and refute spurious claims made about the level of community opposition or support for different control methods.

Now almost two decades have passed and there is still considerable controversy surrounding the management of wild horses in Australia (Ellicot 2019; Hannam 2020; Brewer 2020). There have been a handful of studies to examine public views and management preferences regarding horses (i.e. Ballard 2005; Nimmo, Miller, and Adams 2007; Selby 2015); however, these have only focused on particular regions or specific issues and a large-scale representative survey of the Australian public is yet to be undertaken.

Scientific research that examines the public’s thoughts and actions towards wildlife management is relatively new. Over the last two to three decades ‘human dimensions’ research has been applied to a wide range of wildlife issues in North America (Decker, Riley, and Siemer 2012; Manfredo et al. 2009), however, it is only recently that the importance of this approach has been recognised in Australia (Miller 2009). Discovering, understanding, and applying insights about how people value wildlife, how they want wildlife to be managed and how they are affected by wildlife and wildlife management decisions can contribute greatly

to the delivery of rigorous, effective and widely accepted management outcomes (Decker, Riley, and Siemer 2012).

At this point, it is important to note that ecologists and wildlife managers' may not be equipped to undertake human dimension research without a reasonable awareness of the appropriate research methodologies, therefore, it is best to seek collaborations with researchers that have suitable qualifications and experience in psychological or sociological methods (Jones et al. 1998). Recently, psychologists from the University of New England in NSW have contributed to human dimensions of pest animal management through collaborations on projects focusing on aspects of the management of cats (McLeod, Hine, and Bengsen 2015; McLeod, Hine et al. 2017; McLeod, Driver et al. 2017; McLeod, Hine, and Driver 2019), wild dogs (Please et al. 2018) and kangaroos (Sharp and McLeod 2016; McLeod and Sharp 2014; Sharp 2015), and they also have developed practical guidelines for achieving uptake of best practice management methods (see below for more details).

DEVELOPING BEST PRACTICE MANAGEMENT TO MINIMISE ANIMAL SUFFERING

As discussed earlier in this chapter, the main aim of pest animal management is not to focus on killing large numbers of animals but to reduce detrimental impacts. To achieve this aim it is recommended that a 'strategic approach' to management is taken (Braysher 1993). This involves the use of scientifically based procedures that are humane, cost-effective and integrated with ecologically sustainable land management (Braysher 2017; Sharp and Saunders 2011). 'Best practice' is a term used to describe the best way to address a specific management issue and, in this case, it means the best way to manage the damage caused by pest animals, which includes adopting a strategic approach (Braysher 2017). Over the years there has been much research to examine the economic and ecological elements of pest management but only recently has there been a focus on improving the humaneness of pest animal management in Australia and incorporating animal welfare into best practice management (Sharp and Saunders 2011). In this section, I provide an outline of this body of work and then discuss areas where further improvements can be made.

The management of pest animals includes the application of methods such as shooting, trapping, poisoning, exclusion, capture and removal, habitat manipulation and biological control, all of which have animal welfare implications. To minimise animal suffering during pest animal management we need to understand what the impacts are, and develop methods and strategies to minimise suffering wherever possible. Note that it is not only the intended targets of management that can experience harm. Non-target animals such as dependent young, members of social groups, animals that consume carcasses of poisoned animals and animals that prey on the target species can all be affected in varying ways from a pest control method or programme.

Selection of the most humane control method that will be effective at achieving the desired outcomes is a good strategy to aim for. For example, when controlling low numbers of mice in a household setting it would be more humane to use snap-back kill traps in preference to baiting with anticoagulants and has the bonus of being less of a risk to non-target animals, such as pets. But how do we know which methods are the most humane?

Sharp and Saunders (2008, 2011) have developed a model to examine the animal welfare impacts of control methods and to determine which methods are more or less humane compared to other methods. The model uses published scientific information and expert judgement to examine the negative impacts that a pest control or culling method has on an animal's welfare and, if it is a lethal method, the impacts of the method of killing. A score is generated so that the relative humaneness of different methods can be compared. Prior to this model, there had been no single, agreed framework that systematically examines all risks to animal welfare, or that could be used to compare the relative impacts of the many different lethal and non-lethal techniques. In 2008, the humaneness model was initially applied to the commonly used methods used to control pests in Australia (Sharp and Saunders 2011, 2008) and since then it has been applied to a wide range of management methods and wildlife species, for example, camels (Hart et al. 2013), kangaroos (McLeod and Sharp 2020); and wild horses (Independent Technical Reference Group 2015). The model is considered a milestone in assessing wildlife management welfare impacts (Littin et al. 2014) and has also been applied to a range of pest control methods in New Zealand (Beausoleil et al. 2016) and the United Kingdom (Baker, Sharp, and Macdonald 2016).

Another approach to minimising harms is to develop and apply standard procedures for control methods. Since the humaneness of an individual control technique is highly dependent on how a control technique is applied and on the skill level of the operator involved, paying attention to details such as bait delivery, lethal dose rates, timing and coordination of control can have significant effects on animal welfare and effectiveness of control programmes. By standardising the way in which control methods are applied, many of the negative welfare impacts can be reduced or even prevented. In Australia, standard operating procedures (SOPs) and codes of practice (COPs) for the humane control of pest animals in Australia have been developed to address this issue (Sharp and Saunders 2004; Sharp and Saunders 2005). Each of the SOPs describes control techniques and their application as well as animal welfare impacts for target and non-target species and strategies to minimise any harmful impacts. The COPs provide general information on best practice management, control strategies, species biology and impact and also a summary of the humaneness, efficacy, cost-effectiveness and target specificity of each control method. Prior to their development, few guidelines or standard procedures existed and those that were available did not adequately cover animal welfare issues. An extensive review of the literature and consultation with a wide range of stakeholders, including government and non-government agencies, animal welfare groups and technical specialists, was required to produce these documents and they were subject to a high level of peer

review during the process to achieve national adoption. There now exists over 60 COPs and SOPs for 14 different species, which have been adopted at a national level and are available on the Pest Smart website (<https://pestsmart.org.au/>). The development and refinement of these documents are ongoing, with a set of COPs and SOPs that are specific to NSW currently being written.

Although there have been some significant changes over the past 30 years in the way that pest animals are managed, there is still room for improvement. Refinements need to be made to existing methods to improve animal welfare outcomes and more humane methods still need to be developed so that some of the less humane methods can be phased out. There is also still a lot that we need to learn about the impacts of some methods on both target and non-target animals and there are gaps in our knowledge regarding the specific effects that some methods have on physiology and behaviour. For example, what do animals experience when they have been poisoned with 1080? Do they feel pain and are they insensible during the period when they are convulsing prior to death? Also, how does this compare among different species? With shooting, how often does the phenomenon of ‘hydrostatic shock’ occur? How long does it take for an animal to lose consciousness with a chest shot compared with a head shot? During aerial shooting, what happens if animals are shot in the spine rather than the brain? And are they conscious when they hit the ground or does a spine shot also render them immediately insensible? The impacts of pest control methods and programmes on dependent young are also not very well understood. Use of knowledge and expertise from animal welfare science will lead to more humane control methods and best practice application of these methods. Animal welfare scientists, veterinarians and animal behaviourists should be working together with pest animal ecologists and natural resource scientists to ensure that suitable animal welfare measures are integrated into research. Animal welfare scientists can provide expertise on ways to minimise the suffering that occurs with existing control methods, testing of new methods that might be more humane and guidance on what data to collect to ensure that animal welfare impact can be more objectively assessed.

ADOPTING BEST PRACTICE MANAGEMENT

It’s not enough to just conduct the research to develop best practice management methods; we need to take further steps to ensure the uptake of recommendations. In Australia, we have guidelines on how best to plan and manage animals to achieve the desired environmental, economic or social results (Braysher 2017), a range of resources that includes books, articles, case studies, technical reports, etc., (<http://www.pestsmart.org.au>) and as discussed above, an extensive set of codes of practice and standard operating procedures that outline how to apply pest control methods in a manner to optimise humaneness (Sharp and Saunders 2005; Centre for Invasive Species Solutions 2019). But we need to make sure they are implemented.

The knowledge generated by researchers needs to reach practitioners (that is, land managers, industry employees and community members) and thus far the

most common approach has been to educate people about the impacts of pests and provide information on how to conduct control. However, the problem with this plan of attack is that just increasing someone's awareness or knowledge doesn't guarantee that they will engage in the recommended practices (Hine, McLeod, and Driver 2019). Fortunately, we now have a range of sophisticated tools that can be used to meet the social and human behaviour challenges of pest animal management and one of these is behavioural science (Martin et al. 2019).

Behavioural science refers to the use of a scientific approach to understand and influence human behaviour. It has the potential to advance effective and humane pest animal management by systematically identifying behavioural barriers to the adoption of best practice and how best to overcome them. The behavioural sciences - which includes social psychology, social marketing and behavioural economics - have generated substantial knowledge about the drivers of, and barriers to, behaviour change and how to design and deliver cost-effective communication programmes that change behaviours for the benefit of society and the environment (Hine et al. 2014).

This approach has been applied in a wide range of areas such as health and safety, education, public service delivery and environmental protection (for numerous recent examples, see Organisation for Economic Cooperation and Development (OECD) 2017). It is also starting to be applied to specific issues affecting animals (HBCA 2019). However, behavioural science has largely been an untapped resource in many areas including agriculture, conservation and pest animal management. In recent years though there have been advances in this area in Australia with researchers from the University of New England in NSW and the Invasive Animals Cooperative Research Centre (succeeded by the Centre for Invasive Species Solutions) publishing guidelines that outline a systematic approach for developing more effective communication related to pest animals (Hine et al. 2014) and how to conduct behaviour change interventions (Hine, McLeod, and Driver 2019). To date, in the area of pest animal control, a behavioural science approach has been used to examine issues around the adoption of recommended practices for cat management (McLeod, Hine, and Bengsen 2015; McLeod, Hine et al. 2017; McLeod, Driver et al. 2017; McLeod, Hine, and Driver 2019), wild dog management in peri-urban areas (Please et al. 2018; Hine, McLeod, and Please 2020) and harvesting of kangaroos (Sharp and McLeod 2016, see below for more details).

In the next section of the chapter, I will outline some of the work I have conducted with my colleagues on the commercial harvesting of kangaroos in Australia to show how an interdisciplinary approach as described above can contribute to improving outcomes for animal welfare and a range of stakeholders.

A CASE STUDY: THE COMMERCIAL HARVESTING OF KANGAROOS IN AUSTRALIA

Commercial kangaroo harvesting is the shooting of wild, free-ranging kangaroos to gain an economic return from the sale of their meat and hides. Adult kangaroos, predominantly males, are killed with a shot to the head by professional

shooters who hold the necessary permits and licences. On average, 2–3 million kangaroos are killed annually during harvesting.

Although kangaroos have been harvested for over 50 years there is still considerable controversy over the practice with opponents arguing that harvesting is brutal and cruel and that kangaroo young, in particular, experience considerable pain, distress and suffering. Others view it as an ethical and animal welfare-friendly way of acquiring meat for human (and companion animal) consumption since the animals are killed instantly with a shot to the head, within their own environment and under much less stress than farmed domestic stock (Sharp 2015). Furthermore, there is continuing debate about whether kangaroos should be harvested at all with some groups maintaining that commercial use of kangaroos, without adequate evidence of their impact, is not sufficient justification for killing them (RSPCA Australia 2010; 2002).

JUSTIFYING KANGAROO HARVESTING

The justification for kangaroo harvesting is a complex and contentious issue. Depending on an individual's views, kangaroos can be pests that need to be regulated, a natural resource that can be sustainably harvested or a national icon that should be safeguarded.

Pastoralists view kangaroos as overabundant pests as they compete with livestock for food and water, consume crops and damage fences. There is a broad agreement amongst ecologists that following European settlement, kangaroos have increased in abundance due to pastoral practices employed to improve the management of domestic livestock (Frith 1964; Shepherd and Caughley 1987; Newsome 1975). These include reducing the abundance of dingoes to ease predation pressure on livestock; promoting the spread of man-made water sources; and modification of vegetation communities through land-clearing and overgrazing by livestock that fostered the growth of forbs and grasses—foods preferred by kangaroos. The perception that kangaroos hindered effective management of rangelands for grazing livestock was used as the main justification for pastoralists wanting to cull kangaroos for pest management (Gibson and Young 1987). The commercial kangaroo harvesting industry evolved from this viewpoint in the 1970s (Lunney 2010).

So, kangaroos are perceived as pests, but what are the impacts and how important are they? Research has mainly focused on competition for food with livestock. Under good seasonal conditions – when there is likely to be adequate food for both wildlife and livestock – competition is unlikely to occur (Edwards 1990; McLeod 1996). Under poor seasonal conditions, kangaroos and livestock are likely to compete for food. However, when the conditions are between good and bad, the evidence for competition is equivocal, and the extent that commercial harvesting increases agricultural productivity during these times by reducing competition is unclear (Pople and McLeod 2000).

Although the commercial industry initially developed from the view that kangaroos were pests, in the last decade their status has shifted from pest

to renewable resource that can be sustainably harvested. This change in status is unambiguously acknowledged in the management plans of states that harvest kangaroos commercially for export (New South Wales, Queensland, South Australia and Western Australia) - the overarching goal of these plans is to support the sustainable use of kangaroos, in accordance with the principles of ecologically sustainable development. The South Australian and Western Australian plans acknowledge that commercial harvesting has some role to play in reducing the damage caused by overabundant kangaroos, but the other two plans state that pest control is not an aim of commercial harvesting management.

If the justification of harvesting in management plans is now 'to provide for the sustainable use of kangaroo species', what evidence is there that harvesting is sustainable and how would this be evaluated in a cost-benefit analysis of harvesting? There are now decades of research examining the effects of harvesting on kangaroos and there is no evidence that current harvesting practices threaten the viability of kangaroo populations (McLeod and Sharp 2020). Research has emphasised that the primary driver of kangaroo population dynamics is rainfall and harvesting does not prevent the kangaroos' natural ability to recover from disturbances, such as drought (Caughley 1987; Pople 2003).

One of the main costs of harvesting is the impact that it has on animal welfare. Recent assessments to examine these impacts have demonstrated that commercial harvesting practices that are compliant with a National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Commercial Purposes (Commonwealth of Australia 2008) have the highest humaneness relative to other methods suitable for managing kangaroos in broad-scale situations, such as non-commercial shooting, translocation, capture followed by euthanasia or fertility control (McLeod and Sharp 2020). In addition, commercial harvesting has high levels of acceptability by the general public (Sharp 2015).

Despite these findings, sustainable use of kangaroos is not accepted by all stakeholders, particularly animal protection groups. These groups argue that sustainable use alone is not sufficient justification for killing. For groups with a predominantly animal welfare ethic (e.g. RSPCA Australia), a necessary condition for commercial use to be justified is quantitative evidence that harvesting mitigates pest impacts (RSPCA Australia 2010). However, for others - particularly those whose philosophies align with animal rights views - commercial use cannot be justified on any grounds.

UNDERSTANDING COMMUNITY CONCERNS AND ATTITUDES

Determining what the public think and feel and how they behave with regard to the management of kangaroos can help with the development and delivery of effective messages that raise public awareness and understanding about the issues, generate higher levels of acceptability for some methods and build public confidence in the regulators and managers that are required to make decisions about when and how kangaroos are managed (Sharp 2015).

We have conducted two surveys of the Australian public to determine their views on kangaroo management. In the first study, we asked a representative sample to rate different kangaroo management methods based on acceptability, humaneness, effectiveness, safety to the public, and the likelihood of contributing to the extinction of kangaroos. In addition, affective associations with kangaroos and attitudes towards three methods of killing (lethal injection, shooting and blunt trauma) were also assessed, along with a measure of general knowledge about kangaroos. The results indicate that the majority of the general public prefer non-lethal methods to lethal methods but when lethal methods are used, commercial harvesting (whereby the animal is shot, and the carcass is used) is preferred over other methods. Interestingly, the method rated by the public as most acceptable and most humane was translocation. This is at odds with studies that have shown that the outcomes for translocated wildlife are often poor with animals frequently suffering a range of negative welfare impacts leading to chronic stress and mortality, especially when the release site is not optimal (Higginbottom and Page 2010; Whisson, Holland, and Carlyon 2012; Kerle 2018; McLeod and Sharp 2020). We concluded that the public view kangaroos with strong affection but there is scope for improving people's general knowledge regarding kangaroo biology, ecology and management (McLeod and Sharp 2014; Sharp 2015).

In the second study, we used 'audience segmentation' methodology - a technique commonly used in 'social marketing' - to identify groups of Australians that share similar attitudes, knowledge and beliefs about kangaroos and their management. With audience segmentation, the aim is to select specific criteria (or variables) to characterise each segment (or profile) so that communication can be tailored to the particular segment or segments of interest. Members of each group have something in common (e.g. higher or lower concern for animal welfare or the environment) that will make them respond in a similar way to messages about kangaroo management (Sharp 2015; Sharp, McLeod, and Hine 2014).

Based on our set of psychological profiling variables, we identified three distinct kangaroo management mindsets in the Australian community. These groups were labelled: *Concerned*, *Neutral* and *Accepting*. The *Concerned* group (23%) had a higher proportion of females and inner-city dwellers compared with the two other groups. Members of this group view kangaroos more positively and have greater concern for animal welfare and the environment than the other groups, but surprisingly scored the lowest on kangaroo knowledge. The *Accepting* group (10%) had a majority of males living in rural areas or villages and larger country towns. The members of this group view kangaroos more negatively, and have less concern for animal welfare and the environment but on average had more knowledge about kangaroos than the other two groups. The *Neutral* group was the largest group, comprising 66% of our sample. For the members of this group, the mean scores on most of the profiling variables were close to the sample average, that is, in between the *Concerned* and *Accepting* groups. The groups differed significantly on a set of validation variables including support for different

management methods, purchasing of kangaroo products and activism behaviour. The Concerned group was the least supportive of the kangaroo management methods presented and preferred no management. They were also the least likely to buy kangaroo products and the most likely to take part in activist behaviours. In addition, the three groups also differed in their responses to a range of different messages about kangaroo management, such as factsheets, news items, websites, etc. This segmentation study demonstrates the value of a quantitative psychological approach to aid understanding of the knowledge, attitude and behaviours of the Australian public with regard to controversial wildlife management issues.

Understanding the full range of stakeholder attitudes when making management decisions is also essential. Box 6.2 provides an example of the importance of considering other stakeholder views such as those of landholders.

BOX 6.2 MALE-ONLY HARVESTING OF KANGAROOS SPECIES

The kangaroo species that are harvested in mainland Australia are: red kangaroo (*Osphranter rufus*) (Figure 6.2) in Qld, NSW, SA and WA; eastern grey kangaroo (*Macropus giganteus*) in Qld, NSW and Vic; western grey kangaroo (*M. fuliginosus*) in NSW, SA, Vic and WA; common wallaroo or euro (*M. robustus*) in Qld, NSW and SA.



FIGURE 6.2 Red kangaroos (*Osphranter rufus*). (Trudy Sharp.)

Kangaroos are sexually dimorphic in body size, with males having faster growth rates and reaching higher maximum body mass than females (Dawson 2012). Consequently, kangaroo harvesters prefer to take male kangaroos as the profitability per carcass is greater (McLeod and Sharp 2020).

THE ISSUE

In 2012, in response to perceived high levels of community concern and pressure from animal protection groups about the negative welfare impacts on kangaroo young during harvesting (Ben-Ami et al. 2014; RSPCA Australia 2002) the main kangaroo processors adopted a policy to accept only male kangaroo carcasses from harvesters (Borda 2018). It was argued that since female kangaroos won't be shot then young-at-foot will not be orphaned and in-pouch young will not need to be euthanased. This was also in keeping with the National Code of Practice for the Humane Shooting of Kangaroos and Wallabies for Commercial Purposes which states that shooters should avoid shooting female kangaroos where it is obvious that they have dependent young (Commonwealth of Australia 2008).

OUTCOMES OF CHANGING TO A MALE-ONLY HARVESTING STRATEGY

Prior to 2012, the long-term annual sex bias of the harvest has about 3:1 (male:female). After the change in harvest strategy to a male-only harvesting, the sex bias became more extreme and about 95% of all harvested kangaroos were males (i.e. a sex ratio of 20:1) (McLeod and Sharp 2020).

In 2018, a survey of NSW landholders revealed that the majority were opposed to a male-only harvesting strategy and viewed it as ineffective (McLeod and Sharp 2020). They expressed considerable concern that it does not adequately reduce kangaroo numbers and, therefore, does not address the significant impacts that kangaroos have on their properties. Modelling also validated this belief - male-only harvesting is not an effective management tool for reducing the grazing pressure of kangaroos (McLeod and Sharp 2020). There was also concern about the impact on harvesters who would need to work longer for less money and the many kangaroos that are not harvested but likely to suffer and die during the ongoing drought.

The Kangaroo Industry Association reviewed the male-only policy and started accepting female carcasses again in July 2018.

WAS THERE AN IMPROVEMENT IN ANIMAL WELFARE?

The primary aim of introducing a male-only harvest was to improve animal welfare in harvesting by removing the need for harvesters to deal with dependent young and so for this aspect there was a reduction in harm. However, because landholders perceived that the impacts from kangaroos were no longer being managed by harvesting, they then turned to use other management methods, primarily non-commercial shooting. In doing so the negative impacts on dependent young were simply shifted from commercial harvesting to non-commercial shooting and further animal welfare issues were thus created.

In 2018, the NSW government made changes to the non-commercial shooting of kangaroos that made it easier for landholders to obtain permission to cull the large numbers of kangaroos that were having a negative impact during the persistent drought. These changes included: promotion of volunteer shooters, simplified procedures for obtaining a 'licence to harm kangaroos' from the NSW Department of Planning, Industry and Environment, removal of the requirement to attach tags to carcasses and allowing the use of carcasses for non-commercial purposes (NSW Department of Primary Industries 2018). Non-commercial shooting is not regulated to the same extent as commercial harvesting; shooters are not required to meet a minimum standard of proficiency; and there is no auditing to ensure that they only take headshots, therefore, animal welfare is more at risk.

During this time there were also numerous anecdotal reports of landholders using inhumane management methods such as poisoning, hunting and exclusion from water and food (e.g. see Bradfield 2017; Local Land Services Western Region 2016).

Commercial harvesting is the most humane of the available kangaroo management methods and is also the most effective for reducing the broad-scale abundance of kangaroos and consequently the negative impacts of kangaroo grazing on primary production (McLeod and Sharp 2014; 2020). Therefore, resorting to management methods that are less humane (or have the potential to be), did not result in an improvement in the welfare of kangaroos.

WHAT WAS LEARNT?

This example demonstrates the importance of understanding and considering the views and perspectives of *all* stakeholders involved in wildlife management. Management decisions need to be evidence-based otherwise there can be unintended consequences that have harmful effects on animal welfare and stakeholders.

DEVELOPING BEST PRACTICE HARVESTING TO MINIMISE ANIMAL SUFFERING

Best practice for commercial harvesting of kangaroos is outlined in a National Code of Practice for the Shooting of Kangaroos and Wallabies for Commercial Purposes (Commonwealth of Australia 2008). Information in the current Code is partly evidence-based and partly guided by information provided by the kangaroo industry. Some aspects of the Code have been criticised, especially those concerning the methods used for euthanasia of pouch young and the fate of young at foot after a female has been shot (RSPCA Australia 2002, 1985). To address

some of these concerns and to provide evidence-based information that could be included in a future revision of the Code, we conducted research to: observe harvesting procedures and examine carcasses to assess methods for killing kangaroo young; test a spring-powered captive bolt gun for killing pouch young; and determine the short-term welfare impacts of maternal separation on young-at-foot.

We observed the killing methods used by harvesters and evaluated their humaneness using the data collected in conjunction with information from other scientific studies of euthanasia and slaughter methods. We found that, given the environment where harvesting is conducted, the currently used euthanasia methods for young kangaroos, when applied correctly, can be effective and relatively humane. However, there are some areas where improvements need to be made, for example, methods need to be standardised and harvesters require specific training in their application (McLeod and Sharp 2014; Sharp 2015). The spring-operated captive bolt gun that we tested was not effective at causing insensibility in more than 95% of animals, which is the minimum acceptable threshold for captive bolt devices in domestic animal abattoirs (Sharp et al. 2015). Therefore, until further devices (e.g. cartridge powered captive bolt guns) can be assessed for efficacy in pouch young we recommended that operators continue to use the existing prescribed killing methods. With regard to the impact of maternal separation on young-at-foot, our experimental trials demonstrated that, although there were no mortalities in the short-term, maternal separation results in a number of behavioural changes that are likely to reflect (or lead to) negative affective states that could include anxiety, fear, hunger, loneliness, frustration, helplessness and distress in kangaroo young-at-foot (Sharp 2015). Harvesters need to be educated about these negative welfare impacts and to be more strongly encouraged to humanely euthanase orphaned young-at-foot whenever possible to prevent animal suffering.

We recommended that the relevant findings from this research be used to refine best practice and be incorporated into standard operating procedures and a revised Code to provide more detailed guidance and ensure consistency in the application of euthanasia methods with the aim of minimising negative welfare impacts, especially on young kangaroos. A revised Code is now in the final stages of development and expected to be released in mid-2020. Future research to further refine best practice harvesting could include determining the long-term impacts on orphaned young-at-foot: the social impacts of removing individual kangaroos on mob structure and social learning; and testing of additional captive bolt devices. Note that there has been a recent preliminary study on the efficacy of gunpowder-powered captive bolts for the euthanasia of kangaroo pouch young (Hampton 2019) and, although the results appear promising, further testing still is required.

ADOPTING BEST PRACTICE MANAGEMENT

Although guidelines on best practice harvesting are outlined in the Code, and harvesters are expected to abide by the Code as a requirement of their licence,

there was little information on how much harvesters understood about the Code and to what extent they were following some of the requirements that are not audited. One of these was the requirement to euthanase dependent young-at-foot to prevent further suffering after their mother had been shot. There had been anecdotal reports that harvesters either cannot euthanase young-at-foot (e.g. they do not see them, or they flee) or will not (e.g. they do not think it is necessary) (RSPCA Australia 2002; Croft 2004). We investigated this aspect of harvesting using a Theory of Planned Behaviour study to examine the beliefs, attitudes and behaviour of harvesters with regard to the euthanasia of young-at-foot (Sharp and McLeod 2016). Our findings backed up the reports. For the most part, harvesters intend to euthanase young at foot but often can't because they escape. In some cases, however, they can euthanase them but don't.

We were able to determine that a range of beliefs and internal conflicts, such as trying to reduce the suffering of the young-at-foot but not wanting to take away their chance at life, and also not wanting to reduce the numbers of kangaroos for future harvest, were likely to be influencing their behaviour. In addition, harvesters receive a great deal of social pressure and inconsistent messages about what they should do when faced with the situation of an orphaned young-at-foot. State kangaroo management agencies as well as farmers and graziers want them to euthanase joeys, but they perceive strong pressure from animal protection groups (and to a lesser extent the general public) not to euthanase them. To reduce the suffering of dependent young, a consistent message to euthanase them must come from all outside influences but should be especially strong from the management agencies since harvesters are motivated to comply with them the most. However, making the euthanasia of young-at-foot a requirement of the Code is problematic since it is not always achievable. Rather, we recommend that instructions on what to do when they encounter young-at-foot and information on the welfare consequences of leaving young to fend for themselves are included in harvester training material, standard operating procedures and an updated version of the Code.

The combination of animal welfare science (to measure the impacts of harvesting practices on dependent young) and aspects of behavioural science and social psychology (to measure harvester beliefs, attitudes and behaviour and public views about kangaroo management) has been used to successfully investigate a number of issues that had been left unresolved for many years.

HOW WILL FOLLOWING A ONE WELFARE APPROACH CONTRIBUTE TO IMPROVED ANIMAL WELFARE AND BETTER HUMAN WELL-BEING?

Animal welfare in pest animal management can be improved by applying knowledge and techniques from animal welfare science. Pest control methods and strategies can be continually refined with the aims of reducing animal suffering. Techniques and practices that minimise harm will also lead to higher levels of support from a range of stakeholders and the general public. A human dimensions approach such as behavioural science can lead to better uptake of the most

humane and effective control methods available and ensure they are applied in a consistent way.

Improving human well-being is a bit more complicated. One Welfare encourages a holistic approach that considers all views and perspectives, and aims to find solutions that provide the best available well-being option for all. The problem with finding the best option for all is that stakeholders involved with pest animal management are numerous and diverse and hold strong views that are often diametrically opposed. One aspect that they have in common is emotional involvement. Some of those affected by pest impacts can experience high levels of psychological stress, for example, landholders whose livestock are attacked by wild dogs (Ecker, Please, and Maybery 2017). In addition, stakeholders who voice concerns about animal suffering and death during pest control are also likely to experience considerable anguish, especially if they feel that their views are not being considered. It's likely that some operators conducting pest control could also experience traumatic stress in a similar way to that reported by veterinarians (Whiting and Marion 2011), animal shelter personnel (Bennett and Rohlf 2005) and slaughterhouse workers (Baran, Rogelberg, and Clausen 2016) who kill healthy animals as part of their occupation. Our study of kangaroo harvesters provided evidence that they experience emotional conflict as part of their job – they do not like killing young kangaroos and prefer not to take away their chance at life but also want to reduce their suffering (Sharp and McLeod 2016).

For pest animal management to be effective and humane we need to understand these differing values and emotions and try to reduce conflict with transparent and respectful communication. As an example, practitioners need to acknowledge that all pest control methods cause some degree of animal suffering. Making a statement such as '1080 is a humane and lethal poison for feral cats' (Eason and Frampton 1991) implies that 1080 has minimal welfare impacts. However, there is more to it than that since poisoned cats experience disorientation, uncoordinated movements, vocalisation and vomiting for several hours before death. As recommended by Hadidian (2012) it is important that the animal welfare impacts are openly recognised if we are to achieve focused and constructive dialogues about the consequences of management. Another example is the demonising of animals because they are considered pest species. This is done to decrease their value and to justify treating them poorly. Kessing's (1990b, 1990a) portrayal of feral cats and rabbits in her images are good examples of this. Portraying pests as wicked or evil is viewed by people that are concerned about ethical pest management as provocative and insulting and does not help with constructive discussion.

Similarly, critics of management need to desist from cherry-picking or misrepresenting information to further their agenda. In one example, Vegan Australia, in a submission on the 2017–2027 Australian Pest Animal Strategy, quotes a study by Barlow, Kean and Briggs (1997) to back up their argument that sterilisation is just as effective as lethal methods for pest control (Westcott 2016). However, there are several more recent studies that supersede this work and demonstrate that fertility control is *less* effective than lethal methods (McLeod and Saunders 2014; Pople and McLeod 2010) yet these are not mentioned in their submission.

In another example, animal protection groups claim that kangaroo harvesting is unsustainable since kangaroo populations are slow growing with a maximum rate of increase of 8%–10% per annum (Kangaroos at Risk 2015; Australian Society for Kangaroos 2011). However, this statement is based on the findings of a single study on the population of one species (western grey) in a small area (300 ha). The large number of independent studies conducted over many decades and broad areas to estimate kangaroo populations and annual growth rates (e.g. Caughley, Bayliss, and Giles 1984; Bayliss 1985; Fletcher et al. 1990) have been ignored. These studies show that the maximum rates of increase are consistently several times greater than the 8%–10% figure quoted. Data have thus been cherry-picked to suit their purpose whilst overlooking studies that present an opposing view. For further examples of misleading information, invalid comparisons and ‘straw man’ arguments relating to kangaroo harvesting refer to Cooney et al. (2012).

CONCLUSIONS

The management of wildlife consists of three specialised dimensions: wildlife, habitats and humans (Decker, Riley, and Siemer 2012). Pest animal management has traditionally focused on the animal and environment aspects, and with great success, but the emphasis now needs to shift to the human dimension. This chapter outlines the benefits of adopting an interdisciplinary approach for achieving more acceptable, effective and humane pest animal management. It emphasises a more comprehensive and holistic approach that respectfully considers the range of views, attitudes and behaviours of all stakeholders and is informed by science.

The management of pest animals is a ‘wicked problem’ - a challenge, that is, complex and contentious. Solutions to wicked problems involve asking difficult questions and disrupting established ways of thinking and acting. All stakeholders need to be encouraged to see beyond their own values and look more broadly at the wider range of perspectives and viewpoints. Wicked problems also demand the input of multiple disciplines with relevant knowledge and expertise. Many pest animal managers and researchers are not equipped to conduct rigorous psychological or sociological research or to understand the animal welfare impacts of management methods; therefore, they need to seek input from experts in these fields. Scientists also need to communicate the results of their work more effectively and make it more accessible.

Collaboration is key and there needs to be an open acknowledgement that a more co-operative approach is needed for success. Compromise will be necessary - it is unlikely that any one group can achieve all they aspire to. But the costs will be far outweighed by the benefits to the welfare and well-being of humans and animals.

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7 Managing Welfare and Well-being in Animal Disease Control Programmes

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INTRODUCTION

Farm animal disease control programmes, by their nature, impose restrictions and additional work on farmers. The basic elements of disease control of identifying where infection is present, containing infection and then eliminating infection, all impact on normal farming operations to a greater or lesser extent depending on the disease.

Disease control programmes are usually based on surveillance regimes designed to identify the presence of disease in susceptible populations as early as possible. For endemic diseases, this can include regular herd testing as it occurs with bovine tuberculosis control programmes, inspection for the disease during normal commercial slaughter and screening of samples collected regularly such as bulk milk samples collected each time milk is picked up from a dairy farm.

Surveillance programmes for exotic diseases are usually managed by the government. These can include sample collection and testing from sentinel herds, surveillance for insect vectors of diseases, testing of samples collected for other

health testing, abattoir surveillance and providing a method for veterinarians and animal owners to report suspected exotic disease.

Veterinarians play a key role in disease surveillance as they are likely to be the first person a farmer calls if they have concerns about animal health on the farm. Therefore, when examining animals, possible exotic diseases, and endemic diseases with a control programme, should be included in the differential diagnosis. It is worth bearing in mind that this may be the first case of something new, and advice should be sought from the appropriate authorities. In New Zealand, this would be done by phoning the Ministry for Primary Industries free phone number for reporting suspected exotic diseases in animals.

Once the infection has been identified on a farm, finding where else the infection is present usually starts with tracing animal movements into and from the property, known as backward and forward tracing, respectively. In some countries, and for some species of farm animals, national identification and tracing systems operate, and where animals have been identified with approved tags or other means of identification, and movements have been properly recorded, including within the mandated time frame, tracing animals is a relatively quick and straight forward process. However, in the absence of tracing systems, or where the records are incomplete, farmers need to be contacted to gather tracing information. This can be a time-consuming process and depending on how good the farmer's own records are, may also give unreliable information.

Once the location of the animals of interest has been confirmed these will need to be assessed for signs of infection. Usually, this will involve a veterinary visit to the farm to examine the animals and collect samples, such as throat swabs, blood samples and/or tissue samples. These activities will impose extra work on the farmer as animals will need to be mustered for sampling, and this may involve separating them from different groups of animals on the farm. The animals will need to be presented for examination and sampling and this will normally involve some sort of restraint. After sampling, it may be necessary to hold the animals separately to await test results. This work will be additional to normal farm duties and in some cases may impose a large amount of additional work.

If infection among animals on a farm is confirmed, then these animals need to be managed to prevent further spread of the disease. This almost always means the animals must stay on the farm and may need to be managed separately from other animals also on the farm. For some diseases, treatment may eliminate the disease. Alternatively, these animals may need to be slaughtered to prevent the ongoing spread of disease. For a fast-moving disease, such as Foot and Mouth Disease, this must be done as soon as possible, and will usually be done on the farm. For other diseases, such as *Mycoplasma bovis*, this can be done at a more measured pace and via normal commercial slaughter processes. Depending on the disease, only animals confirmed with the disease may be slaughtered, for example, bovine tuberculosis, or if tests do not distinguish between infected and non-infected animals with enough confidence, then the whole herd or flock may be slaughtered. In situations where all the animals on the farm are slaughtered,

the property will undergo a cleaning and disinfection process, normally followed by a stand-down period, before restocking is permitted.

THE *MYCOPLASMA BOVIS* CONTROL PROGRAMME IN NEW ZEALAND

Mycoplasma bovis is a bacterial illness of cattle commonly causing mastitis, abortion, pneumonia and arthritis, and affecting all ages of animals. The bacteria do not affect humans and the meat and pasteurised milk from animals carrying the infection is not a food safety risk. The disease is common in cattle farming industries around the world; however, New Zealand was free of the disease until at least 2015.

This disease is difficult to test for as the bacteria tend to 'hide' in places such as tonsillar crypts, which are hard to sample in live animals. Animals do not always mount an immune response to the presence of the bacteria; therefore, testing for antibodies as an indicator of infection can result in false-negative results. Infected milking cows may shed the bacteria in their milk, but this is done intermittently. However, herd screening via the use of bulk milk testing has proved to be useful in New Zealand.

The bacteria itself does not have a normal cell wall, therefore, most antibiotics are ineffective. This means there is no effective treatment for animals that are infected and show clinical signs. This feature also means an effective vaccine has not yet been developed.

The first confirmed diagnosis of *Mycoplasma bovis* in New Zealand was in a dairy herd in July 2017 [1], though subsequent tracing indicated the disease had probably been in New Zealand since late 2015. As this disease was exotic for New Zealand, an exotic disease response was initiated. Under the direction of the Ministry for Primary Industries, tracing of all animal movements onto and off the farm was initiated. In addition, the whole herd was scheduled for slaughter because the diagnostic tests available were not able to distinguish between infected and non-infected animals with enough confidence for managing an exotic disease. In this herd, some animals had severe clinical signs of infection, with accompanying welfare impacts, and were identified for slaughter on welfare grounds.

Under the response process, all herds that had links to an infected herd were tested, and for those that had animals with test positive results, all cattle were slaughtered. This was followed by cleaning and disinfection of equipment and animal housing on the farm and then a stand-down period of 60 days. To assist with identifying infected dairy herds, surveillance testing was initiated nationwide using bulk milk samples collected at the time of milk pick-up. This was initially done for all herds in early 2018, and then at the beginning of the next lactation in spring 2018. Subsequently, this testing was expanded to be a monthly test for all herds supplying milk for processing.

This exotic disease response continued until May 2018 when a decision was made to attempt an eradication programme. No other country has tried to eradicate *Mycoplasma bovis* so this meant embarking on a programme that would

need to be evaluated and adjusted, based on experience, over time. This decision was based on a number of factors, including evidence of very limited distribution (less than 50 herds) within the national cattle herd, lack of an effective treatment regime for the disease, and an analysis of the ongoing health and welfare impacts of this disease. It was determined that *Mycoplasma bovis* could spread to 40% of farms in 10 years and lead to a 2% drop in production as a result. This was estimated to cost the industry \$NZ1.3 billion over 10 years, whereas an eradication programme was costed at \$NZ886 million [2].

Earnings from the primary sector are particularly important for the New Zealand economy and maintaining productivity in the agricultural sector is critical to New Zealand's sustainable economic growth. Dairy products and red meat are the top two export earners for the country; New Zealand is the largest dairy exporter in the world, and the sixth-largest beef exporter [3–5].

In June 2020, three years after the first diagnosis of *Mycoplasma bovis*, the disease had been confirmed on 249 farms in the country, of which 58 were dairy farms, 136 were beef farms and 55 were other farming enterprises. Almost all of these farms had been cleared of infection, with only 12 remaining as 'active' confirmed properties. In total 1,487,194 tests had been completed and 157,492 cattle culled for disease control purposes. Farmers are entitled to compensation if they are affected by disease control activities and \$NZ159.2 million had been paid out over the 3-year period [6].

THE IMPACT OF THE *MYCOPLASMA BOVIS* CONTROL PROGRAMME

The *Mycoplasma bovis* eradication programme is on track, however, despite farmers being eligible for compensation for financial losses there are other impacts on farmers, and people associated with the farming community, because of the eradication programme.

When a farmer is notified that his or her property is of interest as a result of forward or backward tracing from an infected property, or as a result of surveillance testing, there is the inevitable worry about what this might mean for the animals on the farm and the farm business itself. In high-risk cases, restrictions on the movement of animals or animal products off the farm may be placed as soon as the farm is identified, and this has impacts on the ability to sell stock and other products, for example, milk. If this comes at a time of year when farmers would usually sell stock, such as store stock for finishing at other properties, then the lack of income, as well as the potential for overstocking and feed shortages can have a big impact on the farm business, welfare of the animals and consequently farmer well-being.

In most cases, testing of at-risk animals or the whole herd will be required to confirm the disease status of the farm. This will involve presenting the animals so that they can be examined and sampled. This is unlikely to happen at a time when the farmer would be mustering the animals for another purpose, so this becomes an additional task with the potential to disrupt farm routines and

possibly interrupting important seasonal tasks, such as harvesting or calving and lambing. For large properties where animals are spread over many hectares, or even square kilometres, the time and resources required for mustering are very significant.

Once animals are sampled there will be a delay of some days before results are known. This will require the farmer to keep these animals reasonably close to handling facilities so that in the result of a positive test, the animals can be identified for slaughter. Again, this can be disruptive to farm routines.

Once a herd has tested positive it is destined for slaughter. As *Mycoplasma bovis* is not a fast-moving disease and animals that are otherwise healthy can be slaughtered for human consumption, slaughter can be timed to fit in with processing capacity at meat plants, or be done at a suitable time in the farming cycle such as the end of the milking season for dairy cows. However, most farmers find that caring for animals that are destined for slaughter based on disease status, especially when the animals are apparently healthy and would not normally be slaughtered at that time, emotionally draining. When this is coupled with uncertainty of the actual slaughter date this becomes stressful for the people involved.

Once the animals have been removed from the farm, items that have come into contact with the animals, such as milking equipment, and facilities such as animal housing, need to be cleaned and disinfected. This is followed by a 60 day stand-down period before the farm can be restocked. This period of 'nothing to do' can also be stressful for farmers, and without animals to manage grass and crops, growth and productivity can be affected.

Most farmers choose to remain farming and, therefore, need to source animals for a new herd once the stand-down period ends. There is no shortage of cattle in New Zealand, with around 5 million milking cows plus support stock [4], and 3.6 million beef cattle [7], however, finding animals to meet the specific requirements for the farm that have a low risk of reintroducing *Mycoplasma bovis* is not always easy.

Compensation is available for affected farmers, and this is specifically set up to allow farmers to be no worse or better off as a result of disease response activities. Farmers need to apply, and to establish the amount of compensation payable, so detailed records are required. Payment can also be made for future losses such as loss of milk production when cows are slaughtered before the end of the milking season and it is not feasible to restock until the beginning of the new season. For farmers, it is not always clear what can be claimed for. Once the claim is submitted it goes through an evaluation and approval process which can take some time, hence farmers may be in financial difficulty before payments are received, another source of stress at a time when they are dealing with the aftermath of losing a herd.

Community prejudice against farmers who are in the testing process, or who have infected herds is also a concern. This can range from refusal of contractors to come to the farm as they normally would, to teasing of children at school. The testing process causes disruption on the farm and may lead to loss of income, both of which can cause stress, without the additional stress arising from being ostracised by the community.

MANAGING THE IMPACTS OF THE DISEASE CONTROL PROGRAMME

Experience has shown that there are two main areas to focus on when minimising the impacts of a disease control programme. The first is managing farmer well-being in the widest sense, and the second is ensuring the animal welfare impacts are reduced as much as possible.

As noted previously, response activities at a farm level are stressful for farmers. The focus needs to be on supporting each farmer as he or she is likely to have concerns specific to their own farming situation. This is best done when one to one support can be consistently provided to the farmers and for this response, this was done by allocating an Infected Place Manager to each farm. The person in this role was the 'go between' between the farmer and the response and was responsible for getting all information to the farmer in a timely manner, and making sure that all activities that needed to happen on the farm were coordinated. The meant that the farmer had one person he or she could contact with all questions, and did not have to deal with a range of other people or organisations to ensure everything was in place for activities, such as animal testing.

It is important that people who are placed in the role of Infected Place Manager have some knowledge of farming and farm systems. They are then better placed to offer credible advice and support and can also anticipate issues that may occur and take preventative action. People who are under stress, such as farmers involved in a disease response, may not always make good decisions, or any decisions at all, and in a seasonal farming system, such as in New Zealand, delaying decisions can have a significant impact on the productivity of the farm and welfare of the animals.

In addition, farms under restriction will probably have to be managed differently from how the farmer has usually farmed. Even for an experienced farmer this can be challenging, so having an Infected Place Manager who can work alongside the farmer to adjust aspects of farm management is helpful.

Knowledge and understanding of seasonal farm systems are also important for response management. Response activities will be more effective if they take place in step with the seasonal calendar. For example, if a herd of pregnant cows needs to be slaughtered, then this is best done no later than the end of the second trimester. This will mean the welfare impacts of transportation to slaughter are minimised. If the cows are not slaughtered before calving then there are both cows and calves to deal with, and depending on where the cows calve, the conditions may not be suitable for calves such as lack of shelter. When farmers see that management of the response is taking these sorts of considerations into account there is more trust in the 'system' and less stress.

Applying for compensation is another area where support for farmers proved to be very valuable. In the *Mycoplasma bovis* response, the two main farmer levy organisations (DairyNZ and Beef + Lamb New Zealand) set up a specialist team to assist farmers prepare their applications for compensation. This meant that the

applications were prepared to a high standard and the turn-around time for payments to farmers was improved. Easing financial concerns helped reduce stress for farmers.

Within the farming community support from peers is particularly important. In New Zealand, there are several organisations set up to provide such support, as well as Federated Farmers which is a member organisation. Ensuring that personnel from these organisations were available for farmers was important as these people were often experienced farmers, independent to the response, who could provide valuable support to vulnerable farmers.

The considerations for managing animal welfare in this response are in the context of seasonal, largely pasture-based farming systems. A good understanding of the farming calendar is needed to plan ahead, especially for events that are fixed and cannot be moved, such as calving periods and harvest times. Plans need to be in place to manage all classes of stock prior to critical times. Pregnant cows destined for slaughter should be transported well before their calving date, if calves are going to be born proper provision needs to be made for their care, if lactating cows cannot be slaughtered prior to being dried off then acceptable drying off procedures need to be planned for, if stock is being held for longer than normal (perhaps due to lack of slaughter capacity) then provisions for adequate feeding and health care need to be set up. Many farmers take up farming because they like working with animals and to see avoidable animal welfare issues is upsetting for them and can also have an impact on the public perception of the response.

LEARNINGS

The success of any disease response programme depends on the cooperation of everyone involved. People need to be willing to act responsibly and do the 'right thing', from reporting initial signs of disease to the authorities in a timely manner to following all instructions given as part of response management. Good communication and actively managing the well-being of farmers and the welfare of the animals are essential for this cooperation to be maintained for the duration of the response.

Communication needs to be tailored to the audience and there are likely to be differing approaches for individual farmers, farming communities and the wider public. Communication should focus on what information is needed for decision-making, why a particular decision was made, the time frame for any activities that result from the decision, and what support is available for affected parties. In this way, everyone is informed and understands the reasons for the process being followed. Cooperation is more likely when this happens.

In addition, the reasons for the way the response is being handled need to be sensible for the situation and likely to contribute to the success of the response. For a response in a seasonal pasture-based system, a good understanding of farm systems is necessary for these criteria to be met, and this needs to be married with the epidemiological work that underpins the response. Those affected by the

response, as well as the general public, will be more likely to support response activities when this is the case.

As any response progresses there will be learnings to improve both the response activities and preventative actions that can be taken to minimise the spread and impact of the disease. Regular reviews should be undertaken, and findings implemented in a timely fashion. Where there are actions that farmers can take, then a process to inform and support change, should be implemented. Where regulatory requirements are not being met then actions to improve compliance need to occur and be visible.

THE ROLE OF VETERINARIANS

VETERINARIANS IN PRACTICE

Veterinarians in practice in rural areas are an integral part of the community and often seen as trusted advisors for their farmer clients. During the *Mycoplasma bovis* response, veterinarians in rural practice were not generally directly involved in response work, however, due to their relationships with affected farmers were often seen as an independent expert that the farmer could discuss many aspects of disease management and the impact of the disease on their herd with. This means veterinarians should keep up to date with the progress of the response and with the developing expert knowledge so that they can use this information in their discussions with farmers. Veterinarians are well placed to 'interpret' the technical information for farmers and put this into context for an individual farmer and his or her farming situation.

Due to the relationships that veterinarians build up with their farmer clients, they will also be able to identify when a farmer is not coping well with the situation on the farm. This would be the time to check how the farmer is feeling and whether support would be helpful. Even farmers who would normally be regarded as good farmers may need support during stressful times, and particularly so if their normal farming practices and routines are disrupted by disease response activities. Having an awareness of the source and range of support services for farmers, and how to link a farmer to these services, could be considered part of responsible veterinary practice.

During stressful times people in rural communities will often work together to provide support for each other. This may involve helping individual farmers with work on the farm, however, community activities such as gatherings with a shared meal are common, and give farmers and their families a chance to get off the farm and talk to other farmers. Veterinarians and veterinary practices can support these activities financially, but more importantly, by attending and interacting with the farmers. This clearly demonstrates that the veterinarians care about their clients and can be an opportunity to get feedback about farmers concerns and needs which can be passed onto response managers, or used to identify how the veterinarians can best support their farmer clients.

During the *Mycoplasma bovis* response, farmer meetings initiated by the Ministry for Primary Industries were often used to present information about the

disease and the response to farmers. These were held on a local basis and the veterinarians practising in the area were encouraged to attend. Doing so meant that the veterinarians were hearing the same messages as the farmers and were then better placed to discuss the content and implications of the information with their clients. These meetings were also an opportunity to ask questions of response managers, and especially to clarify aspects of the response management that may be of concern to farmers in the local area.

VETERINARIANS IN INDUSTRY AND GOVERNMENT

In any animal disease response veterinarians with specialist skills and knowledge in epidemiology, disease investigation, pathology and policy development will be involved. These veterinarians are not necessarily out on the farm but still play a key role in the response.

Collaboration between all veterinarians is very important for the success of the response, with a two-way information flow essential. Opportunities should be sought to share information – this could be by regular newsletters or electronic newsletters, veterinary meetings which can be held either in person or online and articles in veterinary publications. Establishment of a working group with representatives of veterinarians in industry and in clinical practice, and holding regular meetings is also an effective way of keeping all groups of veterinarians well informed. A working group is also a good way to raise awareness of emerging issues and facilitate proactive management of these issues.

CONCLUSIONS

National farm animal disease control programmes, especially those that involve a disease with significant animal welfare impacts, or where many animals will be culled, are ambitious and require planning, coordination and most importantly the cooperation of all involved. Good communication and a focus on managing the well-being of the people involved are essential for success. This is best achieved with open, transparent communication that clearly explains what decisions are being made, what information these are based on, how they will be implemented and how the impacts will be managed. It is also important that the decisions are reasonable within the context of the farming system, which in New Zealand is largely a seasonal pasture-based farming system.

