UFAW Animal Welfare Series

Companion Animal Care and Welfare

The UFAW Companion Animal Handbook

Edited by: James Yeates

WILEY Blackwell

Companion Animal Care and Welfare

The Universities Federation for Animal Welfare

UFAW, founded in 1926, is an internationally recognised, independent, scientific and educational animal welfare charity that promotes high standards of welfare for farm, companion, laboratory and captive wild animals, and for those animals with which we interact in the wild. It works to improve animals' lives by:

- Funding and publishing developments in the science and technology that underpin advances in animal welfare;
- Promoting education in animal care and welfare;
- Providing information, organising meetings and publishing books, videos, articles, technical reports and the journal Animal Welfare;
- Providing expert advice to government departments and other bodies and helping to draft and amend laws and guidelines;
- Enlisting the energies of animal keepers, scientists, veterinarians, lawyers and others who care about animals.

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Sir Peter Medawar CBE FRS, 8 May 1957

Nobel Laureate (1960), Chairman of the UFAW Scientific Advisory Committee (1951–1962)

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Foreword

Humans have kept animals as pets for at least 12 000 years, but possibly for much longer. During this time, most animals were kept for practical reasons as farmed animals for food or as working animals, but we know that pet keeping was widespread in recent hunter-gatherer societies, suggesting it may well have also occurred in Palaeolithic societies. In other words, many people just seem to like having an animal around. Keeping, feeding, and caring for animals can be a substantial cost, and until recently, it tended to be the better off who kept companion animals. Today, however, the practice is becoming much more widespread, and the number of companion animals throughout the world is increasing dramatically.

The vast majority of those people who keep companion animals do so because they have a love of animals. Most wish to keep them healthy and happy, and indeed, many treat their pet as a member of the family. However, it is all too easy to misunderstand animals' needs and to make mistakes that result in poor welfare or suffering. Although companion animals may be treated as one of the family, animals are not humans, and their needs are often quite different to those of humans. The fact is, that keeping and caring for animals properly requires knowledge gained through experience, research, or education, and it is not just owners who need this information. Others such as veterinarians, shelter and quarantine staff, and those responsible for setting or enforcing standards all need to understand how to meet companion animals' needs.

The Universities Federation for Animal Welfare (UFAW) was founded with the intention of using science to inform our understanding of how to care for and meet the needs of animals and, for many years, UFAW has produced handbooks on the care and management of animals used in research (first edition 1947) and farm animals (first edition 1971). In these 'handbooks', which have developed into quite heavy tomes, experts in the field sift and synthesise the available specialist and scientific knowledge to provide authoritative and accessible advice for those at the sharp end who have to make practical decisions on the care of these animals. We were therefore delighted when James Yeates approached us and offered to add to the series by producing a handbook using the same approach for companion animals. Yeates has already written a book for the UFAW/Wiley animal welfare series on Animal Welfare in Veterinary Practice and is

eminently qualified to carry out this task, with a well-established academic interest in ethics and animal welfare.

Yeates has brought together experts from around the world to contribute chapters on a wide range of species and species groups, providing information on their natural history, husbandry and health, and signs of poor welfare. He also addresses the practicalities of euthanasia – a difficult and painful subject for many pet owners and veterinarians – but essential to avoid unnecessary suffering. The chapters also include suggestions for improving the welfare of the species or groups of species, providing some useful ideas for long-term strategies to improve the welfare of companion species through, for example, education, changes to legislation, or development of better products.

We are extraordinarily grateful to James Yeates and to the chapter authors who have put so much hard work and their expertise into a volume that, we hope, will improve the welfare of millions of animals around the world.

Robert Hubrecht
UFAW

April 2018

Prologue

This book aims to be a comprehensive and practical reference for everyone who cares about how we should care for our companion animals. Since 1926, Universities Federation for Animal Welfare (UFAW) has improved animal welfare through its publications, which are both robustly informed and engagingly readable. To date, UFAW publications have predominantly focused on farm and laboratory contexts, and the UFAW Farm Animal and Laboratory Animal Handbooks are now illustrious, popular, mainstream references and essential reading for all involved in animal welfare science, policymaking, and practice.

People are now beginning to give more attention to the welfare of companion animals because the animals are an increasingly important part of modern society. Pet keeping appears to be growing in popularity, acceptability, stature, and economic impact in many countries, with an estimated 202 million cats and 171 million dogs worldwide. In many Asian and African countries, pet keeping is only recently growing in popularity, but with limited 'folk wisdom' about pets' needs. In many American and European countries, the popularity of pets has generated multibillion-dollar industries based on traditional misinformation and pseudo-scientific fads, and it is only now being realised that owners' love does not make pets' lives a utopian ideal and that many welfare compromises are mainstream. Indeed, ignorance may be less dangerous than its progeny, misinformation. In many countries worldwide, there is an increasing awareness that pets (like spouses and children) are not things whose treatment can be considered merely a 'private' concern. And in many of the same countries, animal welfare is growing as a societal concern in general. These changes make it essential to critically examine pet keeping and to determine how pet breeding, care, and trade can deliver the best animal welfare outcomes.