The impacts of a disease control programme on farmers are significant and though financial compensation can ameliorate some of these impacts, the impact of having a whole herd culled, and significant disruption to normal life goes beyond financial concerns. A successful disease control programme takes these considerations into account and veterinarians can play an important role in achieving this success.

Veterinarians with their understanding of animal disease management and their connections to their farmers and rural communities play a key role in communicating information about disease response management to farmers. This

means veterinarians need to keep up to date with response progress, and understand the technical aspects of the response so that they can work with their farmer clients to achieve the best outcome for the farm business, the farmer and the animals on the farm. This may involve facilitating additional support for farmers who need it.

The contribution of those veterinarians working in the wider industry, and for the government is also significant, and it is important that all veterinarians work collaboratively to ensure the best outcome for any disease control programme.

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8 Rabies Control in Indonesia

Working Together to Protect Animal and Human Welfare

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RABIES IN OUR BACKYARD

Worldwide many people know of rabies and frequently refer to it as “mad dog” disease. For centuries, this colloquial name has symbolised people’s fear of the disease and Indonesia is no exception. Indeed, the word ‘rabies’ is derived from the Latin *rabere* which means “to rage or rave”. *Rabere* is also often ascribed to Sanskrit *rabhas*, which means “violence” (Wilkinson 2002). Judging from its literal meaning, the name of this disease provides an insight into the horror it causes. In communities, when symptoms of this disease appear, lives are at stake; untreated, rabies infection is fatal.

Rabies is a major public health issue in many countries globally (World Health Organization 2020a) even though rabies is not a disease with the potential to cause millions of deaths through a pandemic. It is estimated that 59,000 people die annually from rabies worldwide and this disease is responsible for the loss of 3.7 million *disability-adjusted life years (DALYs)* (Hampson et al. 2015). Of these, 95% of cases occur in Asia and Africa, meaning that more than 90% of human rabies deaths occur in low- and middle-income countries. Rabies is a major burden in Asia, with an estimated 35,170 human deaths per year accounting for 35% of global rabies deaths (World Health Organization 2020a).

Rabies has a long history in Indonesia, the first Indonesia rabies case was reported by Schoorl in a horse in Jakarta (1884); the second case by J.W. Esser in a buffalo in Bekasi (1889). In 1890, Penning reported the first case in a dog with E.V. de Haan documenting the first human case in 1894 (Ministry of Health-MoH 2017). Over centuries, rabies outbreaks spread to other regions in Indonesia. As of 2019, 26 provinces have been declared infected by rabies with four historically free provinces and four provinces declared free of rabies (Ministry of Agriculture-MoA 2019b).

In Indonesia, the number of human rabies cases is lower than other infectious diseases such as dengue fever, but as a disease that is 100% preventable, it remains a significant concern. According to the Indonesian Ministry of Health, in

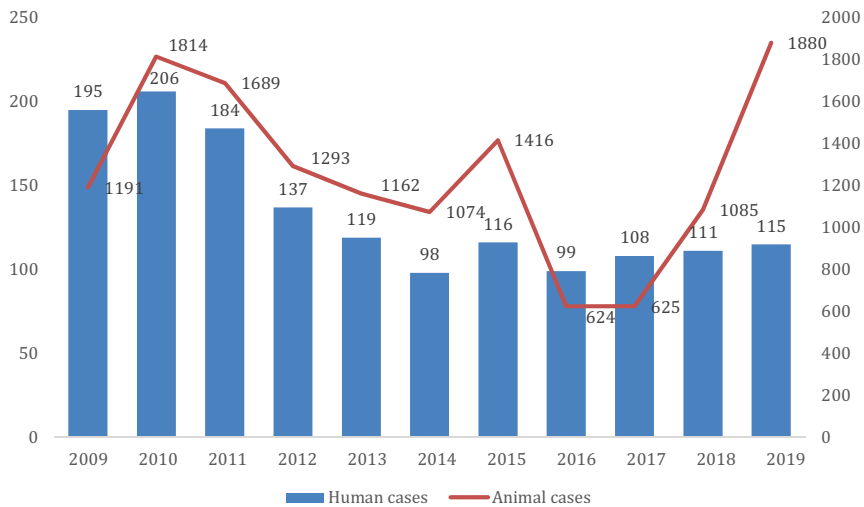


FIGURE 8.1 The number of rabies cases in humans and animals in Indonesia (MoH, MoA, MoEF 2019).

the 2009–2018 period, more than 50,000 animal bite cases were recorded, which might have been related to rabies; most cases occurred in the provinces of Bali, East Nusa Tenggara and North Sumatera. From samples submitted and tested in animal health laboratories, the average annual number of animal rabies cases reported was around 1,200 during this same period (Ministry of Agriculture 2019b), while between 90 and 200 human rabies deaths were recorded annually. Figure 8.1 shows the number of rabies cases in humans and animals in Indonesia between 2009 and 2019.

Post-exposure prophylaxis (PEP) is recommended as an effective means of preventing rabies deaths in humans exposed to bites from potentially rabid animals (GARC 2016). However, the availability of PEP vaccine in Indonesia has not met the needs in the field with, on average, PEP treatments provided to only 70% of people suffering animal bites per year. This results in many bite victims not receiving proper treatment after bite incidents with an average of 136 people dying annually from rabies in Indonesia, and 1,368 human rabies deaths recorded between 2009 and 2018 (Ministry of Health; Ministry of Agriculture; Ministry of Environment and Forestry-MoEF 2019).

As in other countries in Asia and Africa, rabies in Indonesia is being maintained within the domestic dog population. Not surprisingly, rabies is almost always associated with dogs and dog bites by the public. So far, there is no evidence of persistent wildlife involvement in the disease cycle (Mustiana 2013).

Over the past two decades, many countries have taken actions to strengthen rabies control and elimination efforts by increasing the scale of dog vaccination programmes, making human anti-rabies vaccines and antiserum (rabies immune globulin) more available/accessible, and involving communities in rabies control programmes. Indonesia has been part of this endeavour. However, for numerous

reasons, these efforts to eradicate rabies on most islands in Indonesia have not been successful. The constraints include difficulties in vaccinating roaming dogs, cold chain management and vaccine delivery to remote areas, socio-cultural differences across the archipelago, and lack of human and financial resources. The failure of this control is demonstrated by the spread of rabies to islands that were previously free of this disease in recent years, including Flores (1997), Bali (2008), Nias (2010), Kisar (2012) (Mustiana 2013) and Sumbawa (2019).

The struggle to control rabies is exemplified by the situation on Flores Island. The rabies control programme on Flores Island, established after the introduction and spread of the disease in 2007, has not shown significant progress. The initial control response involved culling dogs in infected villages in East Flores District (1998–1999). About 70% of all dogs were culled, yet the disease continued to spread throughout the island. Since 2000 other control measures have been implemented on the island, including mass dog vaccination, culling roaming dogs, dog quarantine at entry points to the island, and the provision of PEP for dog bite victims. Additional control measures implemented included the investigation of animal bite cases, diagnostic testing of suspected rabid dogs and animal bite victim backtracing (Widyaningsih et al. 2004).

The annual dog rabies vaccination programme implemented by the local government, which requires participation by all dog owners, was initially carried out in Ende and Manggarai Districts. This was followed by other districts such as East Flores, Sikka, Nagekeo, East Manggarai and West Manggarai. However, the number of dogs vaccinated during 2012 was only about 53% (23%–83%) of the total registered dog population (Wera et al. 2013), and by 2013, the programme had not succeeded in eliminating rabies on Flores Island. Around 3,500 animal bite cases by suspected rabid dogs and around 19 human deaths due to rabies have occurred each year, despite an investment of over IDR 14.1 billion (USD 957,730) per year in control activities by both human and animal health sectors (Rijsemus 2013).

The struggle on Flores to combat rabies caught the attention of the central government. Collaboration between the central government and the local governments of East Nusa Tenggara, with technical support from the UN Food and Agriculture Organization (FAO) Indonesia and the World Society for the Protection of Animals (WSPA) (later World Animal Protection-WAP) in Flores and Lembata Islands (2013–2016) was developed and based on the experiences of controlling rabies in Bali Island. More than 350 people were trained to carry out and record dog vaccination during the collaboration programme. This resulted in a significant increase in the number of dogs vaccinated in Flores Island with 167,500 (2014) and 265,000 (2015) dogs vaccinated (MoA, MoA, MoEF 2019). However, the overall results have neither met expectations nor controlled the disease.

On the island of Bali, which had been historically rabies-free, the rabies prevention and control strategy at the time of the first incursion and outbreak of rabies in late 2008 focused on emergency dog vaccination, surveillance, stray dog culling and raising public awareness. Despite government efforts to implement these response activities and cross-sectoral coordination (2008–2009), rabies continued to spread rapidly throughout Bali Island (Nugroho et al. 2013; Putra et al. 2013).

As Bali is an island famous as a tourism destination in Indonesia, the rabies outbreak rapidly drew international attention. The Ministry of Agriculture and the Bali local government livestock service, with strategic support from FAO, implemented a massive rabies control programme in Bali since 2011. Mass dog vaccination campaigns were carried out throughout Bali achieving >70% vaccination coverage, which substantially reduced the incidence and spread of rabies in 2011–2013. The collaboration resulted in a reduction in animal cases from 121 in 2012 to 44 cases in 2013 (64%), and human cases decreased from seven (2012) to one case (2013) (Putra et al. 2013).

Nevertheless, the incidence of rabies cases increased again in 2014 and 2015 due to a range of factors (including funding constraints and the failure to use an internationally certified vaccine), resulting in the ongoing requirement for continuing and repeated vaccination campaigns to control and advance to the eventual elimination of rabies from Bali. Following the rise in dog and human rabies cases in Bali in 2014 and 2015, augmented rabies control efforts by the Bali authorities, the central government and FAO resulted in a significant (61%) reduction of animal cases in 2016 (529 to 206 cases), which continued in 2017 with an 83% reduction compared to 2015 (529 to 92) (Suseno 2019). However, the trend reversed in 2018, with an increased number of dog and human cases reported in both 2018 and 2019.

It is clearly stated by Suseno (2019) that to eradicate rabies from Indonesia, time and commitment combined with a collaborative cross-sectoral One Health approach is required. In addition, the experience with rabies control on both Bali and Flores Islands led to the conclusion that rabies control is not just a technical issue; it is also deeply linked to more complex social issues. The complexity of rabies-associated problems and rabies control should be recognized and understood so that control efforts can be carried out effectively and efficiently.

THE COMPLEXITY OF RABIES

Rabies experts tend to see rabies as a zoonotic disease problem alone, commonly thinking of it as solely an animal health or human health problem. Prior to 2009, it was rare to see it discussed as a more complex and complicated disease control problem. This led to inefficient and ineffective rabies control as the strategy was not developed comprehensively considering factors beyond the animal health domain.

RABIES CONTROL IS NOT JUST AN ANIMAL HEALTH PROBLEM

Rabies is recognized as one of the oldest zoonotic diseases (Blanton and Wallace 2016). It is classified as one of the Neglected Tropical Diseases (NTD) that predominantly affect poor and vulnerable populations who live in remote rural locations. Approximately 80% of human cases occur in rural areas (World Health Organization 2020b) with 99% of reported rabies transmission to humans occurring through dog bites (World Health Organization 2020b). Rabies is often associated with lower levels of formal education, marginalised groups, and myths and

beliefs that apply in certain societies. As in other regions of the world, the incidence of rabies in Indonesia is influenced by factors related to socio-economics, culture and ecology.

Despite the fact that this disease has been one of the top Indonesian national priority diseases for decades, the regional rabies elimination pathway outlined by the Association of Southeast Asian Nations (ASEAN) to achieve rabies elimination in the Region by 2020 has not been successful.

Conceiving of rabies as solely an animal health issue has been a major barrier. Consequently, rabies control strategies were only developed by the animal health sector, resulting in ineffective and unsustainable control. Experience has taught us that rabies control requires active community involvement as well as interventions for dogs and other animal reservoirs (Häsler 2014), hence, rabies control fits neatly under the One Welfare umbrella (Colonius and Earley 2013).

Many factors contributed to the increasing incidence of rabies in certain areas of Indonesia, such as Bali and Flores-East Nusa Tenggara. Like Bali, previously, Flores Island was historically free of rabies. The first rabies case was reported in Larantuka City, East Flores District in 1997. Over the next 4 years, rabies spread to Sikka (1998), Ende (1999), Lembata (1999), Ngada (2000) and Manggarai Districts (2000) (Scott-Orr et al. 2009). West Manggarai District, located on the western tip of the island was free of rabies until 2014 when rabies cases were reported. Rabies spread was facilitated by the failure of rabies control in dogs and poor case management of dog bite victims. Other factors contributing to a higher incidence of rabies in Indonesia to that observed in other countries in Africa and Asia include: (1) low government priority, (2) epidemiological constraints, (3) operational constraints and (4) lack of adequate financial support and human resources (Lembo et al. 2010).

In view of this complexity, in 2015, FAO, the Global Alliance for Rabies Control (GARC), the *Office International des Epizooties* (OIE-World Organization for Animal Health) and the UN World Health Organization (WHO) created a platform called the global framework for the elimination of dog-mediated human rabies known as STOP-R (Figure 8.2) (GARC 2016). The framework is based on five pillars, namely, the Socio-cultural, Technical, Organizational, Political, and Resource-oriented aspects of the action plan.

This framework illustrates that rabies is not merely an animal health issue but rather a complex One Health problem requiring the cooperation of all sectors to achieve eradication.

SOCIAL-CULTURE AND DOGS

Indonesia is the largest Muslim majority country in the world. However, dogs are still an important animal in society, particularly in rural areas. Ethnic diversity in Indonesia also affects the position of dogs within the community. The role of dogs in Indonesia is related to their role, not only as a house/property guard but it is also related to socio-economics, religion and traditional beliefs.

The position of dogs in West Sumatran society, a predominantly Muslim area, includes their role as guards of field crops and as a working animal during pig



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Food and Agriculture Organization of the United Nations



Global Alliance for Rabies Control

GLOBAL FRAMEWORK FOR THE ELIMINATION OF DOG-MEDIATED HUMAN RABIES

Dog-mediated human rabies kills tens of thousands of people every year worldwide. Freedom from dog-mediated human rabies is a global public good and is feasible with currently available tools.

In accordance with the consensus of the Global Conference (Geneva, 10-11 December 2015), this framework provides a coordinated approach and vision for the global elimination of dog-mediated human rabies. It is intended to harmonize actions and provide adaptable, achievable guidance for country and regional strategies.

The five pillars of rabies elimination (STOP-R)

1 SOCIO-CULTURAL

Rabies control involves a wide range of stakeholders including the general public. The socio-cultural context influences rabies perceptions and dog management practices and behaviours. Understanding the context guides approaches to motivate behavioural changes and plan feasible delivery of services.

Includes activities like:

- Awareness: build awareness of dog-mediated rabies as a preventable global public health problem including the role of dogs in rabies transmission, such as World Rabies Day and the Endable-on-Rabies campaign
- Responsible dog ownership: promote responsible dog ownership and dog registration/dog licensing and identification, including dog vaccination, in accordance with OIE standards
- Bite prevention and treatment: develop bite prevention and first aid for both children and adults
- Post-exposure prophylaxis: increase awareness and understanding of post-exposure prophylaxis (PEP) pathways and options including intradermal administration
- Community engagement: encourage community involvement and mobilize local resources and strategies to eliminate dog-mediated rabies

2 TECHNICAL

Effective animal health and public health systems are required to eliminate dog-mediated human rabies. These systems must be integrated and able to detect, respond, prevent, and eradicate rabies and related zoonoses.

Includes activities like:

- Vaccination: ensure safe, efficacious and accessible dog and human vaccines and immunoglobulins, and vaccination as the most cost-effective intervention to achieve dog-mediated rabies elimination
- Logistics: collect data on needs and forecasts to inform the vaccine procurement system and to create and implement a national rabies control and implementation of mass dog vaccination programmes and PEP
- Diagnostics: ensure capacity and capability for rapid and accurate rabies diagnosis, including the use of well-equipped laboratories and trained personnel
- Surveillance: support improved data sampling, reporting, and data-sharing
- Technical support: provide guidance and technical support for the regional and national plans, including promoting the use of existing tools and concept programmes, and then scale up through leveraging of success

3 ORGANIZATION

The One Health approach of close collaboration between national and regional coordination through national and international networks

Includes activities like:

- One Health: promote the One Health approach of close collaboration between national and regional coordination through national and international networks
- Good governance: establish good governance, including clear roles, responsibilities, and accountable outcomes and timelines
- Harmonization: align work plans and activities with national and regional priorities and approaches fostering effective coordination and collaboration
- Coordination: coordinate and combine human resources, logistics and infrastructure of other programmes and initiatives, as appropriate and feasible
- Indicators and performance: identify targets and their indicators to support performance measurement, including the use of existing tools and indicators
- Identify areas requiring attention or extra support
- Monitoring and evaluation: support monitoring and evaluation of national plans and programmes, and ensure effective delivery

4 POLITICAL

Success depends on political will and support for elimination of dog-mediated human rabies. Political will results from recognition of rabies elimination as a national, regional and global public good.

Includes activities like:

- Political support: political support is essential and most relevant during the early stages of rabies elimination (upstream natural disasters, etc)
- International support: encourage countries to request a resolution on dog-mediated human rabies to the World Health Assembly (WHO) and the General Assembly of Delegates (OIE)
- Legal frameworks: establish and enforce legal frameworks to regulate rabies risk reduction and rabies elimination
- Demonstrate impacts: demonstrate the compelling case for mass dog vaccination programmes and their impact on rabies preventing and saving human lives
- Regional engagement: support active national and regional engagement and cooperation to support rabies elimination through a programme and promote the exchange of lessons learnt and experiences to leverage resources and engagement

5 RESOURCES

Rabies elimination activities frequently span several years and therefore require sustained, long-term support.

Includes activities like:

- Case for investment: promote dog-mediated human rabies elimination to persuade countries, policy makers and the public of the benefits and value of investing in rabies elimination strategies
- Business case: develop a business case for dog-mediated human rabies elimination based on the Global Framework for Dog-mediated Human Rabies Elimination
- Partnerships (private and public investment) to leverage resources and engagement

CRITICAL SUCCESS FACTORS

- Long-term political and social commitment
- Community engagement
- Sustainable vaccination of 70% of the at-risk dog population
- Proof of concept: start small, scale up
- Sufficient resources, logistics and infrastructure
- Present sector leads and clear strategies for rabies elimination
- Sufficient supply of quality, sound rabies vaccines and human immunoglobulins
- Broad media, oral and at-risk populations
- Conduct performance measurement at all levels
- Maintain trained and motivated implementation personnel

STRATEGIC VISION: zero human deaths from dog-mediated rabies by 2030 in participating countries

FIGURE 8.2 The Global Framework to eliminate dog-mediated rabies deaths by 2030. (Food and Agriculture Organization, Global Alliance for Rabies Control, World Organization for Animal Health, World Health Organization 2016)

hunting. This differs in East Nusa Tenggara where dogs have a high economic value and have cultural values, such as their role in religious ceremonies and events. In contrast to the situation in Flores, dogs for the Balinese symbolize purity. The Balinese believe when a *Pandava*¹ family member dies, he will be followed by a dog to a *Svarga Loka*.² The dog of Yudistira, the eldest of the Pandavas, could even enter the *Svarga Loka* because of his loyalty and honesty. The dramatic sequence of Yudistira and his four younger siblings is often used as a symbol of holiness and honesty. Thus according to Balinese Hindu beliefs, dogs are believed to be the carriers of people to heaven (Adnyana 2016).

The unique function of dogs in each region greatly influences the spread of rabies within and between areas. The economic value of dogs also influences the movement of dogs in Indonesia associated with trade between islands.

There is no denying that inter-area and inter-island trade is an important factor triggering new cases in provinces that were free of rabies (Dibia et al. 2015). The absence of confirmed rabies reservoirs in wildlife in Indonesia supports the hypothesis that the spread of rabies from island to island occurs through the movement and traffic of dogs controlled by humans (Mustiana 2013). The new outbreaks in Flores (1997), Bali (2008) and Sumbawa (2019) are understood to have been transmitted through dogs brought from other infected islands on fishing boats, associated with trade and cultural practices (Dibia et al. 2015).

This was confirmed by a study that investigated 27 brain samples collected from rabies-infected animals of various species on the islands of Bali, Sumatra, Kalimantan, Sulawesi, Java and Flores between 2008 and 2010. Based on genome sequencing and phylogeny, the ancestors of the Indonesian rabies virus came from Java and their descendants were transmitted to Kalimantan, then onwards to Sumatra, Flores and Bali. The descendants of the Flores rabies virus were transmitted to Sulawesi and back to Kalimantan. These viruses, transmitted by dogs, are found in various animal species (Dibia et al. 2015).

The economic value of dogs is associated with the trade in dogs between provinces and islands. One of the highest dog trading rates relates to hunting dogs in West Sumatra (Lubabah 2019). It is estimated that more than 18,000 dogs are sent to West Sumatra each year from West Java as hunting dogs (Lubabah 2019). West Java is also known as a source of dog meat for trading in Central Java; each month an estimated 13,000 dogs are sent to Central Java and Yogyakarta for household consumption (Walden and Arifah 2019).

However, in relation to rabies control in Indonesia the government and policymakers frequently over-focus on conventional technical matters without

¹ The Pandavas (Sanskrit: पाण्डव, IAST: pāṇḍava) are the central characters of the Hindu epic Mahabharata who fought the Mahabharata War against their cousins Kauravas for the throne of Hastinapur in Kurukshetra. They were five brothers, namely Yudhishtira, Bhima, Arjuna, Nakula and Sahadeva.

² Swarga (Sanskrit: स्वर्ग), also known as Swarga or *Svarga Loka*, is one of the seven higher *lokas* (esoteric planes) in Hindu cosmology. The seven *lokas* consist of *Bhuloka*, *Bhuvar loka*, *Svarga loka* (*Indraloka*), *Maharloka*, *Janaloka*, *Taparloka*, *Satyaloka*.

considering local, social and cultural issues when developing their strategies. Lack of government motivation and knowledge, narrow understanding of cultural issues and limited funds remain significant obstacles to the success of eliminating rabies not only in Indonesia but also in almost all developing countries where the disease is endemic (Wilde et al. 2004).

POLITICS

One important factor in controlling rabies, which is also a pillar in the global framework for the elimination of dog-mediated human rabies, is politics. Politics is hugely important because rabies control requires political commitment, which translates into effective rabies control implementation. Political commitment places rabies as an important issue on the government's agenda and allows policymakers to mobilize resources for rabies control.

Many countries such as Indonesia agreed that rabies is an important disease, but this is not reflected in terms of adequate programmes and funding for rabies control. This lack of Government commitment and limited funding affects other control elements, such as technical implementation in the field.

Under the Indonesian government structure, as in many countries, zoonotic disease involves two sectors, namely the animal sector under the domain of the Ministry of Agriculture and the health sector under the domain of the Ministry of Health. However, this does not automatically make rabies a priority programme in each ministry.

The Ministry of Agriculture under its mandate focuses more on increasing the productivity of livestock; and dogs, as the main animal transmitting rabies cannot be categorized as livestock. At the same time, the Ministry of Health focuses on health issues, which cause higher mortality than rabies, such as dengue, tuberculosis and non-infectious diseases such as cancer and heart disease.

The other major challenge is the administrative autonomy of local governments, where autonomy is granted through decentralisation from the provincial level down to the district level. This enables each provincial and district government to control its own agenda, which often becomes an issue when implementing national programmes. These challenges contribute to the non-prioritisation of rabies, which in turn leads to a lack of resources for rabies control at the local level.

A further common difficulty relates to changes in policy when local leadership changes. Provincial and district leaders sometimes do not continue to implement a policy that had been formulated by a previous administration and was considered a priority.

DOG ECOLOGY AND FREE-ROAMING DOGS

It is estimated that 500 million domestic dogs worldwide are free-roaming or poorly supervised (Hsu et al. 2003). These dogs are mainly found in low- and middle-income countries like Indonesia, particularly due to social practices,

traditional culture, the limited care provided by their owners and rapid urbanization (Hsu 2007). This situation is exacerbated when there is no dog population control programme implemented by the authorities.

Free-roaming dogs are found in both urban and rural settings. Free-roaming dogs, despite their acceptance by communities in most regions of the world, are recognized as contributing to the complexity of rabies control. The public's attitude towards dogs varies widely; human–roaming dog relationships can fall into different categories of community acceptance from strong disregard to strong regard from one community to another or even within communities that are divided in their view of the dog.

Bali Island is known as the island of paradise and it's also known as the dog's island due to the high density of dogs. Bali's dog population is estimated at 500,000–600,000 dogs (104 dogs/km²) (FAO 2019), making Bali one of the most densely dog-populated areas in Indonesia.

An ecological study of dogs in Bali showed that they were mainly free roaming (66%) even though 95% of them had an owner (Figure 8.3) (Jatikusumah et al. 2012). Based on the current estimate of the Bali dog population, about 370,000 dogs would be expected to be free-roaming. Another study showed that the Balinese on average own 1–3 dogs per household. A high percentage of owners (97%) reported feeding household food scraps or commercial dog food to their dogs twice or more every day, with most of them keeping their dogs as companion animals (99%) (FAO 2017).

This finding shows that most Balinese have a close relationship with dogs as companion animals, house guards, and to discharge other functions. The availability of food at waste/garbage collection sites and feeding dogs by

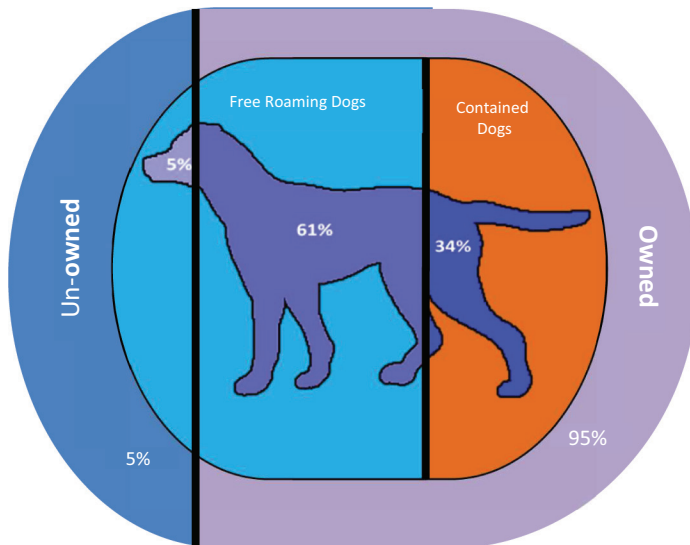


FIGURE 8.3 Proportions of the different types of dog ownership in Bali.

owners/communities allows free-roaming dogs to receive enough nutrition to support ongoing reproduction.

A dog fertility study in Bali showed that from the 100 female dogs observed for 1 year, 51 gave birth once, 32 gave birth twice, while the other 17 did not reproduce that year.

The study also showed the total number of births that occurred in the year as 115. Dogs between the ages of 2 and 3 years give birth most frequently. However, even 10-year-old dogs were still able to give birth to puppies. During the study period, the total number of puppies born was 477, consisting of 244 (51%) males and 233 (49%) females. The number of puppies born in each whelping ranged from 4 to 5 (95% CI), with an average number of pups of 4.15 per birth. The fate of the 477 puppies born was: 52 (12%) died immediately; 189 (40%) were directly given to relatives or others; 210 (44%) were kept by the owner; and 26 puppies were sold, discarded or lost (CIVAS 2013).

With this dynamic dog ecology and a projected increased dog population, the initial rabies outbreaks in Bali in late-2008 caused considerable alarm. An increasing number of dog bite cases and rabies deaths were reported, particularly in 2009 and 2010. Twenty-eight human rabies deaths were recorded in 2009, with 82 in 2010, while reported dog bite cases reached 21,806 in 2009 and 60,434 in 2010 (Ministry of Health 2011).

Dog bites can make the public feel unsafe or insecure because they fear attacks, rabies transmission, or even death, despite the fact that the vast majority of roaming dogs are friendly or submissive to humans and pose little threat.

DOG SOCIAL PROBLEMS: TRAFFIC ACCIDENT

Due to the large number of free roaming dogs, it is not surprising that traffic accidents involving dogs and motorcycles in Bali are quite high. In the first half of 2018, it was reported that 7% of traffic accidents in Bali involved animals (collision with/avoidance of animals), with most being caused by free-roaming dogs (Kadafi 2018). In 2019, there were 6,484 traffic accidents recorded costing an estimated IDR 5 billion (USD 400,000) in damages (*Badan Pusat Statistik* Bali 2020). Motor traffic accidents involving free-roaming dogs resulted in a wide variety of injuries, from minor injuries to fatalities. In terms of animal welfare, dogs hit by larger vehicles (cars, trucks, etc.) were killed or severely injured. This issue is also recognized by local Bali animal welfare NGOs.

One of the first public responses to the rabies outbreak in 2008–2010 was to move dogs into the streets and some communities then took a strong dislike to roaming dogs, seeing them as objects to be avoided or destroyed. This caused other social problems such as increasing traffic accidents and dogs scavenging on garbage dumps.

Due to these issues, the rabies control programme needed to pay attention to the social problems related to free-roaming dogs. A responsible dog ownership programme should be an integral part of any rabies control campaign so that control interventions can be carried out effectively and in a sustainable way.

DOG SOCIAL PROBLEMS: GARBAGE SCAVENGING

Another social problem relating to free-roaming dogs is garbage scavenging. The dog ecology study showed that most of the food consumed by free-roaming dogs came from garbage (74%) mainly that was thrown out by households as well as scattered food waste. The other source of food for these dogs was temple offerings (13%) provided by their owners (13%), mainly as food scraps. The results of these studies in 2013 provided an indication as to how owners manage their dogs. A high percentage of respondents reported owning dogs that were allowed to roam freely with the dogs obtaining most of their food from waste/garbage. This finding suggests the importance of increasing responsible dog ownership practices (CIVAS 2013).

The garbage problem in Bali is not a new issue. The local government has tried to tackle this problem since early 2000. The traditional Balinese approach was to use food packaging made from natural materials such as banana leaves, which would decompose naturally and not harm the environment. However, as the use of plastics became more widespread, the use of natural packages has diminished, and people tend to use plastics more. The tourism industry, as one of the main pillars of the Bali economy, also significantly increased the garbage problem on the island.

Recent research reveals that every day Bali produces 4,281 tonnes of waste or 1.5 million tonnes every year. Only 48% of this waste is managed by local authorities. Waste in Bali mainly (50%) originates from three districts, namely Denpasar, Badung and Gianyar, and 70% of this waste ends up in the Suwung landfill (Muhajir 2019). The large quantity of food waste contributes significantly to the maintenance and reproduction of the free-roaming dog population.

Dog population management (DPM) is a multifaceted concept that aims to improve the health and well-being of free-roaming dogs. Two of the eight DPM components (controlling access to feed sources and sterilization/contraception) aim directly to reduce free-roaming dog problems and reduce dog population size (Taylor et al. 2017). A comprehensive DPM approach can facilitate more effective rabies control.

MISCONCEPTION AROUND RABIES CONTROL AND ANIMAL WELFARE ISSUES

Mass dog vaccination is seen as a long-term strategy that is more cost-effective than the dependency on the application of PEP to all dog bite victims. This logical argument is based on the fact that controlling rabies in its population source, namely dogs, will lead to the protection of humans, livestock and other animals from dog-mediated rabies (Cleaveland et al. 2014). However, a misconception has arisen regarding controlling rabies directly at its source. Many people believe this to mean the depopulation (culling) of stray and roaming dogs, which are considered a source of rabies transmission.

Free-roaming dogs in Indonesia, as in other countries present many problems to public safety and environmental health (GARC 2018). They also increase

public anxiety, particularly when rabies outbreaks occur. A general debate around free-roaming dogs and dog population follows when this disease occurs, and a rabies outbreak can be the tipping point at which authorities finally decide to respond.

Superficially, reducing the dog population should help limit the spread of rabies. However, culling does not address the source of new or replacement animals and has been found to have only a temporary effect on population size. Indiscriminate culling of dogs in communities where rabies vaccination programmes are operating is likely to remove vaccinated dogs from communities, resulting in lower vaccination coverage and a counter-productive increase in rabies transmission as dog populations recover (GARC 2018).

Hence, culling is simply not an effective way of controlling rabies, and worse, it undermines the development of long-term solutions. Additionally, the use of culling can frequently result in a backlash from the community, especially if inhumane methods (administration of poison) are used (GARC 2018).

The past experience of dog culling in Flores in 1997 should have been a major lesson for Indonesia. When the rabies outbreak was reported in September 1997, the local authorities responded with massive killing of dogs starting in early 1998. Approximately 70% of the dogs in the district where rabies had been introduced were killed during that year, yet canine rabies was not controlled on Flores (Widyaningsih et al. 2004). At that time, it was estimated that the costs due to rabies in Flores were USD 1.12 million per year, with the cost of dogs culling being the highest (at around 39% of the total cost), followed by PEP (35%), dog vaccination (24%), pre-exposure prophylaxis (PrEP) (1.4%), and other costs (1.3%) consisting of animal bite case investigations, diagnostics for suspected rabid dogs, tracing of human contacts with rabies-infected dogs and quarantine of imported dogs (Wera et al. 2013) (Table 8.1).

Mass dog culling in certain areas in Indonesia has been shown to have no long-term impact on the control of rabies. The mass dog culling in Flores and some other areas has proven to be a waste of time and resources that could have been better used instead to implement a sustainable, effective rabies control programme. Moreover, culling also creates other problems, particularly related to animal welfare.

Most local authorities focus on a small number of key interventions, mainly vaccination of dogs, post-exposure prophylaxis following animal bites and/or culling of the canine population and other animal reservoirs. Many local policy-makers across Indonesia thought that this combined technical approach was sufficient for rabies elimination without any consideration of local contexts, including the role of dogs in society.

However, national authorities have now recognized this problem and support the development of a Masterplan for rabies control in dogs and a One Health cross-sectoral roadmap for rabies elimination by 2030. Both documents advocate for local authorities to follow the strategy that has been developed based on local situations and available resources. In both national strategies, the ineffectiveness and counter-productiveness of mass dog culling are highlighted.

TABLE 8.1
Why Is Vaccination Recommended, Not Dog Culling?

What is the epidemiological basis of infectious diseases eradication, including rabies?

- 1. The basic reproduction number (R_0) is an estimate of the number of secondary infections caused by a single infection in vulnerable populations
- 2. To control and eradicate infectious disease, R_0 must be reduced to <1
- 3. The rabies' R_0 must be reduced from 1–2 to <1 in order to eradicate the disease
- 4. By making $R_0 <1$, the number of new infections will decrease over time, which results in the disappearance of the disease
- 5. Vaccination can reduce R_0 to <1 and break the chain of transmission

Why is dog vaccination recommended in the fight against rabies?

- 1. Dog vaccination is cheaper than dog culling (Haesler et al. 2012)
- 2. Vaccination has an impact in reducing the transmission intensity and duration
- 3. Vaccination will induce herd immunity, which can reduce R_0 (World Health Organization 2018)

Why is dog culling not recommended in rabies eradication?

- 1. The effect of dog culling on rabies eradication is very small
 - a. The rabies virus can still survive with a density of 2 dogs/km² (Hampson et al. 2009; Morders et al. 2013)
 - b. Rabies outbreaks can still occur with a density of 5 dogs/km² (Knobel et al. 2013)
- 2. Field experience indicates that dog culling is often conducted randomly, which often results in vaccinated dogs being killed
- 3. Dog culling often encounters opposition from the community, which causes resistance to government field programmes, including vaccination campaigns

**ONE HEALTH AND ONE WELFARE FOR
RABIES CONTROL**

RABIES CONTROL NEEDS A MULTI-SECTORAL APPROACH

The complexity of the rabies problem shows that effective and sustainable rabies control and eradication cannot be done by one sector alone. In Indonesia, this One Health approach has been discussed between government officials, health practitioners, and academia since the major outbreak of highly pathogenic avian influenza (HPAI) H5N1 in 2003. This approach is not new, since the cross-sectoral principle was recognized by Rudolf Virchow as long ago as 1821. One century later, the ideas laid out by Virchow were integrated into a single health model connecting human health with animal health. Calvin Schwabe in the 1960s introduced the “One Medicine” concept/model emphasizing the need for collaboration between human and wildlife pathologists as a means of controlling and even preventing disease spread (Zinsstag et al. 2011).

Now, many countries recognize the benefits of taking a One Health approach that is multi-sectoral and multidisciplinary to build national mechanisms for

coordination, communication and collaboration to address health threats at the human-animal-environment interface.

The One Health concept gained traction in Indonesia in 2004–2006 as the H5N1 HPAI pandemic threat increased. At that time Indonesia recorded the highest global death rate due to avian influenza (bird flu). The One Health concept acknowledges the importance of a multi-sectoral and trans-disciplinary approach working at the local, regional, national, and global levels – intending to achieve optimal health outcomes recognizing the interconnection between people, animals, plants and their shared environment (CDC 2018).

In the past, Indonesia had already recognized the value of an integrated approach to strategies for rabies control. However, this did not offer a truly comprehensive approach, but only addressed legislation, and coordination between sectors focusing on the specific tasks of each sector. The joint decision letter from three ministries (Ministry of Agriculture, Ministry of Health, and Ministry of Internal Affairs) on rabies at that time did not establish a systematic working system to support integrated field activities.

In 2016, to promote a One Health approach specifically for rabies eradication, WHO, FAO, OIE, and GARC joined forces to support countries and launched a global framework providing technical advice to accelerate actions towards the elimination of dog-mediated rabies by 2030 (WHO 2018). The importance and requirement for multi-sectoral collaboration (One Health approach) to eliminate dog-transmitted human rabies was emphasised in this framework (Cleaveland et al. 2014; Lavan et al. 2017; Cowen 2016).

During the 2010 rabies outbreak in Bali, FAO in collaboration with MoA and MoH developed the integrated bite case management (IBCM) protocol. This protocol was based on the practical implementation of the One Health approach. Following this principle, FAO also introduced DPM in 2017, which recognizes the complexity of dog population ecology and offers a comprehensive solution to address the rabies problem.

INTEGRATED BITE CASE MANAGEMENT (IBCM)

Any rabies control programme should involve multiple sectors, including animal health and public health, and requires the implementation of the One Health approach (WHO 2018). By implementing IBCM, many human deaths from rabies can be prevented since it can increase access to affordable and timely medicines and vaccines in public health centres. It has already shown that post-animal bite treatment with the application of anti-rabies vaccine and rabies immune globulin (antiserum) is almost 100% effective in preventing rabies deaths (GARC 2016).

Eradicating rabies, both in humans and animals, could be greatly improved by implementing the IBCM protocol in all regions alongside the main rabies elimination tool, the annual mass dog vaccination programme. We already know that rabies is a neglected disease, which according to WHO (2018) suffers from unreliable data capture, inadequate surveillance and poorly implemented control programmes in many countries. The poor surveillance system, unreported cases,

frequent misdiagnoses and lack of coordination between the sectors involved are the main causes of the low estimation of the total disease burden due to rabies (World Health Organization 2018). As a form of coordination and technical collaboration between animal health and public health, IBCM significantly increases and improves bite case management and the field level control of dog-mediated rabies.

The IBCM protocol could also act as risk-based surveillance for rabies. This programme could increase the sensitivity of surveillance by capturing cases from primary health care centres. Through the application of this protocol, it is expected that every bite case reported to a public health worker will be coordinated and followed up through a collaborative cross-sectoral field investigation with animal health workers. This activity is expected to obtain feedback and information for health personnel to decide on whether to continue providing PEP for bite victims or to discontinue it based on the results of investigation and diagnosis from veterinary services staff. IBCM implementation is expected to be able to detect more cases through reporting so that there will be follow-up by animal health workers of all animal-bite cases based on reports from health workers.

IBCM implementation is one of the key elements of the One Health approach to control rabies at the field level, which was first introduced by FAO in Bali Province. The practical operational implementation of IBCM falls into three activities: communication, coordination and collaboration. Communication refers to the timely sharing of data and information between relevant stakeholders. Coordination is the integration of various efforts between stakeholders to address and control problems, and collaboration is the readiness to work together and share resources. The IBCM protocol was later scaled-up and used in other areas of Indonesia.

Since 2011, FAO has worked with technical ministries (MoA, MoA and MoIA) to implement the IBCM protocol to control rabies in several rabies-endemic areas of the country. Reporting and appropriate OH management/treatment of dog-bite cases using the IBCM protocol increased from 1% before the programme to 64.8% (754/1,163)³ of the 1,163 reported integrated bite cases after programme implementation. FAO reported that the programme resulted in an estimated benefit-cost ratio (BCR) of between 6.56 and 14.35 meaning that every one US dollar invested in the programme generates benefits of between USD 6.56 and USD 14.35 every year in the district where it is implemented (FAO 2020).

MASS VACCINATION OF DOGS

Animal vaccination is the main technical strategy in eradicating rabies (GARC 2016). The main objective of rabies vaccination is to immunize susceptible animals in a population so that herd immunity is generated to reduce the rate of infection in these vulnerable populations (Ministry of Agriculture 2019a). In

³ The calculation is based on the bite response cases divided by all the bite case reports (Data until December 2018).

other words, by developing herd immunity, vaccination will reduce the basic reproductive number (R_0) of rabies to less than 1, which will lead to the eradication of the disease.

Generally, the rabies' R_0 is low (<2), hence the implementation of mass dog vaccination has a high possibility of success if a minimum of 20%–45% of dogs are vaccinated and immune at any given time. A higher proportion of the dog population must be vaccinated to maintain the level of coverage required for disease elimination. This is to account for vaccination failure and immunity erosion over time due to population turnover. Some factors play an essential role in determining the minimum level of herd immunity needed, such as demographics, behaviour and spatial characteristics. In addition, dog population estimates play a crucial role in the logistical planning of vaccination campaigns and post-vaccination surveys to estimate vaccination coverage. As a general rule, annual vaccination coverage of 70% is advised.

Rabies elimination that is focused on vaccinating the animal source population (usually dogs) costs much less than human prophylactic vaccination or PEP application in bitten humans and is considered to be the most effective, financially efficient and sustainable means of controlling rabies (Haesler et al. 2012; ASEAN 2016; GARC 2016). Some countries that have embarked upon dog vaccination programmes to eradicate rabies have succeeded in significantly reducing rabies cases and successfully eliminating rabies virus from their countries. One region that has advanced very well is Latin America, especially in countries such as Mexico, Chile and Argentina, as well as Caribbean Island states where rabies cases in both animals and humans have been successfully reduced by carrying out mass dog vaccination campaigns (Ministry of Health 2017; World Health Organization 2018). While, the United States, United Kingdom, Ireland, Japan, Taiwan, Hong Kong, Singapore and part of Malaysia have successfully eliminated dog-mediated rabies through mass dog vaccination and the enforcement of animal import quarantine.

Parenteral injection is the preferred method of vaccinating domestic dogs but in some cases, this may be impractical when animals are elusive, wary of humans or difficult to handle. Feral, stray and free-roaming owned dogs can be as difficult to access as wild animals. In Bali, the government continues to use parenteral vaccination and employs dog catchers to overcome this issue at a considerable cost in terms of time and manpower. However, oral vaccination (rabies vaccine delivered within a bait) of animals may have potential to reach elusive animals, thus increasing vaccination coverage. This option was successfully developed to control rabies in red foxes in North America and Europe.

Planning of mass dog vaccination campaigns should be based on up-to-date epidemiological knowledge of the rabies situation in the target area and knowledge of dog ecology. This should include documented information on the ownership/containment status of dogs such as: owned and contained; owned but roaming; community dogs, and roaming dogs. A detailed, logical and feasible implementation plan must be agreed by all partners and properly documented. There is a need for certainty in advance about financial support, infrastructure, vaccine and

vaccination resources, and adequate technical capacity to carry out the vaccination programme. In addition, vaccine application monitoring, post-vaccination coverage surveys and programme implementation evaluation must be allowed for and budgeted (ASEAN 2016). Reliable information on the current estimated dog population must also be available to ensure success.

DOG POPULATION MANAGEMENT

Dog population is one factor that has a significant influence on rabies control programmes, especially in achieving and maintaining the required vaccination coverage, which is suggested as 70%. High carrying capacity for dogs and high dog fertility affects high individual turnover in the dog population (FAO, WSPA, IZSAM 2014). Therefore, a clear need has arisen to manage dog populations effectively and efficiently without causing animal suffering. High dog-population density in an area with the capacity to breed and reproduce more than twice per year, flags the imperative need for a dog population management (DPM) programme. The DPM approach is a combination of general and technical strategies that must be carried out comprehensively, inclusively and sustainably to have high impact and to maintain the effectiveness of the vaccination programme (Ministry of Agriculture 2019a).

DPM is one of the strategies that should be considered in efforts to eradicate rabies because dogs are the main global reservoir host for rabies transmission. Uncontrolled dog populations increase the risk of rabies transmission to humans and also impact other issues, such as (1) animal welfare, (2) effective rabies elimination and other zoonotic problems, (3) injuries through traffic accidents and (4) social problems such as complaints from the community and the public's fear of dog bites.

There are eight components of DPM, namely education, legislation, dog registration and identification, sterilization and contraception, temporary shelter and animal rescue facilities, controlling access to feed sources, vaccination and other treatments, and humane euthanasia. Depending on the specific situation, in many cases, some of these elements can be addressed simultaneously, and do not need to be conducted sequentially (FAO, WSPA, IZSAM 2014). Since dogs have diverse functions and values in different societies, any DPM programme needs to define appropriate and culture-specific measures that also take local dog population dynamics into account. DPM programmes should also increase communities' awareness of possible disease risks and should aim to increase health-protective behaviours important for disease prevention (e.g. hand washing, dog vaccination and deworming), so as to foster healthy and safe interactions with dogs (FAO, WSPA, IZSAM 2014).

Several tools have been identified to support design and implementation of DPM programmes and should be further developed. A knowledge, attitudes and practices (KAP) survey template is valuable to explore dog populations and their owners/carers. Monitoring and evaluation have been highlighted as an essential part of DPM programmes in order to improve programmes' performance. It is recommended that a set of outcome-based indicators be developed and validated,

including both universal indicators suitable for all programmes and some contextually specific indicators (FAO, WSPA, IZSAM 2014).

All in all, a rabies control programme, which is combined with a strong and comprehensive DPM plan will ensure greater success.

RABIES CONTROL TO IMPROVE ANIMAL WELFARE AND HUMAN WELL-BEING

Combating rabies requires accepting the complexity of the problem. Recognizing systems' interconnectivity and the cross-sectoral dimension of rabies control is essential. Eliminating rabies requires an interdisciplinary approach for effective and efficient programme management. The One Health and One Welfare approach could address these complex challenges to promote the health and welfare of all species and the environment by integrating all relevant disciplines to work together at the systems level. These approaches help to empower the animal welfare and human well-being fields to address the connections between science and policy more effectively in various areas of human society, including environmental science and sustainability.

NATIONAL MASTER PLAN/ROADMAP FOR RABIES ERADICATION

In 2017, recognizing the complexity of the issues and the importance of the One Health approach to achieve rabies control, the Ministry of Agriculture with support from FAO and World Animal Protection (WAP) developed a National Master Plan for the eradication of rabies using a One Health framework. The master plan embraced the One Health concept for the eradication of rabies and also developed specific technical action guidelines for local governments to follow (Ministry of Agriculture 2019a).

In addition in 2019, the Government of Indonesia with support from FAO and WHO developed a One Health National Roadmap for the elimination of rabies in Indonesia by 2030. The National Roadmap was developed jointly across ministries with the objective of refining and formalising a national strategy for rabies eradication using the One Health approach, to be followed by all stakeholders, especially local government public health and veterinary services (Ministry of Health, Ministry of Agriculture, Ministry of Environment and Forestry 2019).

The One Health National rabies Master Plan advocates for a stepwise approach to rabies elimination and provides guidance on actions to be carried out by each ministry at the national level and by local government services at the sub-national level.

In addition in 2019, FAO, OIE and WHO launched "Taking a Multisectoral, One Health Approach: A Tripartite Guide to Addressing Zoonotic Diseases in Countries", a guide for countries on taking a One Health approach to address zoonotic diseases. This guide, referred to as the Tripartite Zoonosis Guide (TZG), provides principles, best practices and options to assist countries in achieving

sustainable and functional collaboration at the human-animal-environment interface (OIE 2019).

The TZG is expected to support countries in their efforts to make improvements in their zoonotic disease frameworks, strategies, and policies. This guide also recognizes the limitations that may be experienced by different countries and provides advice on making the best use of limited resources and reducing indirect societal losses, such as impacts on livelihoods of small producers, nutrition and restriction of trade and tourism (OIE 2019).

INTEGRATED SURVEILLANCE

A key element identified during the development of the Indonesian zoonotic disease control strategy was the need of decision-makers and field officers for an integrated One Health disease surveillance information system. Consequently, a One Health platform was designed to facilitate early detection and response, and the sharing of information and coordination between sectors.

The integrated surveillance information system facilitates communication and information and data sharing between each sectoral information system for analysis by a cross-sectoral working group. The One Health platform will also produce useful information for decision-making on the prevention and control of targeted zoonoses and EID.

The Government of Indonesia initiated this integrated surveillance platform called SIZE (*Sistem Informasi Zoonosis dan EID*-Zoonoses and EID Information System) in 2015. Initially, SIZE integrated two surveillance information systems: SKDR (*Sistem Kewaspadaan Dini dan Respon* - Early Warning and Response Information System) of the Ministry of Health; and *iSIKH-NAS* (*Sistem Informasi Kesehatan Hewan Nasional* - National Animal Health Information System) from the Ministry of Agriculture. In 2018, SIZE was enhanced to include the wildlife health surveillance system (*SehatSatli-Sistem Kesehatan Satwa Liar* - Wildlife Health Information System) of the Ministry of Environment and Forestry (MoEF).

SIZE was piloted in four districts in Indonesia where the One Health approach was being rolled out, namely Bengkalis in Riau Province, Boyolali in Central Java province, Ketapang in West Kalimantan province and Minahasa in North Sulawesi province.

For piloting purposes, rabies was employed as the example of an endemic zoonotic disease of importance to human, animal and wildlife health to demonstrate the relevance of One Health implementation at the field level.

Evaluation results of the first 6 months of the trial showed good progress. Most of the field officers (85%) thought that SIZE had facilitated the early detection and response to rabies cases. Most users (83%) also felt that SIZE facilitated coordination between sectors. The majority of SIZE users (85%) felt that it contributed to decreasing the number of fatal human rabies cases (FAO 2020).

In 2020, the Government has planned to enhance this platform by adding other zoonotic diseases and EID into the system. The Government with the support

of international partners also plans to expand the system to other provinces in Indonesia.

LEGISLATION TO SUPPORT RABIES CONTROL

Political commitment is key to fighting rabies and other zoonotic diseases. Political commitment enables resources (human and financial) to be mobilized to develop sufficient technical capacities to implement effective and cost-efficient control strategies.

In terms of politics, a legal basis is crucial to address and support the implementation of disease eradication programmes. In July 2019, the President of the Republic of Indonesia issued Presidential Instruction No 4/2019 to increase capacity in controlling and eradicating zoonoses and EID, and encouraging closer communication, coordination and collaboration between line ministries.

This legislation clearly instructs 26 ministries under the President's direction, especially those ministries involved with the human health, animal health and wildlife health sectors to increase their capacity and work within a One Health framework. With the issuance of this presidential instruction, the Indonesian government has clearly demonstrated its concern about, and intention to tackle zoonoses. However, challenges still remain in translating this policy into tangible government programmes that can be directly appreciated by the community.

The difficulties experienced by local government services in implementing national zoonotic disease eradication programmes using a standardized technical approach have also been recognised. These difficulties arise due to differences in the priorities and approaches adopted by different district governments based on regional autonomy legislation. The Ministry of Internal Affairs (MoIA) issued *Peraturan Menteri Dalam Negeri (Permendagri)* No 101/2018- (Ministry of Internal Affairs Regulation No 101/2018) on the provision of minimum service standards for districts/cities. In this regulation, zoonoses are categorized as non-natural disasters for which a minimum standard of service must be budgeted and made available by district and city administrations throughout Indonesia.

Regulation 101/2018 makes it mandatory for local governments to allocate minimum resources as part of the minimum standard of services, including resources to address and respond to zoonoses as non-natural disasters.

These new policies have instilled new life into the rabies eradication programme in Indonesia; especially in relation to gaining political support to mobilize resources. However, there are still many other challenges that require strenuous and focused advocacy efforts at the national and sub-national levels.

CHALLENGES FOR RABIES CONTROL

To date, the challenges faced in eliminating rabies in Indonesia include difficulties associated with conducting mass dog vaccination to achieve 70% coverage, cold chain management, vaccine distribution to remote areas, large roaming dog populations, socio-cultural attitudes and lack of resources (Adjid 2005). In addition,

Sarosa et al. (2000) stated that other obstacles to rabies control in the past were inadequate vaccine provision by central and local government and the use of poison to cull dogs (Sarosa et al. 2000). Since 2015, the strategy of dog depopulation using strychnine is no longer officially recommended by the central government in controlling rabies for technical, animal welfare and economic reasons.

Control of dog movement between regions, even from infected to free areas, is very difficult to monitor and enforce. In addition, the extensive geographical area of the country, coupled with difficult terrain, insufficient animal health quarantine staff, and less than optimal community and local government participation in rabies eradication have all contributed to delays in eliminating rabies in Indonesia (Sarosa et al. 2000).

A study conducted in Flores by Rijsemus (2013) indicated that the success of the programme depends on three main things: level of vaccination coverage, dog population dynamics and length of immunity induced by the vaccine. The low level of vaccination coverage was due to a weak dog registration system, limited recording of dog locations, and failure to properly mark vaccinated dogs. High population dynamics on Flores Island was caused by the large number of dogs dying before reaching 1 year of age, so that the population structure was dominated by puppies (under 3 months of age). The high population turnover and low vaccination rates resulted in the percentage of vaccinated dogs decreasing every year.

Meanwhile in Bali, the main challenge to rabies elimination was the large percentage (61%) of owned roaming dogs (CIVAS 2013), making it logistically difficult to effect mass dog vaccination. The use of low-quality locally produced vaccines during the vaccination campaigns in 2014/2015 caused the incidence of rabies to increase. The downward trend in rabies incidence resumed in 2016 following the administration of high-quality animal rabies vaccines during the mass dog vaccination campaign (DeBalogh 2018). A study that examined institutional problems related to the implementation of the Bali rabies elimination programme identified weak regulation as a major problem, which also contributed to the lack of cross-sectoral coordination and multi-stakeholder collaboration at national and regional levels (Manro and Yovani 2018).

CONCLUSIONS

Combating rabies requires acknowledging the complexity of problems that must be addressed jointly by all partners. The development of an effective rabies control and eradication strategy requires the incorporation of technical and non-technical aspects of disease prevention and control. Achieving high vaccination coverage of dogs through mass vaccination together with DPM, integrated surveillance (including integrated bite case management), and continuous public awareness campaigns remain key technical strategies. These aspects of rabies control and eradication are relatively well understood and do not present major barriers to control activities. The existence of key legislative and policy tools is essential but not sufficient in itself for successful control programmes. Political commitment, availability of sufficient financial and human resources, collaboration between

partners, and the involvement of all relevant stakeholders have proven to be the key to successful implementation of rabies control programmes. To eliminate rabies from Indonesia will require time and commitment not just from the Government, but also from the community. It is through this partnership that improved animal welfare will also lead to improved human health and well-being.

RECOMMENDATIONS

- Adopt a cross-sectoral and interdisciplinary One Health approach that enables all to agree on, participate in and work towards an agreed rabies control target.
- Use a unifying One Health agreement to facilitate coordination, collaboration and communication between human, domestic animal and wild-life sectors to ensure the efficient use and sharing of resources.
- Devote time and resources to understand the socio-cultural dimensions and political aspects associated with effective rabies control.
- Continue high-level advocacy to Ministries (such as the National Development Planning Agency/Bappenas, the Ministry of Finance and the Ministry of Internal Affairs) involved with the funding and implementation of the rabies eradication programme to support long-term planning for rabies control and achieve elimination by 2030.
- Establish and adequately finance a National One Health platform that supports real-time disease surveillance, information sharing and regular inter-sectoral analysis and discussion of disease detection and control reports.
- Plan well to ensure that no legal, logistical and/or financial constraints impede control activities.
- Employ targeted surveillance through integrated bite case management to increase case detection and prevent human fatalities due to rabies.
- Conduct comprehensive nationwide mass dog vaccination campaigns annually in all rabies-endemic areas with significant dog populations to achieve high coverage.
- Implement dog population management strategies to encourage responsible dog ownership, with a focus on vaccinating dogs to maintain high levels of coverage.
- Do not conduct mass culling of dogs, as it is not only inhumane but also ineffective as a means of rabies control.

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9 The Role of One Welfare in Development and Nutrition Security

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INTRODUCTION

The World Health Organization defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity

(World Health Organisation 2018). This sentiment applies to animals as well. An animal's welfare is not just about health and growth. Animal welfare includes its behavioural opportunities and feelings as well.

Throughout this chapter, we advocate for a *welfare-sensitive approach* in projects where animal-focused outcomes are secondary to people-focused outcomes. This is because there is evidence demonstrating that proposed improvements to human development and food security, where animals are involved, could be more effective and have a greater impact if animal welfare was considered as a part of the process.

This chapter does not advocate for an equal consideration for animals as people, or that the rights of animals should be put above people who do not have their own basic rights met. It does however advocate for consideration for animal welfare beyond a token one.

Concern for animal welfare is underpinned by evidence demonstrating that animals are sentient (Mellor and Beausoleil 2015). This means that animals' biological, behavioural and emotional needs need to be met and that there is a duty to animals under our care. This is supported by a growing concern for animal welfare globally. For example, all continents now have regional animal welfare strategies (e.g. (African Union - Inter-African Bureau for Animal Resources (AU-IBAR) 2017)).

Animal welfare is no longer considered solely the concern of high-income countries. This reflects a societal shift, but it also captures long-held beliefs of communities. As some of the examples in this chapter point out as well, connection of owners to the welfare of their animals has been long established. In this sense, including animal welfare in development and food security activities could be considered as 'catching up'.

In terms of defining *development*, we are broadly referring to actions and opportunities that aim to promote 'good change' within the lives of all household members Chambers 1995, definition described by Kelly (2016). Nutrition security as a condition when all people at all times consume food of sufficient quantity and quality in terms of variety, diversity, nutrient content and safety to meet their dietary needs and food preferences for an active and healthy life, coupled with a sanitary environment, adequate health and care (CFS 2012). Development activities may include a nutrition security component; so often throughout this chapter, we refer to all of these types of projects and actions as *development*.

This chapter describes win-win-wins that development and nutrition security projects benefit from when animal, human and environmental well-being are focused on together. It needs to be acknowledged, however, that when these combined wins do not exist that animals, or the environment, should not be the groups to always lose out in cases where the needs and ability of the people involved are *already* being met.

Using a *welfare-sensitive approach* will help to achieve two- and three-way benefits between the three entities of people, animals and environment in the One Welfare framework. Without this integration, the longevity and success of projects may be at risk.

THE ROLE OF ANIMALS IN DEVELOPMENT AND NUTRITIONAL SECURITY

Livestock and working animals are indispensable for people's welfare; for their health, food security and livelihoods. The ownership of animals is critical for the livelihoods and food security of billions of people globally, and animals provide an essential role in the livelihoods, income and food security of over 50% of the 900 million people world-wide living on less than US\$1.9/day (World Bank 2019).

ANIMALS AND NUTRITION SECURITY

The hunting of various terrestrial and aquatic animal species for food and fibre production has accompanied the development of modern humans for over 200,000 years and animal domestication over the past 12,000 years (Teletchea 2019). The nutrient composition of animal-source foods aligns with human nutrient requirements, particularly during the critical first 1,000 days of life covering the period from conception through pregnancy up to 2 years of age (Dror and Allen 2011, Grace et al. 2018). Concerningly, UNICEF (2019) stated in the State of the World's Children Report that poor diet quality is driving malnutrition in early childhood with 59% of children aged 6–23 months not being fed eggs, dairy, fish or meat. Furthermore, following years of continual progress, the number of people worldwide living with chronic hunger has risen for four consecutive years with almost 690 million people, or 8.9% of the global population, undernourished in 2019 (FAO IFAD UNICEF WFP WHO 2020). The combined impact of multiple crises in 2020 (COVID-19 pandemic, locust plagues, extreme weather events and spread of infectious disease and pests; Alders et al. (2020)) are expected to see at least an addition 135 million people hungry prior to the end of the year (United Nations World Food Programme 2020). Animal-source foods could play an important role in reducing stunting and some key micronutrient deficiencies as eggs, milk, meat, and offal are all nutrient-dense food products that contain high-quality proteins and several highly bioavailable vitamins (e.g. vitamin B12, only available in foods of animal origin, preformed vitamin A, and vitamin D) and minerals (e.g. iron, zinc, and calcium) (de Bruyn et al. 2020, Alders et al. 2018, Alonso, Dominguez-Salas, and Grace 2019, Adesogan et al. 2020).

Nutritional research has suggested that more sustainable diets would be achieved by ensuring that human-edible foods (e.g. cereals, pulses, etc.) are eaten directly by people (Berners-Lee et al. 2018). However, rather than competing with crops for land, much of the animal-source food produced in resource-limited settings uses nonhuman-edible feed resources and on rangelands that would otherwise be unproductive for human food purposes (Wingett, Allman-Farinelli, and Alders 2018). While some conventional livestock grazing practices can negatively impact on ecosystem structure, function and composition (Eldridge et al. 2016), sustainable regenerative livestock grazing may contribute to improved health, productivity and rangeland ecosystem function (Teague and Kreuter 2020, Alders et al. 2019).

ANIMALS AND HUMAN DEVELOPMENT

Livestock also forms a part of people's cultural identity and individual sense of purpose and status. Livestock plays a wide number of critical roles for families and communities in low-to-middle income countries: they are a source of income and an asset, with livestock and working animals provide manure fertiliser and draught power, climate and seasonal resilience, and personal, cultural and social benefits, including prestige, ceremonial use and dowry value (Salmon et al. 2018).

Livestock generates capital and income and can contribute to three major pathways out of poverty. They increase resilience through livelihood diversification by acting as an offset when crops fail, and an entry point into entrepreneurship that often do not require land ownership or significant capital investment. Animals can improve smallholder and pastoral productivity through traction and nutrient cycling. They can also increase market participation. These diverse roles also mean that there are diverse types of livestock kept by smallholder farmers. This diversity builds in resilience into their production system and livelihoods (Perry and Grace 2009).

For people owning working animals, these contribute a largely unrecognised and invisible contribution comes from working livestock (International Coalition for Working Equids 2019). Facilitating farming and transportation: they pull ploughs and carts, deliver goods to market and are critical for water collection for households and other livestock. Urban working animals aid in construction, the transport of people and goods, and refuse collection, and while not often given much focus internationally, the role of working animals can be even more important than that of livestock. An example of how including care for working animals can improve their welfare, family and community well-being is described in Case Study 9.1.

Case Study 9.1: Equine Welfare Project

Provided by World Horse Welfare

Organisations: World Horse Welfare, National University of Lesotho, Riders for Health, Ministry of Agriculture and Food Security

Location: Maseru and Mafeteng districts, Lesotho

Equids are the cultural symbol of Lesotho, yet their value in sustaining livelihoods often missed. In a project run by Riders for Health, in coordination with the Ministry of Health, horses and their owners have been recruited to reach people living in the most remote areas of the highlands in order to achieve the government's commitment to healthcare for all. These horses transport samples and test results from homes to clinics and have become the direct link for these marginalised groups of people to access diagnostic HIV testing and subsequent treatment if needed.

World Horse Welfare works together with the National University of Lesotho and Riders for Health in ensuring that the owners of working equids used to

deliver healthcare for highland communities are supported in maintaining the health and welfare of their equids. Owners are upskilled in transporting samples and supported in accessing good quality and affordable services for their equids.

The project helps owners and users treat their working equids in a welfare-friendly manner that demonstrates good knowledge of husbandry, first aid, health care and hoof care, with improved access to good quality extension services. This directly benefits the horses and the people that rely on them, as well as those receiving health services provided in regional areas.

Through the support of the Ministry of Agriculture and Food Security, the project has trained livestock extension officers in the practical knowledge and skills required to support owners in taking better care of their equids. These officers are often the first line of support for farming communities and as such are called upon to provide advice and assistance in adapting management practices (such as feeding and housing) to improve animal health and welfare and in preventing, identifying and treating illness, injury and disease. Training has targeted basic skills in handling, behaviours, primary first aid care and disease prevention to empower the extension officers to support working equids and their owners.

Through the project, owners have started to make sustainable changes to their behaviours in managing their equids so that they are better able to meet their welfare needs and in return strengthen their own livelihoods. By building the equid-specific knowledge of extension officers based in communities, as well as improving their practical experience and confidence to treat working equids, the project is helping to improve the quality of extension services provided to owners by the Ministry of Agriculture and Food Security.

With all these critical roles, it is no wonder that such a significant proportion of programmes targeted at improving the health and livelihoods of vulnerable communities. Ensuring that these animals are able to fulfil these roles is critical, which is where considering their welfare in this context becomes important.

DOES ANIMAL WELFARE HAVE A PLACE WHEN HUMAN WELFARE IS COMPROMISED?

One major reason why there is concern for animal welfare is because animals are sentient, meaning they have the ability to experience emotions, both positive and negative (Duncan 2006). This gives them an inherent agency as a being, rather than an inanimate object. Because animals are sentient, there are ethical concerns that their basic needs should be met.

While concern for the welfare of animals is valid, in situations when the rights of animals, people and the environment are all at risk, it can be reasonable that the rights of the animals should be the lower priority compared to that of people. The concern for animal welfare is obviously particularly difficult to justify in situations where the welfare of people is already being compromised. Never are

we attempting to create equal rights for animals in contexts where the rights of people are not being met. However, animal welfare can synergistically interact with livelihoods. An example of the three-way interaction between human, animal and environmental well-being is outlined in Case Study 9.2.

Case Study 9.2: One Health Work in Brick Kilns; Establishment of a Brick Kiln Coalition Workforce

Provided by Brooke

Organisations: Brooke, International Labour Organisation (ILO), the South Asia Initiative to End Violence Against Children (SAIEVAC), the Donkey Sanctuary, the International Centre for Integrated Mountain Development (ICIMOD), World Wildlife Fund (WWF), ActionAid Nepal, International Union For Conservation of Nature (IUCN) and Global Fairness Initiative.

Location: Pakistan

In 2018, Brooke formed a coalition of organisations dedicated to better labour, animal health and welfare, child labour, conversation and environmental health respectively.

This coalition was formed in recognition of the fact that to truly improve the health and welfare of animals working in these kilns, we must find a way to support and improve the lives of their owners, and the state of the environment they work in.

Interventions to date have included the introduction of human and animal first aid kits into kilns, health and safety training, linking workers to social care and health care schemes and the ‘Green Bricks’ initiative which is tackling harmful kiln emissions through the implementation of new ‘clean air’ technology.

The coalition has jointly advocated for changes to the policy that encourage best practice in kilns through supporting the implementation of the OIE standards for working equids, pooling technical expertise to ensure change is reflected in each key sector and strengthen animal health and welfare laws.

Working alongside the Government in Pakistan and the Brick Kiln Association, efforts to tackle the high levels of pollution and land degradation that these kilns are responsible for by planting trees within kilns has started. These trees include fruit and shade species and will not only reduce carbon footprints but provide shade and shelter to the working animals and their owners who work under the burning sun.

The tree planting initiatives have resulted in more shade and shelter for working animals. Brooke’s training of local vets has ensured that brick kiln communities have access to a local, Brooke trained vet who understands the issues in brick kilns and who can pass on their knowledge through community visits and workshops. Our work with farrier and saddle makers is ensuring that animals receive the best care and equipment possible. Not only does this improve the welfare of animals but provides those we train with a skill and importantly, a livelihood (Figure 9.1).



FIGURE 9.1 Women working with horses in the heat of Lucknow brick kiln in India, Photo credit, Brooke

In this chapter, we advocate for a *welfare-sensitive approach*. A welfare-sensitive approach means that the welfare of animals should be given due consideration in programmes and actions aimed to improve human and social development and food security. There are two broad benefits from taking a welfare-sensitive approach. Firstly, including animal welfare into programmes creates the opportunity to increase their long-term impacts and sustainability. Secondly, it may prevent any future challenges that could arise from inadequate evaluation of animal needs.

As described by Kelly (2016), animal welfare and ethics needs to be included in the planning and discussion around development, to ensure both the development benefits to animals and people are recognised, and disadvantages are avoided. To quote:

A fun and novel gift of a donkey may equally be perceived as a cruel, environmentally unsustainable and misguided development effort, a valuable asset, or a burden to a household struggling to feed existing mouths. Exacerbating this situation is the fact that much of the debate around animals in a developing context is heavily polarized between livestock welfare, and animal rights, with a very limited middle ground.

(Kelly 2016)

This is where the relevance of a *welfare-sensitive approach* becomes clear.

The welfare of animals in situations of dramatic compromise, including chronic low resource settings and acute emergency situations, is aligned with the welfare of their owners and carers. Ensuring animals are healthy and well means people's livelihood needs are being met. For production animals, this means they

are growing and producing well. For working animals, this means they are fit and healthy for work. This directly affects the income and nutritional needs of families. In both of these instances, animal welfare is a critical component to this, but it is often felt to be an issue that does not pertain to settings where human welfare is compromised.

A summary of practices that benefit cattle welfare and productivity simultaneously is presented below (Table 9.1; reproduced from Devereux (2014), originally

TABLE 9.1
Practices that Simultaneously Improve Animal Welfare and Animal Productivity

On the farm

Animal Welfare can make your job easier and improve your yields

- Branding the cattle in the correct place is less painful and ensures the animal can recuperate quicker.
- All procedures (dehorning, castration, branding) must be carried out on very young calves.
- Provide your cattle access to shade and water at all times.
- Inject in the correct location.
- Provide your animals with enough food and water.
- Control parasites regularly.

Handling

Animal Welfare can make animal handling easier and more efficient

- Do not use prods, sticks, sharp objects or harm the animal in any way.
- Give the animal a few seconds to study shadows, contrasts and obstacles.
- Remove unnecessary objects from the chutes where the animals are handled.
- Limit the number of people working the animals.
- Work the animals in small groups.

Transport

Animal Welfare can increase your earnings and make your job easier

- Transport cattle in trucks that are in good condition.
- Trucks should have non-slip floors.
- Trucks should be kept clean.
- Do not transport sick or injured animals.
- Use the correct density and appropriate group divisions to load trucks.
- Use well -designed trucks.
- Ensure trucks are driven sensibly.

Slaughter

Animal Welfare can increase your profits

- Provide water for the animals in waiting pens.
 - Appropriate handling of the animals avoids carcass losses.
 - Place the stunner in the correct location during stunning.
 - Verify that the animal is properly stunned before it is bled.
 - Keep the stunning equipment dry, clean and in an appropriate place.
-

adapted from Humane Society International (2008)). This gives some simple examples of the benefits animal welfare can have on basic productivity.

CONSIDERING ANIMAL WELFARE IN CONTEXT

Before describing the tangible interactions between animal welfare and human development work, it's important to consider what animal welfare may mean to different people. Perceptions or attitudes towards animals will depend on the type of animal it is and what it is being used for. This 'affect and utility' interaction is well discussed by Serpell (2004). Attitudes can be influenced by a number of factors: individual factors, including personality, stereotypes, values and experiences; social factors, including culture, gender, ethnicity and religion; and information, knowledge and past experience with animals (Serpell 2004, Munoz et al. 2019, Hemsworth, Sherwen, and Coleman 2018). This means that there will be diverse considerations around animal welfare both between and within each community that projects operate in.

It is important to respect and consider this diversity of ethical perspectives. When considering animal welfare in development settings, the role of animals and perceptions on welfare within cultures that the animals and the intervention are based needs to be considered. This will influence how animal welfare is perceived and acted upon. As with all aspects of development, Western ethical norms should not be the basis for action or assumption.

Regardless of the cultural and ethical norms around animal welfare, the *science* of animal welfare clearly identifies the needs of animals. This evidence-based approach is important to follow, and details of this are given below in *How to take a welfare-sensitive approach*. The ethical components are important for engagement and driving practice change. Case Study 9.3 describes an example of this, capturing the thoughts of a community about what animal welfare means to them, how they recognise it in their animals, and what they need to do to improve it. This example also demonstrates a method that can be used to capture the thoughts and beliefs of a group towards animal welfare.

Case Study 9.3: Community Conversations on Animal Welfare (ILRI)

Provided by International Livestock Research Institute (ILRI) (Lemma et al. 2019)

Organisations: International Livestock Research Institute (ILRI), University of Melbourne, International Center for Agricultural Research in the Dry Areas (ICARDA), conducted as a part of CGIAR Research Program on Livestock

Location: Yabello, Ethiopia

Community conversations are facilitated discussions and social learning processes among community members. They help participants identify and analyse

their knowledge, attitudes and practices about animal welfare and discuss how these affect the welfare of their animals and their own livelihoods. These conversations were held in Yabello, Borana zone of Oromia region, Ethiopia, which is an agro-pastoral community. Forty-six community members (33 female) and community leaders participated, along with 6 local research and development partners (2 female), and livestock experts, and communications and gender experts.

Community members described the inter-reliance of their well-being, animal welfare and the environment, capturing the three components of One Welfare in different ways.

During the conversations, community members highlighted that animals have feelings, and they were able to identify conditions that make animals happy or sad. They connected how animals felt to the environment, describing animals as happy when there is rainfall because they get enough feed, and show signs of natural behaviours like playing with each other and making a loud noise. A woman participant said, “our animals are sad and feel bad when they are emaciated, when there was no feed and water, if they are ill.”

Community members described their reliance on livestock as the main source of livelihoods, social status and respect in pastoral communities.

Our animals are many things for us. Cows give us milk and baby calves; male bulls are used for ploughing our land. Camels and donkeys are used to carry materials like fetching water. When we sell sheep or goat, we get money to buy feed for our children.

Community members describe being able to communicate with their animals and express any feelings related to their animals, especially for cattle. Men and women often use songs to communicate and connect with their animals in this way.



FIGURE 9.2 Photo credit: ILRI/Mamusha Lemma.

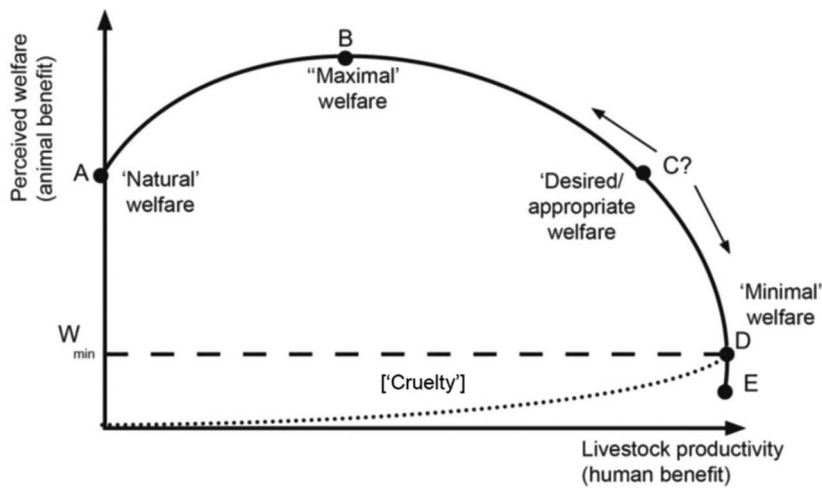
Through the community conversation process, members identified solutions and actions that they would like to take to address some of the issues they identified related to improving the welfare of their animals. This included pond construction to increase water availability for their animals, buying veterinary drugs from approved sources, and exploring the use of alternative feeds to fill fodder gaps (Figure 9.2).

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RELEVANCE OF ANIMAL WELFARE IN RESOURCE-POOR SITUATIONS

In resource-poor settings, animal welfare goes hand in hand with productivity and animal health, which then leads to benefits for the household as described above in *The role of animals in the development and nutritional security*. This is represented by a theoretical “n” curve (Figure 9.3), where animal welfare improves as resources are provided, until it reaches a tipping point where production and welfare limits are pushed (Devereux 2014, McInerney 2004). In resource-poor settings, investing in animal welfare goes hand in hand with benefits to productivity and livelihoods. These investments can include adequate feed and water access, improved husbandry and housing, and improved access to veterinary services.



Source: McInerney (2004).

FIGURE 9.3 Synergies and conflicts between animal welfare and livestock productivity

Considering animal welfare from a health perspective, vaccinations of cattle against East Coast Fever have been associated with improved milk production, reduced herd mortality and reduced use of antibiotics and acaricides (Marsh et al. 2016). All of these improvements are associated with increased income and reduced expenditure. Households that vaccinated their cattle then spent more on education for boys and girls and food for the household. In addition to these critical household benefits, the reduced use of antibiotics and acaricides also has positive social impacts by reducing the risk of antimicrobial resistance and environmental contamination from acaricides. This example demonstrates the benefit of development investment using a One Health, One Welfare framework. Another great example of this is shown in Case Study 9.4.

Case Study 9.4: Strengthening Food and Nutrition Security through Family Poultry and Crop Integration in Tanzania and Zambia

Provided by Robyn Alders

Organisations: University of Sydney, Tanzania Veterinary Laboratory Agency, Zambian Ministry of Fisheries and Livestock, Sokoine University of Agriculture, Kyeema Foundation, Royal Veterinary College

Location: Central Tanzania and southeastern Zambia

There is no single, perfect diet that fits everyone but rather a series of dietary options depending on locally available and accessible food and the age, gender and reproductive status of each person. In many resource-poor environments, food availability is influenced by seasonal farming and production patterns, livestock ownership, indigenous plants and animals, socioeconomic circumstances, cultural beliefs and the presence of affordable food produced elsewhere (Alders et al. 2016). There are often trade-offs and synergies between nutritional security, food safety, livelihoods, women's empowerment and ecosystem services (Alders et al. 2018).

The goal of this project was to reduce childhood under-nutrition by analysing and testing opportunities to enhance the key role that women play in improving poultry and crop integration and efficiency to strengthen household nutrition (Alders et al. 2014).

A One Health approach was adopted in the design, implementation and analysis of findings of the project. Achieving sustainable improvements to monotonous cereal-based rural household diets requires participatory methods, interdisciplinarity and multi-sectoral involvement, to adopt a holistic, systems approach to disease prevention and food and nutrition security. With funding from the Australian Centre for International Agricultural Research (ACIAR), the project team worked to understand the food and nutrition systems in the project area and implement community-based interventions. Project activities supported improved family poultry and crop production, nutritional awareness and capacity building of research students. Quantitative and qualitative results documented the complexity of household food and nutrition systems in semi-arid



FIGURE 9.4 Rosemary Ackley (Community Assistant) and Caroline Kapande (Community Vaccinator), Sanza. Credit: Robyn Alders, Sanza Ward, Tanzania, May 2017.

areas during a time of considerable weather variability. Associations between improved child and maternal nutrition outcomes and project interventions, differing household cultures and rainfall patterns were investigated (de Bruyn et al. 2017, 2018; Grech et al. 2018).

Key lessons learnt during implementation include the importance of: adapting research tools and awareness-raising materials to local conditions (especially in relation to socio-economic status and local foods); involving district governments, local community leaders and general women and men community representatives in project implementation and evaluation; understanding the local agricultural calendar and timing project activities accordingly; taking time to build a common vision across disciplines and sectors; promoting climate-smart agricultural and livestock practices; and recognising that nutrition security is intimately linked to household and community resilience and socio-economic status (Maulaga et al. 2018; Rukambile et al. 2020).

Following the project, the need for government food distribution programmes during the hunger periods was reduced in the project area in Central Tanzania (Maulaga et al. 2018) and chicken numbers increased in households that adhered to the 4-monthly vaccination schedule (de Bruyn et al. 2017) (Figure 9.4).

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Access to enough quality feed is critical for animal welfare and productivity, and feed access is a major constraint for smallholder farmers (Franzel et al. 2014). Growing and feeding fodder trees is one example of three-way benefits under a One Welfare framework. Fodder trees provide substantial environmental benefits, including reduced erosion and increased resilience; being associated with better nutrition, growth and production of livestock; all of which lead to improve household food security and income (Franzel et al. 2014). Other potential animal welfare benefits that come from this include opportunity for nutrient and feed

diversity, and behavioural enrichment. For example, providing forage to young goats improved their growth rates and increased their total daily feed intake (Niang et al. 1996).

Resource availability can constrain development programmes. For example, a development initiative by the Rwandan government to provide one cow of mixed genetics (local or imported European genetics) to poor households had the aim to improve household nutrition and income opportunities (Klapwijk et al. 2014). On evaluation, it was found that only the best-resourced farmers may be able to maintain a local breed cow, or possibly a European cow, under specific scenarios. These were not the farms targeted by the initiative. Poorly resourced farmers, who the programme targeted, and who comprise 86% of the population, did not have access to enough feed resources to keep either a local or European cow. The publication evaluating the programme only focused on the fodder availability of the program, not any social, human health and nutrition, or livelihoods evaluation, so these benefits are not known here. The limitations described in terms of fodder availability, and so the productivity and welfare of the animals, highlights a series of potential risks. Inadequate feed availability prevents cattle from reaching their production potential and risks its reproductive health and longevity. Relating back to the quote from Kelly at the start of this section, programmes where animals are gifted can often require some resource input from recipient families too, either to secure animals initially or to maintain animals. In this scenario, households were at risk of not receiving the level of benefits they may expect to receive from the intervention. The intervention possibly creates further risk by asking for family investment (financially or via other resources like time to care for and feed the cow). This is just one of the examples of how a welfare-sensitive approach to project planning can avoid negative impacts on both the animals and people involved.

Many animal-focused interventions in low resource settings will sit on the left side of the 'n' curve (Figure 9.3), having a mutual benefit to welfare and productivity. Compromises to both welfare and productivity will occur, however, in interventions that are not designed to support both the people and or the animals. This includes livestock improvement programmes that introduce performance traits that are too demanding for the resources available, inadequate veterinary support, environmental conditions or workload capacity of the household. Under resource-limited conditions, livestock genetics are rarely the most limiting feature and higher performing breeds should only be considered when their health and nutritional requirements can be met (FAO 2014).

RELEVANCE OF ANIMAL WELFARE IN SITUATIONS ACUTELY IMPACTING PEOPLE

The long-term displacement of people from their homes can be driven by armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters (United Nations Office for the Coordination of Humanitarian Affairs). Welfare of animals may be the last consideration in times

of crisis, but the loss of livestock and working animals can leave refugees and internally displaced people (IDPs) facing a significant second disaster that can lead to long-term malnutrition, food insecurity, debt and dependency as the animals that they depend on disappear (World Animal Protection Unknown).

The impact of this is wide-ranging. Data on these losses are scarce. It has been estimated that around 50% of animals perished during and shortly after the relocation process as people from Blue Nile state in Sudan were forced to leave their homes for camps in Maban County in the newly formed South Sudan (Hoots 2018). One study by Society for the Protection of Animals Abroad (SPANNA) identified 85% mortality rate of donkeys in the Abu Shouk refugee camp, Darfur, Sudan, over an 18-month period. This was described as being a loss of a “critical lifeline to a future outside the camp” for owners (Pollock 2018).

Livestock also plays an important role in human nutrition in refugee camps, creating opportunities to include at least a small amount of animal products into people’s diets (Angeloni and Carr 2018). A lack of meat for refugees has also been reported to lead to large scale poaching (World Wildlife Fund 2008), so providing opportunities for keeping and caring for livestock in these acute settings can also have possible benefits for zoonotic disease spread and wildlife and environmental impacts.

Disaster response contingency plans do often involve animals because this is such a problem. The UN Sendai Framework for Disaster Risk Reduction (Pearson and Pelling 2015) explicitly recognises the need to accommodate livestock and working animals, and the Livestock Emergency Guidelines and Standards (Watson 2011) provide guidelines for rapid and slow-onset disasters. Continuing to increase the role animal welfare has in these settings and supporting owners to care for their animals in these intense settings, can have both short- and long-term benefits to the health and welfare of the owners and communities in refugee/IDP camps.

HOW TO TAKE A WELFARE-SENSITIVE APPROACH

Taking a welfare-sensitive approach will increase the likelihood of capturing benefits to animals, people and the environment, and identifying situations where one or more entities is not benefiting or coping well with the intervention.

Additional opportunities for benefits in research and development projects by taking a welfare-sensitive approach include:

- *Identifying risks to interventions while there is time to correct them, or before they even start.* Using welfare indicators and welfare assessment can provide welfare data that can act as early warnings about situations where animals are not coping, but while they are still ‘fixable’. As examples, reductions in body condition can indicate inadequate feed; changes in behaviour can indicate inappropriate feed or environments; changes in coat or hoof health can indicate environmental issues; and early indicators of illness can be the catalyst to early veterinary intervention.

- *Understanding additional needs of a program.* Animal welfare can be used to identify animal management issues that require future investment, capacity development, or intervention. In this way, animal welfare indicators can be used to set up a programme of work that leads to long-term sustainability of a development initiative.
- *Identifying improvement and reporting to donors.* Welfare indicators and animal performance can be used to report short term and intermediate outcomes to donors, as they can be more time-sensitive than end-of-project outcomes like changes to household income, and human nutrition improvements that often take time to take effect and often subject to externalities.

THE ROLE AND RESPONSIBILITY FOR ANIMAL ETHICS AND ANIMAL WELFARE IN DEVELOPMENT PROJECTS

Interaction with animal welfare and ethics review boards/bodies (AWERBs) before the start of a research and development (R&D) activity is a beneficial process that helps integrate a welfare-sensitive approach. Going through these review processes, which are often essential for components of research and development activities, can ensure legal requirements are being upheld, local laws are being adhered to, and that any findings are able to be published in journals because AWERB approval is a requirement of many journals.

AWERBs are charged with ensuring good animal welfare for the animals under your care, improving scientific outcomes, promote awareness of animal welfare and the 3Rs (see below), providing a forum for discussion and development of ethical advice to the establishment licence holder on all matters related to animal welfare, care and use at their establishment. They can also be involved in supporting named persons and other staff dealing with animals, on animal welfare, ethical issues and provision of appropriate training; and helping to promote a culture of care within the establishment and, as appropriate, in the wider community.

The principles of the 3Rs were developed over 50 years ago providing a framework for performing more humane animal research (OIE 2012). Since then they have been embedded in national and international legislation and regulations on the use of animals in scientific procedures, as well as in the policies of organisations that fund or conduct animal research. The 3Rs are:

1. *Replacement:* Methods that avoid or replace the use of animals;
2. *Refinement:* Methods that minimise animal suffering and improve welfare;
3. *Reduction:* Methods that minimise the number of animals used per experiment.

Animal welfare and ethics are continually changing as more research becomes available on how to best care for animals. Continuous improvement for care for animals to both improve animal care and R&D practice is a valuable step.

ANIMAL WELFARE AS A TOOL TO STRENGTHEN AND MEASURE PROJECT IMPACT

Current thinking around animal welfare recognises animals as sentient beings, accepts that welfare encompasses physical, emotional and natural components with multiple influences, and it acknowledges that animals have the capacity to suffer on account of negative physical and emotional states, and to benefit from and enjoy positive experiences.

The Five Domains model is recommended as a basis when assessing an animal’s needs and welfare (Mellor and Beausoleil 2015). The five domains framework comprehensively describes the essential components for an animal’s quality of life: nutrition, environment, health, behaviour and mental state. It builds on the important aspects of the well-known Five Freedoms, while addressing some of their limitations. For example, the five freedoms described an absence of negative experiences, which is not possible, and arguably undesirable, and it does not describe positive experiences that are needed for an animal to have a ‘life worth living’. Examples of contributions to the Five Domains are captured in Table 9.2.

TABLE 9.2
Welfare Opportunities and Challenges According to the Five Domains of Animal Welfare

Nutritional contributors to animal welfare	• Feed and water access • Changes to diet • Feed diversity
Environmental contributors to animal welfare	• The type and quality of housing • Free movement • Floor surface and cleanliness • Compassionate handling and restraint • Shade and shelter • Air quality
Health contributors to animal welfare	• Regular clinical checks • Vaccinations and other basic preventative veterinary care
Behavioural contributors to animal welfare	• Social contact (positive or negative) • Restraint and tethering (method, duration) • Ability for natural behaviour expression • Human-animal interactions: handling, training, treatments, reinforcement
Changes to routine and quality of life	• Mental contributors are linked to the other four components above, and include • Stressors in environment: noise, smell, taste, touch, sight (people, animals, machinery)

Purpose

The first important step is to identify what the purpose of welfare assessment is for you and your project, and how you want to assess welfare. It could be that you want to assess the welfare of animals in a current context to understand where the easy first wins, or that you want to measure welfare changes after a project has been implemented. The components of welfare assessment will be the same, but the goal will determine some specific indicators you choose, the timeframe you will work across, and whether or not you need to consider reproductive and seasonal variations.

Conducting Welfare Assessment

When designing the welfare assessment, who will be conducting it needs to be considered. Many of the livestock tools developed are for third party, trained auditors, or researchers and technical staff, and so require training to achieve competency. These tools, like that from Welfare Quality Project (Blokhuys et al. 2010), AssureWel (2010), Animal Welfare Indicators Project (AWIN) (AWIN 2015), and scientific literature (Alam et al. 2020, Munoz et al. 2017, Bekele et al. 2020) can be a useful starting point for adaptation.

Animal welfare NGOs have also developed welfare assessment tools that can be used by people with a wide range of backgrounds. Examples from the working equid charity Brooke, include comprehensive published protocols (Sommerville, Brown, and Upjohn 2018) through to a pictorial traffic light system, which is a great example of an accessible assessment tool for anyone in the field and requires little to no training (Brooke West Africa 2016).

Participation

When developing welfare assessment tools, engaging relevant stakeholders is important for both acceptance and execution of the program, but also to get local knowledge of problems and opportunities that may need targeted indicators. Understanding how communities think and feel about their animals is essential and gives important insight about how change could be created.

Choose Your Indicators

Indicators need to be selected so they are relevant to the circumstances. This is another benefit of taking a participatory approach, because you can understand the environment and challenges faced by people and their animals better. A set of considerations when developing your welfare assessment are in Figure 9.5. Focusing on animal-based indicators, but also including resource and management-based indicators, will give information on the past, current and potential welfare challenges facing an animal.

THE VALUE OF USING A ONE WELFARE APPROACH

The framework of One Welfare describes clear, and natural relationships. It supports a One Health framework and builds on it. Many of the examples in this

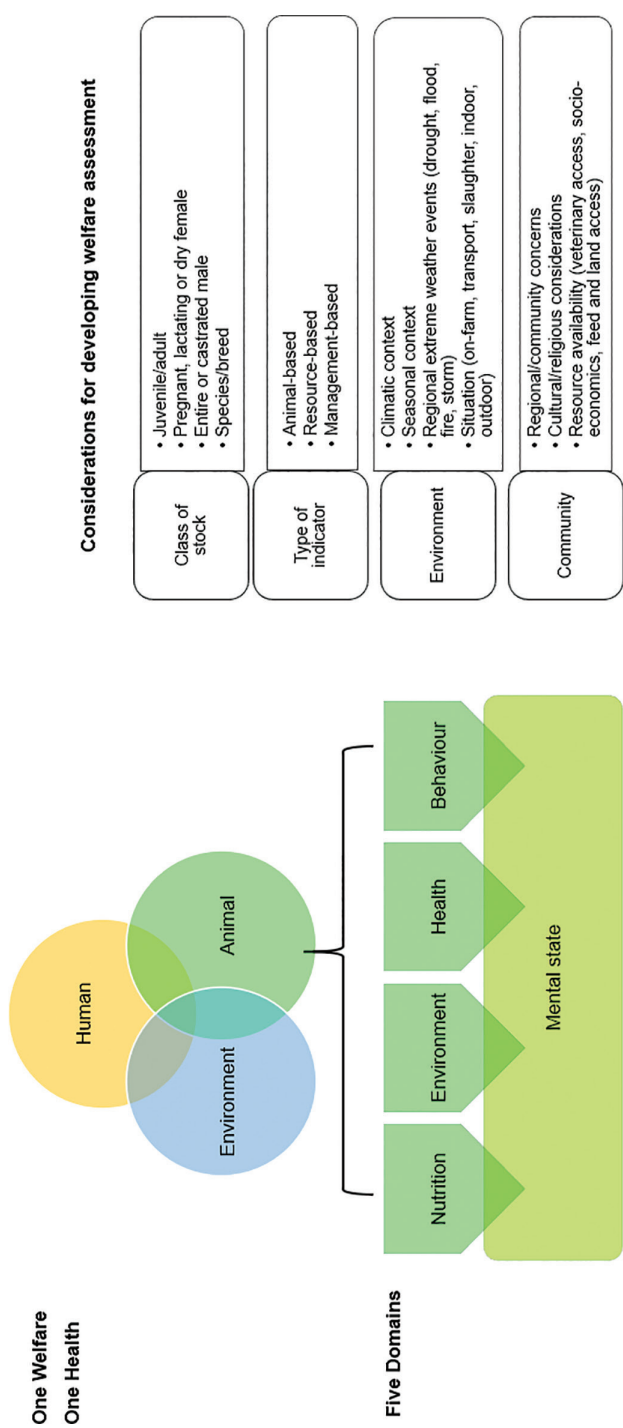


FIGURE 9.5 When considering animal welfare and health, the Five Domains framework describes the essential components that contribute to an animal's quality of life. When designing animal welfare assessment, it should be regionally specific. The list of considerations acts as a checklist when developing a welfare assessment. Using both aspects will give animal-focused data that can contribute to a One Welfare and One Health approach.

chapter show this. The interconnection was described by One Health, and One Welfare frameworks demonstrate the importance of connecting and caring for animals and the environment, even when resources are limited. Work from Kenya and Eritrea, outlined in Case Study 9.5, demonstrates the benefits that infrastructure investment can have on the three entities of One Welfare.

Case Study 9.5: Carbon Offset Project

Provided by The Donkey Sanctuary

Organisations: The Donkey Sanctuary, CO₂ balance

Location: Kenya and Eritrea

The Donkey Sanctuary's global outreach involves visits to projects around the world to improve the lives of working donkeys and the communities that depend on them. In early 2017, the animal welfare charity engaged with CO₂ balance (<https://www.co2balance.com/>) to discuss available options to offset the organisation's annual air travel and achieve travel carbon neutrality over time. By supporting CO₂ balance projects in Kenya and Eritrea, it contributed to offset the carbon emissions of travel while helping donkeys and communities in Africa. The partnership focused on rehabilitating local community boreholes and the provision of energy-efficient stoves to households. The results highlight One Welfare synergies.

Within Eritrea most families own a donkey; one of its tasks is to carry the water collected back to the home. Through the rehabilitation of local community boreholes, people can source their water closer to home, rather than walk further to find an alternative water source. This means less travelling for the donkey and a shorter distance to carry the water back to the home.

Mrs Haddas Tesfamariam, a housewife from Balwa, Eritrea described health and well-being benefits for both her family and her donkey. When the project repaired her community's broken hand pump it meant she no longer had to take her children and donkey on a 4-hour daily journey to fetch water from a stream. Haddas and her family are drinking clean water and her children no longer get diarrhoea, incurring medical costs, and her children have more time for education. She adds: "It is with the help of my donkey that I can do my daily tasks and improve my livelihood."

The burden of wood collection also falls on the donkeys. The brick stoves provided half the amount of firewood needed, meaning not only less work for the donkeys, but a reduced amount of carbon emission, preventing deforestation and benefitting wildlife. The stoves are also a healthier method of cooking as it reduces indoor smoke, and smoke inhalation, by half. This particular issue – which the World Health Organisation dubbed the "kitchen killer" – is a serious problem in Africa, responsible for 1.9 million deaths in Africa every year (<https://co2balance.wordpress.com/tag/development/>). Together, both of these infrastructure improvements have been demonstrated to benefit families, donkeys and the local environment, capturing the essence of One Welfare (Figure 9.6).



FIGURE 9.6 Photo credit: The Donkey Sanctuary

There are some limitations that need to be addressed, however. Firstly, the evidence base of the role of One Welfare in development settings needs to be expanded to extensively test the benefits that have been described using examples throughout this chapter. Evidence for two-way synergies can be readily found, particularly the bi-directional benefits between human and animal well-being in resource-poor settings. Welfare gains for both people and animals in these contexts are focused on fundamental needs of food, health and safety. There are not as many examples of three-way interactions, but the expectation is that they will increase as frameworks like One Welfare and One Health are used as both project planning tools and evaluation tools.

Secondly, the benefits need to be genuine, but will have different scales and may be difficult to identify. For example, there may be a net positive gain across the three entities, but a neutral result for one of the three entities. There are clear risks for tradeoffs too. For example, interventions aimed at improving animal welfare could lead to increased workload for the animal carer. This can include a gender component as well with women being livestock carers but their work less recognised. Or, improved animal survival may mean more livestock are kept, and so increased impact on the environment. While each entity can be negatively impacted, the human impacts are likely to be the most easily identified. Even negative impacts on people can be hard to identify in the case where the negatively impacted party has a low agency, voice or decision-making power. Compromise to animal or environmental well-being is going to be even less obvious.

One value of using a One Welfare approach is that it encourages cross-disciplinary collaboration in order to consider all components of the framework, so experts are likely to be able to identify the subtle changes described above. Another benefit of the One Welfare framework in this context is it goes

hand-in-hand with the One Health framework. The momentum of One Health means that the familiarity with how the three entities of people, animals and environment interact with each other is present, and so there is a pathway to expand it to encompass the broader concepts of well-being described by One Welfare.

By taking a welfare-sensitive approach in nutrition security and development settings, it is anticipated that benefits to all three of the entities outlined in the One Welfare framework can be realised.

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10 The Laboratory Animal Veterinarian's Contribution to One Welfare

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INTRODUCTION

It was around 2,400 years ago in Ancient Greece when it was recognised that humans could learn about our species through studying other animals. From these early beginnings, where observation was mainly used to document physiology, key human understandings of physiology developed through the works of William Harvey in the renaissance period (Ericsson, Crim, and Franklin 2013). Later in 1865, the French physiologist Claude Bernard proposed inducing disease in animals through chemical and physical means (Bernard 1957): a concept akin to the definition of animal modelling as understood today. The 'model' definition implies that the used animal is not the focus of the research, but rather their utility is based on the similarity of this animal's biological reactions to our own, or another species. In spite of this all-encompassing definition, the general

understanding is that animal models are modelling humans (Hau and Schapiro 2011). Today, animal models are routinely employed across the spectrum of biomedical research, including, immunology, oncology, neuroscience and infectious disease.

Laboratory animals can be *any* species of non-human animal but their key distinguishing feature is that they are intended for use in research, teaching or testing. In many cases, they may have varying genetics or anatomical and physiological features that differ from the rest of their species. These characteristics may have occurred naturally, or more commonly, have been induced through experimental manipulation; a key example being genetically modified mice. In practice, laboratory animals are usually considered to have a defined health and genetic status and are purpose-bred for this use.

Biomedical research typically comes to mind when considering the types of research on animals. However, there are a variety of other common uses. Agricultural research is generally performed to increase the productivity and sustainability of systems for animals kept for food. Safety testing of products for human use including medicines, food additives, agricultural chemicals and cosmetics often requires testing on animals to meet regulatory and licensing requirements. Wildlife and aquatic animals may be studied in captive or natural environments as part of conservation work, or for studies into invasive pest management. Animals may additionally be used in education at both school and tertiary level. There is also an increasing use of invertebrates in research, most often the *Drosophila* fruit fly and the nematode *Caenorhabditis elegans* (Wilson-Sanders 2011). Capture and interpretation of figures for worldwide animal usage is challenging given the differences in reporting, and definitions used between countries. For representative purposes, Figure 10.1 illustrates the latest available EU figures on species of animal, and purposes of animals used for scientific purposes.

Based on this broad definition of laboratory animals and their range of usages, it naturally follows that settings for their use are varied. Many basic experiments occur in academic institutions throughout the world. Drug development and applied research may take place in pharmaceutical companies, and safety testing of products prior to market release is typically conducted by contract research organisations. Government agencies also conduct military medical research, which includes chemical weapons defence research, optimisation to battlefield life-saving techniques and survivorship research (Martinic 2012).

LABORATORY ANIMALS, ONE HEALTH AND ONE WELFARE

In these times of complex changes occurring at global level, for example, the visible impacts of climate change or the rise of pandemics, the connections between humans, pets, livestock, wildlife and the environment become increasingly evident. In recognition of the need for an integrated approach to tackle these problems, the ‘one health’ and ‘one welfare’ approaches advocate for multiple sectors to work together to achieve better public health outcomes (Zinsstag et al. 2011).

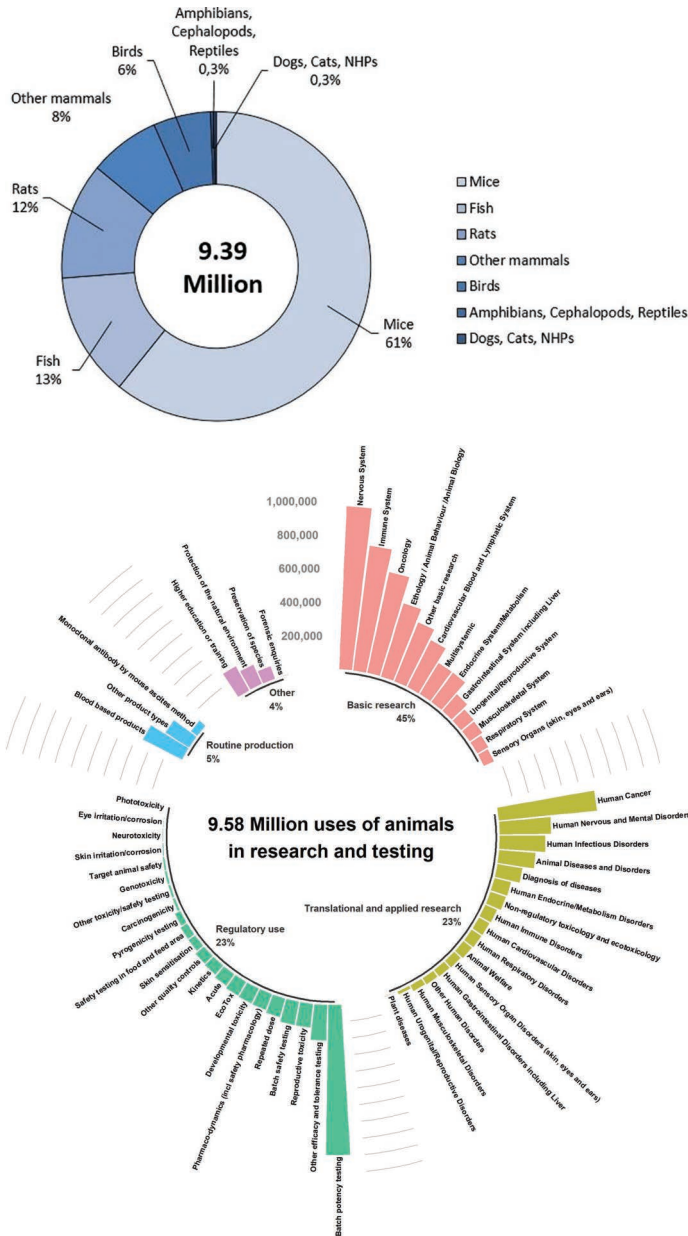


FIGURE 10.1 (a) Species percentages used in scientific research in EU in 2017. (2019 report on the statistics on the use of animals for scientific purposes in the member states of the European Union in 2015–2017. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0016>.) (b) Categories of scientific purposes for which animals were used in the EU in 2017. (2019 report on the statistics on the use of animals for scientific purposes in the member states of the European Union in 2015–2017. Available at: <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0016>.)

Based on the concept of laboratory animals modelling human disease, there is an obvious integration of the laboratory animal field with the one health mission. Animal research goals are to develop biological understanding, novel techniques, and therapeutics to improve human health. By extension, much of this research can also be used to benefit other animals and the environment (Wimsey and Job 2017).

In a sense, laboratory animal veterinarians by virtue of their role are firmly embedded as participants in the one health approach. They work collaboratively with PhD scientists, medical clinicians, and a variety of other specialists with the common goal of attaining stated research aims. Veterinarians are often physically co-located with these collaborators in human medical or veterinary medical research institutions. Due to their connections with a wide variety of research groups working in different discipline areas they also facilitate knowledge transfer and the establishment of cross-networks between areas (Wimsey and Job 2017).

A One Welfare approach complements and overlaps with the One Health approach since welfare and human well-being are directly related to aspects of physical and mental health. In a similar vein to one health, initiatives to improve human and animal well-being are complex and reliant on both international and domestic policy with consideration for cultural, religious and economic perspectives, in addition to the scientific viewpoint. Considering the two approaches in an integrated fashion maximises efficiency and improvements (Pinillos et al. 2016).

ETHICAL CONSIDERATIONS

Whilst all use of animals by humans, including the keeping of companion animals provoke ethical questions, the use of animals in research does invoke a key difference; it is foreseeable that pain, distress or harm may result from procedures occurring, and in many cases, this event is necessary for the research to occur. The ethical dilemma then being that sentient animals may be harmed by the experiments, yet benefits may accrue for human and animal health, and the environment. There is, and likely never will be, agreement in how to address this dilemma (Svendsen, Sandøe, and Thorn 1997).

However, available data suggests that the majority of the population are broadly in support of animal use in research providing certain criteria are met, and with the exclusion of certain unacceptable procedures, that is, there is an ethical limit to pain or suffering (or the species) to which it may be caused (Ormandy and Schuppli 2014, von Roten 2012). In practical terms, the requirements for maintaining this approval then are that, (1) studies where severe pain or suffering is anticipated should not be allowed, and (2) a study is acceptable only if a substantial benefit to humans accrues, and the results could not be achieved using a method which causes less distress (Svendsen, Sandøe, and Thorn 1997).

The traditional model concerning public attitudes to science has implied that the public does not have the requisite level of background knowledge to be involved in discussions about animal research – the ‘Enlightenment’ model

(Ormandy et al. 2019). This model has been widely criticised with a number of studies actually demonstrating that as public knowledge increases, support declines (Evans and Durant 1995, Vrij et al. 2003, Ormandy, Schuppli, and Weary 2013). In opposition to the traditional model, commentators more recently have decried the idea of separating science and society calling instead for the democratisation of science (Jasanoff 2004, Irwin 2001). In the context of the one welfare agenda, and in light of this increased democratisation, it is increasingly important to understand public attitudes to research practices. Scientists can hardly claim to be providing benefits to human welfare and the environment if large sections of the population are actually opposed to the practices and are therefore unwilling beneficiaries of the stated gains.

THE ROLES OF THE LABORATORY ANIMAL VETERINARIAN

The job of the laboratory animal veterinarian is diverse and those with no direct experience of the role may be surprised to learn that a relatively small proportion of the work is clinical in nature. The role requires an understanding of a range of disciplines, as well as an effective liaison with practitioners of these disciplines. These disciplines include education and training, occupational health and safety, engineering as it pertains to facility management, law and regulatory process, applied ethics, and research methodology.

The following will examine the various roles of the laboratory animal veterinarian, highlighting the facets of this role, which play into the one welfare agenda, but also areas of conflict and limitations of the approach.

CLINICAL LABORATORY ANIMAL MEDICINE

Most institutions globally are required to ensure that animals have access to adequate veterinary care. This care should be of a standard consistent with that expected under state veterinary licensing acts, being current accepted professional practice. In addition to the requirement for providing care, there is often an expectation that the veterinary clinician will provide advice on the need for appropriate veterinary equipment, design of animal health and housing suites and the number of trained personnel required for the provision of veterinary care. The veterinarian also provides clinical input into protocols pertaining to husbandry or procedures, such as those for handling, anaesthesia, analgesia and euthanasia (Alvarado and Dixon 2013).

The clinical role of laboratory animal clinicians is similar to other areas of veterinary speciality. Animals may need emergency treatment at any hour of the day, and typically suffer from dystocia, traumatic injury, congenital disorders and ageing conditions just as companion animals or livestock might. However, the small size of rodents may complicate diagnosis and treatment. Furthermore, whilst an individual's welfare is always important, population health also needs particular consideration given the impact of disease on animals and research findings. For these reasons, many veterinarians undertake specialised training in laboratory

animal medicine which undeniably advances the service provision that laboratory animal veterinarians can provide.

A key feature of animal models is that they are 'standardised'. The main objective of this being to improve the reproducibility of results between laboratories, reduce variation and ultimately increase the possibility of successful translation of research findings to humans (Van Zutphen, Baumans, and Beynen 2003). Standardisation is typically achieved through controlling both environmental and animal-related variables. This includes physical factors such as noise, temperature, air quality, and chemical usage. Animal-related factors include that biological make-up is uniform, for example, age and genetic status, and animals are microbiologically similar, generally being free of specific pathogens (Bayne 2005).

Based on the need for standardisation, a considerable proportion of the clinical role of a laboratory animal veterinarian is focussed on practices to create and maintain colonies free of a selected number of organisms, so-called 'clean' colonies. Whilst, the long-standing practice of having animals living in highly sanitised conditions and devoid of natural infections has been controversial of late due to the concern that this is not a good model for human immune systems, (Willyard 2018) its premise is sound. Overt disease clearly has negative implications for animal welfare. However, the problem is more extensive than first appears. Many pathogens, especially in rodents, produce subclinical infections that can through physiological and immunological alterations impact on research results. As an example, the relatively new discovery of mouse norovirus, suggested to be endemic in mice, has provoked great concern amongst immunologists due to its ability to induce an interferon-B response and histopathological lesions (Doom, Turula, and Hill 2009).

Routine animal health surveillance programmes are commonplace in rodent facilities to identify and potentially exclude those disease-causing pathogens deemed unacceptable. The focus on pathogen exclusion in specific-pathogen-free colonies leads to different treatment options compared to other areas of veterinary practice. Imagine the scenario where a few mice in an immunocompromised colony succumb to an infection. Whilst the infection may be able to be treated to lead to a subclinical state or even complete elimination of disease, this may not be the best course of action. In the time taken to identify and treat affected animals, the infection may have spread through the whole colony affecting many more animals and associated research. Laboratory animal veterinarians typically have in their arsenal of animal health management approaches, some unique approaches. These include the possibility of establishing 'clean' colonies through embryo or caesarean rederivation and transfer techniques, temporary cessation of breeding to eradicate pathogens, or short-term quarantine, treatment and judicious screening before colony reintroduction.

The goal of standardisation is well established and arguably remains one of the pillars of laboratory animal science. Its role in promoting human health and welfare is clear through its impact on experimental findings. However, it does

present some unique challenges to the one welfare agenda through the potential impact on animal welfare.

Standardisation has led to housing and husbandry systems that might actually compromise the achievement of animal's basic biological needs, paradoxically introducing confounding variability in experimental data. For example, mice housed in small 'shoe box' cages, with litter alone and provision of standard pelleted diet, are offered limited opportunity to perform behaviours such as foraging, gnawing, exploring or nesting (Olsson and Dahlborn 2002). As another example, individually ventilated caging systems were developed to reduce exposure of animals to microorganisms, but also reduce exposure of workers to allergens from animal urine and dander. With their clear benefits to human and animal welfare, their use has proliferated around the world. However, research has suggested that these closed systems with their forced ventilation and associated noise and vibration could actually lead to chronic stress in animals, which may induce changes in behaviour and neurobiology, common outcomes in research studies (Burman et al. 2014).

Another conflict associated with developments in animal modelling and standardisation is that scientists are increasingly using genetic modification technology, such as gene targeting or transgenics to design a mutation similar to that of a human disease and to investigate the effects of this mutation (Buehr et al. 2003). Many areas of human medicine have been advanced through the use of these technologies, (Dennis 2002) including the development of treatments for cystic fibrosis and diseases arising from single-gene mutations, such as sickle cell anaemia amongst many others (The Royal Society 2001). Genetic modification (GM) per se does not necessarily imply that an animal's welfare will be impaired. However, factors such as the reproductive technologies involved in creating GM animals, unintended effects on the genome, and the genetic modifications themselves may increase the risk of welfare problems (Buehr et al. 2003).

Aside from the potential welfare issues surrounding genetically-modified animals, the public tend to view genetic modification of any sort negatively (Birke et al. 2007). Objections include that this is a violation of nature with these animals being 'unnatural', and that unintended consequences may result (Macnaghten 2004). The latter involve perceptions of risk and the effect that animals may have on the environment if released. Concerns that GM animals accidentally released could breed or compete with wild populations, could mutate with harmful effect, or transfer genes to other species such as humans are just some of the concerns held. At a deeper ethical level, there are also widely held concerns that the issue is not solely about the genetic modification that has been done to date, but that which can be achieved with the established technology (Walton 2017). This argument, often called the slippery slope argument, at its simplest, contends that the use of gene manipulation now may lead to a future situation where human eugenics may be allowed (Walton 2017). Genetic modification, therefore, presents new challenges in gaining public acceptance of animal-based research. As a result of this concern, and indeed if the purported risks actually eventuate, the case of GM

animals challenges the view that animal research contributes to a one welfare agenda.

With respect to genetic modification, a fairly common outcome is that animals may be immunocompromised and therefore respond with clinical infection to commensal agents that would normally be innocuous, for example, *S. aureus*. As a result, veterinarians often have to respond to this challenge as part of a preventative or therapeutic strategy. This often involves instigating antibiotic treatment. Compared to veterinarians in private practice, laboratory animal veterinarians have several advantages in this prescribing. Generally, antibiotics are administered as directed by trained animal care staff, and there is good access to microbiology services to acquire antibiotic sensitivity data. In spite of this, late-generation antibiotics such as enrofloxacin are frequently reached for due to known species sensitivities to certain penicillin-containing antibiotics, their broad spectrum of activity and minimal rate of adverse effects (Troughon and Lefebvre 2016). However, enrofloxacin is on the list of Veterinary Critically Important Antimicrobials being both important for use in veterinary and human medicine, and essential against specific infections with lack of therapeutic alternatives (World Organization for Animal Health 2017). Enrofloxacin and ciprofloxacin have long environmental persistence periods, with half-lives potentially in their thousands of days. This contamination can affect the growth and activity of the soil microbial communities, impacting soil fertility and soil ecosystems (Girardi et al. 2011). With recent concerns about the emergence of quinolone-resistant bacterial strains as well as the impact on the environment of the overuse of these drugs, a one welfare approach would suggest that these drugs be used sparingly in laboratory animal medicine- an area perhaps in need of a focused campaign targeting laboratory animal professionals.

As an outcome both of research studies and the standardisation process involving large amounts of breeding, and the need to minimise the spread of infectious disease, euthanasia of animals inevitably becomes a routine process. This may involve a significant number of animals. The field has already recognised that specific psychosocial hazards may be encountered when working with laboratory animals. This includes desensitisation to certain procedures, such as euthanasia, the inability of staff to discuss their work with those outside the field due to a closed-door mentality, and the complex human-animal relationship in the research setting. These factors all contribute to euthanasia stress and compassion fatigue. Compassion fatigue causes a change in empathetic ability which may be a secondary traumatic stress response. This may lead to the caregiver having reduced capacity or interest in being empathetic. Such events not only impact on individuals and those close to them but can have systemic effects on the workplace impacting other staff members. For example, organisational consequences of compassion fatigue include absenteeism, poor teamwork, and negativity towards management. These events may introduce scientific variability and reduce the quality of animal care (Newsome et al. 2019). Whilst, as a participant in the process the laboratory animal veterinarian may personally suffer from compassion fatigue, it is suggested that they may also be able to use their professional status

and leadership position, working with other professional groups, to highlight the issue and encourage greater attention to it. Recommendations to tackle this issue include providing training in stress management, fostering discussion on euthanasia, assisting caregivers to identify personal support systems and rostering staff to reduce the time directly engaged in euthanasia (Newsome et al. 2019). From a one welfare perspective, reducing the risk and impact of compassion fatigue is imperative.

EDUCATION AND TRAINING

According to the American College of Laboratory Animal Medicine Role statement, education of scientific, animal care, and ancillary staff comprises around 5% of the laboratory animal veterinarian's role (Colby, Turner, and Vasbinder 2007). Laboratory animal veterinarians are frequently involved in delivering formal didactic and hands-on training, as well as assessment of competency, to a variety of staff in the institution on subject areas ranging from general husbandry, procedure performance, anaesthetic, analgesic and surgical techniques, and regulatory oversight of research. The challenge for veterinarians as educators is that they have to tailor training to a range of educational backgrounds, (Bayne et al. 2011) and often with no standardised curriculum as a guide.

Poorly conducted procedures can lead to morbidity and mortality resulting in removal from the study, as well as events such as infections, poor healing, metabolic disturbances, and blood loss which all impact on welfare as well as research outcomes (NHMRC 2008). Therefore, the role of the veterinarians in upskilling researchers and animal care staff is critical to the one welfare agenda. Veterinarians are the only personnel that by virtue of their training have an in-depth cross-species knowledge of systems biology, comparative medicine, surgery and anaesthesiology, epidemiology and public health.

One particular area where veterinarians have an important education and advisory role but where conflict with the one welfare approach may occur is in the use of pain management strategies. Pain management is an ethical obligation and is frequently required as a condition of regulatory approval. However, it presents a methodological challenge for researchers (Carbone and Austin 2016). Anaesthetic and analgesic agents, and untreated pain, have effects on animal biology (Jirkof 2017). The majority of analgesics stimulate the immune system, but untreated pain cause general immunosuppression (Peterson, Nunamaker, and Turner 2017). As an example of the complex and unpredictable response of the body to analgesics, morphine, induces changes in natural killer cell activity, cytokine production, and mitogen-induced lymphocyte proliferation leading to immunosuppression (Roy et al. 2005, Page 2005). However, opioids administered in cancer pain models have been shown to improve immune system function, inhibiting metastasis and reducing tumour growth (Sasamura et al. 2002, Gaspani et al. 2002). An understanding of the differences in responses to both analgesic use and pain based on species, timing of analgesic administration and class of agent is also essential.

Reluctance to use analgesics in animal models is common amongst scientists, especially in studies of immunology, and in the main these concerns are well-grounded in science. However, it is not clear in many cases whether scientists have rationalised potential confounds from analgesic use against the effects of non-use of analgesics in painful scenarios. There is also a valid argument that with careful consideration of experimental design to include adequate control groups, as well as adequate reporting of analgesic use in published reports, threats to validity and reproducibility will be reduced. Notwithstanding clear gaps in scientific knowledge on the effects of certain classes of drugs, compared with others on model outcomes, veterinarians are well placed to be able to guide these discussions and direct further research in this area.

Other training and education roles performed by laboratory animal veterinarians are perhaps less obvious and less performed, but nevertheless of great importance. In spite of well-publicised benefits accruing it is a cause of public angst that animals are used for medical research and public health purposes. In recent years there have been global calls for increased transparency in animal research and more dialogue between lawmakers, scientists and the general public. Greater transparency is proposed to increase public confidence in the regulation of animal research and improve public acceptance rates (Varga et al. 2010). Laboratory animal science personnel are often conflicted in communicating their work. They rely on public acceptance, or a social licence, for their work to continue and to receive funding, against the backdrop of the societal pressure to cease research animal use, but they fear that the public may not understand their work (Newsome et al. 2019, Holmberg and Ideland 2010). Community engagement is widely acknowledged as important in the public governance of science. There is however little consensus on the process to better engage the public on animal research (Ormandy et al. 2019).

As champions of animal health and often well-respected in this regard, the veterinarian is ideally placed to play an active role in educational and outreach programmes to interact with the community on issues such as why animals are used, the regulatory process and how welfare is safeguarded (Joint Working Group on Veterinary Care et al. 2008). In fact, it is possible that the public are unaware of the extent of the veterinarian's involvement in research, and knowledge of this fact might go some way to increasing public confidence in the regulatory process.

Another emergent area of endeavour is that of metascience. This 'science' based on concerns around the ability to replicate and translate results from both *in vitro* and *in vivo* studies is essentially the study of science itself. At its heart lies calls for preregistration of studies, filling out checklists on facets of experimental design and reporting, and making elements of the research process publically available (Munafò 2017). This area is gaining momentum, fuelled by interest from funders and journal editors. It represents a real opportunity to address some of these burning issues in pre-clinical research, improving the science, and the outcomes resulting, and lessening the ethical costs associated with research through minimising the number of poorly conducted experiments. Veterinarians can adopt an important role in this process by educating on, and promoting the

use of documents such as the ARRIVE guidelines when designing research studies (Kilkenny et al. 2010).

Maintaining the social and political licence for the practice of animal research, as well as support for improving and enhancing practice must occur in order to achieve the continuing One Welfare benefits. Transparency and reproducibility initiatives are gaining impetus and require buy-in from many professionals at different levels of organisations. Veterinarians need to take an active and leadership role in this space to reverse the trend of declining support for animal research and to enable the benefits to be realised.

RESEARCHER SUPPORT

A critical role of the laboratory animal veterinarian is to provide support to the research teams. This support extends from pre-approval in the research planning stages, through to conducting the research and often in interpretation and publication of the findings. Through enhancing the quality, of protocols and the performance of techniques within them, vets play a vital role in enhancing reproducibility and translatability of research.

Typical input of the veterinarian into project planning and performance spans a few domains. Given their comparative cross-species knowledge veterinarians provide valuable input into the choice of animal model, based on scientific considerations, but also considering practical limitations, for example, the small size of rodents makes some procedures unfeasible to perform. Veterinarians are also best placed to provide advice on normative biology such as anatomical peculiarities or background lesions of common rodent strains which play into animal model decision-making. Given this input, it is important for the veterinarian to be sufficiently familiar with the science, as well as the scientific method, to contribute effectively to project discussions. For this reason, as well as no doubt having an interest in research in general, many laboratory animal veterinarians are dual qualified with both veterinary and higher degree by research qualifications.

When protocols require surgical intervention, the veterinarian should have a significant role advising on the techniques themselves and required instrumentation, aseptic techniques and the associated use of anaesthetic and analgesic agents, taking into consideration the risk of study confounding and how best to select an agent to minimise this. In some jurisdictions, as determined by national law or by local policy, acts of surgery may only be performed by, or under the direct supervision of, veterinary surgeons and they, therefore, take on responsibility for all experimental surgery. This is particularly common when so-called 'large' or non-rodent laboratory animal species are involved (American College of Laboratory Animal Medicine 2019).

Given this role, the possession of interpersonal skills that enable individuals to work well in teams is of considerable importance. The specific skills required of the veterinarian to be an effective team member will depend on the function of the team, and veterinarians are highly likely to be members of several teams. Undoubtedly, better results for animal welfare and science will accrue from teams

where there is mutual respect afforded to all members based on recognition of their own unique expertise. Veterinarians who are adept at negotiation also have a distinct advantage when it comes to ensuring that researchers in their enthusiasm do not overstep legal and ethical boundaries (Bayne et al. 2011).

Whilst there are numerous benefits in veterinarians becoming established team members and working collaboratively alongside scientists as part of specific projects, consideration needs to be taken to avoid conflict of interests. If the veterinarian has a substantial role in the study and is sufficiently invested, they may no longer be in a position to provide impartial advice on humane endpoints, or be seen to do so. In these situations, alternative veterinary oversight is likely to be required and this may come at an economic cost. Economic pressures may also cause other conflicts to arise, for example, in the common situation where research funding is limited and there is institutional pressure to obtain and maintain it, the veterinarian may be torn between weighing economic factors against ethical considerations (Bayne et al. 2011).

REGULATORY AND ADMINISTRATIVE COMPLIANCE

There are frequently complex ethical issues arising in the course of animal research due to the utilitarian ethical framework on which research is based. This framework requires a balancing of the promotion of one species (usually human) health against potential distress and suffering of animal species. Ethical dilemmas encountered may be general, for example, the acceptability of deliberately modifying an animal's genome, or specific to an experimental protocol. In recognition of this most countries have established regulatory processes to oversee animal care and use facilities and perform an ethical review of study protocols. As already discussed, the one welfare benefits achieved as a result of research on animals can only occur if domestic and international policy enables the work to be performed, and a social licence is present. Therefore, not only is the existence of an effective system of regulation important, but the awareness of, and trust in this system by members of the public. Regulatory systems range from punitive to persuasive, where cooperation and education predominate (Whittaker 2014). Despite global differences in enforcement mechanisms under these systems, ranging from centralised (usually government) mechanisms to self-regulation, the veterinarian often plays a substantial role in local compliance processes.

Before discussing the specific roles of the veterinarian in compliance processes, referral needs to be made to two important frameworks or concepts widely referred to in animal research establishments and processes. These principles are the 3Rs and the Culture of Care. The 3Rs introduced by Russel and Burch in 1959 has become a founding tenet of animal research (Russell and Burch 1959). These guiding principles suggest that the use of *Replacement, Reduction and Refinement* should be a foundation for diminishing and possibly eliminating inhumanity, or in more common parlance, distress. Replacement means the 'substitution for conscious living higher animals of insentient material', Reduction refers to 'reduction in the numbers of animals used to obtain information of a given amount and

precision’ and ‘Refinement means any decrease in the incidence or severity of inhumane procedures applied to those animals which still have to be used’ (Russell and Burch 1959). Although pre-dating discussions around one health and welfare, Russel and Burch’s framework fits neatly within the concept. Through their discussions in the book, they sought to demonstrate that better scientific results were achieved when animals experienced no distress, or the least possible. They also alluded to wider policy considerations by asserting the linkage between animal distress and poor results and how these events waste the considerable expenditure on animal resources, facilities, and personnel.

The Culture of Care is recognized as the foundation of humane and responsible science (Hawkins and Bertelsen 2019). In practice, it represents an establishment-wide commitment to advancing the 3Rs, animal welfare, staff care, scientific rigour and transparency. It, therefore, creates a culture that goes beyond mere compliance to excelling, as assessed by evidence-based metrics, in all pillars needed to achieve the goal of optimal animal welfare (see Figure 10.2). Consideration of the extent and the number of actors as depicted in this process is important when considering the veterinarian’s role in achieving the outcome. Their role is significant and often needed at many levels, but requires one welfare collaborative working to maximise impact.

An increasing number of countries have a form of ethical review process. These committees are primarily responsible for de novo protocol approvals,

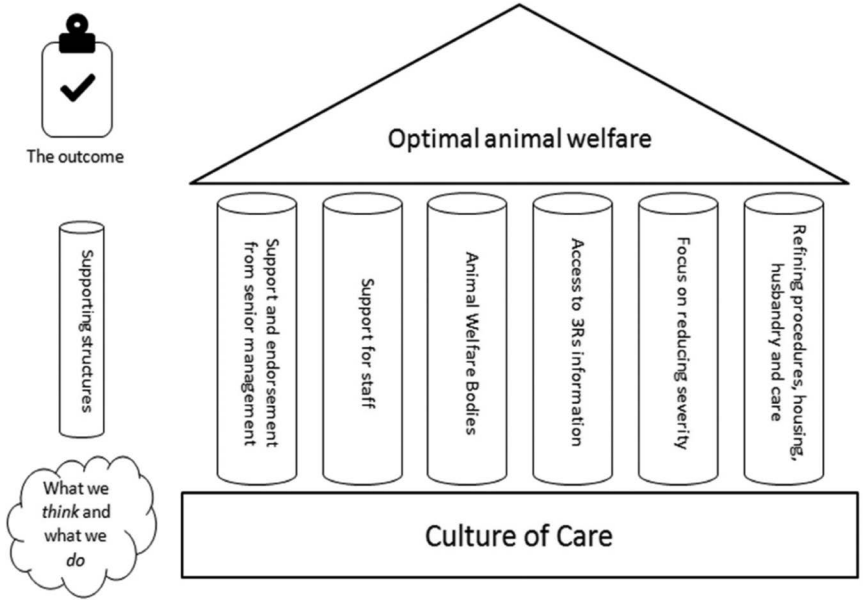


FIGURE 10.2 Linkage of the institutional culture of care with the achievement of optimal animal welfare. (Hawkins and Bertelsen. 2019. “3Rs-Related and Objective Indicators to Help Assess the Culture of Care.” *Animals* 9 (11):969. Reprinted under a Creative Commons Attribution CC BY 4.0 license.)

amendment reviews and post-approval monitoring via protocol monitoring, review of adverse event reports and inspections (Plante and James 2008). Animal ethics committees are often regarded by those within the institution, and probably external to it, as the final arbiters on procedures and the guardians of animal welfare. However, it is worth paying regard to the emphasis placed in the culture of care philosophy on collaboration, the ethics committee being just one supporting pillar of the process. Participation of the veterinarian in the work of these bodies is common and often mandated via statute. (2008) Particular roles of the veterinarian in these ethical approval processes includes advising on model selection, endpoint criteria, procedures, provision of anaesthetics and analgesics, and general animal care. They are also commonly tasked with ensuring investigators are trained and competent in the procedures to be performed. As experts in animal health and welfare, they should also be up-to-date with current developments in the field and should be promoting advancement to practice through the adoption of new and refined techniques, policies and procedures (Joint Working Group on Veterinary Care et al. 2008).

Other formal compliance roles of the veterinarian include making regular visits to animal facilities, to enable assessment of ongoing animal health and welfare and identify infrastructure issues that may be impacting on animal health. Outcomes from these inspections should be communicated to other relevant stakeholders including scientists, building managers, and ethics committees to ensure that action is taken where warranted. Veterinarians may also have certification responsibilities as a result of laws relating to biosecurity and quarantine, transport, or pharmaceutical products (scheduled drugs), with goals to protect human and animal health through preventing unauthorised access to drugs, and zoonotic or cross-species transmission of disease. Experienced laboratory animal veterinarians may also become involved in policy development at a national or international level through engagement with various regulatory authorities or laboratory animal societies. They may also offer their services to accrediting agencies such as AAALAC International.

Veterinarians are generally involved as part of post-approval monitoring processes in the investigation of any unexpected adverse events that arise. This is not just a compliance exercise, since such events may herald concerns with study design, performance or drugs administered that necessitate cessation of the study and reflection on future steps for welfare and scientific reasons. For example, toxicity responses may be recorded which may lead to valuable information about the nature of the drug itself or dosage. In some countries, the ultimate responsibility for major decisions of an animal welfare nature, such as euthanasia, rests with the veterinarian, in others it remains with the researcher (Joint Working Group on Veterinary Care et al. 2008). In the case of the latter, veterinarians usually provide an advisory role and actions contrary to their advice may not be looked on favourably by animal ethics committees. The former situation may lead to conflicts with researchers which can be detrimental to ongoing working relationships. Another form of conflict is possible; veterinarians who have often made an oath to ensure the health and welfare of animals under their care may have a

real or perceived internal conflict in balancing research outcomes, with animal welfare, to make a judgement call as to when endpoints should be implemented. Appropriate institutional management systems should be in place to allow conflict resolution safeguarding animal welfare and the professional responsibilities of the veterinarian (2008).

In an extension to being the final arbiter on decisions made during protocols, the veterinarian may be tasked by the ethics committee with being the day-to-day compliance officer responsible for determining and taking action on protocol violations of an administrative nature. Whilst, it may be a requirement under State laws that approved protocols are complied with to the letter, whether it is, or indeed should be, the role of veterinarians to monitor and enforce this is debatable. Over recent years there has been debate across the world on whether institutions have the balance right between assuring compliance and animal welfare. Whilst they are not always mutually exclusive, a focus on compliance may be of detriment to the other by diverting resources, which may be better used addressing welfare concerns. Perhaps, the middle ground is that the focus should be on highlighting protocol violations, which could impact on animal welfare. A similar concern has been extended to ethics committees and whether they are truly conducting an ethical review, or ensuring compliance with the rules. Answers and solutions to these questions will be unique to the jurisdiction considered, the institutions involved and even the make-up of individuals concerned but they are important questions for consideration.

Where veterinarians are used as compliance officers, there is a danger that this policing type role leads to breakdown of the working relationship between researchers and the veterinarian. Researchers need to be able to freely approach the veterinarian when there is an animal welfare issue or if they need technical assistance. A well-functioning relationship is therefore critical in safeguarding welfare and research outcomes. A fear of punitive responses by the veterinarian will likely hinder free dialogue and trust, and discourage collaborative working practices. For this reason, where veterinary knowledge is considered necessary in compliance monitoring, a number of US institutions employ veterinarians who purely work in compliance and training roles, and others who provide clinical and research support.

Whilst some institutions employ staff directly responsible for compliance, and others delegate the role to their veterinarian, the reality is that these people are unable to have the resources available to identify every protocol violation that occurs. In order to really achieve administrative compliance, collegial cooperation is needed. Klein and Bayne (2007) propose that establishment of a culture of care, conscience and responsibility is more important than the regulatory framework in existence because it encourages workplace integrity, good communication, ethical decision making, clear authority lines and a system of continuous improvement. Elements to achieving this culture of care include leadership with appropriate authority and involvement, an ethics committee willing to share its expectations with researchers, veterinary staff that are regarded as colleagues in research teams, and training to encourage these aspects (Klein and Bayne 2007).

FACILITY MANAGEMENT

There is considerable overlap between clinical activities to secure optimal health and welfare of animals and the management activities required to ensure that the structures are in place to do this. For this reason, many laboratory animal veterinarians have managerial responsibilities for facilities or programmes of animal care and use. The academic and clinical skills they possess over a range of disciplines provides them with an excellent background for this role.

There are many facets to a facility management role. Commonly there are responsibilities for personnel management and training. This does not just involve direct staff reports, but also those visitors to the facility such as researchers, students and contractors. The manager has the responsibility not only for their job performance, systems of operating and career progression, but their overall health and safety.

Occupational health and safety is a constant and key role for the veterinary facility manager. New hazards are continually emerging necessitating new methods for protecting employees to comply with ethical and legal obligations under health and safety laws. The major potential hazards to those working with animals are allergies, injury, and infection.

Allergies are relatively common among laboratory animal workers with around 10% of individuals being symptomatic, and a greater proportion sensitised (Feary et al. 2019). Fortunately, advances in engineering controls such as micro-isolator caging and use of respiratory protection have made laboratory animal allergy largely preventable. However, as discussed earlier, they may come at a cost to animal welfare. The need to wear full personal protective equipment and maintain animals in isolator caging is likely to impair the human-animal bond and may create a source of distress in its own right. The veterinarian needs to balance the benefits to personnel, against the compromise to animal welfare in their decision-making.

Injuries can be animal-related such as kicks or bites or derived from the use of chemicals agents which are in abundance in any laboratory area. Many of these risks can be mitigated through appropriate training, supervision and experience.

The risk of staff acquiring infection from research animals is relatively low and can be minimised through appropriate sourcing of animals and the use of preventative measures such as containment caging and personal protective equipment (PPE). However, in some areas of animal use the risk may be relatively greater. These include where staff are working with primates, wild animals such as bats, or carrying out infectious disease research where the pathogen concerned is highly transmissible and /or causes serious human disease. In these cases, specialised measures will need to be put in place which may include specialised facility design (physical containment), personnel and animal screening or surveillance, and extra controls achieved through advanced engineering and PPE.

In addition to managing staff health, facility managers likely have oversight of building considerations relating to the animal health and surveillance program. They may be responsible for deciding on, and implementing rederivation and

quarantine programmes for incoming animals, as well as instigating and interpreting health screens for animals currently housed. Management of sub-sections of facilities with different levels of health status so they do not compromise animal health is imperative. This is achieved through considered personnel and equipment movement, and exclusion practices (Joint Working Group on Veterinary Care et al. 2008). A range of complex and specialised equipment, including large pieces of plant, are frequently housed in animal facilities for the purpose of maintaining a 'clean SPF' environment. The veterinarian, therefore, needs a good working knowledge of the operations of autoclaves, automated drinker systems and air handling racks to name just a few.

Veterinarians should have a role in the design of new facilities, since facility management and process management can all influence the delivery of veterinary care, and therefore potentially impact on animal health and welfare. A function that has received increased attention in recent years is the need for an emergency plan to be enacted in the case of a natural disaster, pandemic or attack on property. These plans need to specifically deal with animal escape, given the potential impact this may have on the community and the environment (Joint Working Group on Veterinary Care et al. 2008).

It can be seen from the above that the managerial role is diverse and requires not only skills in management and strategic thinking but knowledge of occupational health and safety, basic engineering and regulatory aspects. There are also clear One Welfare links. Actions of a facility manager frequently directly impact on animal care and consequently welfare. They also impact on human mental and physical well-being for those individuals who work within the facility. Importantly, perhaps more so than in other roles of the laboratory animal veterinarian, actions of the facility manager may also impact on the community. This extension may apply to direct family members of facility personnel, but also wider afield. A few scenarios can be envisaged where this may happen. Firstly, consider the accidental release of an infectious agent, with limited control measures, into the community as a result of poor biocontainment practices. This could have catastrophic outcomes for human health and by extension animal health, the environment and the economy should it impact on health care systems, and people and animal movements. The recent COVID-19 outbreak serves as a perfect example as to the devastating consequences an infectious agent, with limited control options, may have on animal and human health, lifestyle and the economy generally. As a further example, consider the un-intentional release of non-native, pest or perhaps genetically modified animals into the environment. These may have a devastating impact on native flora or fauna due to competition or through the introduction of pathogens. For this reason, there are strict biosecurity controls over the use of cane toads (*R.marina*), an introduced pest, in laboratories within Australia, and the *Xenopus laevis* frog which can introduce the devastating fungal causative agent of chytridiomycosis to wild amphibian populations (Schmeller et al. 2011). There may also be less obvious and perhaps quantifiable impacts of research facilities on the environment as a result of air, soil and water pollution following incineration processes and runoff.

The veterinarian is well-placed to understand the key features of an animal care and use programme required, and balance efficiency without compromise to animal welfare. However, in order to achieve the best possible results they need to carry out this responsibility as part of a functional multi-disciplinary team, comprising experts from all these discipline areas, and with the buy-in of the wider community.

COMPARATIVE MEDICINE AND 3Rs RESEARCH

A number of laboratory animal veterinarians are actively involved as chief investigators in clinical research on the health and welfare of laboratory animals, and 3Rs strategies. Some of this work has promoted major advances in the field, improving both animal welfare and scientific outcomes. As an example, a significant body of research on laboratory animal analgesia has progressed our understanding on the effectiveness, required dosage and impacts on the research of a range of opioid and non-steroidal anti-inflammatory drugs, rendering these drugs now routinely used in laboratory animal practice (Flecknell and Thomas 2017). Furthermore, in recent years there has been development and refinement of methods of assessment of pain and affective state, such as use of grimace scales and nest building scoring (see reviews of Whittaker and Howarth 2014, Jirkof 2014). In some cases, these research tools have been progressed to the extent that they are now being used clinically for welfare assessment. Due to advancements in surveillance and detection of laboratory animal pathogens, clinical disease in laboratory rodent colonies is virtually unheard of, and subclinical infections whilst still present, are much reduced (Nicklas 2007).

There is unlikely to be any other group of scientists that has the knowledge and experience, as well as the commitment to pursue comparative medicine research. Without this involvement, these advances would likely not have been achieved, and animal welfare and science would be the poorer for it. Additionally, veterinarians can encourage and mentor other staff, such as technicians to become research active, further advancing the comparative medicine research agenda.

Whilst some laboratory animal veterinarians are clearly engaged in research, there is undoubtedly much untapped talent. Perhaps, due to busy schedules, lack of encouragement from their employers, or uncertainty in their research skills, the performance of primary research is probably limited or non-existent in the role of most laboratory animal veterinarians. There are challenges in changing the status quo. Gaining institutional support for such activities may require a paradigm shift, and is unlikely to be seen as a high priority in University research agendas. However, support from ethics committees and funders (even if intangible in nature) can counter reluctance. For institutions with veterinary schools, this research may even link in with existing programmes of research. Clinical research by its nature is often performed during the course of usual practice and can generally be performed with a limited budget. Technicians, research trainees or undergraduate students can be co-opted onto projects increasing their research and project management skills and job satisfaction. Veterinarians should be supported by their employers to pursue career development opportunities such

as specialisation programmes, or higher degrees by research which all include research components.

The role of the veterinarian in driving comparative medicine research cannot be understated. Progress in animal welfare, and particular refinement research needs this input to continue, and there remains much more to be done. Unlike other areas of veterinary practice, veterinarians already have collaborative working relationships with researchers, who can be called on for mentorship and advice on experimental design. The veterinarians possess the specific knowledge and experience. Together, using a one welfare collaborative approach, research outcomes that promote animal welfare and the reliability and reproducibility of science can be achieved.

CASE EXAMPLE - RESEARCH INTO NOVEL METHODS OF VERTEBRATE PEST CONTROL

A group of researchers have been engaged to develop and test a new method of trapping and killing feral cats. In your local area, there is a large population of feral cats and they are seen by some as a threat to protected species, especially certain birds and marsupials. Current pest management strategies such as Trap, Neuter, Return programmes have had limited success and the researchers have been approached by an external company to co-develop a more effective, *lethal* control method. The researchers are proposing to use a specially designed trap that detects the cat presence via sensors, in which case a quantity of feral cat bait (currently tested and in use) is released into the trap for the animal's consumption. The primary research aims are to determine the effectiveness of the new system, as determined by how many cats are killed over a specific timeframe, the rate of correct mechanical functioning to trap the cat and release the bait, and non-target species impacts. They are currently writing their protocol for ethical approval and have approached the laboratory animal veterinarian as a source of advice on the project, and in particular any refinements that they may suggest.

ONE WELFARE ISSUES

1. *Killing of Cats*: The destruction of cats is an ethical issue since these animals are sentient and are regarded by most people as having intrinsic value. There are also welfare concerns since the method of killing the animals is not rapid and there will likely be a prolonged period of distress and potentially pain. Animals may also be distressed by being detained in the trap.
2. *Risk to Non-target Species*: Many pest management strategies have impacts on non-target species. This may include non-feral pet cats. Whilst, the methods used are designed to minimise this, given that this is a new untested technique, there is the possibility that this will occur.
3. *Feral Cats Pose a Risk to the Ecosystem*: Predation of wildlife, especially threatened or endangered species, is a threat to species diversity.

The public depend on the health of neighbourhood ecosystems for maintaining their quality of life (whether they are aware of this or not).

4. *Public Viewpoint*: Conservationists, environmentalists and bird lovers are usually proponents of feral cat control and likely feel that their well-being is affected by feral cat presence since they are passionate about the issue. Conversely, cat lovers are vocal advocates of non-lethal control measures.
5. *Feral Cat Welfare*: Feral cats may be hungry, diseased and frequently injured resulting in poor welfare and a shortened lifespan.
6. *Zoonoses*: Feral cats may transmit zoonotic diseases such as toxoplasma or cat scratch fever to humans.
7. *Issue of Human Creation*: The feral cat problem has been created by people. Irresponsible pet ownership caused by failing to neuter animals and abandonment created feral populations. The propensity of some people to feed these animals, or availability of food through other means such as open bin containers, sustains their population.

The ethics committee through discussion will perform an overall ethical analysis on the project to determine whether it should proceed. The main role of the veterinarian is to suggest methods of mitigating distress as part of the protocol. There are a number of ideas that can be discussed:

1. Can the traps be tested in the lab, for example, using cat-sized inanimate objects, to pilot the trap design.
2. Since there are concerns for non-target species can there be a consideration for personnel to be present at trap sites, or for video monitoring of the traps with researchers in close proximity, to step in and release non-target species.
3. The projects main aims are to test the sensor technology and mechanical workings of the trap, rather than the bait which is already in use. In this case can researchers step in as soon as a cat is trapped and euthanase the cat by a potentially more humane method, such as through injection of sodium pentobarbitone.
4. Can conditions be placed on weather conditions at time of trapping to avoid inclement weather or where there are extremes of temperature, and trapped animals may suffer as a result.

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11 Fish Welfare and One Welfare – A Veterinarian’s Perspective

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INTRODUCTION

The largest group of vertebrate animals in the world is the bony fishes (Class Osteichthyes). As veterinarians, we pride ourselves in looking after the health and well-being of all animals, but historically this has generally not included fish.

The number of veterinarians involved in looking after fish is small but increasing. Some veterinary schools are making room to include training in fish health. In most schools, though, where the curriculum is already crowded, it is still more a token gesture than a dedicated component of the course.

Fish, however, are very similar in many respects to other vertebrate animals, which may come as a surprise to many who cannot get past the fact that they live underwater. Understanding the structure and function of gills is not difficult. From then on, much of what is taught in veterinary schools with respect to veterinary aspects of animal health is applicable to fish. Training in physiology, pathobiology, microbiology, nutrition, reproduction, pharmacology, therapeutics, toxicology, epidemiology and surgery all provide vets with a strong comparative foundation to be able to work successfully with fish, including looking after the welfare of fish, which of course is the topic of this chapter.

Fish are vertebrate animals and as such should be afforded the same care we give other vertebrates. Veterinarians who are educated to understand the needs of aquatic animals can help to ensure that the welfare requirements of this significant and important class of animals are met.

In this chapter, we focus on fish welfare and provide veterinarians who may not be used to working with these animals with an understanding of our current knowledge of fish welfare. Our aim is to ensure that veterinarians, currently considered the leading advocates for the welfare of terrestrial animals, are also able to be the leading advocates for the welfare of fish.

There are of course other aquatic animals that are also deserved of welfare considerations, including molluscs and crustaceans which are both invertebrates. In this chapter, we have limited our considerations to welfare of vertebrate fish. Hopefully, as our understanding of welfare of aquatic invertebrates improves, there will be a subsequent edition of this book with a chapter regarding the welfare of these animals as well!

FISH AND THEIR IMPORTANCE TO HUMANS

As humans, we have a lot to thank fish for. If it were not for fish, many of our civilisations would not have survived. Fish have provided a valuable food source since the first humans began walking on this planet. More recently, our consumption of fish is increasing. In 1961, each of us on average consumed 9.0 kg of fish (FAO, 2020).¹ By 2018, this has increased to 20.5 kg per person (FAO, 2020).

¹ The calculation on the amount of fish we were eating is based on 'food fish', that is, fish destined for human consumption, thus excluding fish for non-food uses. The calculation also refers to 'apparent consumption', which is the average food available for consumption, which, for a number of reasons which we discuss is not equal to food intake.

Today, many cultures rely on fish as their main source of high-quality protein. In a number of countries – including Bangladesh, Cambodia, the Gambia, Ghana, Indonesia, Sierra Leone, Sri Lanka and some small island states – fish contribute 50% or more of people's total animal protein intake (FAO, 2020). Moreover, fish provided about 3.3 billion people with almost 20% of their average per capita intake of animal protein (FAO, 2020).

In Australia, a very high proportion (95%) of us consume seafood (FRDC, 2019). We consumed an estimated 248,403 tonnes in 2001–2002, which increased to 341,092 tonnes in 2016–2017 (Mobsby and Curtotti, 2018). A substantial proportion of the seafood consumed is fish.

Fish have been important to humans in other ways besides providing food. Fish housed in indoor tanks are one of the most widely kept pets in Australia. Many people form a strong attachment to their fish, as most of us do to animals that we have in our care. Increasingly, fish are also a valuable animal for use in research. Many of our spectacular environmental wonders in this country and in the world would be significantly different if it were not for fish – just think of the Great Barrier Reef devoid of any fish. It is doubtful if the booming tourist industry in Queensland would be the same were these beautiful animals not there.

Fish of course can be pests – not through their own intentions, but usually because we, as humans, introduced them to areas where they had not previously been. Currently in Australia, we have millions of European carp inhabiting our freshwater waterways. We see them as noxious, but it is not their fault they are there – it is ours. While causing environmental damage, they are also still animals, worthy of our care and consideration. As such, we need to consider their welfare when addressing measures to restore environments.

Many fish are also intelligent and capable of remarkable feats. We would urge any veterinarian doubting this to view the following two links (<https://youtu.be/giNH6oHPGmw> and https://www.youtube.com/watch?v=VQr8xDk_UaY), which provide two remarkable examples of the intelligence and capabilities of fish. The first video shows how fish can collaborate with other species to hunt. The second displays the incredible artistry of a very small fish in its attempts to attract a mate. This of course highlights a major similarity fish have with other animals – the need to eat and to reproduce are nature's great drivers for perseverance, innovation and change.

ANIMAL WELFARE AND FISH

'Animal welfare' is a complex issue, even when dealing with terrestrial animals. Our empathy for terrestrial animals has ensured, though, that animal welfare has come a long way over the last few decades. Fish are not warm and they are not fuzzy. Indeed, many fish have quite sharp spikes! You cannot hold a fish out of the water and cradle it lovingly – doing so will lead to its death. And fish don't have eyelids, no matter what Pixar wants to make us believe in films such as 'Finding Nemo'. No doubt part of Finding Nemo's success at the box office was because its leading fish (and shark) characters could talk. They also had eyelids,

which as veterinarians would understand, are quite redundant underwater! Not, though, if you are seeking to have your viewing public empathise with those characters.

For many people, the most common image they see of a fish is of an animal being held out of the water by the person who has just captured it or perhaps their local fishmonger showing them the catch of the day. Fish being held in this way appear as lifeless, inanimate objects, which is understandable given that they are either dead or struggling to breathe. Fish being kept in aquariums allow us to observe the fish in their water environment, but aquariums – like zoos – place constraints on the normal behaviour of the animal.

Whether or not these constraints on behaviour matter to fish is a question that has not been resolved and is likely to depend on the species in question. Importantly, there is still ongoing debate on whether or not fish can experience pain on a conscious level, as we discuss in the following section.

THE PAIN DEBATE

For terrestrial animals, there is general acceptance that dogs, cows and even birds are sentient beings. While the general scientific consensus is that fish are likely sentient, there are some in the scientific community who argue against this. Much of the argument and debate centres on pain and sentience and the concept of consciousness.

One could argue that it is all semantics. We tend to agree. However, if one begins to debate whether or not fish feel pain or whether they are sentient then one must include discussion on defining consciousness and whether fish can be considered as conscious beings given its definition. However, veterinarians know that it is not possible to prove that even terrestrial animals are conscious beings.

We concede that even with a well-referenced argument we will not be able to prove pain and sentience in fish, at least not with the tools we currently have. Personally, we consider the evidence to be compelling that fish are sentient and we also believe that there is much we can do with respect to looking after fish welfare without engaging in the debate about pain and sentience.

We do this by not ignoring the debate, but by moving beyond the semantics (which, as mentioned, much of the debate is based on) and considering what actions we can take now as veterinarians to make immediate improvements on the ‘well-being’ of fish, a term we consider reasonable to use. Making improvements to the well-being of the fish we have under our care will also bring many direct benefits to the humans involved, which fits in very well with the theme of One Welfare.

Some veterinarians reading this will likely want to understand more about the issues, concepts and opinions around pain and sentience in fish as a basis for forming an opinion on fish welfare. We have, therefore, provided further discussion on this in the following section, to help ensure that when discussions do come up about fish welfare (as they invariably do), any veterinarians involved in the discussion can talk knowledgeably about these issues. Hopefully, though, they

can also quickly move the conversation onto what we can do right now to improve fish welfare in a very practical way as we explain later in the chapter.

CONSCIOUSNESS AND SENTIENCE

Given that consciousness in a terrestrial animal still cannot be truly proven, should we consider that a fish can ‘suffer’? Given that a significant part of a veterinarian’s job is to alleviate and minimise pain and its attendant suffering, it is important for us to be knowledgeable on this important issue.

Firstly, it cannot be disputed that fish are vertebrates, and we would also argue that it should not be disputed that fish are vertebrate *animals*. However, given that fish are still not included in the definition of ‘animal’ in some Australian legislation then we must concede that from a regulatory view it does depend on whereabouts in Australia the fish is as to whether it is legally defined as an animal or not.

Notwithstanding legislative definitions, usually definitions of ‘animal’ and ‘sentient animal’ include all vertebrates, and thus include fish. Some, therefore, would argue that fish should be considered sentient. Others, however, dispute this.

When considering sentience, one can find a variety of definitions in the literature. For the purposes of transparency in this discussion, we have used the definition put forward by Mellor, who considers sentience to be the ability to ‘consciously perceive by the senses’ and to ‘experience subjectively’ (Mellor, 2019). What this means is that a sentient animal has the capacity to experience negative emotional or mental states, such as pain and distress, and positive emotional or mental states, such as contentment and excitement.

The debate in the scientific literature about whether fish are ‘sentient’ animals mostly centres around the ability, or lack thereof, of fish to experience pain. Pain has been defined as a negative sensory and emotional experience that indicates actual or potential tissue damage (International Association for the Study of Pain, 2018). In other words, pain is not only a sensory or reflex experience, but must also, by definition, include an emotional component, that is, pain must be experienced as being unpleasant in some way in order to be classified as pain. We refer those who would like to read more about the fish pain debate to Chatigny (2018), Graham, von Keyserlingk, and Franks (2018) and Brown (2015) who provide more details around the arguments for and against fish feeling pain, and a background to the debate.

Fish have been shown unequivocally to react behaviourally and physiologically to noxious stimuli (Mettam, Oulton, McCrohan, and Sneddon, 2011; Newby and Stevens, 2008; Reilly, Quinn, Cossins, and Sneddon, 2008; Sneddon, 2003). However, some argue (e.g. Key 2015; Rose et al. 2014) that what fish experience is not pain, but nociception, which is a reflex, unconscious, sensory experience that does not involve an associated emotional state, and, therefore, lacks the experience of suffering.

Brown (2015), however, states that ‘it is unreasonable to separate the physical detection of pain from the emotional or cognitive response to it since they are

so clearly part of an integrated system that has evolved to reduce the chances of injury.’ We tend to agree with this, suggesting that a distinction between pain and nociception is neither useful nor practical for veterinarians working with fish.

We also point out that there is a compelling and increasing body of evidence that shows that fish react to aversive stimuli in a way that is consistent with fish feeling pain. Learned avoidance of predators and other aversive stimuli has been shown to occur in fish (Brown, 2015). It makes sense from both a biological and an evolutionary perspective that these reactions also include an emotional response, that is, the mental perception of pain or fear as an unpleasant experience. An experience of pain as being unpleasant would help fish to reduce further injury in the present and learn to avoid damage in the future.

While we do consider the current scientific evidence that fish feel pain to be persuasive, we are also of the opinion that animals, especially vertebrate animals, which are so similar to humans genetically, evolutionarily, biologically and physiologically, should be assumed to be sentient unless there is strong evidence to say otherwise. This ‘precautionary principle’ is frequently used as a guide for animal use in research, but it can also be readily applied by veterinarians and farmers for the benefit of fish. This principle also serves the fundamental veterinary ethic of ‘First, do no harm’.

FISH WELFARE AND UNNECESSARY SUFFERING

We now come to consider what is meant by the term ‘fish welfare’. Defining fish welfare is not a simple task. Broadly, the term ‘animal welfare’ can be used reasonably interchangeably with the term ‘animal well-being’. It encompasses not only the health of the animal and its biological functioning, but also the animal’s subjective internal mental or emotional state (Fraser, 2003; Fraser, Weary, Pajor, and Milligan, 1997). Some definitions of animal welfare may also consider natural living, and the ability to perform natural or normal behaviours, as an important part of animal welfare (Fraser, 2003; Fraser et al., 1997). While natural living is often highly valued by consumers and the public, it can be difficult to define what ‘natural’ means for domesticated or captive-bred animals. As well as this, some natural behaviours, such as aggressive encounters and fleeing predators, are likely to be unpleasant and contribute to poor welfare. There are, however, likely to be some natural behaviours that animals are highly motivated to perform. Stress and a negative emotional or mental state may occur if they are prevented from doing so (Dawkins, 1988; Špinka, 2006).

Animal welfare assessment frameworks such as the Five Domains (Mellor and Beausoleil, 2015) incorporate all of the core animal welfare concepts (biological functioning, feelings and normal behaviour), within the domains of nutrition, environment, health, behaviour and mental state. Considering all of these domains when thinking about or assessing animal welfare gives a more comprehensive picture of welfare than just considering some of them. However, the ‘weight’ or value given to particular aspects of welfare may vary depending on the individuals’ beliefs and values. These beliefs and values inform all animal welfare

assessments, so it is important for vets to be aware of their own and their client's values, as this will impact how animal welfare is both assessed and addressed.

When we consider fish welfare, there is much we still need to learn about fishes' behavioural and mental requirements for good welfare, and these are likely to be species-specific. However there are many things we can do to improve fish welfare with the knowledge we currently have, and this is what we will focus on in the remainder of this chapter. With specific reference to pain, we suggest that the debate on fish pain should not preclude us as veterinarians from aiming to avoid, minimise and treat fish pain, just like we would any other vertebrate animal in our care.

There is also what we consider as 'unnecessary' suffering. In other words, fish are being exposed to suffering where there really is no need that they should be. On a practical level, we can reduce exposure of fish to unnecessary suffering right now in very pragmatic ways and in so doing make significant welfare improvements for fish we interact with. As we explain below, taking pragmatic steps to reduce unnecessary suffering and improve fish welfare from a One Welfare perspective not only benefits the fish, but it also benefits people involved in the care and well-being of the fish.

PHYSICAL HEALTH AS AN ESSENTIAL CRITERION OF GOOD WELFARE

As Marian Dawkins notes, the most obvious and accepted criterion that is essential to good welfare of animals is the physical health of the animals (Dawkins, 1998). We do not need to get into a debate on issues of pain, sentience and consciousness to be able to ensure that the physical health of the fish that we have in our care is being looked after.

THE WATER ENVIRONMENT

For veterinarians working with terrestrial animals, ensuring an understanding of the water environment in which fish live is a critical step towards understanding how to ensure that fish are physically healthy. An important step we can all take in making practical improvements to fish welfare in Australia is ensuring that all fish we have under our care, be it fish that are held in aquariums, fish we farm, fish being held in tanks in restaurants or fish being used in research are provided with optimal water quality while they in our care.

There are also benefits to humans in ensuring the water quality is optimal for the fish we are caring for. For fish farmers, optimal water quality ensures the fish achieve good growth and suffer minimal health issues. The colours displayed by fish being kept in aquariums can be affected by water quality – when water quality is poor for the particular fish species, its skin colour may lose its usual lustre. Optimal water quality in aquariums, therefore, is important not only for the fish but also for the enjoyment of the people keeping them. Fish being transported can

quickly die if optimal water quality is not maintained, causing significant financial loss. Even sub-optimal water quality – where fish don't die but are adversely affected – can cause high levels of morbidity in fish post-transport with increased risk of opportunistic infection and disease, again leading to financial loss.

We wish we could give you a prescriptive list of what optimal water is for fish. But, unfortunately, with over 30,000 species of fish living in a vast range of different habitats around the world, there is of course not one list but many. However, there are a few key water quality parameters that are important to monitor when looking after any fish species, acknowledging that the optimal range of each parameter varies depending on the fish species. As veterinarians, we just need to find out what that range is for any species we are dealing with. Such information is readily available, particularly for the more common species.

DISSOLVED OXYGEN

The first parameter is oxygen, or more precisely the dissolved oxygen in the water in which fish are housed. Unlike air, with its constant and abundant amount (21%) of oxygen that is available to us, there is significantly less oxygen (well less than 1%) available in the water in which fish live. Fortunately, fish have a remarkable ability to extract the little amount of oxygen there is in the water using their gills. Just like our lungs, where blood is brought in close contact with air, fish bring blood in close contact with water in their gills.

Just like our blood, fish have red blood cells containing haemoglobin.² They have a huge surface area within the gills where they bring this blood in close proximity to the water. They also have a counter-current mechanism operating in their gills that means the blood flowing through the final lamellae flows in an opposite direction to the water, maximising oxygen uptake and discharge of metabolic products such as carbon dioxide and ammonia.

Just like we humans must continue to breathe, fish too must continue to maintain a flow of water across their gills. Most fish do this in two ways – by pumping water continuously (which you can see when you look at a fish in a tank and the covers of its gills, called opercula, opening and closing) which fish can do even when stationary, or by swimming and allowing the water to simply flow over their gills. Some fish, like tuna, during their evolution have lost the ability to pump water and hence must continually swim. If they stop swimming, they die.

The amount of oxygen that can dissolve in water differs depending on the temperature and salinity of the water. As a general rule, for fish in aquariums and being held in tanks, the level of dissolved oxygen should be close to 100% saturation. For fish being farmed that are being fed regularly, it can be difficult to maintain oxygen saturation levels this high, but close monitoring of dissolved oxygen at all times is extremely important if there are high densities of fish in any body of water. There are many ways to increase the amount of oxygen that

² Acknowledging that unlike our blood cells fish red blood cells are nucleated.

dissolves in water. The simplest is by agitating the surface of the water (splashing) or by simply keeping fish in a 'flow through' system, where new water is continually introduced to the system, bringing with it the oxygen that is dissolved in that system. In intensive fish farms, liquid oxygen is kept on-site in large tanks and this is added to the culture tanks.

Holding Fish Out of Water – Why?

One area of welfare that needs to be highlighted is the holding of live fish out of water. This is akin to holding a terrestrial animal underwater. It would not be acceptable to hold a dog underwater, yet it is considered acceptable by some to hold a fish out of water, sometimes for minutes, particularly by recreational anglers who want to release the fish live (a good thing), but who also want to ensure they have good photos of it before they do release it, which will lead to poor fish welfare the longer it is held out of the water. Interestingly, one can find articles in both the scientific and grey literature debating how long it is acceptable to hold a fish out of water before putting it back. Indeed, government agencies involved with recreational angling sometimes consider the benefits of providing guidance to anglers about an 'acceptable' time of holding fish out of water.

But we don't see similar articles appearing about how long it is acceptable to have a dog/cat/pig/deer (insert any terrestrial animal here) hold its breath for before allowing it to breathe again. We hope that one day we will no longer be debating about how long it is acceptable to allow a fish to not breathe. When educating recreational anglers (which we regularly do), we always make them aware of our concerns over this. Essentially, while it may be more practical to get a fish out of water to be able to, for example, remove the hook quickly before releasing the fish (which sometimes is a legal requirement if, for example, a fish that is smaller than the legal catch limit for that species), the time out of water should be absolutely minimised and there should not be any 'acceptable' time period to hold a fish out of water. *Any* time out of water is detrimental to fish health and welfare.

ORGANIC MATTER

The next important aspect of fish culture that veterinarians need to understand is that fish excrete their wastes directly into the water in which they live and hence these wastes must not be allowed to build up or they can cause a deterioration in the water quality. High loads of organic material, for example, waste or uneaten feed, will quickly create problems in the water if they are not removed. These problems include having a buildup of bacteria in the water which utilise the nutrients in the uneaten feed. Many bacteria require oxygen, thus competing with the fish, so this places a demand on the already limited amount of oxygen there is in the water. Bacteria can also release toxins into the water and some bacteria can become pathogenic, invading and infecting the fish they are in close contact with. The potential for this occurring increases if fish are stressed due to low oxygen levels or other environmental stressors.

AMMONIA

A major compound that must be monitored closely in water is ammonia. Unlike mammals and birds that get rid of their excess nitrogen as urea and uric acid respectively, fish get rid of their excess nitrogen as ammonia, primarily excreting it out through their gills. Ammonia is in two forms in water: an ionised form and an un-ionised form. It is the un-ionised form that is toxic and the proportion of this increases as the pH of the water increases. There are tables that provide the proportion of un-ionised ammonia in the water given that the total ammonia and the pH are known. Salinity also has some influence on this proportion, as does temperature, so both also need to be known. Hence the total amount of ammonia and the pH of the water should always be monitored to ensure toxic levels of un-ionised ammonia do not develop in the water.

WATER TEMPERATURE

The water temperature is another very important parameter to monitor to ensure good fish health. Fish are poikilothermic. Their internal body temperature is the same as the water they are living in. The working muscles of fish, like other animals, heat up during exercise. This warms the blood flowing through the muscle. This warmed blood travels back to the heart where it is immediately pumped through the gills. As noted previously, there is a huge surface area in the gills to facilitate oxygen transfer. This large area also facilitates the loss of any heat and ensures that the blood that leaves the gills and heads back to the muscle has lost its heat and is at the same temperature as the water. The gills are, in effect, a wonderful heat exchanger.

Maintaining an internal temperature the same as the outside temperature has some great benefits for the fish, one of these being that much less energy is required just to maintain an internal body temperature as terrestrial animals do. However, metabolism is greatly affected by temperature and so different fish species have developed an optimal temperature range at which their metabolism operates most efficiently. If the temperature is too low, or too high for a particular fish species, problems will develop and ultimately a fish will die if kept in water that is at a temperature too far outside its optimal range.

As veterinarians, we must know what the water temperature tolerance range is for the fish we are caring for. As an example, we farm Atlantic salmon in open net pens in Tasmania. Atlantic salmon are an introduced species, their natural habitat being the Atlantic Ocean. Water temperatures above 18°C are outside of the Atlantic salmon's tolerance range and salmon being held in water above 20°C are going to struggle. What exacerbates the problem is that any increase in water temperature increases metabolic processes in the salmon and thereby increases their oxygen requirement. However, as water temperatures increase, the amount of oxygen that can dissolve in the water decreases, leading to a dangerous situation of higher demand for oxygen, but less available oxygen.

Having said that, fish being farmed are often maintained at temperatures that are at the higher end of their tolerance range. This is because their growth rate is dependent on water temperature – the higher the temperature (within the limits of the species) the faster is the potential for growth.

Provided all aspects of good water quality are maintained, growing fish at temperatures at the higher end of their tolerance range can be perfectly acceptable from a welfare perspective, particularly if fish are healthy and feed well. This has other benefits as unlike terrestrial animals including cows and pigs, fish do not require energy to maintain a constant internal temperature nor do they require energy to support their own bodyweight against gravity. Proportionally, therefore, fish utilise more of the energy in the food they consume for growth.

OTHER WATER QUALITY PARAMETERS

There are many other aspects of water quality that can influence the health of fish. These include pH (already briefly mentioned) and salinity (some fish can tolerate a range of salinities, others are either solely freshwater or solely saltwater tolerant), but understanding that there are key parameters that need to be maintained at optimal levels for good health of the fish is an important start. There are many fish currently being kept across Australia where water quality conditions are not ideal and this is usually because of ignorance rather than malice. Improving the understanding of veterinarians as to what constitutes good water quality will, we think, help to expand the knowledge of people caring for fish. This will improve the health of the fish, improve survival, reduce morbidity and improve the satisfaction of the people looking after the fish. Looking after fish welfare in this manner brings benefits to both fish and people.

STOCKING DENSITY

The amount of space that fish have in a tank or cage is one aspect that must be mentioned here. Many people will observe fish in a tank and comment that there appear to be too many fish in the tank, based on their perception of terrestrial animals (chicken in cages being a good analogy).

The key to density for fish in tanks or ponds or cages is the water quality. If good water quality can be maintained at a given density of fish, then the density is not necessarily too high. Many fish are schooling animals and are very used to being in close proximity. They have sensory apparatus including the lateral line down each side of their bodies that allow for very good spatial awareness. However, if high densities lead to problems with the water quality, such as low dissolved oxygen levels and high ammonia, then the density may be too high.

In some fish, the density at which they are kept can change their behaviour, which can have welfare implications. Murray cod (*Maccullochella peelii*), a large, freshwater fish found in waterways of the Murray Darling basin, can be quite territorial and if only a few Murray cod are placed in a tank they can show

considerable territorial aggression towards each other. However, if the density of these cod is increased in the tank, their behaviour can change to a less aggressive and more social and tolerant nature.

THE KILLING OF FISH TO EAT

Around the world, millions of fish are still being killed in a manner that would be considered totally unacceptable for terrestrial animals. It is probably the most conspicuous area of welfare that highlights the different standards used for fish versus for terrestrial animals, at least in Australia.

Currently, a person can allow a fish to die by asphyxiation without getting into legal trouble, but to allow a cow or dog to slowly drown (the equivalent of a fish asphyxiating when removed from the water) would potentially invoke criminal charges. Asphyxiation is an unacceptable killing method for fish, as fish can take a prolonged period of time to become unresponsive, likely leading to a prolonged period of suffering (AVMA, 2020; Close et al., 1997; Poli, Parisi, Scappini, and Zampacavallo, 2005). It is considered to be an inhumane method of killing an animal (AVMA, 2020; OIE, 2019). Anything that causes unnecessary pain or suffering prior to the loss of consciousness we consider to be unacceptable when there are more humane alternatives available.

It should be obvious to veterinarians reading this (and anyone else for that matter), that considerations regarding the killing of fish should be no different to the considerations given to the killing of any other vertebrate animals.

We have established that killing fish by asphyxiation is a serious fish welfare issue. However, another pertinent and important concern with this method is the damage that is done to the muscles of the fish during the dying process. We know that there can be a detrimental build-up of lactic acid and heat in the muscles of cows, pigs and chickens when the capture and killing process is stressful. While there is a welfare issue around the stressful killing of terrestrial animals, there is also a product quality issue. This is also true of fish.

Physiologically, fish muscle has many similarities to the muscle of other vertebrate animals including cows and pigs. One anatomical difference is that in terrestrial animals the aerobic (slow-twitch) and anaerobic (fast-twitch) muscles are mixed together. In fish, the red (aerobic) and white (anaerobic) are separate as can be observed when dissecting the muscle of any bony fish. Physiologically, though, similar processes occur within a fish during a stressful capture and prolonged period of dying. Yet fish being captured to eat are often allowed to die in a highly stressful manner, which is not only detrimental for the fish but also to its eating qualities.

In Australia, a great deal of importance has historically been placed on ensuring any fish purchased is 'fresh'. A key reason for this may be the fact that the deterioration in the eating qualities of a fish that has undergone a very stressful death is quite rapid even if kept chilled. Unlike terrestrial animals, where some degradation of connective tissue leads to improved quality of the muscle, in fish, such degradation can lead to a soft, 'mushy' flesh that is considered undesirable (Daskalova, 2019).

However, fish that undergo ‘rested harvest’ – where there is minimal stress and an immediate cessation of brain activity by spiking or percussion stunning on removal from the water – can maintain very good quality for 10 days or longer if kept chilled. Understandably, there are great economic, food quality and sustainability benefits in extending the shelf life of the fish that are farmed.

Fish farming is leading the way in humane methods of killing fish *en masse*. Although the driver for these practices has been to improve the eating qualities of the fish, fish welfare has greatly benefited as well.

In Australia, all Atlantic salmon and ocean trout being grown in Tasmania are percussion stunned within seconds of coming out of the water. Percussion stunning, when administered so that there is an immediate and permanent loss of consciousness to the fish, is considered a humane method of killing (AVMA, 2016; OIE, 2019). In South Australia, divers individually lead Southern bluefin tuna into a covered raceway where they are escalated up to the deck of a boat pulled alongside the cage. The darkness in the raceway keeps them calm during the journey, which takes only a few seconds. As they emerge from the raceway, they are immediately brain spiked before being bled and processed. Brain spiking leads to immediate cessation of consciousness and brain function and is also considered a humane method for killing fish (AVMA, 2016; OIE, 2019). In New South Wales, an innovative Murray Cod farmer is individually spiking or percussion stunning all fish being harvested, which has led to these fish being sold into the lucrative Japanese sushi market, such is the quality of the flesh.

So why are so many fish being captured recreationally and commercially in this country still allowed to die in a manner that does such damage to the quality of the fish to eat, not to mention the welfare concerns regarding these practices?

We believe there are a number of reasons behind this. The first is because the practice of ‘humane’ killing – and by this, we mean the immediate cessation of brain function when removed from the water – was never a consideration for those pioneering fishers heading out many years ago to catch fish to be sold or feed local communities. It was also not a prime consideration for more modern practices of catching fish. There have always been economic and social drivers behind catching as many fish as possible in as little amount of time as possible. If there was no difference in the price paid for fish being caught using different methods, then there was not a financial incentive to catch fish in a way that may slow down how many fish can be caught in a given time period. Particularly if it was considered that the only benefit would have been fish welfare.

As we’ve also discussed, if those catching the fish had not considered that the fish might be capable of suffering or pain, then there is little incentive to be concerned about what killing method should be used from a fish welfare perspective.

There were also human welfare considerations here – the open oceans can be treacherous places and the longer one stayed out the more chance of injury or, worse, the death of crew or loss of a boat. The number of fish caught may also historically have been the difference between a village surviving and a village starving that year. We also concede that in many traditional artisanal fisheries serving small villages, the amount of fish handled was very low, and fish were

consumed within a few hours after capture (Huss, 1995). There was therefore very little time for the quality of the fish to deteriorate to any great extent. Hence, fishing methods were understandably developed based on these considerations and not on fish welfare.

Boats used to capture fish have improved markedly since those early fishers went out and the volume of fish being caught has also increased. Locating schools of fish has been greatly assisted by technologies such as sonar. While some fishers are changing fishing practices to better look after the welfare of fish (though this is not the driver – product quality is), there are still many fishers, both commercial and recreational, who still make little effort to ensure captured fish are killed quickly.

In the recreational fishing sector, we believe that there is a considerable lack of understanding (or perhaps apathy?) about how product quality is linked closely to fish welfare. A large proportion of anglers, in our opinion, simply don't understand that the way a fish is killed will affect its eating qualities. As previously mentioned, we realise that for many people the welfare of the fish is not of prime consideration and again there are likely a number of recreational anglers who are unaware that fish can feel pain.

If we can improve the understanding of this link between welfare and eating quality, we believe there will perhaps be a reduction in unnecessary suffering for the fish, which will also benefit the people catching those fish. The World Organization for Animal Health (OIE) Aquatic Animal Health Code and the American Veterinary Medical Association both have freely accessible guidelines on the humane killing of fish for food, including methods such as spiking that can be used by recreational fishers (AVMA, 2016; OIE, 2019).

There are also sustainability issues here. Because of the internal damage caused by a stressful dying process and the deterioration in eating qualities as we described above, fish that undergo a stressful death also have a shorter shelf life. Less time available to be sold can lead to increased wastage, and the worldwide wastage in seafood is staggering. One study done in the United States (US) estimated that between 2009 and 2013, 40%–47% of the edible US seafood supply went uneaten during this period (Love, Fry, Milli, and Neff, 2015). The greatest area of loss (waste) occurred at the levels of the consumers, which made up for 51%–63% of the loss (Love et al., 2015). There are a number of factors that lead to this loss including poor utilisation of all parts of the fish. Anything that can be done to reduce that wastage is beneficial. Improving the number of days a product can be sold will help to reduce the amount of fish that is thrown out, either because it is no longer able to be sold or if being held at home because it has become inedible.

Humane killing methods are therefore better for the fish, improve its eating qualities and also contribute to improved sustainability of the fisheries.

ARE THERE IMPACTS ON CHANGING FISHING PRACTICES?

In many countries, people's livelihoods depend on capturing fish using methods that do not necessarily result in the humane death of the fish. Killing fish

humanely by methods such as stunning and spiking can increase the time taken fishing. If restrictions were imposed on types of fishing that led to less fish being caught and people going hungry then, from a One Welfare perspective, it would not be a positive outcome.

In Australia, we have people depending on commercial fisheries for their livelihood. Fisheries management authorities at both the State and Commonwealth level allow a specific quantity of wild fish to be caught in this country each year and monitor this closely.³ In the commercial sector, it would cause adverse social and human impacts if changes were immediately mandated so that all fish captured had to be humanely killed. In this sector, change needs to be a gradual process to ensure that all benefit, not least of all the fish.

Change is occurring in some commercial fishing operations. Welfare Codes of Practices have been developed for a number of styles of commercial wild capture fishing⁴ in Australia. Some of the recommendations include reducing the time the net is being towed before it is brought to the surface in trawl operations. In mesh netting operations, reducing 'soak' times (the period of time the net is in the water) can improve the quality of some of the fish being caught due to them not dying over a prolonged period. Immediately spiking the brain of fish caught by hand-lining is becoming more common.

Recreational angling is an activity in which millions of Australians participate each year. In this sector, there is no reason that change should not be rapid.

A key to driving change will be, in our opinion, educating those who purchase fish to eat that fish are worthy of being given welfare considerations. Critical to this will be the understanding that the killing process used affects the eating qualities of that fish, just like it does with other animals. The speed at which practices change will be accelerated if the general public are also willing to pay a premium price for quality fish, killed humanely. We hope that veterinarians can become more involved in this, given their accepted position as advocates of animal welfare.

But, like many things, it is not all simple, particularly when one considers fishing practices from a One Welfare perspective.

Case Study – The Commercial Capture of Sardines

We discuss the issue of how to humanely kill fish captured in the wild here as it does raise some important ethical considerations. We acknowledge that it can still be a dangerous exercise to journey out to the open seas to capture fish. We accept that the size of some fish – for example, sardines, where the average size of each fish may be 50 g – precludes the use of mechanisms that can individually kill each fish as it comes out of the water.

³ At the Commonwealth level, this is managed by the Australian Fisheries Management Authority <https://www.afma.gov.au/>

⁴ The Welfare Codes of Practice are available at <https://www.frdc.com.au/en/issues/aquatic-animal-welfare/aaw---research>

Sardines (*Sardinops sagax*), also called pilchards, are a small, schooling fish that can live up to 9 years, reaching sexual maturity at around 1 year (Sinovčić, Keč, and Zorica, 2008). There are some very well managed industries fishing for sardines in Australia which they do under a strict quota system.⁵ Sardines can be captured by encircling the school with a net that is then drawn in, crowding up the school of sardines next to the boat (a method known as purse seining). Schools can consist of millions of fish. Onboard sonar technologies help locate schools.

As a purse seine net is pulled in, the school is crowded, which is necessary to allow pumping of fish onto the boat and into its hold. Usually, sardines are pumped directly into refrigerated saltwater where the temperatures can be at or below 0°C. As the chilled water is saltwater, there will not be an osmotic stress. It is very important to rapidly chill small fish as the smaller the fish, the quicker that spoilage of fish can occur due to their higher surface/volume ratio compared with larger species.

What is also important to acknowledge is that weather conditions can vary considerably during fishing. Rough weather is often encountered, placing vessel and crew at risk.

A NOTE ON KILLING OF FISH BY IMMERSION IN ICE

Various studies have been done to look at the welfare aspects of killing fish by immersion in an ice slurry. It has been shown that, for larger fish, this can significantly prolong time to death (Close et al., 1997; Poli et al., 2005). For this reason, rapid chilling is only considered humane in very small and non-cold adapted fish (AVMA, 2016). For very small fish, though, (e.g. zebrafish, with an average size of less than 1 g), achieving death by immersion in an ice slurry has been shown to be less stressful and more rapid than immersion in an anaesthetic solution (Blessing, Marshall, and Balcombe, 2010; Wilson, Bunte, and Carty, 2009). These studies indicate that the time to death for the zebrafish was a matter of seconds (Blessing et al., 2010; Wilson et al., 2009).

The reason fish size is important relates to the rate of heat loss via thermal conduction from the body. In smaller fish, this is much more rapid. In large fish, the cooling of the brain can be delayed by the insulating properties of the cranium and fatty tissue around it (Blessing et al., 2010).

As far as we are aware, no specific studies have been conducted on sardines to determine the time of death when they are immersed in saltwater at 0°C. We suggest that for the individual fish, it is very quick, likely less than a minute. This is longer than if each individual sardine was given a quick blow to the head (stunned) where loss of consciousness is immediate.

⁵ One example of this is the South Australian sardine fishery, more information about which is available at https://www.pir.sa.gov.au/fishing/commercial_fishing/fisheries/sardine_fishery

However, it would not be practical to individually stun every sardine in a school that has been captured. For sardines that had not yet been killed, the stress of being crowded in the purse seine would be significantly prolonged and it is conceivable that some may die due to the stress or injuries they may be exposed to in the purse seine net, particularly if they were being held for hours.

Pumping sardines into chilled seawater in the hold of the boat, where they die relatively quickly, may not bring about as rapid a death to each sardine as could be achieved by individual stunning, however, it is likely a better welfare outcome for the school of fish overall.

In addition, the shorter the operation, the less risk there is to the vessel and to the crew where a prolonged period of capture increases risk. With a small-sized fish such as a sardine, it could therefore be argued that catching large numbers of these fish in this manner has better overall welfare outcomes (particularly One Welfare outcomes) than if the process were to be prolonged by killing fish individually over a considerable number of hours.

ONE WELFARE AND THE KILLING OF FISH

In keeping with the 'One Welfare' theme of this book, we'd like to provide another example of where looking after the welfare of the fish can have implications for the welfare of humans. This example relates to the deterioration of the quality of the fish, a subject we touched on briefly earlier in this chapter.

The humane killing of fish reduces unnecessary suffering in the fish and improves its eating quality, as we have discussed. It must also be said, though, that immediately after killing the fish it must be quickly chilled to avoid spoilage. Most recreational anglers in Australia have access to ice or refrigeration, which makes immediate chilling after killing the fish possible. All farmed fish that are killed are immediately put into a slush ice (which is a mixture of ice and water) or refrigerated saltwater. Commercial wild capture fisheries generally chill the fish they catch straight away, even if they don't always immediately kill the fish.

However, in remote areas of some countries there sometimes is no access to ice or refrigeration. In tropical countries, air temperatures can rapidly lead to the spoilage of a fish once it dies. Maintaining a fish alive as long as possible can delay such spoilage.

This was brought home starkly to one of the authors of this chapter who was visiting a remote area in a tropical country and was present in a boat when a large barramundi was caught. The fish was thrown alive into the back of the boat where there was a small amount of water. The plan was that it would be taken back to the local village to be eaten that evening.

The small amount of water in the boat kept the fish alive, but only just. Periodically, it would jump up and thrash, likely in an attempt to get back in the water. After doing this for perhaps fifteen minutes or so, the author, concerned about the welfare of the fish and not thinking beyond that, asked whether it would be possible to kill the fish to stop its suffering. Because the author, who was a visitor to the area, had requested it, the fish was immediately given a quick blow

to the head. No comment was made and the fish remained still (and dead) for the rest of the trip.

However, on arriving back at the village, the fish was picked up and thrown into the river, where it slowly floated away. On questioning why this was done and why the fish was not being taken back to the family to eat, the author was informed that the fish was 'no good'. The author had neglected to consider that a dead fish, with no refrigeration and lying out in 30°C heat, would spoil and potentially cause a human welfare issue for those who ate it. Keeping the fish alive as long as possible would have ensured it remained in a condition that was considered safe to eat.

In such a situation, the welfare of humans understandably was of more concern to the villagers than the welfare of the fish. It provided an important lesson.

EUTHANASIA OF AQUARIUM FISH

In 2019, it was estimated that 11% of Australian households kept fish as pets, amounting to an estimated 11 million fish (AMA, 2019). In comparison, while nearly 40% of households kept one or more dogs as pets, the total number of dogs being kept as pets in Australia was a little over 5 million. As a group, there are more fish being kept as pets than any other group of animals in Australia.

We have discussed the importance of water quality for fish welfare, and this applies to pet fish too. As many species of fish are kept as pets, the optimal water quality for each species needs to be known to ensure the quality of the water in which the fish is housed is suitable for the species being kept.

From time to time fish may get sick. Sometimes owners will take their pet fish to a veterinarian. Often, however, the owner may themselves decide to euthanase the fish. There is, though, little readily available information in Australia for owners (and indeed veterinarians) on humane euthanasia techniques for aquarium fish.

Fortunately, this issue was identified and addressed in 2013, and the report *Humane Euthanasia Techniques for Ornamental Fish* (Jones and Daly, 2013⁶) was released. This report found that there was no reason why owners should not be permitted to euthanize their fish if they are suffering, as long as it has done in a humane manner. They identified that the best and preferred method for the euthanasia of aquarium fish in the home and retail environment was the use of a registered clove oil derivative (such as AQUI-S[®]) which can be added to the water in concentrations sufficient to result in an anaesthetic overdose. Such a compound covers all pet fish types.

The report also noted, though, that the availability of this product in small volumes is an issue that needs to be considered.

Clove oil, which is readily available, is not a registered product for use as an anaesthetic for fish. However, clove oil has been reported as an effective fish anaesthetic and euthanasia agent, when diluted with alcohol to improve water

⁶ Available at <http://piaa.net.au/wp-content/uploads/2015/10/Humane-Euthanasia-Techniques-for-Ornamental-Fish-AAWS-Document.pdf>

solubility (e.g. Fernandes et al., 2015). Clove oil is available at pharmacies or online and so, despite not being registered for use in fish, we consider it important that veterinarians are aware of its potential.

It is relatively well known that some pet fish are flushed down the toilet when sick or no longer wanted. We have made comment on the Pixar film 'Finding Nemo' previously in this chapter. Unfortunately, this film also popularized the misconception that all drains lead to the ocean and if you were to flush a fish down a toilet it may end up in a waterway as well. However, from both a fish welfare and a biosecurity perspective, the flushing of an unwanted pet fish down the toilet or drain is totally unacceptable. A fish disposed of in this manner is unlikely to die quickly, being exposed to poor water quality, physical injury or starvation prior to dying. Pet fish that are released into waterways and survive can become pest species, and may carry pathogens that pose a biosecurity risk to native aquatic species.

FISH USED IN RESEARCH

Fish are being increasingly used in a research setting for studies in areas as diverse as ecology, conservation, endocrinology and genetics (Utne-Palm and Smith, 2020). This is due, in part, to the growth of aquaculture and the need for research to aid in maximising fish production (Utne-Palm and Smith, 2020), but it is also a result of the increasing popularity of fish as laboratory animals. Fish are used as models for human disease, in fundamental biological research and in environmental research in fields such as conservation ecology and environmental science (Johansen, Needham, and Colquhoun, 2006; Utne-Palm and Smith, 2020). Fish are also used as model species in research looking at the toxic effects of chemicals in the environment (Williams, Readman, and Owen, 2009). The use of fish in research is another area where we as humans benefit from fish, such work contributing to human health and welfare through aquaculture, biomedical and biological research, as well as helping to improve environmental health in ecological, environmental and toxicological studies.

The most common fish species that are used in the laboratory is the zebrafish (*Danio rerio*). This species is popular for a number of reasons, including their small space requirement, low cost of upkeep, high reproductive rate, external embryo development, and the fact that their tissues are transparent, the latter two making observation of internal anatomy and development possible (Bailone et al., 2019; Lieschke and Currie, 2007; Utne-Palm and Smith, 2020). Zebrafish also share a relatively high proportion of human genes, with 70% of the human and zebrafish genome being homologous (Bailone et al., 2019; Utne-Palm and Smith, 2020). For this reason, zebrafish are commonly used in some areas of genetic research (Lieschke and Currie, 2007).

Fish in the laboratory may face a variety of welfare challenges. These include social challenges, invasive identification procedures, lack of enrichment, the potential for pain due to scientific procedures, disease, handling stress, water quality issues, inappropriate lighting or light cycles, noise and transport (Iaria et al., 2019; Johansen et al., 2006; Sloman, Bouyoucos, Brooks, and Sneddon, 2019;

Williams et al., 2009). Many of these welfare challenges require species-specific solutions. An example of this is that while Murray Cod become aggressive if stocking density in captivity is too low, as has been noted previously in this chapter, other fish, such as the European seabass (*Dicentrarchus labrax*), show reduced feed intake and growth when kept at high stocking densities (Santos, Schrama, Mamauag, Rombout, and Verreth, 2010).

Veterinarians, especially those with postgraduate qualifications and experience in fish health, are well placed to provide advice on biosecurity, treatment of disease, analgesia and anaesthesia for fish in research. Veterinarians can also provide recommendations on fish housing and husbandry, through their work in roles such as laboratory veterinarians, research animal welfare officers and as part of animal ethics committees, which are required in many countries to approve and oversee animal research.

Ensuring that the potential for pain and stress is reduced in research animals, and that fish are housed appropriately for their species and in good quality water, not only improves the lives of the animals but also makes for better quality research. Pain and stress can affect experimental measurements of interest and, therefore, have a negative effect on research results. Veterinarians have important roles to play in optimising fish welfare in research, leading to research outcomes that help fish, humans and the environment.

We do think it important to point out for the veterinarians reading this that fish used in research are generally protected under legislation and regulations that do not apply to other fish. For instance, in Australia, while fish in research are granted welfare protection under the National Health and Medical Research Council *Australian code for the care and use of animals for scientific purposes* (NHMRC, 2013), non-research fish in two Australian states are excluded from the definition of ‘animal’ under law, exempting them from animal welfare and animal cruelty legal protection in these states (Government of South Australia, 2002; Government of Western Australia, 2019).

CONCLUSIONS

Bony fish are the largest group of vertebrate animals on this planet. They are important for both human and environmental health. There is a growing body of scientific evidence that fish are capable of pain and suffering, as well as complex behaviours and cognition. However, compared to terrestrial animal species the welfare of this enormous group of animals has not been well addressed.

As has been discussed in this chapter, this has not only been to the detriment of fish but also to the detriment of humans. There are great benefits to us by looking after the welfare of fish when interacting with these animals, be that in commercial or recreational fishing, fish farming, research, or aquarium fish. And by doing this there will also be benefits to the fish themselves.

Veterinarians, with their background in animal health and disease, are well placed to step up and lead the way in improving fish welfare.

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12 Working Animals – One Health, One Welfare

Ben Sturgeon

The Society for the Protection of
Animals Abroad

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INTRODUCTION

It is estimated between 100 and 125 million working donkeys, horses and mules, and up to 250 million working animals globally including camels, oxen and elephants, are essential to the livelihoods of some of the poorest communities reaching up to 1 billion vulnerable and marginalised people worldwide (Figure 12.1).

In rural areas, the animals facilitate farming and transportation pulling ploughs and carts, delivering goods to market, herding livestock and collecting water for household and agricultural use. In urban areas, they support construction, the transport of people and goods, tourism, mining and refuse collection.

By enabling their owners to participate in work, working animals allow individual incomes, boost local, regional and national economies, as well as further benefit communities by enabling education, access to basic services and supporting gender equality.

Perhaps, less well-recognised benefits provided include social empowerment, mental well-being, environmental protection, disaster preparedness and climatic resilience.

The effects can be summarised as Total Economic Value (TEV) and as Socioeconomic Value (SEV) and are recognised in some organisations and Governments as areas of shared legislative and moral responsibility. This shared responsibility is met mainly under the One Health concept by supporting the United

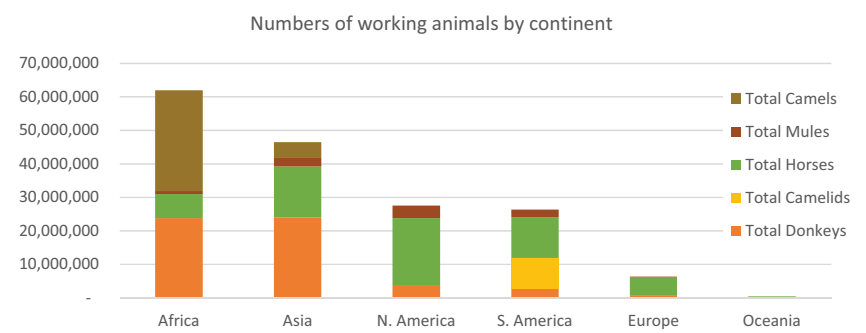


FIGURE 12.1 Relative contribution of equids in working animal populations worldwide (SPANA, 2019).

Nations Sustainable Development Goals (SDGs) 2030 which promotes global human health through 17 core goals and activities. That many of these SDGs are reliant upon the health and welfare of working animals highlights their important contribution to human health and environmental protection.

Despite this recognition, their relevance and quantification of contributions are poorly articulated in developing countries, and equids especially, of the working animals, are rarely included in development and poverty reduction programmes, or within the agendas of national livestock ministries (Pritchard, 2014). With intersectional deficiencies commonplace, such data demonstrating working equid and overall animal input into the economic and social development of communities and into wider national economies are lacking resulting in either slow or no recognition by key stakeholders and policymakers.

The short and long term effects of this are poor animal welfare, predisposition to endemic disease, possible exposure to zoonotic disease, loss of natural resources, environmental degradation and risk to climatic and human-led emergency.

Under the concept of “one health” and “one welfare” it is recognised there is a vital interconnection between the environment and the health and welfare of all animals, including humans (Garcia, 2015, 2016). Addressing the connection between human health and animal health, policy and science, including environmental science and sustainability is key to both following the SDGs and promoting global health.

WORKING ANIMAL POPULATIONS

In giving perspective to the importance of working equids to human development, it is necessary to quantify the basic population numbers within developmental countries (Tables 12.1–12.3).

Of working equids, FAOSTAT analysis (2017) estimates 125 million, including 54.9m donkeys, 60.5m horses, 9.6m mules and camels (Tables 12.4–12.7). Of these animals, 75% of the world equid population undertake work and over

TABLE 12.1
Total Populations by Species (FAOSTAT, 2017)

Total by Species	
Horses	60,540,753
Donkeys	54,978,230
Camels	34,829,975
Mules	9,685,278
Camelids	9,018,913
Total	169,053,149^a

^a Oxen and elephants unrecorded.

TABLE 12.2
Total Populations by Continents (FAOSTAT, 2017)

Total by Continent	
Country	Value
1. Africa	62,011,656
2. Asia	46,527,903
3. N. America	27,532,041
4. S. America	26,336,128
5. Europe	6,242,383
6. Oceania	400,281

TABLE 12.3
Top Ten Country Populations by Species (FAOSTAT, 2017)

Total Working Animals: Horses, Donkeys, Mules, Camels, Camelids			
Country	Value	Country	Value
1. Mexico	12,950,006	7. Brazil	7,585,252
2. Ethiopia	12,623,845	8. Somalia	7,267,856
3. China	12,329,887	9. Pakistan	6,900,000
4. Chad	11,638,798	10. Korea (DPR)	6,812,478
5. USA	10,562,723	11. Sudan	6,311,629
6. Peru	7,673,928		

TABLE 12.4
Species Population by Country

Donkeys	
Country	Value
1. Ethiopia	8,778,750
2. Korea (DPR)	6,764,212
3. Pakistan	5,200,000
4. China	4,568,500
5. Mexico	3,283,017
6. Chad	3,186,581
7. Korea (Rep)	2,415,654
8. Niger	1,837,429
9. Iran	1,531,079
10. Egypt	1,493,369

TABLE 12.5
Species Population by Country

Horses	
Country	Value
1. USA	10,510,748
2. Mexico	6,380,179
3. China	5,509,787
4. Brazil	5,501,872
5. Mongolia	3,939,813
6. Argentina	2,527,764
7. Kazakhstan	2,415,654
8. Ethiopia	2,228,258
9. Russia	1,381,331
10. Colombia	1,185,896
11. Chad	1,166,908

TABLE 12.6
Species Population by Country

Mules	
Country	Value
1. Mexico	3,286,810
2. China	1,928,600
3. Brazil	1,242,073
4. Ethiopia	406,174
5. Morocco	392,000
6. Peru	314,596
7. Colombia	230,000
8. Pakistan	200,000
9. India	195,710
10. Argentina	185,501

95% of donkeys globally are kept for work (Starkey and Starkey, 2000; Lunn and Stringer, 2014). Of perhaps greater concern is the finding that 99% of the world’s equine vets treat less than 10% of equids globally.

**AN OVERVIEW OF HUMAN DEPENDENCE
ON WORKING ANIMALS**

As an example, it is estimated that between 5 and 20 people depend on every working equid (McKenna, 2007) with the animals supporting between an estimated

TABLE 12.7
Species Population by Country

Camels	
Country	Value
1. Chad	7,285,309
2. Somalia	7,222,181
3. Sudan	4,849,003
4. Kenya	3,338,757
5. Niger	1,788,149
6. Mauritania	1,479,648
7. Ethiopia	1,210,663
8. Mali	1,192,900
9. Pakistan	1,100,000
10. Saudi Arabia	485,926

300 million (Reed, 2011) to 600 million people globally (McKenna, 2007) and all working animals 1 billion people.

Working animals contribute to livelihoods, benefit whole communities, national economies and to global health through five identified capita – namely: human capital, financial capital, physical capital, natural capital and social capital, all of which are considered livelihood assets (Randolph et al., 2007).

These are described as “the livelihoods framework”, Figure 12.3 (Carney, 1998), and in summary include:

Human Capital

- Access to health care and schools
- Reduction in human physical load and labour
- Relieving female physical burden, freeing time for other household or income-generating activities and child care (Valette and Upjohn, 2014)

Pritchard (2011 and 2014) found that working donkeys contributed to the lives of women, children and other vulnerable groups by increasing labour effectiveness in the household, freeing up more time for other activities contributing to social, human and financial capital including childcare, attendance at women’s groups, taking part in local politics and diversifying household incomes.

Natural Capital

- A working equid as a natural resource
- Transport of small ruminants and animals to health care posts
- Providing draught power for agricultural work
- Providing manure for fertilizer and milk, meat and hides for use or income
- Easier access to water

Rahman and Reed (2014) highlighted that in 50 developing countries, containing half of the total human population of the world, there is a heavy dependence on draught animals as an energy source. They described draught animals as being used to plough approximately 120 million hectares of farm land in India, representing 60% of total cultivable area; and that working animals are used for agricultural operations in 52% of the cultivated area of the world as well as for hauling over 250 million vehicles (i.e. ploughs, carts).

Physical Capital (Figure 12.2)

- Pack &/or cart movement of agricultural and livestock products to/from the market
- Value chain to provide service to agriculture, industry, etc.
- Taxi services, carting goods or being rented, providing an income for owners
- Transporting water and fodder for other livestock

It is estimated 1 billion people depend on livestock for food and income (World Bank, 2009; FAO, 2011) and that 95% of these farmers live below the poverty line and rely on animals to survive (UN Resources for Speakers on Global issues, Rural Poverty in the Developing World, 2016).

A study in Sudan introducing animal traction technology found that it resulted in improved farming efficiency (increased cultivation area by 128%), reduced drudgery, increased income (including off-farm activities such as selling livestock, renting carts) and living conditions. It also led to positive environmental outcomes (minimised water loss and soil water erosion, improved soil fertility). Participants had better nutrition and started earning enough money to buy luxury items such as clothes, shoes, medicine and leisure items, for example, bikes, radios. They could even invest or save some money for the future (Bello and Muneer, 2008).

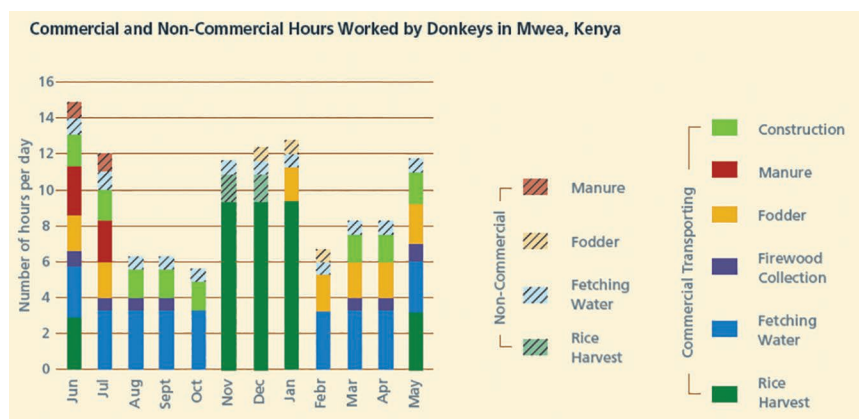


FIGURE 12.2 Average working donkey hours. (From: *Invisible Workers* Brooke, 2015.)

Financial Capital

- A working animal is a natural asset and can be a commodity
- Income generation through direct use or hire
- Indirect income through transportation of goods and people
- Savings – time, labour
- Access to loan or credit

In a survey in Ethiopia, all households said equine animals were economically important (rural/urban and all wealth levels). The average household net return from equine ownership and use was 4419 ETB (USD 330) per year. The income from the equines accounted for 14% of total income. (Admassu and Shiferaw, 2011). Gebre-Selassie (2004) demonstrated that equines provide a lifeline for 85% of Ethiopians who live in rural areas and depend on subsistence farming to make a living and produce enough food to survive.

In Mali (Doumbia, 2014), the monthly income generated by donkeys was over £100 for 33.3% of owners, £100–£300 for 46.7% and over £300 for 20% suggesting 66.7% of owners earn more than £100 a month, which is significant for their survival.

Social Capital

- Increased social status
- Strengthening social
- Development of community projects, that is, school building
- Facilitating access to social groups
- Providing a source of bride wealth

Martin-Curran and Smith (2005), and Valette and Upjohn (2014) identified that the lending of animals in times of need such as during ploughing and harvesting seasons improved relations and social standing of individuals within extended families and benefitted sustainable community livelihoods (Figure 12.3).

CLIMATE PROTECTION

Whilst such capita confirm the benefit of working animals to individuals and to communities, it also provides evidence of wider national economic benefits and environmental protectionism. Van Dijk et al. (2014), identified that agriculture is the main source of livelihoods for 2.5 billion people with working animals providing a key source of power in terms of both production and distribution. Cerutti et al. (2014) stated that animal-drawn machines were potentially the only option in hilly areas of developed countries, where constraints to mobility and working operations are frequent for motorised vehicles. Campbell and Knowles (2011) highlighted that 75% of the world's traction energy is provided by working equids.

From a simple power perspective, and as an example of the immense indirect benefit of working animals, the draught animal power (DAP) of India's 100 million draught animals is estimated to be equivalent to 40,000 megawatts of electric

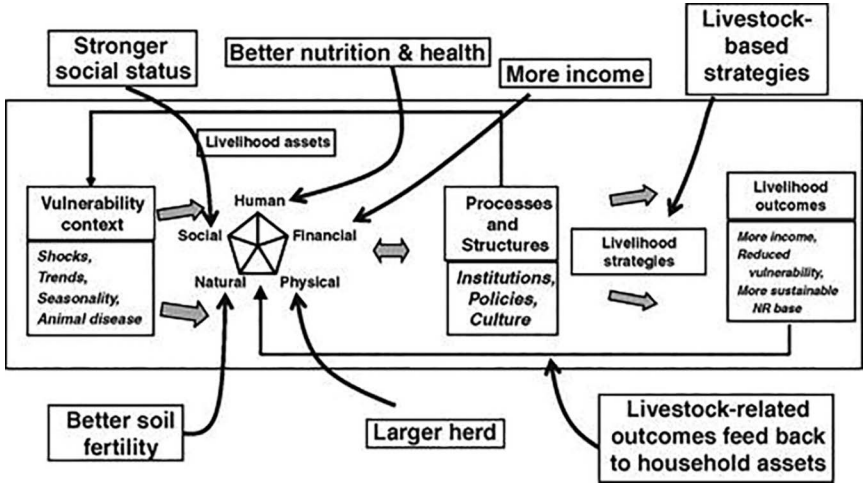


FIGURE 12.3 The Livelihoods Framework. (From: Sustainable Livelihoods Framework Carney, 1998 with contributions of livestock to strengthening the asset base. NR=natural resources.)

TABLE 12.8
Differential Power Produced by Draught Work

Animal	Typical Weight (kN)	Pull-Weight Ratio	Power Output (W)	Energy Output per Day (MJ)
Ox	4.5	0.11	450	10
Buffalo	5.5	0.12	520	9.5
Horse	4.0	0.13	500	18
Donkey	1.5	0.13	200	3
Mule	3.0	0.13	400	8.5
Camel	5.0	0.13	650	14

power. This is calculated to be equivalent to half the present power generation capacity of India (Rahman and Reed, 2014), with the power output ranging from 200 W for a donkey to over 500 W for a buffalo (FAO, 2000) (Table 12.8).

The positive influence on climate change was further suggested by Rahmen and Reed (2014) that with an estimated 400m draught animals, the supply of power to agricultural production systems, would save power equivalent to around 20 million tonnes of petroleum per year.

Given that climate change forms a substantial threat to the livelihood of small-holder farmers already affected by the increased variability of annual rains (Van Dijk and Pritchard, 2014) by enabling both on-farm and off-farm income, working

animals can reduce the agricultural risks associated with climate change-related weather patterns (FAO, 2011).

For example, they can lead to better yields and larger cultivation areas compared to working the land by hand and owners can earn non-farm related income from renting out animals and by transporting goods (Van Dijk and Pritchard, 2014). Furthermore, with an increasing expectation of the negative impacts of climate change on natural resources, water scarcity is expected to increase and lead to a higher demand for working animals to transport water over longer distances. Working animals then are a clear asset in this regard, especially donkeys, which appear to have a significant drought survival advantage over cattle (Van Dijk and Pritchard, 2014).

Lastly, as highlighted in *Natural Capital*, working animals are considered a renewable energy source. They play a role in avoiding and reducing carbon emissions. For example, the use of horse manure instead of fired bricks for production of bio-fuel and for building materials; and in the removal of carbon dioxide enhanced through composting and use of manure for fertilisation and improvement in soil structure.

A study by Cerutti et al. (2014), showed that animal traction had better environmental performance versus mechanical traction (when measuring the quantity of produce and area of cultivated land). They showed that animal traction reduced the environmental impact, and importantly produced more goods/cultivated land for the same amount of emissions (e.g. 311.30 kg of wood per 1 kg CO₂, vs 79.64 kg using mechanical traction). Whilst the extent to which working animals contribute to reduced carbon emissions due to the burning of fossil fuels is currently unclear; and whilst direct evidence is lacking, it is fair to say the implication is implicit (Van Dijk and Pritchard, 2014).

WOMEN

Although *Human and Social Capital* highlight the positive benefits of working animals, and especially donkeys, on female empowerment, it is appropriate to further highlight the important interactions.

It is estimated that two-thirds of poor livestock *keepers* (approximately 400 million) are women (FAO, 2009) and that working animals significantly ease the workload for women (Carr and Hartl, 2010; Van Dijk et al., 2014). For example, in Pakistan, women who have a donkey cart can bring wood and fodder home in 1 hour and 30 minutes whilst it takes 4 hours for women who do not have a donkey. Donkey carts can transport a whole month's worth of firewood in a single day, whereas women who carry wood on their heads have to fetch it every day. This leads to reduced stress and fatigue (Pritchard, 2011), a sense of improved security (Martin-Curran and Smith, 2005) and allows more time for child care (Valette and Upjohn, 2014). Owning working animals also improves social standing (Valette and Upjohn, 2014) and provides an entry point to income-generating activities (Stringer et al., 2014).

Seventy-seven percentage of women in a study across Kenya, Ethiopia, Pakistan and India put horses, mules and donkeys in the first position when asked to rank livestock. They were ranked first by 91% of groups for their role in helping with household chores (Valette and Upjohn, 2014). Eighty percentage of women in the study had a say in the purchase of livestock and 50% reported the decision was mutually agreed. All women interviewed said they were caregivers for working equids and use them for household chores, income generation and social events (despite a frequent assumption that they only deal with small livestock). Ninety-seven percentage of women used working equids for income generation. This income enabled them to join social groups requiring payment of a monthly contribution which can then be made available by the women in times of need (e.g. through loans or payment for important events). When a woman is not able to pay her financial contribution to the group, it results in her and her family's status being lessened in the community.

Despite this and importantly, women have little or no access to education and training on equine health and welfare, including husbandry practices and diseases.

LACK OF RECOGNITION AND DATA

Although the arguments for recognition of value both economically and socially appear to be significant and for many people dependent upon them overwhelming; working animals do not appear in most national agricultural or rural transport strategies and policies.

National statistics for example, on numbers of working animals, which inform FAOSTAT and other international databases, often do not exist or need to be more accurate (Van Dijk et al., 2014; Stringer et al., 2014). Their visibility is described, especially for working equids, as being *close to zero*. Pritchard (2014) and Brooke (2015) have both valuably explored the contributions of working equids to building the asset base of poor communities but point out that data on the socio-economic contributions to livelihoods and national economies are grossly inadequate. Furthermore, they note that what is available generally appears in the grey literature, and is largely unavailable to policymakers.

Indeed few studies evaluating the contributions of livestock to national economies have acknowledged the lack of attention to draught power animals. The Intergovernmental Authority on Development (IGAD) in Eastern Africa, which published a series of reports between 2010 and 2012 on the contribution of livestock to its member states' economy stated:

None of the reports in this series – on Ethiopia, Kenya, Sudan or Uganda – has been able to obtain sufficient information to reliably estimate the economic importance of animal power. IGAD should consider introducing a region-wide programme of work on the prevalence and economic value of animal power usage in IGAD countries, a subject that is chronically neglected by both academic research and government agricultural monitoring systems.

(Behnke and Nakinya, 2012).

Furthermore, individual animal species research is even more scant; in its report on Kenya, IGAD also noted: “There is material (...) on working equines, but there is not enough information in these sources to quantify the economic benefits of donkey usage.” (Behnke and Muthami, 2011)

Effectively working animals are rarely acknowledged as a specific group and are not usually addressed through livestock interventions, which tend to prioritise production animals. It is sometimes assumed that working animals are of secondary value, even if their labour is essential for household income and the survival of other livestock (Valette and Upjohn, 2014) as highlighted. As a result, they are also absent from other important livestock-related sectors such as education, research and health including both animal health and human health. They are, therefore, frequently not included in disease eradication and vaccination campaigns, and despite many working animal and equine diseases featuring on the OIE notifiable disease list, and indeed include zoonoses, these diseases are not included in government disease surveillance systems. Equine specific drugs are rarely available and the lack of attention to equine welfare is reflected in the training of vets and paravets which rarely includes an equine element (Stringer et al., 2014; Valette and Upjohn, 2014).

Due to this, working animals are invariably not included in commonly used qualitative and quantitative livelihoods indicators. The qualitative benefits of working animal use are well recognised by the animal owners and their families. However, there is very little evidence of the monetary value versus human labour, which means that groups that use working animals may not be aware of the impact of those animals on their income. (Van Dijk et al., 2014). As a result, there is little movement in national governments to either include the animals in modern legislation or provide enforcement of existing legislation, or internationally advocate and lobby for recognition.

Example: In Bo-Chang, Botswana 2017 SPANA reported “multiple instances and examples of animal welfare compromise and cruelty over a prolonged period of time resulting in multiple deaths identified at an abattoir trading in donkey skins.” Each individual example was described and documented that they “could and would be potentially referred to a court of law under the Cruelty to Animals Act (Chapter 37:02)” (Figure 12.9). In the inspection, hundreds of animals were found dead due to malnutrition and 452 were eventually euthanased due to neglect.

Acting under the current legislation the abattoir owner was eventually fined 50 pula, or the equivalent, at the time of writing, of £3.20. This was due to legislation being both non-existent and out of date, with the last writing of the Animal Welfare Act dated 1965.

THE UNITED NATIONS AND SUSTAINABLE DEVELOPMENT GOALS (SDGs)

It is important, when considering the contributions of working animals, to recognise the interconnections between animal welfare and other disciplines in

support of global sustainable development. The role of veterinary teams, health workers, research and academics, and of course policymakers in society must be encouraged.

In evidencing the contributions of working animals to human health and human empowerment, the ‘One Health, One Welfare’ approach is consistent with the United Nations Sustainable Development Goals in animal-related areas. In 2015, the adoption of 17 SDGs by the United Nations created a broader scope than the Millennium Development Goals (MDGs), with more detailed targets and indicators across three key areas: economic growth, social inclusion, and environmental protection. These SDGs looked to build on the considerable success of the previous development agenda but also make good on its shortcomings; that the role of working animals can and should play a significant role.

Specifically and ambitiously, it intended to help “build economic growth and address a range of social needs including education, health, social protection and job opportunities, while tackling climate change and environmental protection”. In addition, it aimed to provide a platform for integrated analysis of human health, livestock health and economic welfare in livestock dependent communities whilst also addressing female equality, environmental protection and climate action, education and responsible consumer use and production.

By expanding One Health into One Welfare, veterinary professionals, policymakers and agricultural leaders can make more explicit the recognition between the interconnections of animal welfare, human well-being and the environment.

In strengthening animal health systems through training and capacity building of government-employed veterinarians, expansion of current policy and legislation, and in implementing welfare standards, the activities serve to enhance the recognition and protection of this valuable workforce.

This represents a significant step forward in the implementation of animal welfare standards and policies, with the aim of integrating animal welfare with other relevant areas for the benefit of all, whether they are dependent upon working animals or not.

THE SDGs

The SDGs represent a collection of 17 global goals designed to be a “blueprint to achieve a better and more sustainable future for all”. The SDGs, set in 2015 are intended to be achieved by the year 2030, are part of UN Resolution 70/1, the 2030 Agenda.

There are 169 targets for the 17 goals. Each target has between 1 and 3 indicators used to measure progress toward reaching the targets. In total, there are 232 approved indicators that are intended to measure compliance (UNSC, 2015). The basic 17 goals are:

1. No Poverty
2. Zero Hunger

3. Good Health and Well-being
4. Quality Education
5. Gender Equality
6. Clean Water and Sanitation
7. Affordable and Clean Energy
8. Decent Work and Economic Growth
9. Industry, Innovation and Infrastructure
10. Reducing Inequality
11. Sustainable Cities and Communities
12. Responsible Consumption and Production
13. Climate Action
14. Life Below Water
15. Life On Land
16. Peace, Justice and Strong Institutions
17. Partnerships for the Goals

Specifically, the importance of working animals and especially working equids to the SDGs can be demonstrated through a number of examples:

STRENGTHENING LIVELIHOODS SDG 1 (NO POVERTY), SDG 8 (DECENT WORK AND ECONOMIC GROWTH)

Achieving sustainable change where development needs are greatest and resources most scarce, involves complex partnerships and variable approaches. As an important part of this process, animal welfare supports strong and resilient livelihoods.

- In Mali, it was found that the income of two-thirds of donkey owners was more than three times the average monthly income per capita of US\$55.
- In Mexico, income generated just through working animals in farms studied was equivalent to 30% of the minimum daily wage, plus an additional saving from their use for daily chores and transport that would normally incur a cost (Arriaga-Jordan et al., 2005).
- In Ethiopia, rural households studied demonstrated a significant reliance on working equids for income and employment, with related earnings contributing on average 14% of total family income (Admassu and Shiferaw, 2011).
- Kandpal et al. (2014) demonstrated that in India, the construction industry showed that equid-based income opportunities generated 80% of income and that in India, Pakistan, Kenya and Ethiopia, highlighted that the rural communities ranked working equids as their most important livestock, due to their capacity to provide and support regular income generation.

ACCESS TO VITAL RESOURCES: SDG 3 (GOOD HEALTH AND WELL-BEING), SDG 6 (CLEAN WATER AND SANITATION)

Across the world, millions of people, mainly women and girls, spend up to 200 million hours per day collecting clean water (UNICEF, 2016). Livestock production is also dependent on ready-to-access to water. The simple act of animals carrying water reduces the time required to access it.

- In Tunisia, 80% of respondents to a survey in remote and mountainous regions relied on their donkeys or mules to access and carry freshwater (SPANa, 2018a).
- In Mauritania, access to clean piped water is scarce. In the city of Nouakchott, water carriers use donkeys to carry 400L of water at a time supplying the majority of households and businesses (Ouassat, 2006).

Healthy animals also support healthy lives, promoting well-being at all ages by enabling access to medicines and healthcare facilities.

- One Tunisian survey reported that 90% of respondents use income generated by working animals to afford medical treatments (Ouassat, 2006). Where distance or terrain are barriers to healthcare, in particular for the sick, elderly or pregnant, working animals are often the only source of transport to access appropriate services.

Where human and animal populations live in close proximity, increased veterinary standards and consideration for animal health and welfare represent significant mutual benefits and can contribute to reducing the incidence of direct or vector driven zoonotic disease transmission (ICWE, 2019).

BUILDING RESILIENCE: SDG 2 (ZERO HUNGER), SDG 8 (DECENT WORK AND ECONOMIC GROWTH), SDG 13 (CLIMATE ACTION)

Strong working animals build resilience. The extra income generated through working animals allows people to save money, reinvest in growth and fund access to education (Geiger and Whay, 2016). As an alternative to agricultural vehicles, where such items are expensive or impractical for terrain, their ability to transport goods increases the potential for wider community access to quality nutrition through local food markets.

- 93% of the income of Ethiopian farmers and 100% of the income of Mexican farmers who sold milk and crops, depended on the presence of working animals (Geiger and Whay, 2016).

Working animals are often the most valuable asset that some rural communities own and, therefore, require the largest expense to replace. Climate change and extreme weather events pose a considerable threat to marginalised communities as the loss of working animals can contribute to reductions in agricultural productivity and food security. The

impact on by-products, such as manure for fertilizer, and decreased draught power can also increase financial pressures, where alternatives require additional expenditure.

- In India, extreme weather events such as flooding and cyclones have left communities vulnerable as the loss of working livestock restricts their access to resources and, therefore, the capacity to rebuild their livelihoods (APOWA, 2019).

Many working animal species are well suited to arid zones, supporting livelihoods and increasing the ability of agricultural-dependent communities to adapt to climate change. As an energy source, working animals also offer a mitigating contribution when compared to engine power (Rahmen and Reed, 2014). Protection and consideration of this valuable workforce within national disaster risk reduction strategies helps ensure community resilience and sustainability in the face of climate change.

PRODUCTIVE FARMING SDG 2 (ZERO HUNGER), SDG 12 (RESPONSIBLE CONSUMPTION AND PRODUCTION)

As well as increasing productivity by reducing time and labour in farming, working animals enable farmers to reach markets from otherwise inaccessible areas. This ensures farmers can turn their crops to cash, while allowing the community to access diverse food sources. Without these animals, transporting goods from small-scale production directly to point of sale, or nearest collection point for traders, would be extremely difficult. By promoting local infrastructure, resource efficiency and access to services, working animals support sustainable production.

- One study of Mexican farms, reported that working animal power was valued at US\$500 per farm annually (Brooke, 2014a).

In some countries, many working animals such as equids are also farmed for meat or milk. Ensuring good practices for rearing, transporting and slaughtering animals can help create a better quality product for human consumption and contribute to a more responsible production process.

EMPOWERING WOMEN SDG 5 (GENDER EQUALITY)

Healthy animals empower women. Evidence shows women often rely on working animals to do tasks they would otherwise have to perform themselves. By enabling women to be economically active, they also increase their community status and personal resilience. This economic capability can prevent the worst forms of destitution for lone women (Geiger and Whay, 2016), whether working in rural or urban settings. In some of the world's most marginalised areas with

women-headed households, working animals offer the most affordable source of draught power, providing livelihood support and opportunities to explore otherwise restricted economic, natural and social resources.

- In Senegal, young women are being trained in what were traditional roles designated for men, for example, farriery, and are able to earn a living with their new skill set (Brooke, 2014).
- In India, training women to act as change agents for communities has led to female-led equine welfare groups being set up (Brooke, 2014).

Women's participation in animal health and welfare training sustains knowledge transfer and improves community attitudes towards equids, while also creating a social support structure.

ENABLING EDUCATION SDG 4 (QUALITY EDUCATION)

Caring for animals enables education for children. By providing additional income and undertaking labour tasks otherwise done by people, working animals release children from household work to attend school and help parents care for them at home. They can also be the only available mode of transport in some of the world's most remote and rural communities (Geiger and Whay, 2016). In Costa Rica, outlying communities rely on working animals to access primary and secondary education; transport would be impossible without the use of their horses (CREW, 2018). Improved access to education has far-reaching benefits, including improved literacy rates, gender rights and equality alongside greater economic mobility.

Where agriculture is the main means of livelihood, access to education can provide theoretical and practical skills within this growing sector. Relevant skills-based learning and training, such as veterinary care and welfare science, can also help improve awareness and productivity. The member-led advocacy and regional initiatives of the International Coalition for Working Equids (ICWE) have led to the inclusion of animal health and welfare in the primary curriculum in some parts of the world where coalition members work. These skills and trainings need to be mainstreamed into every community which is dependent on working animals for their livelihoods.

- In Kenya, basic equine welfare is now taught at primary level in many schools, and in Senegal, there are an increasing number of apprenticeships in equine health focussed subjects such as farriery (SPAN, 2019).
- Humane education programmes to promote positive prosocial behaviours including compassion for animals, environmental protection and social justice are also accessible, meaning that education professionals with an International Certificate in Humane Education (ICHE) can transfer knowledge to mainstream settings (SPAN, 2019).

Education can also empower owners and sustain productive benefits. Once trained, people can share welfare-friendly practices within their communities and generate income with newly acquired skills. Practical programmes offer solutions such as properly fitting packsaddles for animals, made using cheap, locally available materials or foot care to prevent animal lameness. In turn, these generate ongoing training opportunities and the development of sustained knowledge transfer, spanning age and gender.

**WORKING TOGETHER FOR THE WELFARE OF PEOPLE AND WORKING ANIMALS
SDG 17 (PARTNERSHIPS FOR THE GOALS)**

To improve the lives of people, it is essential to improve the lives of working animals; they boost the income and resilience of many of the most vulnerable communities. However, poor health and welfare, and overwork can compromise their positive impact. An Ethiopian study (APOWA, 2019) showed that 54% of equids were thin, 93% had body lesions from poor handling and 60% were lame.

Collaborative and mutually beneficial interventions for human and animal well-being are key to supporting sustainable change. Capacity-building projects conducted in partnership across developmental sectors, such as solar-powered borehole construction to benefit nomadic pastoralist communities in drought-prone Turkana, Kenya (SPANAs, 2019) demonstrate how action to ensure reliable resource provision not only supports a human need but also enables healthy animals to maintain their contribution to sustainable livelihoods.

Each of the SDGs can be demonstrated in multiple areas of the world, but as an example, specific recognition in single countries in one geographical area can be found:

Country - Tunisia: Region - Siliana: Example of baseline survey findings in support of SDGs

Sustainable Development Goals	Contributions of Working Animals
 End poverty in all its forms everywhere Related targets include eradication of extreme poverty; reducing the proportion of people living below the national poverty line; equal rights to economic resources and access to basic services and reducing the vulnerability of those exposed to climate, economic, social and environmental shocks.	• Working animals were directly linked to the incomes of 45.9% of those surveyed. • The income generated by working animals pays for basic services including food, housing, education and healthcare • Income generated allows for savings, increasing resilience to shocks and stresses • People use their working animals to travel to and from their place of work

(Continued)

Sustainable Development Goals


End hunger, achieve food security and improved nutrition and promote sustainable agriculture

Related targets include ending hunger and malnutrition; improving agricultural production and sustainable and resilient food production.


Ensure healthy lives and promote well-being for all ages

Related targets include increasing access to health services to reduce infant and maternal mortality; preventable child deaths; reducing disease and reducing the number of road traffic accidents.


Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Related targets include universal access to pre-primary, primary and secondary education; improving vocational skills, including non-formal adult education and training; increasing the number of youths and adults who have relevant skills for employment; and equal access to education for all.

Contributions of Working Animals

- 98.5% of those surveyed spent the income they generated on food for people
- Working animals allow the transport of goods to market, diversifying and improving nutrition
- Working animals are used in agricultural and food production activities
- Most local people cannot afford machines for agricultural tasks or they are not suited to the land
- 90.3% of those surveyed spend the income generated from working animals on medicines for people
- Potential to reduce the incidence of zoonotic diseases through better veterinary care
- Equines transport people to health care services
- Half of owners surveyed spent their income on education
- Working animals transport people to schools and other education facilities
- SPANA trains veterinary professionals increasing their skills and knowledge
- Community training could potentially introduces skills relevant to people's employment that depends on working animals
- Specific vocational training courses in services such as farriery could increase employment opportunities for local people

(Continued)

Sustainable Development Goals



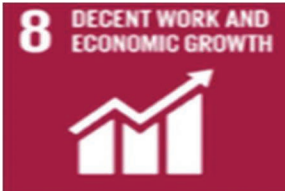
Achieve gender equality and empower all women and girls

Related targets include the promotion of gender equality and the empowerment of all women and girls at all levels.



Ensure availability and sustainable management of water and sanitation for all

Related targets include ensuring safe water and sanitation for all. To substantially reduce the number of people suffering from water scarcity



Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Related targets include promoting sustained economic growth; improving resource efficiency in production and consumption and productive and decent work for all



Ensure sustainable production and consumption patterns

Related targets include the efficient use of natural resources, promoting sustainable and productive practices

Contributions of Working Animals

- Working animals reduce the time women spend on essential daily household tasks
- Women that own their working animals have a significant financial asset and the potential to generate their own income
- 79.4% of people surveyed used their animals to carry water
- Piped water is not available in most homes and people cannot collect water without donkeys
- Working animals were directly linked to the incomes of 45.9% of those surveyed.
- Income generated by working animals contributes to the region's economy
- Healthy working animals increase production in the areas they work
- Working animals increase productivity by reducing time and labour
- Working animals collect wood to be used as a sustainable fuel source

INDIVIDUAL AND COMMUNITY EFFECTS

Whilst much of the preceding argument and presentation highlights the Total Economic and Socio-economic Value of working animals in providing direct and indirect income to subsistence and livelihoods, there are arguably additional benefits to animal ownership beyond those typically outlined in the SDGs where tangible output data can be collected in evidence of their change or impact.

While One Health initiatives traditionally focus on threats to human and animal health, such as zoonoses and a secure food supply, or in promoting the greater use of working animals in improving health; they have not typically promoted an understanding of the many additional beneficial physical and psychosocial impacts of human-animal relationships, and furthermore, how these can be leveraged to improve both human *and* animal health around the world.

The Centers for Disease Control and Prevention's definition of health is "a state of complete physical, mental, and social well-being." This definition includes not only physiological, but also emotional and social (behavioural and natural) states as are often described in the definition of good welfare (Fraser, 2009), and can be described as the "power of the human-animal bond", but how by leveraging this, it may be possible to motivate changes in behaviour that benefit both human and animal welfare (Wong and Kogan, 2013).

Indeed, it is well-recognized that where there are poor states of human welfare there commonly exist poor states of animal welfare, such as is found in countries or regions with emerging economies (Jordan and Lem, 2020).

Similarly, animals often act as indicators of human health and welfare, as can be seen in the link between animal abuse and family violence. Given the surprising findings by the University of Bristol that human violence and domestic violence against women was socially acceptable and widespread in developing countries, with 36% of people believing it is justified in certain situations combined with a lack of data on animal instances of abuse or violence, it is likely animal abuse is common and welfare is poor.

In promoting, via humane education &/or community engagement, the understanding of animal sentience and acceptance of all animals as an important motivator for positive behaviour such as self-responsibility and a positive sense of self, structure and routine (Lem et al., 2013) wider improvements in human health and global compassion can be promoted.

CHALLENGES

As discussed, the value of working animals is not only in the animal itself but to the people who rely upon them and by extension, to nations. Poor working conditions faced by such animals and prevalence of injury or disease adversely affect their health and productivity, which, in turn, has negative consequences for their owners' well-being and wealth (Figure 12.4, Rushton, 2009). As such, animal welfare and human welfare are innately connected and especially evident in the context of livelihoods. Owing to the impoverished situation of these animals and

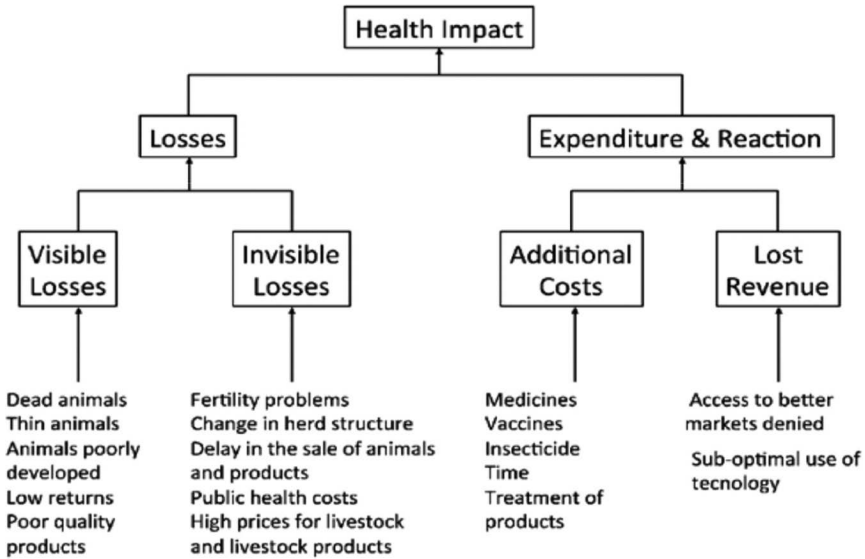


FIGURE 12.4 Animal Disease Impacts. (From: *The Economics of Animal Health and Production*. Rushton, 2009.)

their working in harsh climatic and/or terrain and environments, the health and welfare of these equines is a cause for concern (Pritchard et al., 2005).

The apparent invisibility of the animal populations to policymakers, professional bodies and to law enforcement agencies means that the health, welfare and the basic and universally accepted five domains or freedoms are not addressed or of low priority. Equally, through this same lack of recognition, development of either professional recognition and service infrastructure, in development by veterinary surgeons, and/or para-professionals as well as in general public education means their welfare is invariably unconsidered and as a result poor.

Pritchard et al. (2005) highlighted a number of welfare issues found when evaluating working equids and such evidence has been mirrored in multiple project findings across equid and working animal projects in developing countries as well as in other species (camels, oxen, elephants) used for work (SPANA, 2019). It was also identified that work type, whether in urban or rural environments, commercial or domestic, resulted in similar welfare compromises although frequency and severity varied dependent upon seasons and whether they were used by owners or under rental.

Figure 12.5, demonstrates the approximate distribution of clinical cases spread chronologically through 2019 in SPANA led clinics in Mauritania and represent equids only.

The individual clinical cases presented throughout the same year identified a very typical welfare picture (Figure 12.6) and are similar in other countries, for example, Mali (Figure 12.7) and Zimbabwe (Figure 12.8).

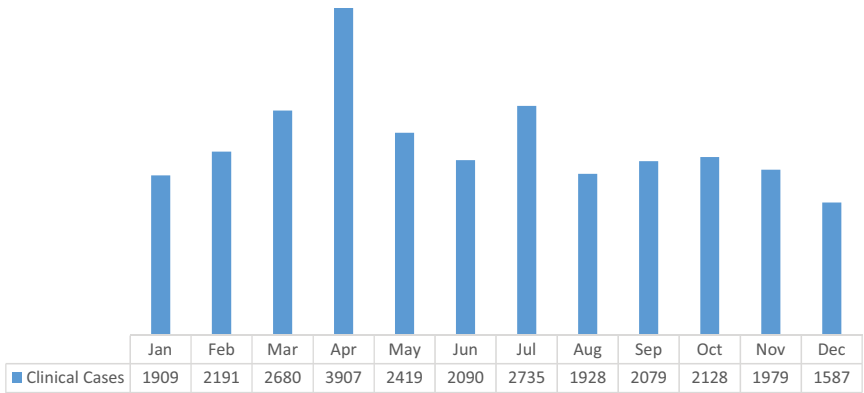


FIGURE 12.5 Approximate distribution of clinical cases of equids spread chronologically through 2019 in Mauritania.

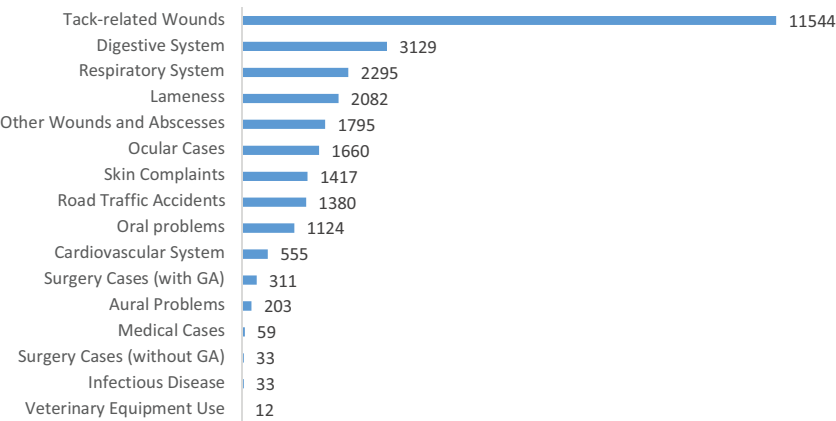


FIGURE 12.6 Individual clinical issues chronicled in Mauritania in 2019.

The primary presentation of tack related injuries is very typical (Pearson et al., 2001) and reflective of the work undertaken by the animals in both domestic and commercial uses where there is reliance on draught power, using carts or simple saddles to carry various loads including people. In addition, inappropriate materials used often are ill-fitted to the animal and on animals often with a poor body condition score (Pritchard et al., 2005) with reduced muscle cover making injury more likely. Training and understanding of cart and harness production, and fit is often lacking and repairs are often temporary and piecemeal (Authors observations).

In such situations, improper harnessing, overloading and overworking are often observed (Kumar et al., 2014). In a study conducted in Ethiopia by Biffa

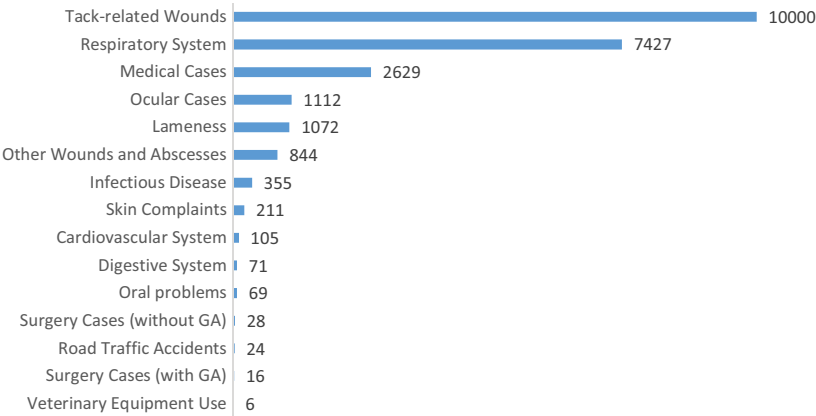


FIGURE 12.7 Individual clinical issues chronicled in Mali in 2019.

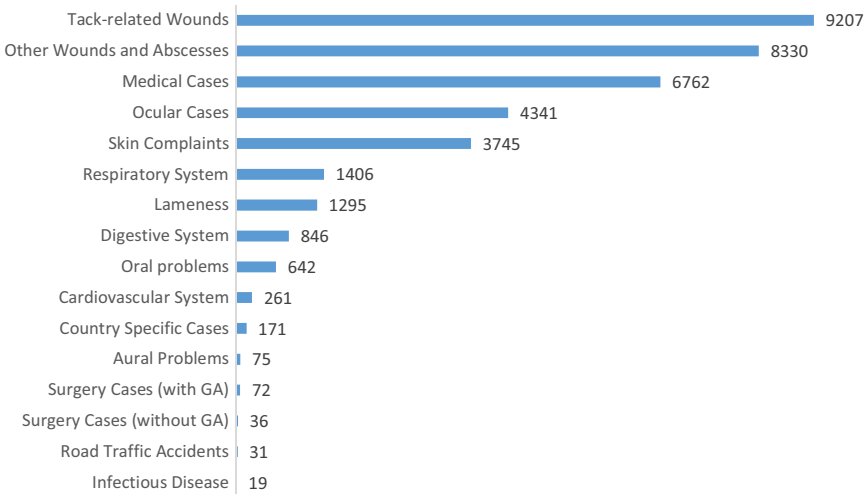


FIGURE 12.8 Individual clinical issues chronicled in Zimbabwe in 2019.

and Woldemeskel (2006), 28.7% of the donkeys were overworked and overloaded, and 26% of the donkeys suffered from external injuries due to improper harness and saddles. Due to this combination, it is expected that fatigue (Pritchard et al., 2005), reduced productivity and ultimately longevity (Smith and Pearson, 2005) are all affected.

Lameness, respiratory disease, ocular issues, medical and digestive presentations are commonalities (Figures 12.4–12.7) and are again associated with the typical nature of work, lack of understanding regarding health needs including rest breaks, food and water; the terrain encountered, tack used on animals (i.e.

inappropriate blinkers), and feeding practices including allowing forage in plastic debris or feeding on general refuse.

Further, use of goads and whips to provide direction to animals tacked improperly, often also without bits or reins, and by those without an understanding of animal sentience and indeed pain, leads to the findings of multiple and variable wounds. It is also not uncommon for animals to experience multiple welfare problems suggesting that comprehensive health, management and welfare promotion programmes are important to alleviate problems (Kumar et al., 2014).

Measurement of welfare is difficult in clinics and by assessors, and various indicators are included in a potential assessment (Lindberg et al., 2003). Whilst a recent introduction of Animal Welfare Indicators (AWIN) improving on-farm feasibility and the use of electronic tools to achieve standardised data collection is recognised (Costa et al., 2016), the ability to undertake and overcome knowledge gaps, introduce and use specific evaluation tools presents challenges in assessment and providing evidenced documentation

Potential common underlying endemic issues including infection, heat stress, general fatigue, and learned helplessness also make some evaluations (of welfare) difficult, including depressed attitude, response to approach and response to contact of the chin. The emergence of indicators such as facial pain (Gleerup et al., 2015) however, may better enable in-field assessors to evaluate evidence of welfare compromise and/or changes.

Use of log frame evaluations incorporates desk-based reviews of existing external and internal data sources; participatory interviews with owners and key stakeholders; and specific animal-oriented surveys (DFID, 2017) allowing the development of both individual animal welfare data as well as information on herd status and potential underlying causes (Shaw et al., 2006).

Utilising such techniques has confirmed welfare issues such as low body condition score, endo- and ectoparasite infestations, mouth problems, skin lesions, limb deformities and gait abnormalities are identified globally in for example Africa, the Middle East, Central Asia and Central America (Burn et al., 2008; Getachew et al., 2008a, b; Broster et al., 2009; Burden et al., 2010).

They have also confirmed deficiencies in owner knowledge regarding topics such as wound management, watering and nutrition requirements, appropriate shelter arrangements and/or access to essential resources such as hard feed, grazing land or veterinary services have further been highlighted in developing countries in Africa, the Middle East and Central Asia (Wells and Krecek, 2001; Curran et al., 2005; Oussat, 2006; Pearson and Krecek, 2006; Shelima et al., 2006).

Indeed, Kumar et al. (2014) highlighted through owner interview, that the considered major constraints to donkey welfare, in decreasing order were, management problems (28.9%), harnessing problems (23.7%), overloading and over working (18.4%), disease and lack of veterinary service programmes (18.4%) and nutritional problems (10.5%).

Aside from identified welfare issues relating to work, owner knowledge and lack of legislative support means that animals are left susceptible to many endemic, and sometimes fatal, conditions both infectious and non-infectious.

In Ethiopia for example, a debilitating cutaneous condition, epizootic lymphangitis is prevalent in between 18.8% and 26.2% of the population of horses, almost all of which are working (Ameni and Siyoum, 2002; Endebu and Roger, 2003; Asfaw et al., 2012). The condition is both infectious and progressively severe often resulting in abandonment by people unable to afford treatment creating further opportunity for spread, and ultimately death of the animal.

In South Africa, the finding of equine piroplasmosis was identified on laboratory evaluation in serum identified seroconversion in upto 98% of horses for *Theileria equi* and 50% for *Babesia caballi* both of which may either cause overt disease or predispose to immune compromise (Motloang et al., 2008).

Furthermore, it is not uncommon for zoonoses (Table 12.9) to be found within the various working species posing a direct threat to human health (Tarazona et al., 2019) many of which are poorly understood by owners.

The importance of these conditions, both endemic and zoonotic, is reflected in the 2020 OIE list of notifiable terrestrial diseases (previous list Class A) many of which are included in both categories. Furthermore, due to the lack of supporting legislation and veterinary infrastructure regarding use of animals including in by-product production (milk, meat and hides); data collating and recording of disease status, zoonoses and notification of disease; many of these conditions are unreported and hence receive little direct control actions further compromising both animal welfare (and productivity) and ultimately human health, wealth and disease.

TABLE 12.9
Selection of Zoonotic Diseases *Potentially* Found in Working Animals

Zoonotic Disease	Organism	Main Reservoirs
Anthrax	<i>Bacillus anthracis</i>	Livestock
Bovine tuberculosis	<i>Mycobacterium bovis</i>	Cattle
Brucellosis	<i>Brucella</i> spp.	Cattle
Campylobacteriosis	<i>Campylobacter</i> spp.	Most species
Cryptosporidiosis	<i>Cryptosporidium</i> spp.	Cattle
Cysticercosis/Taeniasis	<i>Taenia</i> spp.	Cattle
Equine encephalomyelitis	<i>Togavirus</i>	Horses
Glanders	<i>Burkholderia mallei</i>	Horse, donkey, mule
Leptospirosis	<i>Leptospira</i> spp.	Ruminants
Listeriosis	<i>Listeria</i> spp.	Cattle
Q fever	<i>Coxiella burnetii</i>	Cattle
Rabies	Rabies virus and other lyssaviruses	Cattle, horses
Rift Valley fever	Rift Valley fever virus	Cattle
Ringworm	Dermatophyte fungi	Many animal species
Salmonellosis	<i>Salmonella</i> spp.	Most species
Streptococcal sepsis	<i>Streptococcus zooepidemicus</i>	Horses

Source: from Tarazona et al. (2019).

The wider and potential global implication is alarming, especially in view of climatic and environmental change predisposing to spread. Glanders was identified in Germany in 2014, West Nile Fever in France in 2015 and more recently African Horse Sickness was seen for the first time in Thailand in 2020 (Gov, 2020). Whilst these are not directly associated with legislative failure of country of proposed origin, with disease notification and control measures lacking an increasing number of infections, both in animals and humans, seems highly likely.

EMERGENT AND ONGOING CHALLENGES

THE DONKEY SKIN TRADE

Without doubt the livelihoods of millions of people across the developing world depend on the services of working animals such as donkeys. In many countries, donkeys are synonymous with daily life and have significantly contributed to sustainable development. People rely on donkeys for income-generating activities, for transport and draught power to increase agricultural productivity and for carrying water or other goods.

Demand for a product *Ejjiao*, made from the boiling of donkey skins has soared in recent years as an increasing health conscious and ageing Chinese population has grown. *Ejjiao* manufacturers claim the substance has many health benefits, including reducing wrinkles, curing anaemia, boosting energy, enhancing libido and shrinking tumours. However, there is little scientific evidence to support these claims (Leithead, 2017). Although accurate figures for the demand of donkey skins for the production of *Ejjiao* are difficult to obtain, research by the University of Reading, suggests that an estimated 4.8 million skins were required to meet the 2016 production rates of 5,600 tonnes of *Ejjiao* (Bennett and Pfuderer, 2019). Donkeys have low reproductive rates and are notoriously difficult to breed and as a result, the majority of these skins are now sourced from outside China. A spokesperson for one of *Ejjiao*'s largest producers, Dong-E-E-Jiao, confirmed that China imported 3.5 million donkey skins in 2016 (China Daily, 2015). However, the illegal nature of some of the trade means that it is difficult to accurately assess the amount of donkey skins entering China each year. What is known, however, is that China's domestic supply of donkeys has reduced from 11 million in 1992 to 4.6 million in 2017 and demand for skins is impacting on donkey populations globally. Estimates, at the time of writing, suggest the extinction of donkeys as a species within 10 years at the current rate of demand.

As a direct result, Dong-E-E-Jiao has struggled to meet demand, stating a 'lack of interest' from farmers in raising donkeys and has increased its *Ejjiao* prices 16 times in the last decade (China Daily, 2015). Because of a lack of skins and concerns over profit, the company has also partnered with food producers and catering companies to also launch donkey meat products.

Without sufficient regulations and legislation, donkey theft, illegal cross-border movements, inhumane slaughter and inadequate carcass disposal are of increasing

concern. Further concerns regarding the impact of the trade on donkey populations, livelihoods and disease spread have led to many countries taking action. Nineteen countries including Burkina Faso, Mali, Niger, Kenya and Uganda for example, have all banned the export of donkey products to China (TDS, 2019).

Where the trade is legal, it has become large, complex and unregulated. Monitoring the welfare of donkeys or tracing the source of skins is not occurring posing significant concerns for biosecurity and the risk of disease.

Impact of the Trade

Donkeys entering the trade, both legally and illegally are often subjected to mistreatment, poor transport standards, starvation and inhumane slaughter. However, the impact of the trade extends far beyond the welfare of donkeys, significantly affecting the owners and users of these animals, communities, and the environment and raising concerns for biosecurity.

Animal Welfare

At every stage of the process, the Ejiao trade severely compromises the welfare of donkeys. Donkeys including pregnant mares, young foals and sick and injured animals are loaded roughly onto cramped, dangerous vehicles and eventually brutally killed (Oxpeckers, 2017). They are commonly taken on long journeys, across borders, on over-packed trucks, with no access to water. Because the skins of donkeys are easier to remove when the animals are thin, they are often left to starve while awaiting slaughter (Figure 12.9) (SPAN, 2019). These welfare compromises regularly arise as a result of the legal trade, but the consequences of the illegal trade on donkey welfare are significantly worse. Surviving donkeys in regions affected by the trade also face consequences as donkey numbers fall within communities, the increased burden of work falls on those that remain.



FIGURE 12.9 Emaciated donkey awaiting slaughter Botswana (SPAN, 2019).

This causes animals to be overworked and overloaded, leading to an increase in preventable injury and exhaustion.

Environment

Donkey abattoirs have had a significant impact on the surrounding environment. Without adequate monitoring and regulation of existing legislation to ensure their proper disposal, hundreds of donkey carcasses from, for example, the Bo-Chang abattoir in Francistown, Botswana were dumped in makeshift pits (SPANA, 2019). Fluids escaped into the Tati River affecting those communities downstream in Francistown dependent on the river's natural resources (Figure 12.10). Without the inclusion of equids in adequate legislation they do not face the same guidelines for humane and hygienic slaughter as other livestock species. This can also result in a risk that donkey skins are contaminated with disease-causing agents during the slaughtering process, posing further environmental and public health risks.

A largely unregulated international trade in donkey skins is also hypothesised that it could lead to severe impacts on biosecurity and the spread of disease, including the spread of zoonotic diseases. In 2019, outbreaks of respiratory disease were reported across West Africa resulting in the death of donkeys on a mass scale. Whilst the precise source of the outbreak is unknown, the World Organisation for Animal Health (OIE) suggested it was caused by the “illegal movement of animals” (OIE, 2019) in a region known for live trade routes and the illegal smuggling of donkeys (Oxpeckers, 2019). With the movement of live animals across borders, there is a potential for such an outbreak to occur in other regions, further decimating the donkey population and impacting human health and well-being.

Livelihoods

Donkeys support communities by providing a means to generate income, and make vital contributions to sustainable development and contribute to global



FIGURE 12.10 Dumped carcasses at Bo-Chang Botswana (SPANA, 2019).

development objectives including the UN's Sustainable Development Goals (UN, 2019).

Donkey owners often cannot raise the capital to purchase a new donkey if their animal is stolen. As droughts increase in frequency and intensity globally, animals are straying further from home in search of food and water. In doing so they become increasingly vulnerable to theft and illegal trafficking. The trade in skins represents short-term economic gain, disregarding the long-term value of these animals.

Links to Other Criminal Activity

There is sufficient evidence that the trade in donkey skins is linked to wider criminal activities including illegal wildlife trade. Donkey skins are being sold on online platforms offering prohibited products including ivory, pangolin scales and tiger skins (TDS, 2019). The trade has also reportedly been linked with drug cartels in South America (Laverdad, 2017), and terrorism in Afghanistan (NatGeo, 2017). Links to these wider criminal activities demonstrate a disregard for international and national laws and contribute towards the destabilising of social security in vulnerable developing countries.

ANIMAL HEALTH ISSUES

In the preceding discussions, it will be noted that many areas of both health and welfare overlap and that in support of One Health the impact of these is not only on animals but on people and the environment.

In brief summary these individual areas include:

Transboundary and Emerging Diseases for example anthrax and Coronaviruses are associated with unregulated movement and mixing of immunologically naïve animals and people predisposing to various infectious diseases. In recognition of the 2019–2020 global Covid pandemic, many consider such diseases to be the greatest economic threat to animals and humans worldwide (Ward et al., 2020).

Insect Borne Diseases for example African Horse Sickness, first identified in Thailand in 2020 (Reuters, 2020), is evidence of the potential impact of climate change and global warming with the movement of carrier animals, intermediate vector hosts, aligned to poor disease surveillance and control measures with immunologically naïve animals. The entry of such diseases in new regions predisposes great risk to the animals and people reliant upon them, in the case of Thailand, whilst the working equid population is relatively small, the nature of such outbreaks predisposes further spread to neighbouring countries such as Cambodia where populations are much larger and the impact would be hugely significant.

Food Safety and Veterinary Public Health for example spread of zoonoses such as Salmonella and *E. coli*, or of food or product contamination by contaminants dangerous to human health chromium, lead, mercury,

arsenic or indeed adulteration to include products not listed in ingredients lists such as bovine product in equid produced materials (Xinhua news, 2016) is a consequence of lacking or poor legislation, or inadequate enforcement regarding appropriate control of animals, storage and care of animal products and disease testing and notification systems.

Antimicrobial Resistance: Antibiotic resistance is estimated to be associated with over 700,000 human deaths annually (O’Neil, 2016). Although the ability to source and fund use of antibiotics in developmental areas is often difficult and research on resistance in animals is largely absent, evidence of human resistance is identified to common antibiotics such as amoxicillin, penicillin and sulfamethoxazole/trimethoprim (Tadesse et al., 2017) making common treatment of pneumonia and urinary tract infections increasingly difficult. Whilst overuse of antibiotics in working animals has not been confirmed the again general absence of legislation and monitoring regarding veterinary and agricultural acts has the potential to predispose to a worsening situation.

ACTIONS TO HELP WORKING ANIMALS

APPLICATION OF ECONOMICS TO WORKING ANIMAL HEALTH AND WELFARE

Whilst production animals and animal products are included in agricultural GDP and are significant in many developing countries, the inclusion of working animals is conspicuous by its absence in financial summaries. Their importance as a source of rural employment and generator of economic activity (Jones, 2003, Gordon, 2001, Admassu and Shiferaw, 2011) is undeniable and the sector is certainly significant enough, in many countries, to compete for resources across the wider economy and provides significant goods and services through its many activities.

The importance and health of working animals and especially of equids, therefore, remains critical to underpinning the economic prosperity and stability of many people (Upton, 2009; Rushton and Redmond, 2015).

These are somewhat reflected in the acceptance that achieving the UN SDGs by the 2030 timeline but this is largely promoted by western NGOs rather than acceptance within developing countries and reflected in the typical poor data collections and updated or even existent legislation. Furthermore, the associated costs of poor governance reflected in the increasing emergence of zoonoses, transboundary diseases, insect-borne diseases and antimicrobial resistance are currently not possible to include in the overall calculations. The wider effects of loss of social standing, increased gender equality and pay differentials, and mental health consequences are incalculable.

Despite this, the advocacy actions of NGOs either led individually by organisations such as SPANA, or collaboratively through for example the International Coalition for Working Equids (ICWE) is vital in raising awareness both of the importance of the animals and of the impact on people, animals and in the wider economy and environment if it is not recognised.

To deliver such information the development of in-country monitoring and evaluation systems needs to be achieved (Upjohn et al., 2014) alongside modern legislation and enforcement. It has been suggested (Brooke, 2015) that working equids could or should be redefined as “livestock” so that they could be included in livestock policy and programmes which tend to be more advanced. If not then working animal sector-*specific* policies in transport, agriculture, rural development, and construction should be working animal and equine welfare friendly and incorporate their roles and subsequent needs including end of life scenarios, slaughter options and use of direct products.

Awareness raising and political lobbying for example undertaken by NGOs, SPANA and the Brooke in 2019 resulted in a ban by the Kenyan government on all donkey skin trading including products. Whilst this does not represent an inclusion of donkeys into national GDP, it reflects an acceptance by the government of the importance of the animals to the country population and represented a small step in greater inclusion in general legislation.

STRENGTHENING OF VETERINARY SYSTEMS (NEW MARKET OPPORTUNITIES, AND BETTER REGULATORY PREPAREDNESS)

The inclusion of working animals in livestock policy and programmes would necessitate greater visibility in undergraduate curricula and post-graduate and para-professional inclusion in workplace activities. Social research can confirm the economic value of animals not only measured by the food outputs produced and veterinary research can begin to highlight relevant diseases or areas of compromise and methods of improvement can be recommended.

Infrastructural developments to include national disease diagnosis and surveillance schemes including the provision of control measures such as vaccination policy would encourage long-term national herd health. The continued presence of several major endemic and epidemic infectious diseases highlights this long-standing weakness of veterinary infrastructure.

Additional inclusion of production data where animals enter either the food chain or product chain would provide further evidence of potential contributions of working animals and highlight the need to provide and promote sustainable development of the natural resource (Rushton and Redmond, 2015).

Where legislation is provided and professional involvement increases further associate industries may develop including feed manufacturers or para-professional skills such as farriery, dentistry and production of specialised agricultural equipment for working animals emerge with increasing value associated with the working populace.

IMPROVE HUMANE UNDERSTANDING AND OWNER KNOWLEDGE

Information to develop the understanding and application of One Health (Garcia, 2015) in the general human populous should include the design and content of

direct and indirect (informal) educational interventions that are aimed to increase the knowledge of working animal owners about the health and welfare of their animals (Stringer et al., 2011), and also highlight diseases that owners perceive as important requiring preventive interventions (Pradhan et al., 2010).

Morris (2014) highlights the importance of humane education as promoting “respect, compassion, and love” between all living things and also of *inter-relations* between humans and animals and as an important step into achieving long-lasting pro-social behavioural change in all.

Inclusion in general school children curricula, One Health subject matter and animal welfare being included in higher school and undergraduate studies should be of relevance to not only positively influence the health of working animal populations but also to lead generational behavioural change in benefit to other animal species and also to the global environment (SPANA, 2019).

IMPROVED POLITICAL AWARENESS

Intersectional weakness including poor governance both nationally and internationally promotes the many issues seen in working animals (Mellor, 2016). Animal welfare compromises, predisposition to endemic disease, knowledge deficits, emergency and disaster vulnerability, transboundary and emergent disease, etc. are consequences of poor-aligned international recognition. OIE member states and UN councils should adopt and encourage the 2030 SDGs, the OIE standards of Welfare, and the OIE recommendations for animal welfare and professional teaching to promote working animal values, One Health policy and develop an economic base for long term improvement.

COLLABORATIVE NGO WORK

The partnering of NGOs to build lasting collaborations with the government promotes sustainability or process. This often means advocacy and the sharing of collected data to provide appropriate interventions or guide policy brief is necessary. Individual NGO actions, limited by financial resource or expertise, can find increased presence and acceptance of their actions and recommendations where collaborative work is undertaken. The International Coalition for Animal Welfare (ICFAW) for example is an accepted partner to the OIE and can directly influence agendas. Within the umbrella of ICFAW, the combined NGOs of SPANA, the Brooke, World Horse Welfare and the Donkey Sanctuary have aligned as ICWE and via this collective group allows a strong ability to provide information, lobbying and feedback to member states and individual governments and programme leaders alike. Without such collaborative efforts, it is likely actions by the NGOs would be lost or vastly reduced.

Where views are presented and documented in influential organizations such as the OIE, the ability to reconcile the multiple values of working animals and to engender a greater political commitment to working animal welfare and One Health is enhanced and longer term collective progress can be made.

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13 Cow Shelters

Animal Welfare, Human Well-being and the Environment in an Indian Context

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INTRODUCTION

The philosophical beginnings of concepts of animal welfare, quality of life and more broadly, an inclusion of animals in our moral sphere in the West, started with intellectual debate a few centuries ago by great thinkers such as Voltaire, David Hume and Jeremy Bentham, all of whom commented on the moral and ethical place of animals in our society (Jordan 2005). More recently, notable turning points that shaped modern views on animal welfare include the first rudimentary animal

protection laws, the formation of the first societies for the protection of animals and subsequently the formation of the Brambell Committee in 1965 to create the “Five Freedoms” (RSPCA (Australia), n.d.; Duncan, 2006; Keeling, Rushen and Duncan, 2011). For the last decade, the One Health concept has increasingly provided a framework across industries and organisations, to promote the health of humans, animals and the environment through a multidisciplinary approach. One Health has been endorsed by the United Nations, the OIE (World Animal Health Organisation) and the World Bank and it is now universally accepted that the health of human populations is linked with the health of animals and the health of the environment, each depending on the other (García Pinillos et al. 2016). Eventually, this concept was extended to human and animal welfare by Colonius and Earley (2013) and the term “One Welfare” was coined. While traditionally the health of humans or animals has always been treated as separate to their welfare, they argue that this separation is an artificial compartmentalisation; both disciplines affect each other and can be quantified using similar scientific measurements. Over the years, the two concepts have been increasingly integrated, creating a more holistic approach to finding tangible improvements to the physical and emotional well-being of human communities and the animals they interact with, as well as building the resilience of the environment they live in (OIE (World Health Organisation for Animal Health) 2017).

In contrast to the Western story of the animal welfare movement, the Indian sub-continent’s relationship with its animals stems from a completely different historical background. While in the West, both science and ethics have only in contemporary times turned their attention to animal welfare and animal-protection laws as we use them today, Indian legislation is not the direct result of the relatively modern movement for animal welfare. Hence it is a particularly interesting study from a scientific and ethical standpoint. An understanding of these deep philosophical and political roots gives context to the unique belief systems in this region and their particular relationship with animals and their welfare. This belief system has resulted in an abhorrence of the killing of cows, a negligible beef industry in a country with the largest cattle population in the world and the only country in the world that has large-scale, institutionalised preservation of dairy cattle past their productive life, in shelters commonly known as “gaushalas”.

This chapter first explores the interplay of complex cultural, religious, social and political factors that led to the phenomenon of the sacred cow, the ban on its slaughter and the advent of the modern gaushala. It then discusses the ethical dilemmas of gaushalas within the context of One Welfare, highlighting conflicts of interests between stakeholders, limitations of the One Welfare approach and practical solutions that veterinarians can implement in the face of these conflicts, using Preston’s ethical model in an effort to reconcile these dilemmas.

THE INDIAN GAUSHALA—A HISTORICAL AND CHRONOLOGICAL PERSPECTIVE

The oldest evidence of cattle assuming any kind of symbolic role can be traced back to the temples and friezes of the Mesopotamian Civilization, which is thought to have influenced the Indus Valley Civilization and in turn, the Aryans, who

descended from the northwest. By 1500BCE the Aryans had written a large body of literature – the Vedas, considered the original sacred scripture of modern-day Hinduism. These Vedic writings demonstrate not only the pastoral and economic importance of cattle but in equal measure their ritualistic and sacrificial role. By the end of the Vedic period (800-600 BCE), the metaphoric, literary and figurative cow of the Indus Valley had slowly transformed into a literal object of sanctity, to be protected and revered in its own right, especially for its role in supplying milk to a society growing in size and complexity. Emerging sects like Jainism and Buddhism added to the already present concept of inviolability of animals, by introducing the philosophy of ahimsa (non-violence). Buddha's message spread great distances during the rule of King Asoka in the 2nd century BCE and for a time, ahimsa or non-violence became the law of the land. Animal-shelters and cow-homes (gaushalas) emerged all over the country giving official religious sanction to the protection of cattle and increasing restrictions on their slaughter (Lodrick, 1981, 2005; Parel, 1969; Batra, 1981; Korom, 2000; Simoons, 1973). For the next ten centuries, the region saw a continuous invasion by foreign cultures, starting with the Mughal invasions from the 11th century. The cow, already a centrepiece of Hindu philosophy, became a rallying point between the invading beef-eating culture and native communities. Nationalistic sentiment continued to grow during the period of British occupation, from the mid-18th to mid-20th century. Many violent Hindu-centric movements gained momentum, some of which still retain a right-winged cow-centric political agenda today. (Lodrick, 1981, 2005; Korom, 2000; Bajaj and Srinivas, 2004; Kothari and Mishra, 2002).

It was against this backdrop of strong nationalistic emotion mingled with religiously charged sentiments that India gained independence as a secular country in 1947. The first Constitution of India was drafted, and contained an Article recommending that the States make their own enforceable laws (Ministry of Law and Justice, n.d.; Barak-Erez, 2010; Chigateri, 2008; Kang, 2003):

The State shall endeavor to organise agriculture and animal husbandry on modern and scientific lines and shall, in particular, take steps for preserving and improving the breeds, and prohibiting the slaughter, of cows and calves and other milch and draught cattle.

Gradually State laws came into effect all over the country and several prosecutions followed, mainly against cattle buyers and sellers, hide merchants, butchers and other such stakeholders in the cattle industry. To this day, ample instances of vigilantism by self-proclaimed cow protectors, biased court prosecutions and blocking of cattle slaughter and transport licenses (Simoons, 1973; Barak-Erez, 2010; Kang, 2003) are regularly seen in media reports. Alleged cattle traders and their families continue to be abused, beaten in public and murdered (Kateshiya, 2016; Human Rights Watch, 2017). The issue remains emotionally charged and its significance has surprisingly increased relative to the pace of urbanization, modernization and increasing education or affluence levels. Mainstream Indians maintain a strong repulsion to the production and consumption of beef and celebrate cow-centric festivals such as Govardhan Puja and Gopashtami (Lodrick, 2005; Batra, 1981; Alavijeh, 2014). This protects the major role of milk and milk products in the Indian diet.

THE MODERN GAUSHALA'S ROLE AND ETHICAL DILEMMAS OF THE BAN ON COW SLAUGHTER

The Report of the National Commission on Cattle (Lodha, 2002) determined that there were three thousand gaushalas in India, maintaining over 600,000 cattle; Khanna (2012) puts the countrywide estimate even higher, at around four thousand gaushalas. There is a dearth of comprehensive studies on urban animal health in India (Singh et al., 2013), and it is difficult to find a true estimate for country-wide numbers of stray cattle or true numbers of gaushalas. Most gaushalas are inextricably tied to the dominant Hindu religion: many are directly associated with temples or religious institutions. These, and those that are not directly associated with religious association, actively encourage rites, rituals and celebration of cow-centric festivals. Gaushalas often see an increased influx of cattle and small ruminants rescued from ritual slaughter during Muslim festivals. Either out of veneration or fear of a backlash from activists, villagers abandon unproductive or debilitated animals to the streets, rather than sell or slaughter them. These cattle then remain as stray or get picked up by neighbouring gaushalas to live out the remainder of their lives in relative shelter (Lodrick, 1981; Batra, 1981; Singh et al., 2013; Yadav, 2007).

- A. *Public/Animal Health*: Many State laws are explicit in declaring that veterinarians cannot advise or perform euthanasia of cows on humane grounds or for reasons of public/animal health (example: Government of Maharashtra, 1988). This has a significant impact on veterinarian's response to debilitating diseases, such as Brucellosis, an endemic zoonotic disease in Indian cattle, sheep, goats, pigs, buffalo and humans. Conditions of intensive housing and frequent movement of cattle are particularly conducive to the spread of this disease. In the dairy industry, infection leads to infertility and loss of calves/milk. It is estimated that one abortion can cost as much as Rs. 5,000 or USD100 (Renukaradhya, Isloor, and Rajasekhar, 2002); however, the true cost to a producer is likely higher, when taken into consideration the loss of milk, loss of a calf and depreciating value of the cow herself. In recent years the dairy industry has seen intensification as a result of increasing demand for dairy products. This has led to the desired increase in milk production but also in Brucellosis, most specifically in intensively kept herds. In addition, most veterinarians and agriculturists agree that breed improvement will never be properly established unless inferior and infected animals are taken out of circulation and only superior quality animals are preserved for further breeding (Simoons et al., 1979). The inability to cull sub-standard stock creates a barrier in this process and ultimately detracts from the economic viability of dairy farming. Isolating Brucella and Tuberculosis positive cattle through intensive screening of animals in the gaushalas is required to prevent the spread of these diseases to gaushala workers and consumers (where such animals are still

lactating). However, maintaining a Tuberculosis and Brucella positive stock as a separate herd presents ethical and logistical constraints due to the ban on slaughter. Active screening of dairy cattle for Brucellosis and Tuberculosis is absent even in the majority unorganized dairy sector of the country and rarely done in gaushalas. Biosecurity controls are lacking in most gaushalas and in few of them, merely isolating individual sick animals within the premises is the most that are done (Sharma et al., 2019b).

Ethical Dilemma: On one hand the industry is rapidly adopting the western model of intensive, economically driven mass production of milk. On the other hand, not being able to cull infected animals or improve breed selection means that it is virtually impossible to control or eradicate the presence of significant zoonotic diseases in Indian herds, which is not only a financial burden and health risk to farmers and shelters but of significant cost to the animals' welfare. In addition, an ethical conundrum veterinarians and animal care staff face regularly, is not having the choice to opt for humane euthanasia in cases of severe debilitation or illness. In only a few States is there a process of application to a committee of representatives from local administration and animal welfare organisations. The committee then gives a formal recommendation for euthanasia on humane grounds; however, it is fraught with political and religious nuances and is not likely to be a straightforward process.

- B. *Economic and Welfare Impacts of Wandering or Marginal Cattle:* Most cows and bulls, once they are past their economic usefulness, are released to wander free rather than sold. Owners are afraid to sell these animals to non-Hindus, as it may lead to their slaughter (Simoons et al., 1979; Batra, 1981). Much debate exists over the public and animal health implications of these cattle. Marginal or abandoned cattle in India suffer from significant malnutrition and injury from traffic accidents as a consequence of roaming urban streets. Many forage for food in exposed garbage dumps, consuming large amounts of plastic bags that contain discarded human food. They cannot expel these bags, which remain trapped inside, rendering the animal unable to eat and slowly starving to death (The Plastic Cow Project, 2012). Estimates suggest that the number of stray cattle in the capital city of Delhi alone is close to 20,000 (Singh et al., 2013).

Ethical Dilemma: The cost of preserving the lives of cattle, based on a religious belief, amounts to significant compromise of both the health of abandoned animals and their welfare. Furthermore, through zoonoses, resource competition and road traffic dangers, abandoned cows can have a detrimental effect on human health and welfare.

- C. *Economics of Losing Beef Meat as a Source of Nutrition:* Simoons et al. (1979) cite several studies trying to determine the quantity of beef and other by-products from dead cattle that go unrealized in India. Dead cows are often buried or cremated, providing fertilizer for the land, but

no consumable product. In the 1960s, when India experienced severe drought and famine, the issue of unproductive cattle competing for resources with humans for scarce resources sparked the interest of several ecologists and anthropologists from around the world. Surplus cattle clearly compete with humans for land and resources, cause substantial damage to crops, and impede breed improvement, cause soil erosion from overgrazing and are a wasted resource of beef and leather (Yadav, 2007). Despite this apparent source of inefficiency in feeding the Indian population, a benefit to minority and marginal communities was identified, in that cattle were available to them for consumption at a low price, because of the absence of commercial beef enterprises (Simoons et al., 1979; Harris 1992). More recent journal articles and news reports (Chigateri, 2008; Kang, 2003) support this argument. The issue generated considerable debate from economic and husbandry specialists on both sides, and came to be known as the “sacred-cow controversy” in the literature (Lodrick, 2005).

Ethical Dilemma: The subject of using cattle for consumption is fraught with religious sensitivities and political tension; however, having such a large surplus of unproductive cattle surely leads to resource competition, due to a wasted source of nutrients, in particular, protein. Abandoned cattle can cause road traffic accidents. However, sheltered cattle can have better welfare than high output dairy cows, for example, because of less lameness (Sharma et al., 2019a), due to a better living environment and less pressure of high intake and output.

- D. *Animal Welfare Concerns for India's Surplus Cattle:* The concept of animal welfare is not understood throughout the world. Most western concepts of welfare revolve around animals' need for certain requirements for a life of good quality, quite separate from our responsibility towards them. There is a notable omission of any consideration of the preservation or “quantity of life”, for example, in The Five Freedoms or Codes of Practice. It is generally recognized that death is not relevant to welfare, unless it is painful. Yet from an Indian perspective, the sentiment and legislation reflect mainly the protection of the cow's life, rendering the terms “protection” and “welfare” not synonymous. Often cattle are sold clandestinely so as not to attract the attention of both lay observers as well as law enforcers (Simoons et al., 1979; Batra, 1981) and as a result, their transport, lairage and slaughter are driven underground. The condition in which these animals are kept, transported and handled remains completely unregulated. It is estimated that compared to 3,600 legal slaughter houses (for buffaloes, small ruminants and other commercial animals excluding cattle), there are 32,000 unlicensed ones (Chigateri, 2008) that are illegally slaughtering cattle for export or leather. Though it is difficult to get official data on this type of clandestine activity, studies of Bangladeshi abattoirs and livestock markets have found that many of the cattle were legally or illegally exported from India by trek, truck

or train (Alam et al., 2010; Ahsan et al., 2014). One estimate (Ahsan et al., 2014) puts the numbers at 1.7 million cattle exported annually, the majority of which are then slaughtered for meat production. Many of these animals show severe nose and tail injuries from inappropriate handling techniques, dehydration and metabolic exhaustion, as well as hyperthermia and death during transport (Alam et al., 2010).

Ethical Dilemma: Where the definition of animal welfare includes elements of animal rights or religious rights, regulation often falls short of being able to control animal management and husbandry, while successfully preserving animal life, as is seen throughout India. In this case, management practices are driven underground and unable to benefit from scientific progress and evolving technology that has benefitted Western countries. At the same time by banning commercial cattle slaughter, the legislation is preserving the majority sentiment of the Indian population, whether it stems from religion or simply compassionate concern. In contrast, in Australia the majority of people do not support the live export of animals due to serious concern for their welfare (Sinclair et al. 2018); however, the legislation has failed to take these sentiments into account, and live export continues into the present day.

- E. *Gaushala Management Inadequacies:* Gaushala management often grapples with an inadequacy of skilled labour, financial constraints and lack of veterinarian support (Kennedy, Sharma, and Phillips, 2018). Their herds, already a product of being culled from a productive population due to debility, age or disease, often suffer from malnutrition, further leading to reproductive disorders like anoestrous, repeat breeding, uterine infection, cervicitis, pre and postpartum vaginal prolapse, retention of placenta, dystocia and mastitis (Kothari and Mishra, 2002; Yadav, 2007). A cross-sectional study of 54 gaushalas across India highlighted the different challenges faced by gaushalas as compared with dairy units in the West. A 14% mortality rate was seen across gaushalas, which, although higher than those seen in the West cannot be directly compared due to the different demographic of cattle in gaushalas. The authors' experiences have shown that the Cow Comfort Index in gaushalas was low compared to the recommendations, due to insufficient space, little to no pastureland, poor ventilation and hygiene and compromised biosecurity (Sharma et al., 2019b). Considering that the animal interacts with its environment by direct contact with surfaces such as floors, walls, columns, and doors, inadequate or unhygienic housing can generate significant welfare compromise and discomfort. Insufficient space per animal is a very common problem for housed animals (Tarazona, Ceballos, and Broom, 2020). Most gaushalas in India do not provide any bedding material for their animals, and animals are most often resting on concrete or dirt surfaces (Sharma et al., 2019b). Scarcity of fodder that can be used as bedding material, limited manual labour for cleaning of sheds, and lack of knowledge about the welfare benefits of bedding

are some of the reasons for the absence of bedding provision in most of the cow shelters (Sharma et al., 2020). However, international guidelines encourage bedding material since it absorbs moisture, adds resiliency, makes the stall more comfortable, and reduces the potential for injuries and mastitis (Cook, 2002). Conversely, the general temperament of most cattle in gaushalas was seen to be docile with low avoidance scores comparable to those in Europe. This is likely reflective of healthy stock-person attitudes and animal handling, especially in a largely unproductive cattle population that would not need daily handling due to milking (Sharma et al., 2019b). We also found that the cleanliness levels of cows were better than those observed in studies conducted in Europe (Whay et al., 2003; Popescu et al., 2014), once again likely reflective of the high labour input and positive human-animal interactions at many shelters. The authors have also observed that most gaushalas had some form of concrete flooring- either in the form of slabs, roller-compacted concrete or paver blocks (Figure 13.1).

Concrete floors, due to their unyielding nature have shown to cause more hock/knee injuries and claw lesions whereas sand, straw or sawdust have proven to be best for foot health, rumination and lying behaviour (Haskell et al., 2006; Cook, Nordlund, and Oetzel, 2004; Abeni and Bertoni, 2010). Regular wear of concrete floors over a period of time renders it slippery due to reduced friction, further causing lameness and injuries (Shearer and Van Amstel, 2007). It is widely accepted that optimal flooring conditions should include a clean, dry and soft lying area and slip-resistant walking areas (Bartussek, 1999; Abeni and Bertoni, 2010). Lameness is a major welfare concern in most dairy herds across the world (Whay et al., 2003). Our study of Indian gaushalas (Sharma et al.,



FIGURE 13.1 Concrete pave-block flooring at a gaushala in India.

2019a) found claw overgrowth and lameness scores to be significantly lower than those seen in the West; only 4.3% of all animals observed were found to be clinically lame, compared to 11%–22% cows in various systems across Europe (Coignard et al., 2013; Popescu et al., 2013). It is likely that floor abrasions, lower growth rates and high roughage diets fed to non-productive cattle leads to lower incidence of lameness and claw overgrowth, compared to the high energy diets that lactating cattle are typically fed in commercial systems. When tested for water run-off, the majority of sheds observed by the authors did not have enough gradient to facilitate this, increasing the chances of urine pooling during the course of the day, making cleaning regimes all the more important to reduce slipperiness and disease prevalence. Another factor that plays a significant role in cow comfort, lying time and incidence of laminitis is stocking density (Cook, 2002; Cook et al., 2004). The authors observed in several gaushalas, that it was standard practice to let multiple herds out to pasture in the morning, resulting in daily mixing of herds and variable stocking densities when animals were brought back to sheds at the end of the day (Sharma et al., 2019, 2020). Managers did not seem to think this an issue and claimed that most animals voluntarily went back to their own sheds. However, we observed anecdotal cases where animals were blocked off from the entrance to their sheds by groups of passing animals and re-grouping and mixing inevitably occurred, including separation of young from their mothers. Studies have indicated that the mixing of herds can destabilise an established hierarchy, increasing competition for resources, reduced lying and feeding for subordinate animals especially if the mixing also results in higher stocking densities (Talebi et al., 2014; Lobeck-Luchterhand et al., 2015). The practice of mixing also makes it hard to calculate stocking density accurately when it varies daily. Cattle have been shown to consume more water when it is offered *ad libitum* rather than intermittently, and when it is of superior quality and palatability (Meyer et al., 2004). Conversely, natural source (ponds) rather than troughs, thoroughfare locations of water source and inadequately sized troughs have all been shown to decrease water intake (Costa et al., 2013). The authors observed that most gaushalas did not offer *ad lib* water to animals and about half the water points observed were hazy or had the presence of algae/moss, very possibly leading to decreased water consumption and a compromise to welfare especially in times of increased water requirement (Figure 13.2).

Water intake may also fluctuate due to the daily fluctuation in stocking density and instability of herd hierarchy as mentioned above. Another risk factor is food deprivation, which can cause overeating or a change in frequency and length of eating behaviour - especially in subordinate cows (Abeni and Bertoni, 2010; Cook et al., 2004; Pempek, 2016). Since none of the herds we assessed were fed *ad-lib*, with some variation between gaushalas in quantity of feed given per animal, food deprivation is more likely to occur in some herds due to intermittent feeding, overstocking or pen design



FIGURE 13.2 Algae in a water trough at a gaushala in India.

causing social hierarchies and guarding behaviour, irregular feed delivery or sudden changes in diet. Indeed most gaushala managers freely admitted to changing the type of feed according to seasonal availability and market fluctuations. Tethering of cows in almost 40% of observed cow shelters further reduced ad lib consumption of water and fodder, and only fixed time consumption was allowed (Sharma et al., 2020).

Ethical Dilemma: While there is a significant challenge in providing sufficient and reliable resources in gaushalas, the human-animal bond seems to be consistently upheld; this is especially seen through surveys of gaushala managers and animal care staff (Sharma et al., 2020) and in the low avoidance scores of cows in gaushalas. In the west, “no-kill” policies are often applied to dog shelters. A UK-based charity, Dogs Trust states on their website (Dogs Trust, n.d.):

A non destruction policy is central to our ethos. We love dogs and we’re dedicated to saving those whose lives are at risk. Once a dog comes into our care, we treat him or her as we would a much-loved family pet. We’re a dog charity – we’re here to save dogs, not to kill them.

The appeal of such policies may lie in the fact that they take a purely moral stand, without giving in to economic or logistical arguments. The gaushalas of India are founded on similar moral arguments, and are largely looked upon with respect and admiration as pillars of moral, spiritual and religious principles. However, the emphasis on no-kill has resulted in perhaps an unintended lack of knowledge on scientific assessment of the quality of life. This may be compounded by the fact that gaushalas are largely unproductive enterprises, lacking commercial incentives and as a byproduct, have been overlooked by scientific and agricultural stakeholders for implementing strategies to improve animal health and welfare. Levels of knowledge and expertise on animal husbandry amongst gaushala workers also tend to be erratic and unsystematic, with many practices continuing in traditional ways as they have for centuries, not accounting for the changing needs of feeding, sewage and hygiene in the face of the rapid urbanization of the surrounding environments.

ONE WELFARE DECISION-MAKING USING AN ETHICAL EVALUATION TO GENERATE SOLUTIONS

A One Welfare approach requires that we address the welfare problems for cows in gaushalas alongside the welfare of people impacted by the gaushalas. This is an ethical decision, which should be informed by sound information on the welfare of cattle and humans associated with the gaushalas. The decisions on how to evaluate the ethics requires moral reasoning, which has four main elements: moral sensitivity – interpreting the situation for both cattle and humans; moral judgement – judging which action is morally right /wrong for both species; moral motivation – attributing moral values to members of the two species relative to other values; and moral character – having the fortitude to persist in addressing moral issues. The element most discussed is a moral judgement or reasoning. People generally draw on three moral guides (Verrinder, Ostini, and Phillips, 2016): personal interests, recognising norms, such as regulations, and universal principles, such as ‘do no harm to other living beings’. Under this sort of simplified schema, many people in Western society would be probably influenced more by personal interests than universal principles, whereas many people in Indian society would be more likely to give more credence to universal principles, including ahimsa, stemming from their predominantly Hindu religion.

Ethical review usually considers all stakeholders, though it must be recognised that not all have equal weight. Clearly, humans and cows are the two species affected. Most review systems consider both the welfare of all individuals concerned and their rights to life. One of the best is that devised by Preston (Smeak, 2014) and an evaluation of three options – maintaining the gaushala system, closing gaushalas and slaughtering cattle, and closing gaushalas but not slaughtering cattle – is presented in Table 13.1. This considers the five main stakeholders in the process – cattle in India, shelter staff, Hindu members of Indian society, road

TABLE 13.1
Preston's Ethical Evaluation Model Applied to Gaushalas in India

	Action: Maintain Gaushalas for Cattle in India			Action: Close Gaushalas, Implement a Cattle Slaughter System, as Used in Other Countries			Action: Close Gaushalas, Don't Implement a Cattle Slaughter System, as Used in Other Countries		
	Respect Life Desire to Survive √=Benefits, X=Harms	Respect Well-Being Capacity to Enjoy Life, Fulfil Goals and Capabilities √=Benefits, X=Harms		Respect Life √=Benefits, X=Harms	Respect Well-Being √=Benefits, X=Harms		Respect Life √=Benefits, X=Harms	Respect Well-Being √=Benefits, X=Harms	
Stakeholders									
1 Cattle in India	√ natural life preserved	√ cattle reasonably well cared for in gaushalas		X natural life not preserved	Dead animals have no well-being		X Hindu belief in respect for the life of cattle is not supported	X cattle underfed, not cared for	
2 Shelter staff	√ sustained by a job	√ job satisfaction		X no jobs	X no salary		X no jobs	X frustration	
3 Hindu members of Indian society	√ Hindu belief in respect for the life of cattle is supported	√ cattle reasonably well cared for in gaushalas		X Hindu belief in respect for the life of cattle is not supported	Dead animals have no well-being		√/ X cattle lives at risk of car accidents, death from underfeeding	X concerned because cattle underfed, not cared for	
4 Road users	√ cattle removed from streets	√ no added stress when driving		√ cattle removed from streets	√ no added stress when driving		X cattle not removed from streets	X Added stress when driving	

(Continued)

TABLE 13.1 (Continued)
Preston's Ethical Evaluation Model Applied to Gaushalas in India

Stakeholders	Action: Maintain Gaushalas for Cattle in India				Action: Close Gaushalas, Implement a Cattle Slaughter System, as Used in Other Countries		Action: Close Gaushalas, Don't Implement a Cattle Slaughter System, as Used in Other Countries	
	Respect Life		Respect Well-Being		Respect Life		Respect Life	
	Desire to Survive √=Benefits, X=Harms	Desire to Capacity to Enjoy Life, Fulfill Goals and Capabilities √=Benefits, X=Harms	Desire to Capacity to Enjoy Life, Fulfill Goals and Capabilities √=Benefits, X=Harms	Desire to Capacity to Enjoy Life, Fulfill Goals and Capabilities √=Benefits, X=Harms	√=Benefits, X=Harms	√=Benefits, X=Harms	√=Benefits, X=Harms	√=Benefits, X=Harms
5 Consumers	√ old cattle removed from agricultural areas	√ less feed used for sustaining unproductive cattle			√ Beef available	√ less feed used for sustaining unproductive cattle	X crops damaged by old cattle	X feed used for sustaining unproductive cattle
Utilitarian ethics	1				3			5
Rate actions 1–5 (1 = Greatest good for all affected; 5 = Least good for all affected)								
Justice as fairness	1				2			5
Rate actions 1–5 (1 = Fairest for most disadvantaged; 5 = Least fair for the most disadvantaged)								
Virtue Ethics/Integrity	1				4			5
Rate actions 1–5 (1 = most virtuous, consistent with values; 5 = least virtuous, least consistent with values)								

users and consumers (including non-Hindus in India and surrounding countries, particularly Muslims). Considering that cattle and Hindu members of Indian society are the majority stakeholders, in number and impact, a utilitarian perspective suggests that the system of gaushalas offers the greatest good for the greatest number. A Justice as Fairness appraisal also suggests that gaushalas are the most ethical choice because the most disadvantaged stakeholders are arguably the cattle. However, consumers and Hindu members of Indian society, some of whom are also a disadvantaged group in India, are likely to have better well-being. Hence this appraisal method positions cattle slaughtering as only just behind gaushalas. Finally, considering virtue ethics, respecting the Hindu belief in the preservation of the life of cattle, means that maintenance of gaushalas positions this option considerably ahead of the other two options. Overall, the maintenance of gaushalas seems to be ethically defensible by all three appraisal methods.

CONFLICTS OF INTERESTS AND CHALLENGES OF USING THE ONE WELFARE APPROACH

The One Welfare approach acknowledges that the lives of humans and non-human animals are integrally connected. However, it is evident that the connection is greatly influenced by the religious situation – the Indians choose to acknowledge reasonable longevity as being one of the rights of an animal that gives them so much. In Western society, cattle are killed when they are no longer worth maintaining alive, from an economic perspective. This has probably always been the case, except for a few old cows that were put out to graze by small farmers out of respect for their long life of producing milk for human consumption. Before the advent of modern herbage conservation techniques, cattle would be slaughtered before winter in colder climes, shortening their lives without question. In drought times Australian cattle farmers routinely slaughter their cattle because there is no feed available on the farm. It could be bought in, but because farming is for the most part a business, run by large-scale companies, and such expenditure is deemed unprofitable. Only the Eastern religions, Buddhism and Hinduism, respect the sanctity of the cow. Buddhists for the most part do not drink milk and eat a purely vegetarian diet, in the true sense of the word. They, therefore, avoid using cattle as sustenance for their society.

CONCLUSIONS

Although the nationwide ban on cattle-slaughter in India attempts to promote empathy and respect to the life of a cow, it simultaneously creates ethical dilemmas around economic and welfare impacts on both animal populations as well as human populations. From the viewpoint of One Welfare, the law creates a unique conundrum as it separates the concept of protection of life from the concept of welfare; the latter not being well explored or understood amongst stakeholders in India. There is a significant need for scientific exploration of the merits and challenges of preserving unproductive cattle, and the direct effect this has on the

quality of life of the animals, religious stakeholders, community members and the environment that they co-exist in. There is a lack of a systematic, replicable and quantifiable animal welfare assessment protocol as well as a lack of a holistic environmental and social impact assessment to guide stakeholders in balancing the needs of animals, society and the environment. It is our hope that our research will serve as a foundation for future study to ultimately help create benchmarks that drive gaushala management towards a more integrated and holistic approach in protecting and preserving not only the quality of life of animals in our care but building awareness of social and environmental needs in the future.

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14 One Welfare Approach to the Sea Transport of Livestock

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INTRODUCTION

As the world's population continues to rise, the global demand for major livestock commodities is expected to increase between now and 2050, and this must be met through safe sustainable food chains. Notably, much of the challenge needs to be met in Asia where 47% of the world's meat is currently consumed (including 27% in China) and consumption per capita is increasing (OECD/FAO 2018).

The export of livestock via sea transport is one way of meeting this demand, but currently represents an industry facing critical animal welfare scrutiny and significant ethical dilemmas spanning different cultures. Many stakeholders are involved, including the animals, farmers, exporters, consumers, regulators, veterinarians, stockpeople, and the public in both importing and exporting countries, some of whom have competing interests. Industry regulation varies between countries, and may involve standards, a risk management process, auditing, and training requirements, but not all are underpinned by law. Making decisions about animal welfare that impacts human populations in other countries is clearly very complex. In the context of live animal exports across the globe, moving all stakeholders to align with a One Welfare collaborative approach to improve animal and human wellbeing while considering sustainable ecosystems is crucial.

A One Welfare framework recognises the link between animal and human welfare, and environmental sustainability and is underpinned by the awareness that improvements in animal welfare are often correlated with greater food safety for humans (García Pinillos et al. 2016). Providing appropriate nutrition, housing, stocking densities and minimising stress throughout any transport journey, will ensure good animal welfare outcomes and increase the resilience of animals by decreasing their risk of disease. Thus, health and welfare are inextricably linked in livestock production; health refers to the state of being free from disease, while welfare incorporates aspects of their mental state, such as animal comfort and, being free from pain or fear. Animal welfare is a complex entity and may be better understood by the triangulation of three components: ethics (the *values* that people hold about how we should treat animals), science (the *evidence* of any welfare impact of our actions on animals), and law (the *regulations* that define what must or must not be done to animals) (Figure 14.1). Hence the trade of animals is

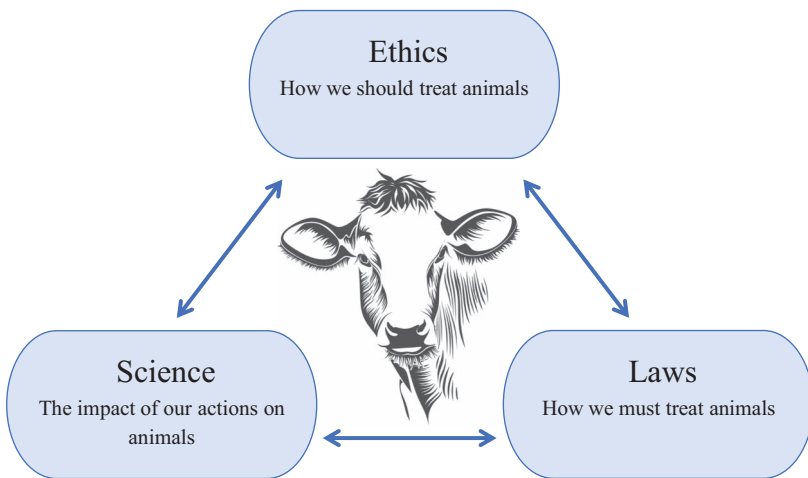


FIGURE 14.1 Animal welfare is multifaceted and with links to ethics, science and law.

particularly problematic as it involves a mixing of varied values and laws amongst a milieu of limited science. Ensuring appropriate standards of health and welfare are achieved, across borders such as those set by the World Organisation for Animal Health (OIE), remains the key challenge.

Trade is an inevitable part of human activity, but when it involves live animals, there are inherent risks for the animals, therefore, veterinary oversight should be mandatory. The veterinary role in the management and trade of livestock should be an integrative process acting at two levels: the individual and the global view. The daily management of the health and welfare of individual livestock often relies on stock-handler actions and the provision of appropriate feedlot and vessel resources, both of which can be underpinned by veterinary insight. In addition, the wider herd- or voyage consignment-health requires stewardship of resources, such as fodder and water availability, good preparation of animals for travel, and knowledge of the technical details of the trade and biosecurity agreements, which are all interconnected with human society. The veterinarian's expertise is needed as the animals' advocate within those integrated teams that link industry, government, and export companies. Knowledge of the far-reaching economic and social consequences of the trade, and importantly, developing animal welfare understanding in co-workers, will foster a common drive to raise minimum standards. With increasing global demand, the world's major food exporters have an opportunity to rethink their interests in maintaining an economically viable agricultural industry with the development of global animal welfare standards. As Australia is a leading exporter of livestock by sea and air, a nation that has contributed significantly to improving animal welfare in destination markets and one where animal welfare is a mainstream societal concern, this chapter focuses on the export of sheep and beef cattle from Australia by sea.

While cultural variation is present across the world, increasing public concern for animal welfare is evident in some countries. Significant societal interest in the Australian live animal export industry exists and there has been long-standing public calls for greater assurance regarding welfare outcomes and even cessation of the trade by sea, which has often been sparked by animal activists campaigns (Coleman 2018, Futureeye Pty Ltd 2018, Fleming, Wickham, Barnes, et al. 2020, Hampton, Jones, and McGreevy 2020). To address this, research regarding how animals are impacted by sea voyages, such as during periods of high heat load, and the need for accountability of livestock from farm gate to slaughter is required (Collins, Hampton, and Barnes 2018). As relationships between humans and other animals are complex and involve many stakeholders, the need for a moderate voice within an emotive field to identify the common ground is becoming increasingly more apparent. A veterinarian voice would be beneficial, especially as veterinarians have inter-disciplinary skills that are well placed to fill this role, to clarify animal welfare definitions and to provide leadership in a complex industry whose animal supply chains cross international borders. The Australian public has shown a growing awareness of farm animal welfare issues over the past 8 years and expects more effective animal welfare regulation to provide assurance that the live export industry is willing to change and be accountable

(Voconiq 2020). The chapter concludes that the Australian live export trade will only be sustainable if governments and industry align their goals and work more closely together to develop new regulations commensurate with the level of social concern. Given the complexities surrounding the trade, strategies that apply a One Welfare approach and emphasize transparency and collaboration as a shared responsibility to mitigate animal welfare risks across borders must be considered.

THE WORLD'S LIVESTOCK EXPORTERS

Globally, the trade of livestock is worth over US\$18 billion per year and continues to grow (Keogh and Day 2016). In the last 20 years, the world's meat consumption has increased, reaching 360 million tonnes in 2018, with developing countries accounting for approximately 85% of the rise (Department of Agriculture Water and the Environment 2020c). Meat availability per capita has been increasing steadily over the past 50 years to approximately double what it was in the 1960s and there is still potential for meat consumption to increase in sub-Saharan Africa (FAOSTAT 2020). With the global middle class estimated to grow from about 450 million in 2005 to 2.1 billion in 2050, demand for protein-rich foods, such as meat and dairy, could more than double from current needs (van der Mensbrugghe et al. 2009). Hence, there will be increased trade between countries with surplus product to those with deficits, such as countries across Asia, the Middle East (ME) and Africa. Such continued growth should be accompanied by collaborative oversight with a One Welfare framework to promote animal welfare, food security and protection of ecosystems, because exporting livestock is not only commercially important, but it has political and social benefits (Mahmoud 2010).

The most common large livestock species transported worldwide are pigs, cattle and sheep. In 2017, the world's top seven exporters of livestock were Denmark, the Netherlands, Canada, Sudan, Australia, and Spain, listed in descending order. Other than Australia and Sudan, whose export numbers were largely sheep, the other country's main exports were pigs. Conversely, the world's seven largest importers of livestock (excluding chickens) were the US, Saudi Arabia, Poland, Italy, Hong Kong, Turkey, and Qatar. For the US, Poland, Italy and Hong Kong, imports were largely pigs, while for Saudi Arabia and Qatar it was sheep, and cattle for Turkey (Levitt 2020).

EUROPE

The movement of livestock across and within Europe by road and sea is extensive, while export to non-EU countries and the ME also occurs. For example, Ireland exports livestock predominately to EU countries, with some cattle also exported to the ME (Bord Bia Irish Food Board n.d.). In 2018, Ireland's live animal exports were valued at €428 million and accounted for 3.1% of the country's agri-food exports (Department of Agriculture Food and the Marine 2019). Spain exports livestock to the ME, with live cattle exports rising by 37% in 2019 due to a positive trade balance of US\$30 million. Cattle exports into the EU in 2019

also increased, mainly due to an increase in demand from Portugal. In 2020, live cattle and sheep exports from Spain to the ME increased during the COVID-19 lockdown, reducing the financial impact of the closure of the local hospitality industry to Spain's economy (Valverde 2020).

France is the largest European producer of beef, ahead of Germany and the United Kingdom (UK), producing 1.3 million tonnes in 2018. Export of cattle and beef from France predominately occurs within the EU, with Italy and Spain being the biggest importers. In 2018, France exported 1.4 million cattle, including calves but excluding breeding stock, with 78% of these exported to Italy (FranceAgriMer 2020). Countries across the EU have established livestock trade routes to countries across the ME and North Africa, but currently do not have live trade within South-East (SE) Asia (Meat and Livestock Australia 2020a). The UK, similar to Ireland, predominately exports livestock for slaughter to the EU (Norris 2005). While being an EU member, the UK was required to adhere to the EU's Council Regulation (EC) 1/2005 on the protection of animals during transport, which provides standards on the live export of livestock. However, as the UK prepares to exit the EU, the banning of livestock exports is under debate (Ares 2019).

AFRICA

Live export from and within the Horn of Africa is estimated to be worth US\$1 billion per year (Musa, Wasonga, and Mtimet 2020), with the region containing approximately 10% of the world's livestock population (Abbas, Yousif, and Nur 2014). Many of these country's economies rely on the export of livestock (Muhumed and Yonis 2018), with it accounting for 30% of Gross Domestic Product (GDP) and 70% of employment for Somaliland (Musa, Wasonga, and Mtimet 2020). While there are many benefits to livestock trade, due to the politically volatile nature of some of these countries, such trade can also become the source of stress and conflict (Majid 2010).

Droughts, import bans – particularly across the Arabian Peninsula, unstable currencies, competition with neighbouring nations and civil unrest across Northern Africa and the ME mean that many countries that export livestock experience boom and bust (Muhumed and Yonis 2018, Musa, Wasonga, and Mtimet 2020). Many livestock are traded illegally between neighbouring countries, and to Kenya and the ME, with importation bans, excessive regulations and fees being the main drivers (Jabbar and Ayele 2004). Livestock export from the Horn of Africa is constrained by poor animal health and condition, caused by poor veterinary infrastructure and the use of vessels and trucks not specifically designed for livestock transport. Thus, the trade has poor biosecurity and livestock are restrained in ways that lead to injury (Abbas, Yousif, and Nur 2014), compromising animal and human health and welfare.

To reduce the risk of import bans due to livestock disease, countries across the Horn of Africa have recently worked to establish quarantine facilities (Musa, Wasonga, and Mtimet 2020). Steps are being taken to improve livestock conditions,

which will address the reduced marketability experienced for poorly conditioned animals at the end of the journey. This is being driven by the economic growth leading to consumers demanding higher quality products across the ME (Jabbar and Ayele 2004). Since Australia's suspension of sheep exports to Saudi Arabia in 2012, some countries within the Horn of Africa have experienced competition with Australian import markets in the Arabian Gulf, while other competitors lie with neighbouring African countries (Musa, Wasonga, and Mtimet 2020).

NORTH AMERICA

The US is an importer and exporter of livestock, with Canada and Mexico predominating both markets. In 2019, the US imported just over 2 million cattle, with 74% of these being cattle and calves for feeding purposes. In total, the US exported 307,281 cattle in 2019, 89% of which went to Canada and 7% to Mexico. The US imported 13,462 sheep and 1,479 goats from Canada in 2019 but exported 23,126 sheep (55% to Mexico and 12% to the Dominican Republic) and 1,179 goats (20% to Mexico and the Philippines) (USDA 2020). Canada's cattle, sheep and goat exports in 2019 were estimated to be worth CA\$23.57 million, with 7,665 dairy cattle, 2,925 beef breeder cattle, 11,862 sheep and 1,479 goats exported predominantly to the US (Canadian Dairy Information Centre 2020a, b, c, d). Mexico exported an estimated 1.34 million head of cattle in 2019, an 8% increase since 2017, with the majority sent to the US while Belize, El Salvador and Costa Rica imported small numbers (Miller 2020).

SOUTH AMERICA

Brazil supplies live cattle to many countries, mainly in Northern Africa and the ME, including Egypt and Lebanon, and South America (de Sá et al. 2018). With Brazil recently being recognised by the OIE to be free of Foot and Mouth Disease (FMD), contagious pleuropneumonia and Bovine Spongiform Encephalopathy (BSE), trade agreements with new countries such as Iran and Vietnam are possible. Trade-in live cattle in the 7 years prior to 2018 have amounted to US\$3.7 billion (Presidency of the Republic of Brazil 2018). In 2019, exports to Turkey, Iraq and Egypt decreased due to problems within Brazilian ports, including the suspension of use of pre-shipment facilities. Despite this, Brazil's agreements with Vietnam and Saudi Arabia, and potential agreements with China, Malaysia and the Mauritius Islands suggest exports from Brazil is increasing (Silva 2019).

NEW ZEALAND

New Zealand livestock exports include sheep, cattle, deer, goats, alpacas and llamas, with exports in 2019 estimated to be worth NZ\$54 million (Ministry for Primary Industries 2020a). The last large consignment of sheep exported from New Zealand occurred in 2003 (Phillips 2008), while exports since 2008 have been solely for breeding purposes, with exemptions requiring approval by the

Director-General of the Ministry of Primary Industries. This occurred because New Zealand argued that control over practices in importing slaughterhouses could not be assured to follow their stipulated animal welfare standards (Ministry for Primary Industries 2020c).

New Zealand's breeder livestock are in demand across the world to assist in genetic improvements, stock new dairy farms and enable countries to work towards food security and meet international agricultural cooperation agreements (Ministry for Primary Industries 2019). In 2019, New Zealand exported 39,489 cattle, 3,919 goats (both mainly to China), 1 deer to Spain, 50 sheep (mainly to Japan), and 75 alpacas and llamas (to seven countries, mainly to The Netherlands) (Ministry for Primary Industries 2020a). Following a recent catastrophic incident of a cattle vessel sinking during a journey to China in 2020, the New Zealand Maritime safety requirements were revised (the 'Heron report'), and a review of the entire trade followed. The Ministry for Primary Industries adopted the report's recommendations to increase inspections of live export ships upon arrival, reduce stocking densities to 90% to align with new Australian standards, increase voyage reporting, including daily veterinary reports, and for the minimum carrying of fodder to be increased to ensure 20% of feed is available for unforeseen voyage delays (Heron, Parr, and Agnew-Harington 2020). A prohibition on livestock exports was instigated, with conditional prohibition to follow a month later. Throughout the process, public cries for the banning of the trade intensified. On the 14th of April 2021, the New Zealand Government announced that cattle live exports by sea would be banned, with a 2-year phase out of the trade to occur (Perry 2021).

Australia exports livestock via sea and air for breeder, feeder, and slaughter purposes. Details on Australia's livestock trade will be the focus of the rest of this chapter.

AUSTRALIA'S LIVE EXPORT INDUSTRY

Australia's livestock export industry has been operating for over 30 years (Phillips 2005). The Australian agricultural industry faces challenges on a regular basis, namely droughts, floods, and bushfires. The severity and duration of these events are increasing, prolonging the time for recovery, and placing pressure on producers to adapt to ensure their sustainability. In 2020, the agricultural industry was faced with a new challenge, COVID-19; however, red meat production was classified as an essential service, highlighting the national and international importance of the industry (Meat and Livestock Australia 2020c). All of these challenges impact Australian livestock exports through livestock availability and cost. While the impact of COVID-19 on livestock exports and how the industry will adapt to this new challenge is unknown, reduced international flights have resulted in a decreased supply of chilled lamb and mutton carcasses being freighted to the ME, resulting in importing countries sourcing chilled carcasses from other countries and was forecasted to increase the demand for live sheep imports.

In 2018–2019, Australian live sheep and cattle exports were valued at AU\$1.7 billion (Meat and Livestock Australia 2020c). While Australia does export other

livestock species, such as goats and alpacas via air transport, the trade is dominated by sheep exports to the ME and cattle exports to SE Asia, with approximately 1.1 million sheep and 1.3 million cattle exported in 2019 (Meat and Livestock Australia 2020c).

The Middle East

Due to the arid conditions across the ME, this region largely relies on livestock imports to feed the human population and to meet the demand for livestock during the religious festivals of Eid ul-Adha and Eid ul-Fitr (Abbas, Yousif, and Nur 2014, Meat and Livestock Australia 2020b). However, import demand to the ME is also influenced by oil price, political stability and conflict (Meat and Livestock Australia 2020c). It is estimated that the ME market requires 6 million head of livestock per year, mainly sheep and goats but includes cattle and camels, of which Australia provides 43% (Abbas, Yousif, and Nur 2014). Sheep live exports account for 30% of Western Australia's annual turn-off of lambs and sheep, with the market particularly important for farmers when seasons deteriorate, allowing stock numbers to be reduced quickly for drought management. The live sheep trade employs approximately 3,443 people, with many Australian businesses, such as fodder manufacturers, livestock agents, transporters and feedlot workers, in addition to farmers, being reliant on the industry for a portion of their revenue (Mecardo 2019). Australia has been exporting live sheep to the ME/ North Africa region for over 50 years and has developed a reputation for high-quality lamb and mutton. Many countries in this region prefer mutton due to the low cost, taste and cooking style. Demand for lamb is projected to increase due to increasing disposable incomes, younger populations and more wealthy expatriates moving to these countries, specifically in the Gulf region (Meat and Livestock Australia 2020b).

The live sheep exports from Australia to the ME have halved over the past decade, from 4.21 million head in 2008 to 1.89 million in 2017, with further declines in 2018 and 2019 due to the moratorium for exports to the region during the northern summer. During the 2019 moratorium, Kuwait and Qatar sourced sheep from Romania and Sudan, while Oman imported sheep from Sudan and Sub-Saharan Africa. The industry has concerns that a continued moratorium will result in a reduced demand for Australian sheep, reducing the current economics (Meat and Livestock Australia 2020c). The ME market is evolving, with increases in air freight of chilled carcasses facilitated through investment in modern shopping centres and supermarkets and an increase in income levels occurring in recent years. Despite these advances, there remains a demand for locally slaughtered livestock, particularly during religious festivals. This traditional drive for livestock will likely persist through modernisation, regardless of where the animals are sourced. Furthermore, freshly slaughtered meat is still perceived as the safest source in this region (Meat and Livestock Australia 2020b).

Australia's largest competitors for the ME sheep trade are Somalia, Sudan, India, Jordan, and Romania, with Georgia, Spain, Hungary, France, and Portugal projected to be future competitors. For beef cattle exported to the ME, the largest competitors for trade, specifically to Turkey, Egypt, Israel, Lebanon and Jordan

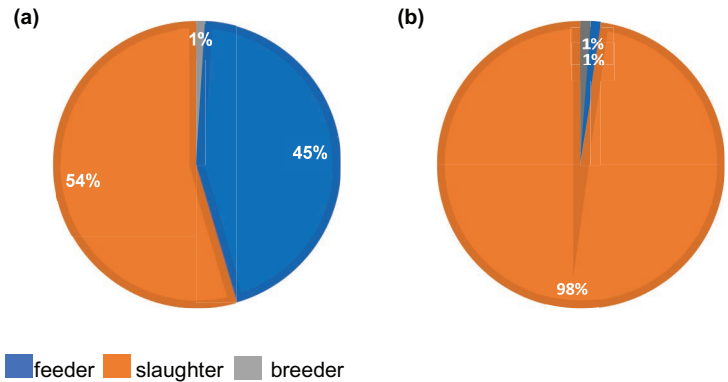


FIGURE 14.2 The percentage of (a) cattle and (b) sheep transported by sea from Australia to the Middle Eastern region and Russia for feeder, slaughter and breeder purposes for the 2019–2020 financial years. (Calculated using figures obtained from Department of Agriculture Water and the Environment 2021a.)

are Uruguay, Brazil, Ukraine and Romania, while Ireland and the US are minor competitors (Meat and Livestock Australia 2020c). In 2020, Australian sheep were exported for predominately slaughter purposes (Figure 14.2b), while cattle were exported for mainly slaughter and feeder purposes (Figure 14.2a). In 2019, Kuwait overtook Qatar to become Australia’s largest importer of sheep, accounting for 34% of the 1.1 million sheep exported (Department of Agriculture Water and the Environment 2021a) (Figure 14.3). Between 2015 and 2020, Australia exported to 12 countries across Africa, the ME and Russia, with Egypt, Mauritius, Bahrain and Lebanon only importing cattle and/or sheep for 1 year during this time period.

South-East Asia

The rapidly growing human population and evolving consumer market have resulted in SE Asia becoming a key importer of Australian livestock, predominately cattle but also sheep, goats, and buffalo. The market demand for cattle is driven by animal purchase prices, which are dictated by animal availability, and climatic extremes, such as droughts and bushfires. Increased beef consumption across SE Asia has resulted from economic growth and urbanisation. China, Vietnam, and Indonesia have shown the most growth, with these regions increasing their beef imports from 100,000 tonnes in 2008 up to 430,000 tonnes in 2013. Detailed trade agreements exist with each importing country, linking the sale of meat products (often with added tariffs) with the sale of live animals (Smith et al. 2018).

Australia’s northern cattle industry hinges on live exports to SE Asia, with 77% of yearly cattle exports transported to the region, with 909,450 head of cattle exported to SE Asia in 2018–2019 financial year (Meat and Livestock Australia 2019). While Australia’s northern cattle industry is proficient in producing weaner calves, a consequence of the limited pasture growth window in this region means

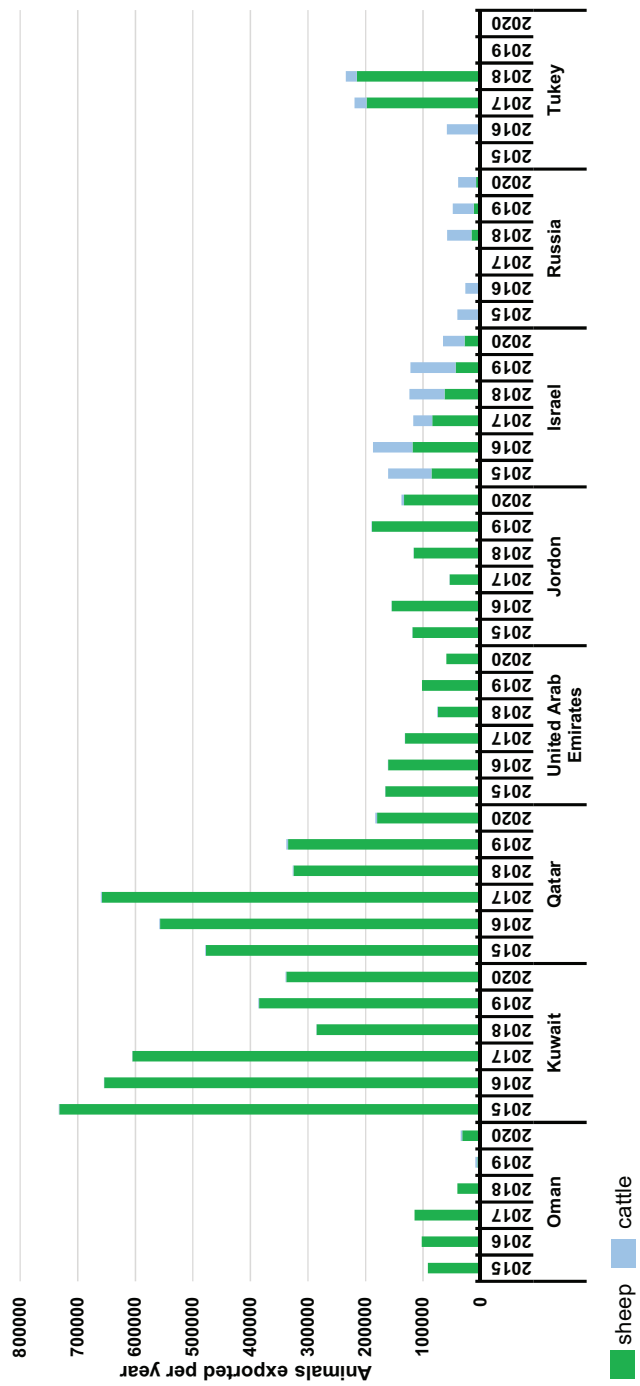


FIGURE 14.3 Live sheep and cattle exported by sea from Australia to countries in the Middle Eastern region and Russia for years. (Calculated using statistics obtained from Department of Agriculture Water and the Environment, 2021a. Note: excludes countries that did not import animals for ≥ 2 years.)

there is an inability to support the production of large volumes of finisher cattle (Meat and Livestock Australia 2020a). Historically, processing cattle in Northern Australia has been limited, as the monsoonal rains during the wet season prevent cattle being mustered and transported for six months of the year. High fixed costs, energy costs, wage bills, and the difficulty of finding qualified tradespeople makes processing not financially viable (Marshall 2019). As a result, the industry has few alternatives to transporting cattle large distances to other countries by sea or across Australia by road, both of which expose cattle to transport stress. As consumer markets across SE Asia are evolving, consumer purchasing behaviours are also changing. For example, the emergence of shopping centres and butcher shops have resulted in a shift of meat purchasing habits away from traditional wet markets. The emergence of a wealthy consumer base, as observed in Vietnam, will also drive changes in these markets (Meat and Livestock Australia 2020a), meaning that the demand for chilled beef products could be on the rise and the investment into more proficient slaughterhouses could occur. It is important that the Australian industry can adapt to remain competitive and take advantage of these market changes. With facility improvements and a client base with more dispensable incomes, improvements in livestock welfare during handling and slaughter could coincide.

In 2019, Indonesia was Australia’s largest importer of live cattle, accounting for 52% of the 1.3 million head exported (Meat and Livestock Australia 2020a) (Figures 14.4 and 14.5). In 2019, cattle exports rose 20% from 2018, with 65% being feeder, 21% slaughter and 13% breeder cattle (Meat and Livestock Australia 2020c). In China, demand for live cattle has also increased, with a 33% rise in imports in May 2019 from the previous year. China also imports feeder and slaughter cattle from Uruguay and breeder cattle from New Zealand, Uruguay and Chile (Meat and Livestock Australia 2020a). In addition to imports from Australia,

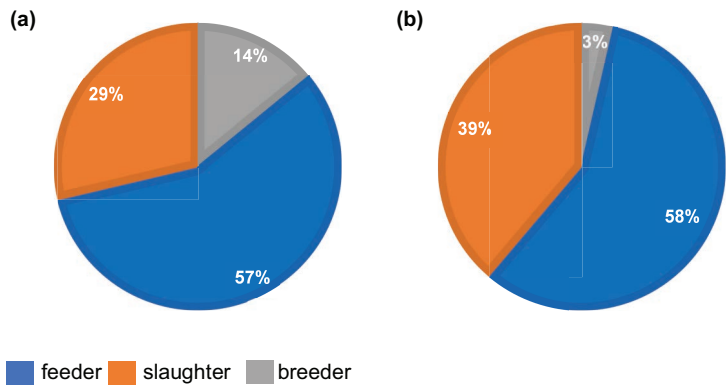


FIGURE 14.4 The percentage of (a) cattle and (b) buffalo transported by sea from Australia to South and South East Asia for feeder, slaughter and breeding purposes for the 2019–2020 financial years. (Calculated using figures obtained from Department of Agriculture Water and the Environment, 2021a).

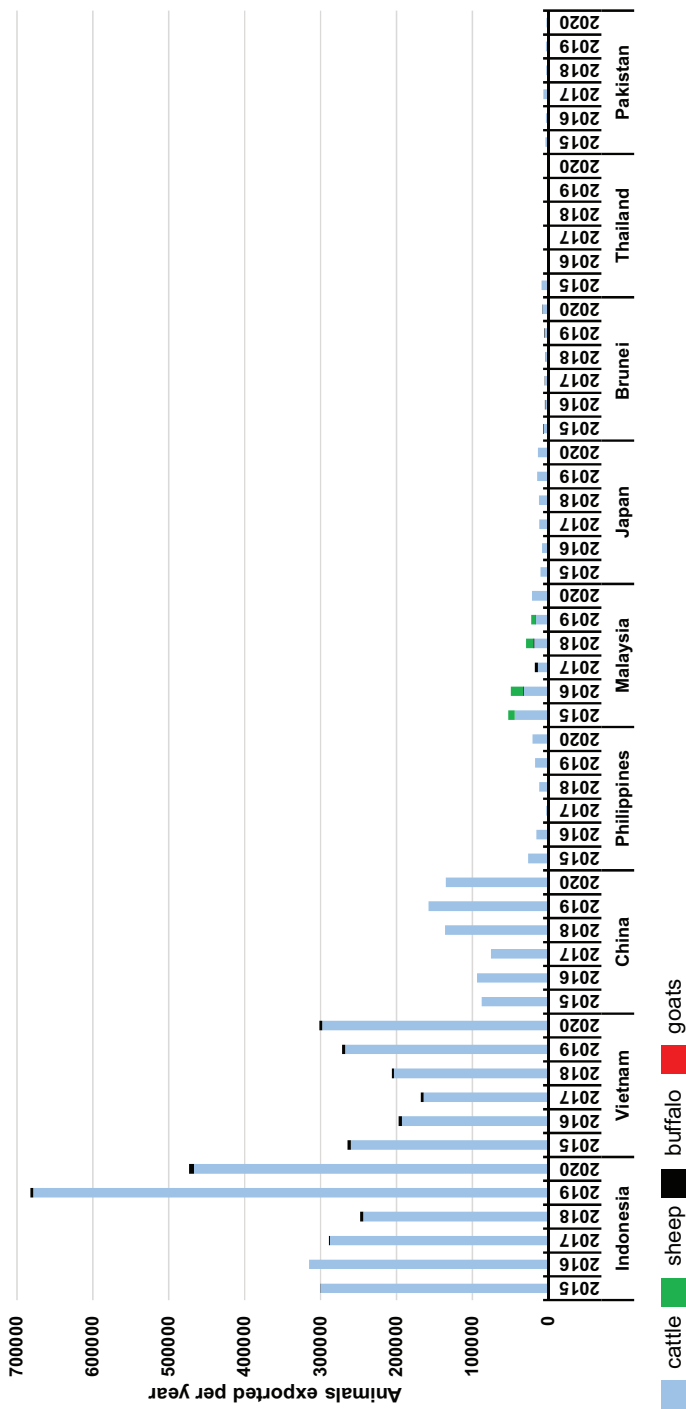


FIGURE 14.5 Live cattle, sheep, buffalo and goats exported by sea from Australia to countries in South and SE Asia for years 2015–2020. (Calculated using statistics obtained from Department of Agriculture Water and the Environment, 2021a. Note: excludes countries that did not import ≥5,000 head of a livestock species per year.)

more cattle are imported to the region through informal routes, specifically into China. In 2015, China, Vietnam, and Indonesia alone imported over 900,000 cattle from distant countries, with hundreds of thousands more having entered China and Vietnam from neighbouring countries (Smith et al. 2018). Recent political tensions between Australia and China have resulted in some Australian agricultural products having tariffs imposed. While this has not yet impacted livestock exports, it is clear that global politics heavily influence the trade, adding to the complexity of industry management. Despite established trade routes between countries throughout SE Asia and the ME, other sources of cattle available at a cheaper rate due to lower production costs are becoming available. While Brazil has previously focused on exporting cattle within South America, their exports to Turkey and the ME have been initiated, and due to FMD now being endemic in Vietnam, it is expected that a trade agreement between these countries will be established. Therefore, Brazil may become a competitor for Australian markets in the future. In 2020, cattle and buffalo were exported to SE Asia predominately for feeder and slaughter purposes (Figure 14.4). While decreases in the number of cattle exported to China and Indonesia occurred between 2019 and 2020, an increase in exports to Vietnam occurred (Figure 14.5). Between 2015 and 2020 Australia exported to 13 countries and regions across South and South-East Asia, with Cambodia, Sri Lanka, Sabah, and Sarawak importing less than 5,000 cattle or buffalo per year. In 2016, Australia also exported 6,677 cattle to Mexico.

BIOSECURITY AND THE TRADE

While international trade enables countries to participate in the global economy, the movement of people, animals and goods has facilitated the increased spread of diseases and pathogens. Regional, national and international movement of livestock has seen the spread of diseases such as avian influenza, FMD, BSE and various viral swine diseases (Shanafelt and Perrings 2017). Disease outbreaks can be disruptive to regional and international trade, through animal movement restrictions, while the flow-on effect can result in world shortages of animal products and reduction of herd sizes and production (Kompas, Nguyen, and Ha 2015). In terms of live export, diseases have caused major welfare concerns for shipments in the past, which can lead to rejection of the consignments, as observed for sheep and camels with pox, orf (Abbas, Yousif, and Nur 2014) and scabby mouth (Coghlan 2014, Petrie 2019), while FMD has led to rejected cloven-hoofed livestock consignments (Phillips 2005). While South Africa was recovering from the 2017 to 2018 listeria outbreak and drought, an FMD outbreak in early 2019 resulted in China, Botswana, Mozambique, Namibia, eSwatini, Zambia and Zimbabwe suspending imports of cloven-footed animals and their red meat (Mugido 2019). Rift Valley fever has resulted in Saudi Arabia banning the importation of livestock from Somalia from the mid-1950s until 1998 and again in 2000. Import bans have large consequences for the exporting country beyond the health and welfare of the livestock in the rejected consignment. For example, these bans against Somalia not only resulted in a loss of income in the millions but led to the depreciation

of the Somaliland shilling and increases in unemployment, urbanisation and deforestation, leading to environmental degradation (Muhumed and Yonis 2018). While import bans can negatively impact the diseased exporting country through major economic loss, they can also provide opportunities for competing export nations. Shifts in consumption habits are also observed, as seen recently with China, while the country had a slowly increasing demand for high-quality beef, the need was exemplified when African Swine Fever reduced pork availability (Meat and Livestock Australia 2020c).

THE LIVE EXPORT JOURNEY

The transport of Australian livestock between countries involves road and sea, and is complex, with total journey lengths ranging from approximately 4 days to over 6 weeks. Most sheep exported live from Australia are sourced from Western Australia and are sent to the ME, with the voyages taking an average of 21 days. In contrast, most cattle are sourced from Northern Australia and are sent to SE Asia, with the voyages taking an average of 5 days (Collins, Hampton, and Barnes 2018). The longest voyages involve livestock being exported to Russia, which takes approximately 45 days. Voyages occur year-round (Norman 2017), except for sheep voyages to and through the ME between June and September (Department of Agriculture Water and the Environment 2020d). The live export journey involves a sequence of events from farm gate to slaughter, with some animals being purchased through saleyards (markets) before being sent to the pre-export feedlot. The journey starts with the muster of animals on the property of origin (often by helicopters, horse riders or motorbikes) into a yard where they are rested overnight before a road transport journey (2–48 hours) to a pre-export assembly depot or feedlot. Here, animals remain for up to 10 days (sheep minimum 5 days, cattle minimum 1–3 days dependent on export market) to habituate to handling and a pelleted feed ration before a shorter road journey to the port where animals are loaded onto the vessel. Both road journeys typically involve a period of feed deprivation, or ‘curfew’, to keep the vehicles clean and prevent injury by slippage. However, depending on the transport duration, curfews of 24 hours or longer, particularly for cattle may occur, and impact the health of the animal as it results in an altered pathogen load in the rumen (Hogan, Petherick, and Phillips 2007). Upon disembarkation in the destination country, livestock may be transported by road directly to trading pens or the slaughterhouse, or if for feeder or breeder purposes, they are transported to feedlots or farms.

In addition to the various types of transport, the export process exposes animals to thermal stress and novelty through multiple changes to their environment and diet and poses unique challenges and welfare risks to animals. These stressors are exemplified for cattle that originated from remote regions as they are unhabituated to humans and confinement, and for sheep that are insufficiently acclimated to high humidity or eating grain. Given Australia’s geographical location, many livestock are exported from cold wet winters to northern hemisphere

summers, resulting in exposure of unacclimated animals to high humidity and hot conditions. Transport during this time increases the occurrence of some heat stress-related events (Shiell, Perkins, and Hewitt 2013). Similarly, some cattle that travel to a northern hemisphere winter maybe unacclimated to the cold. While there is an overwhelming number of Australian animals that are transported without incident, there is a history of numerous adverse animal welfare events associated with long-haul sea voyages worldwide. Such voyages have had poor animal welfare outcomes due to injury, disease, heat stress and high levels of mortality. The major welfare concerns usually revolve around the on-board ship conditions and slaughter in destination countries.

Exposure to heat stress and poor ventilation on-board the vessel remains a major concern for sheep and cattle (Collins, Hampton, and Barnes 2018). The predominant welfare issues for sheep centre around inanition and salmonellosis (Richards et al. 1989), and for cattle, it is injuries and respiratory disease (Phillips 2008). Inappetence in sheep is responsible for approximately 43% of all sheep mortalities and can lead to the onset of salmonellosis (Barnes et al. 2018). Bovine respiratory disease (BRD) is commonly detected and is caused by multiple viruses and bacteria, and vaccinating cattle prior to export can minimise disease incidence (Moore et al. 2014); however, low mortality rates have not made vaccination a priority. How exposure to multiple stressors impact livestock and whether they lead to states of anxiety or depression is of concern (Phillips 2008). Additional concerns regard the vessel environment, such as noise, vibration, and the ship's movement. Whether the latter may result in motion sickness in animals, particularly when ships rise and fall (heave), or undergo a slamming motion when unpredicted waves hit the broad side of the vessel in high seas has been reviewed (Santurtun and Phillips 2015).

All animals are inspected, tested, and certified for various health and pregnancy status, in accordance with the regulations at the feedlots prior to loading. On-board the vessel, the livestock are managed by veterinarians and stockpersons so that all pens of animals are checked 2–3 times daily. Routine care includes the provision of feed and water, management of bedding and the manure pad, washing of decks (cattle ships only), while also monitoring the vessel's systems to ensure a stable microclimate for the animals (Ludeman and Willis 2019). Medical care, humane euthanasia and post-mortems of animals are performed when required. Figure 14.6 illustrates the typical pen and feeding system provided to Australian sheep and cattle on a vessel (fully enclosed) and after arrival in destination feedlots. All animals are checked for fitness to travel and observed at loading and unloading at the ports, as optimal animal handling is critical at this time.

Given our greater understanding of what matters to animals, there is evidence that animal welfare risks increase with the distance travelled (Phillips 2016, Collins, Hampton, and Barnes 2018). However, the role of animal welfare science is pivotal in this discussion and how livestock respond to high environmental heat load, long and short-haul transport, for both land and sea transport, has not been adequately researched. The understanding of animal experiences as they are exposed to numerous husbandry practices and transport is in its infancy,



Sheep on board showing their pen environment and feed troughs on Day 11 on a voyage to the Middle East. The stocking density applied was stipulated by ASEL v2.3 prior to the ASEL review in 2018.



Cattle on board showing their pen environment and feed troughs on a voyage to Vietnam. The stocking density applied was stipulated by ASEL v2.3 prior to the ASEL review in 2018.



Sheep in a feedlot in Kuwait after arrival by sea. Cattle in a feedlot in Vietnam after arrival by sea,

FIGURE 14.6 Images of Australian sheep and beef cattle during sea transport and at destination feedlots. (Images courtesy of Renee Willis, Murdoch University. Lower right image; The Livestock Collective.)

particularly under Australian conditions. Much work is needed to develop welfare assessments that are applicable under varying contexts in order to monitor the animals' response to varying environments and management decisions. This need is increasing with the public's demand for food produced using the most welfare-assured methods. Risk assessments for live export consignments need to be considered on a per voyage basis, with consideration of species, breed, climate, journey duration and destination, as these vary considerably. For example, the challenges that *Bos taurus* and *Bos indicus* cattle face differ and require specific consideration, such as heat load management for *B. taurus* cattle; heavier cattle require lower stocking densities and the provision of bedding compared to light-weight cattle. In addition, the management procedures applied to beef cattle are not applicable to breeder dairy cattle or buffalo, despite perceived breed and species similarities. It is accepted that the longer the journey, the greater the risk, and with each border crossing, more complex management is required. It has not yet been determined whether all the known risks associated with sea voyages, in particular long-haul voyages, can be mitigated, to ensure good animal welfare, and thus, justify the continuation of the trade. If trade is to continue, work to achieve global standards of animal care is an essential first step.

REGULATION AND ANIMAL WELFARE

Regulation of animal welfare in the Australian livestock export industry is complex and due to the multiple sectors of the supply chain, there are several Commonwealth, state and territory legislation that must be adhered to (Fleming, Wickham, Dunston-Clarke et al. 2020). Australia is presently one of only a few countries that require adherence to OIE Global Animal Welfare Standards and other Australian welfare requirements (e.g. Australian Certificate for the Carriage of Livestock) as a condition of trade.

While livestock are within Australia, state and territory animal welfare acts are enforceable, in addition to those relevant maritime regulations, which are enforced by the Australian Maritime Safety Authority (AMSA), while vessels are within Australian waters.

There are two mandated components of regulation for exporting Australian livestock. The Commonwealth's *Australian Standards for the Export of Livestock* (ASEL) must be adhered to during the acquisition and preparation of livestock, and sea transport stages of the supply chain (Department of Agriculture Water and the Environment 2020a) and the *Exporter Supply Chain Assurance System* (ESCAS) stipulates requirements for exporters for slaughter and feeder livestock (breeder livestock are exempt) in the importing country (Department of Agriculture Water and the Environment 2020b) (Figure 14.7). ASEL specifies the responsibilities of stockpersons and veterinarians, regulations concerning the suitability of stock selection, requirements for managing fodder and bedding during transport, and voyage report writing. The export companies are required to report any mortalities to the Australian government for all shipments, and an investigation is triggered if a shipment returns a mortality rate above a threshold (ASEL version 3.1

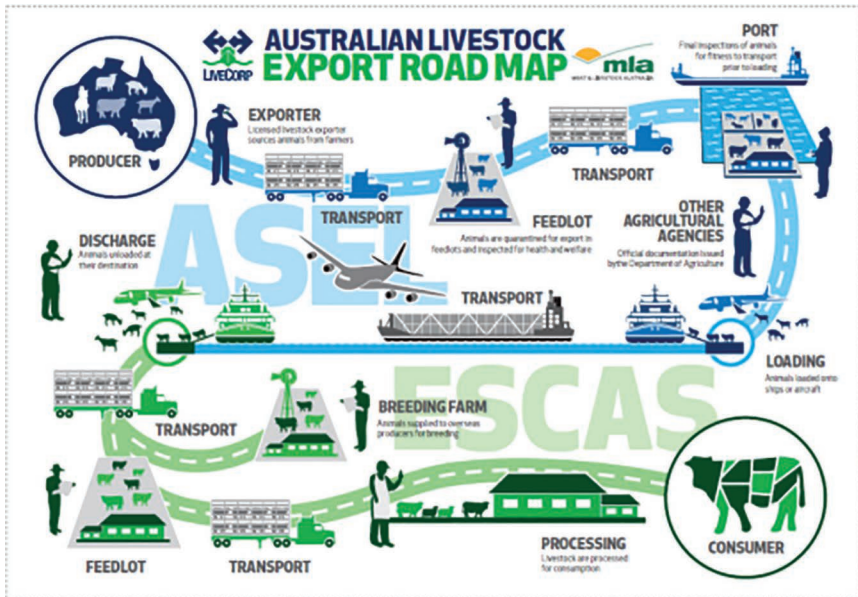


FIGURE 14.7 Australia's live export supply chain and the sectors where ASEL and ESCAS regulatory systems apply (LiveCorp n.d.).

specifies 0.5% for cattle and 1.0% for sheep (Department of Agriculture Water and the Environment 2020e)). Australia is the only major livestock exporter that stipulates animal traceability, control and welfare standards in importing countries for cattle, sheep and goats via ESCAS (Meat and Livestock Australia 2020c). Despite such regulation, adverse animal welfare incidents occur, including the rejection of animals by importing countries and breaches of poor animal handling often on foreign soil. While the industry has responded to address such incidents, these events highlight the problem that no legal system can guarantee that animal mistreatment will never occur.

In the past decade, regulatory reforms have occurred subsequent to media exposés of poor animal welfare, including the publicly broadcasted mistreatment of Australian cattle in an Indonesian abattoir in 2011, and of a heat stress event leading to the death of 2,400 Australian sheep en route to the ME in 2017. Public outrage resulted and the industry's social licence to operate was threatened (Rice et al. 2020). Although the Australian government appears committed to support the live export trade in the long term, swift political action resulted from these adverse events. In 2011, a trade suspension to Indonesia followed the exposé and new regulations via the implementation the ESCAS occurred (Department of Agriculture Water and the Environment 2020b). In 2018, in response to the sheep heat stress exposé, the Australian Government initiated several industry inquiries (McCarthy 2018, Moss 2018), a review of ASEL and imposed a moratorium on sheep exports for the three months of the northern summer each year

(Department of Agriculture Water and the Environment 2020c). Historically, the main measure of animal welfare for the live export industry has been shipboard mortality rates and adherence to regulatory guidelines. In 2018, it was identified that industry regulation was heavily focused on animal mortality and that more measures of welfare reporting were needed (McCarthy 2018).

As mortality represents the extreme end of suffering and poor welfare, risk assessment approaches had been developed by the industry for anticipating conditions likely to precipitate high heat load episodes, known as Heat Stress Risk Assessment (HSRA). Average daily mortality rates are made publicly available, but only apply to consignments exported by sea and are calculated at the end of the voyage. Long-term analyses have shown that livestock mortalities rates have declined since data began being reported in 1995; overall 0.71% and 0.10% for sheep and cattle, respectively (Norman 2017). The Commonwealth review of ASEL version 3.0 was finalised in 2019, which called for significant changes to the Standards (Department of Agriculture Water and the Environment 2020f). The industry responded proactively to adopt most of the 49 recommendations to mitigate the risk of heat load episodes and ASEL v.3.0 was enforced in November 2020 and amended to version 3.1 in May 2021 (Department of Agriculture, Water and the Environment 2021b). In addition to the summer ban for sheep exports, changes included longer times required for livestock in pre-export registered feedlots, reduced notifiable mortality rates for sheep and cattle, stricter requirements for stock-handlers, bedding, more reporting on vessel environmental conditions and animal measures (including more detailed panting scores, demeanour and feeding behaviour), and increased amount of fodder loaded for long voyages, and a reduction of stocking densities. More broadly, ancillary reforms included the phasing out of older ships, improved checks to ensure that ventilation systems operate at maximum capacity and the initiation of an industry standardised data collection and storage system, known as LIVEXCollect.

Given that exported animals travel across international borders where welfare considerations are not equivalent, developing global animal welfare standards is a logical first step. Since 2005, the OIE became involved in developing international guidelines for the welfare of animals. This included Guidelines for the Land and Sea Transport of animals, which have a focus on the competence of animal handlers and exporters, as key parties that ensure the health and welfare of animals being transported (OIE 2021). However, the OIE Welfare standards are not enshrined in legislation, except in Australia under ESCAS requirements. Currently, only national governance of animal welfare is in place, so all workers are bound to treat animals by their own country's values, law, and industry regulations. The governments of 182 countries have formally endorsed the OIE standards and the OIE is assisting member states to implement these standards. Having all importing and exporting countries governments adopt the OIE standards is an attainable goal, and subsequently encouraging each country to use their sovereign rights and responsibility to implement these as global standards within their individual countries is more ambitious. These steps require further dialogue, as awareness of cultural sensitivities are needed to build trust and cooperation

between nations to adopt even higher welfare standards. A recent output of such collaboration between industry and government is that animal welfare laws consistent with Australian expectations for the treatment of cattle will be enshrined in law in Vietnam (MLA 2020). Veterinary input to guide these partnerships in Australia's trading partners is valuable under a One Welfare approach.

THE NEED FOR RESEARCH AND THE MEASUREMENT OF ANIMAL WELFARE

Given the importance of the trade and the level of societal concern about welfare outcomes, further investment in research is essential. Considerable research has previously investigated the influence of heat load variables experienced by transported animals, including diet (Beatty et al. 2007), ventilation (Maunsell Australia 2004) and environmental conditions (Ferguson et al. 2008).

Reliance on mortality as the predominant measure of animal welfare is limiting and focuses solely on extreme animal responses (Pines et al. 2004, McCarthy 2018). Recent comprehensive welfare protocols that include a suite of indicators have been developed for the measurement of livestock welfare on farm (Colditz et al. 2014, Kaurivi et al. 2020). These have been based on international protocols such as Welfare Quality®'s four pillars of Good Feeding, Housing, Health and Appropriate Behaviour. Several reports of potential animal welfare measures suitable for live export context have also been published (Pines et al. 2004, Dunston-Clarke et al. 2020, Fleming, Wickham, Dunston-Clarke, et al. 2020) and one study has identified measures deemed to be practical and relevant by the public, welfare advocates and industry workers (Fleming, Wickham, Barnes, et al. 2020). These indicators need piloting under commercial shipping conditions, including on animals undergoing both short- and long-haul voyages to various destination markets, to gain sufficient data to describe the range of animals' experiences.

Measuring animal welfare is complex as it needs to account for both the physical and subjective experiences of animals. It is remarkably complex when applied across tens of thousands of animals, such as in a live export consignment. Commonly, the measurement of animal welfare will take the form of trying to determine if a particular type of intervention will increase or decrease the welfare of animals. But when making decisions based on welfare assessments, one needs to consider trade-offs, which requires information about the magnitude of effect of particular interventions. This is pertinent when resources may be limiting, such as during confinement on a three-week voyage. Studies on-board vessels could investigate the interactions of the various ship factors (e.g. ventilation, pen design), management (e.g. stocking density, bedding) on sheep and cattle outcomes, particularly on longer journeys (Hampton, Jones, and McGreevy 2020). Such studies should also underpin any government-directed regulatory reform. Further studies in land-based facilities that can examine the direct effects of changing one variable at a time (e.g. varying stocking density in climate-controlled rooms) should be encouraged.

Although previous studies on sea transport have focused on sheep and beef cattle, research on breeder dairy cattle and buffalo is needed to enable breed and

species-specific risks to be addressed. Furthermore, pen-side monitoring of animals and the development of animal-based welfare protocols which consider the cumulative effects of the voyage stressors on the animals would increase transparency and allow industry self-improvement (Dunston-Clarke et al. 2020). Use of such parameters could allow early detection of subtle changes to behaviour, which may indicate early signs of stress or ill-health that enable the mitigation of risk. This would also permit industry benchmarking across species and routes, the identification of resilient lines of animals, and lead to improved animal welfare outcomes. Use of such a system could be made partially transparent, which would allow the industry to demonstrate improved animal welfare performance to the public, which may address the current loss of societal support for the industry. More collaborative effort between industry, government and exporters is required to achieve improvements in welfare along the whole supply chain, and more transparency would garner wider societal support.

VETERINARIANS PLAY KEY ROLES IN ANIMAL HEALTH AND WELFARE

Having animal welfare professionals, such as veterinarians and experienced stockpersons involved at the various stages of a live export journey is important as their roles were founded to protect the health of animals used for human needs. Australian Government Accredited Veterinarians (AAVs) are responsible for pre-export livestock preparation and inspection, and for the daily shipboard work, while non-AAV roles vary from regulatory government positions to industry consultants delivering advice on animal health and welfare. Only veterinarians accredited by the Commonwealth government are permitted to oversee the preparation of livestock for export, review the importing country's biosecurity requirements or accompany livestock on voyages (Ludeman and Willis 2019). However, ASEL requires at least one LiveCorp accredited stockperson to accompany every voyage by sea. This means, some short voyages, such as cattle departing from northern Australian ports to SE Asia, do not require veterinarians on-board, as all animal management is overseen by the stockperson. The AAVs check livestock daily, administer treatments as needed and manage the feeding. Veterinary roles require a good working relationship with the exporting company as their expertise is also applicable to consignment planning, industry research, training of accredited stockpersons, and overseeing the post-embarkation animal health and welfare needs in destination markets (Ludeman and Willis 2019). Veterinarians are also employed to manage operational duties and compliance within livestock export companies. Since 2018, veterinarians and stockpeople have also been appointed as government-appointed Independent Observers mostly on long-haul voyages, following a consignment from loading to disembarkation, to conduct livestock welfare checks and audit the AAV's and stockperson's compliance with ASEL reporting and importing country requirements.

Primarily, veterinarians are monitoring the health and welfare of the livestock and require good knowledge of the disease risk. In addition, ensuring good facilities are available (e.g. loading ramps, slaughter infrastructure) and that

animals are handled in a calm and easy manner will reduce injuries and promote well-being in animals and their human handlers. An understanding of the importance and inter-relationship of all these factors, and how management decisions may influence them is key to successful welfare outcomes for a consignment of many thousands of animals. Figure 14.8 depicts the complex interactions of risk factors for exported livestock first identified by Stinson (2008); this needs to be considered by all AAVs. Briefly, they include animal factors (breed, level of acclimatisation, weight), consignment factors (duration of travel, climate) and ship factors (pen design, stowage plan, ventilation design), which are in addition to the voyage details and climate. It is unlikely that government regulators, industry bodies or independent exporters are able to identify all the risks in their own right (Stinson 2008). In their varied roles, the on-board veterinarians and stockpersons are well placed to negotiate this three-way approach between the regulator, the livestock export industry, and exporters. Australian veterinarians acting in these roles have played a vital role in putting forward and implementing some of the recent improvements the industry has adopted over the past 12 months. However, continued efforts for animal monitoring and regulation up to the point of slaughter, is needed to ensure continuous improvement that safeguards animal welfare at each step of the chain and to build community trust.

Importantly, while much media attention has been placed on ensuring acceptable standards of care of livestock on foreign soil, there remain known activities of high risks to livestock welfare within Australia, particularly in remote northern rangelands of Australia. Some of these activities include the mustering and catching of scrub bulls and buffalos, long-distance road transport, feed lotting under extremely hot conditions, and painful husbandry procedures, such as castration, spaying, dehorning and mulesing, without analgesia. All of these practices require tighter scrutiny by government and industry. Veterinarians and experienced industry stockpeople are well positioned to lead multidisciplinary approaches, including aiding farmers at the community level, through advising exporters and veterinarians working at the international level. Their knowledge and professional experience enable better selection, preparation, and handling of livestock for long-distance travel, and oversight of the repeated handling and treatment of animals first-hand by accompanying the animals on-board alongside the vessels' crews. In combination with understanding the challenges of ensuring sustainability of the livestock supply, trade agreements and the farmers' personal well-being on both Australian and foreign soils, assistance to exporters and regulators within and outside of Australia could also be provided.

CONSIDERATION OF STAKEHOLDER OPINIONS

Reviewing the welfare of livestock during export requires consideration of the many stakeholders from various backgrounds, cultures, religions, and education levels. While livestock are now recognised as sentient beings and deserving of a life with good welfare, the interpretation of this varies between human parties; those who view animals as objects of value to those who believe they are

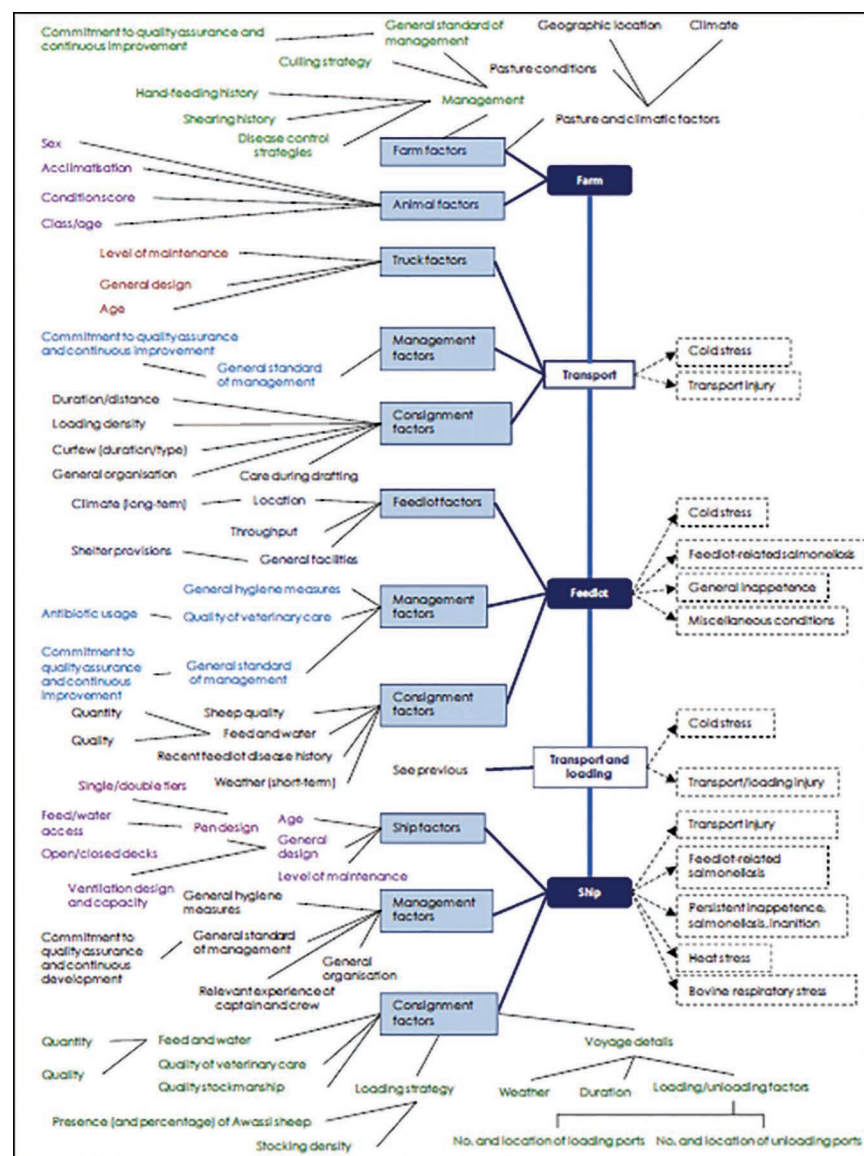


FIGURE 14.8 Web of causative factors. A diagrammatic representation of the live export process, including the causal web of risk factors (on the left) leading to adverse health and welfare outcomes (on the right) (Stinson 2008).

capable of feeling pain and emotions (Broom 2005). Trade between developed livestock-producing nations and developing importing countries must be managed delicately to avoid accusations of exploitation (Tiplady, Walsh, and Phillips 2015). It is of high importance that imported animals arrive at their destination in good health, yet because of the long journey, there is always a risk that animals become stressed or diseased. As a result of a previous adverse event, Australia is one of the few exporting countries that has contingency plans for each consignment to offload elsewhere should a shipment be rejected upon arrival.

Within Australia, opposition against livestock export from animal rights groups started in the late 1970s (Coghlan 2014), with mainstream media exposés, submissions to government and industry calling for regulatory change (either by government or industry) and/or activist campaigns instigating public protests (Mummery and Rodan 2019). Public expectation of welfare standards in exporting countries are high, with these values now being projected upon importing countries (Harris 2005). Predominately, the public are concerned about the suitability of livestock type being transported and the poor handling and management of livestock throughout the journey, at destination feedlots and abattoirs, and that livestock are exposed to adverse conditions and uncomfortable environments (Phillips 2008, Rice et al. 2020). It is believed by many that ideally, the live trade of livestock should be replaced by the trade of chilled carcasses (Broom 2005) acting to minimise the distance between farm and slaughterhouse. Animal welfare campaigners in the UK have argued for a maximum of eight-hour travel limits, with a complete transition to carcase-only trade being most desired (Limb 2018).

After the 2011 exposé of mistreated Australian cattle in Indonesia, a survey of 157 members of the public found that while participants were emotionally disturbed by the media footage, it did not translate to behavioural change, with less than 10% of participants acting by writing to newspapers or local politicians (Tiplady, Walsh, and Phillips 2013). Similarly, while viewers expressed concern for livestock experiencing poor welfare, this did not necessarily impact consumer behaviour. Tighe et al. (2019) found that Australian consumers were more likely to be influenced by economic, social, and seasonal factors, and not necessarily by exposés of poor welfare in the live export industry. A follow-up survey by Tiplady, Walsh, and Phillips (2015) one year after their initial study on 15 of the original participants; overall, despite the disturbing content, participants would prefer to watch such footage and have cases of animal cruelty exposed rather than being sheltered from them.

Handlers and stakeholders in the livestock industry regularly make critical choices that directly impact on animal welfare during transport. Understanding the attitudes of stakeholders in importing countries, including factors that motivate them to improve welfare, can lead to improved trade relations and improved animal welfare (Sinclair, Zito, and Phillips 2017). A 2018 survey of live export industry workers ($n=265$) described their understanding of animal welfare and reported positive attitudes about their workplace. Respondents demonstrated a good understanding of animal welfare, displayed positive empathy toward

livestock, with almost all (97.7%) in agreement that livestock should be treated with respect and 63.4% provided descriptions of welfare improvements they had undertaken in the past (Willis, Dunston-Clarke, Keating et al 2021).

A 2015 Australian survey of 921 participants (comprised 30% from the public who identified as animal welfare advocates, 44% from the public as non-advocates and 26% live export industry workers) described stakeholder opinions of livestock welfare in the export industry. Members of the public were more concerned about livestock welfare than industry workers and held the least amount of concern for livestock at Australian feedlots as compared to all other sectors of the supply chain. For monitoring livestock, the majority of the general public participants believed that data should be collected by independent welfare officers, with results made public and used for industry regulation, and in cases of poor welfare, enable penalties to be enforced. Conversely, live export workers believed that welfare monitoring should be collected by industry workers, be kept confidential and be used for self-regulation (Fleming, Wickham, Barnes, et al. 2020). Another Australian public survey ($n=522$) was performed before and after the exposé of sheep heat stress during a 2017 voyage. Prior to the exposé, most participants stated they believed they were familiar with the live export industry, more felt negatively than positively towards the industry, but a quarter reportedly had no feelings. While many thought the trade should end, 40% reported that cessation of the trade would be dependent on ethical and animal-based factors, with the majority of these based on support for Australian farmers and the economy. After the exposé, while many expressed sadness, anger and empathy for the animals, it did not greatly impact previous opinions of the trade, other than fewer participants stating that cessation of the trade was dependent on ethical and animal-based factors (Sinclair et al. 2018). A 2019 Australian industry survey found that of the 4,830 participants, 72% agreed that the live export trade is economically important, while 67% agreed that cessation of the trade could result in production areas suffering economic hardship (Voconiq 2020). This shows the community understands that livestock export is financially important to producers and the Australian economy. When asked whether the trade should be stopped, 37% disagreed, 28% responded neutrally and 35% agreed with the statement, indicating the community is divided and that cessation of the trade is not a simple action with strong consensus. Despite this division, 33% of participants were found to have low trust in the industry, which extended to Australian and foreign governments. This indicates that the industry and government regulators need to take steps towards greater transparency of the trade to improve the social licence to operate. In the same survey, treatment in Australian domestic processing facilities was considered to provide better treatment than processes in overseas markets (67% agree), with 62% of participants agreeing that animal welfare standards in foreign markets do not equate to those in Australia. Only 43% of participants agreed that animals were treated appropriately during live export from Australia, indicating that the community is not confident about the adequacy of livestock welfare. While respondents understand that the export of livestock is important for food security and improving the diets of people in importing nations, 77%

agreed that ‘it is never acceptable to lower animal welfare standards for religious or cultural reasons’ (Voconiq 2020).

These surveys indicate that while the Australian public has witnessed many adverse welfare events within the live export trade, they remain unclear whether the trade should continue. This is not surprising considering there are social, economic, cultural, and religious aspects influencing people’s perceptions of animal welfare and their feelings towards the trade. A large gap exists between cultural and religious customs, and how certain practices, especially around slaughter, are perceived. While most stakeholders are unified in their adverse feelings towards animal cruelty, there is often low agreement on the actions required to prevent reoccurrence. In 2020, members of the Australian industry took initial steps towards greater transparency through The Livestock Collective, developed to provide a platform to share information from various sectors of the supply chain to the public (The Livestock Collective 2020). It is clear that as societal concern for ethical animal production systems continues to grow, demand for evidence of improved outcomes, not just stated commitments to improve, will be required if the social licence to operate is to be retained and for the trade to continue.

COMPLEXITIES OF THE TRADE: ECONOMICS VERSUS ETHICAL REASONING

Significant populations of people live in environments that are unsuitable for large-scale livestock farming as a result of a poor climate or non-arable terrain, and with significantly poor socio-economic status. Thus, a broad range of global trade consisting of approximately two billion live animals per year and their products has ensued. Over the last millennia, the capacity to produce animals for other nations to eat has accompanied a country’s degree of development (Phillips 2015). Heavily populated countries like China and Saudi Arabia provide a growing demand for high-quality food that can be produced in developed nations that utilise extensive and intensive animal production systems. However, this increased trade in livestock does not necessarily equate to improved diets for the world’s poorest communities but rather may feed the growing middle-class around the world (Phillips 2015). Australia exports approximately two million head of livestock annually, mostly to Asia and the ME, and an analysis from a One Welfare approach is critical if the trade is to be sustainable. Solutions across industries, societies and cultures can be compared and analysed. Even with incomplete data, science’s influence on policy solutions to social problems, such as animal welfare, can be compelling (Colonius and Earley 2013). As previously discussed, veterinarians have the skills required to lead teams to oversee and mandate the correct sourcing, and management during the journey and slaughter of animals. Ultimately, global guidelines are the first step, but unless there are internationally agreed standards regulated at a national level or the adoption of one system or the same level of legal oversight, there can be no guarantee that adverse outcomes will not occur.

Given a live export consignment is a trade of live commodities across countries, significant ethical challenges arise when there is marked difference in the

beliefs of animal rights, the enforcement of animal law and the social, economic, and political standing between one country and its trading partner. Trade in live animals can bring substantial financial benefits for exporters and importers (Schipper 2013), but it requires the trust and goodwill between both trading partners, as well as community support in democratic countries. Questions arise as to whether people in countries with good rainfall, fertile soils and stable government systems have a duty to contribute to the provision of food to those who either cannot support themselves or who are negatively influenced by poor political and trade decisions that hinder their ability to prosper. Equally, what is the best way for citizens who uphold high ethical beliefs about the treatment of animals to share their views on the management of animals in other sovereign countries? The answers are likely to come from dialogue seeking the common ground and reaching practical agreements between nations on global welfare standards.

Assuming a One Welfare approach is adopted, and these shared duties exist across borders, to what extent can they be enforced? The negotiations between countries will be unique for each trade route, as each consignment requires consideration of different political, economic, cultural, and religious backgrounds, which are in addition to the varied climatic and resource challenges that face livestock trade in different regions. Should rules be enforced and apply only for the handling of the imported livestock or for all livestock? The adoption of preferred handling and practices that safeguard animal welfare (such as use of well-designed facilities and stunning at euthanasia) result in less stressed animals and better-quality meat, this may lead to the widespread adoption of better practices throughout the importing country. However, it is likely that this change will not occur at a sufficiently fast pace and require targeted discussion among community leaders. Should there be dialogue by invitation, or a more directed narrative written from leaders in the country supplying the animals to those receiving them? Unlike other areas of concern for farm animals where market-driven changes may result in direct improvements in how the animals are raised (e.g. the sale of non-mulesed wool), concerns for animals in the Australian export trade may not be reflected by those importing them. To address this, the Australian government has attempted to safeguard Australian animals by restricting the supply of livestock to those companies who implement ESCAS. Notably, the difficulty is that the level of animal welfare concern is opposite to the direction of travel as animals are shipped and processed in offshore markets (Fisher 2013). The Australian public has clearly demonstrated high levels of concern, but with no buying power, their influence on the management of exported livestock on vessels and on foreign soil is minimal. The implementation of ESCAS requires the industry to demonstrate livestock traceability, that animals remain within a controlled supply chain up until the point of slaughter, and that they meet health and welfare requirements. Livestock exporters are keenly aware of the threat to their industry arising from perceptions of, or real events depicting poor standards of animal care. However, the reality is there is an inability to prevent animal leakage from the approved chain, hence the risk of mistreatment of animals remains, and the agreed global standards are often lower than what Australian animal

welfare organisations would agree on. Adopting a One Welfare framework is a possible solution, with a panel of experts including veterinarians, animal welfare experts, vessel masters and exporter representatives that demonstrate a shared vision and commitment between importing and exporting nations. Strong leaders can build trust and assist poorer nations to identify limitations in their facilities or animal handling systems, and aid in new designs and stock handler training. The OIE has been exemplary in facilitating animal welfare guidelines and seeking agreements via regular meetings and training sessions among member nations' agricultural ministers or their delegates. Frequently these programs have been led by veterinarians. Without such collaboration, the inability to enforce Australian laws beyond our borders will remain a significant challenge to live export sustainability. However, even if all of this is achieved, could the social licence to export livestock ever be repaired? Risks of poor health and mortality exist under all animal production types and regardless of mitigation strategies, adverse events occur. While the desires of stakeholders at either end of the argument will never align, can a middle ground ever be reached where the risks associated with live export are mitigated enough to allow the trade to be justified?

CONCLUSION

As human populations expand, the demand for high-quality meat increases, and the trade of animals and animal products is likely to continue. The live animal trade is complex and can bring financial benefits for importers and exporters, however, it requires international trade and animal welfare agreements, trust and goodwill between both trading partners, and community support. With sentience in livestock now widely accepted, and animal welfare a major social concern in Australia, community values and expectations of welfare standards in exporting countries are high, and being projected upon importing countries. Gaining societal support for the continuation of the trade will require a change of thinking by industry and will only be possible if all animal welfare concerns are addressed and welfare proactively demonstrated. Although industry maintains it currently manages welfare to the highest standards, it needs to be independently verified. A One Welfare approach offers a new vision to promote key global objectives and networking in animal welfare policy which may improve productivity through a better understanding of the value behind high welfare standards. With collaborative veterinary oversight, operating at both the community and global levels, and further research on the impact of ship factors on livestock, the industry has the opportunity to demonstrate continuous improvement. However, by rethinking their shared interests, governments and industry must work together to develop new global regulations commensurate with the level of social concern.

SUMMARY OF KEY POINTS

The trade of animals between countries is long standing but it currently faces animal welfare scrutiny and creates ethical dilemmas spanning across cultures. It requires

a balance between the need to provide safe animal protein to people in countries with limited ability to produce their own food, with the need to ensure livestock are provided with a life worth living. It is predicted there will be increased trade between countries with surplus product to those with deficits, such as to countries across Asia, the ME and Africa. Such continued demand should be accompanied by a collaborative One Welfare framework to promote animal welfare, food security and the protection of ecosystems. Animal welfare science has identified physical and psychological challenges exist for animals travelling long distances by sea, particularly when travel requires them to cross varying climates. Australia is one of the world's largest exporters of live animals and has contributed significantly to improving animal welfare in destination countries and thus, is well placed to lead industry changes.

Using a One Welfare framework to improve animal welfare and human well-being across the globe requires a collaborative approach where the role of the veterinarian is critical. Further investment in research on monitoring and reporting of animal welfare is needed to gain a greater understanding of the impacts on animals, and if the risks can be mitigated to a level that satisfies the wider community. It should be noted that despite further changes, the industry may never be viewed as humane to some stakeholders, such as animal activists.

A veterinarian's professional experience in dealing with stakeholders who have competing interests, combined with their technical expertise in livestock health and management makes them a valued member of collaborative teams that link industry, government, and export companies. Governance by global animal welfare standards, such as those set up by the OIE, is the ideal means of protecting animals on foreign shores, but it will likely be slow to achieve consensus about enforcing standards by all trading partners. Developing the shared understanding of the animal welfare concerns, not directing blame, will drive early changes to adopt minimum standards. However, in the meantime, without such collaboration, the inability to enforce Australian laws beyond our borders will remain a significant challenge to live export sustainability.

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