Consequently, companion animal welfare is an area of increasing scientific investigation because researchers have begun to reflect and satisfy that need. There is growing international literature on companion animal welfare within veterinary, ethology, and clinical animal behaviour texts, as well as more 'popular' guides. At the same time, our most august institutions are turning to companion animal welfare – for example, the relatively new Companion Animals Department in the RSPCA. Therefore, there is a

demand for accessible scientific information about companion animal welfare and a *supply* of such information, but not yet in a form that is scientific and accessible for owners and policymakers. It is that gap that this book aims to bridge.

This created some challenges for the book. It is a book based on science, not mere opinion. So as editor, I've tried to keep to the rule that readers are given only facts for which there is convincing supporting evidence (albeit always with the risk of new information challenging those facts) or where doing scientific studies would be inappropriate (either because of the harm to animals or the waste of resources). But guidance on what *should* be done cannot be solely scientific because guidance relies on expertise. I've prevented authors from quoting others' guidance (i.e. most references are to scientific studies or similar, rather than merely referring to others' opinions), especially because I've chosen some of the most informed and expert scientists on the planet to write for this book. Other good sources of expertise are given in the references section, which can be taken as 'further reading'. Such scientific information needed to be presented without oversimplification or technical terminology (I have never understood the need for experts to replace everyday words with technical phrases – especially as the latter often just use either the ancient Latin or Greek everyday word or use another English everyday word in an esoteric way). One deliberate exception to the latter is that each chapter uses both the everyday and scientific names of animals and their groups, to serve as a reminder that pets are still animals that evolved most of their biology long before we existed (although, of course, we are animals, too, who share much of that biology). At the same time, the book needed to avoid overly focusing on basic biology or veterinary health issues to cover all welfare issues.

Writing the overarching chapters on biological groups ('Birds', 'Reptiles', etc.) was a particularly difficult task of providing valuable overviews as a starting point, while recognising the wide variety within each biological group. Readers should note the strong caveat that there can be substantial differences even between closely related species; more specific chapters, then, focus on particular companion animal species (hence, the somewhat esoteric examples used where readers' own minds will be screaming better examples for more common pets). More generally, readers may be well advised to dip into particular chapters, albeit always with reference to the overarching chapters both overall (Chapters 1 and 22) and for those animals.

The choice of which species to give their own chapters was particularly tricky. Essentially, this book focuses on companion animals that are (i) commonly kept, (ii) not clearly unsuitable for keeping, and (iii) where there is sufficient scientific information to make an informative science-based book. These three factors inter-relate insofar as there is more information on popular pets and more information can lead to greater suitability, and popularity may have enhanced domestication. I thought about limiting the book to animals that are domesticated 'enough' to provide genuine mutual companionship, but I did not want to exclude popular species who can suffer considerably. My final rule of thumb was to include animals whose knowledge of their pet care will increase and exclude (or at least not explicitly include) rare and unsuitable animals of which I personally hope our knowledge about them as pets will be replaced only by knowledge of them as wild animals, such as amphibians, invertebrates, marsupials, pigs, primates, and pygmy hedgehogs. Perhaps specialist individuals may continue to keep these animals, but that is different to their being 'pets' kept by 'normal' members

of the public. Indeed, one argument to limiting the species allowed to be kept is to focus on generating and disseminating knowledge on those animals, and I suggest that the animals in this book provide a basis for such a 'positive list' as well as kick-starting that knowledge generation and dissemination. This is not to say that the animals in this book are 'easy' or cannot suffer considerably, but simply that they are ones that debatably can be kept in captivity by (and only *by*) people who are sufficiently knowledgeable, committed, and resourced.

My enormous thanks to all the authors for their time – especially with my less-than-subtle timekeeping pressures. All these authors are busy people (part of being so illustrious) and have prioritised this work because of the immense potential influence it can have on improving animals' lives. In particular, my thanks for the information they gave for the overarching chapters. Specific thanks to the authors, both for their chapters and for their contributions for the overarching chapters (all the interesting bits are from them; all the errors my own). Thanks to the anonymous reviewers and the identifiable ones who assisted various authors: Vera Baumans; Emily Blackwell; John Bradshaw; Rachel Casey; Samantha Gaines; Maggie Jennings; Maeve Moorcroft; Christopher Newman; Anna Olsson; Russell Parker; Clifford Warwick; John Webster; Katie Wonham, and particularly Jane Tyson and Nicola White.

As John Webster said in the foreword for the Farm Handbook: 'caring *about* animals is not enough. Caring *for* them is what matters. This requires compassion, understanding and a great deal of skill.' With the different (sometimes) human-animal relationships for companion versus farm animals, this book uses the term *care* more than *management*, but both ideas apply equally to each context. This book seeks to promote the best possible care of our companion animals. It provides the most comprehensive, accessible, and up-to-date guide available, covering, chapter by chapter, the husbandry and care of all major companion animal species from hamsters to horses to fish to amphibians. The book identifies what their needs are, how we know what their needs are, and gives clear advice how those needs can be met. Overarching chapters also provide fresh understanding of animal welfare science, ethics, and the role of society in ensuring the best possible care of companion animals. Owners also need compassion, temperance, self-awareness, resources, and knowledge. This book can help with the last.

James Yeates

Introduction: The Care and Animal Welfare of All Species

1

James Yeates

1.1 Introduction: Concepts in Companion Animal Welfare

Owners have a duty of care to their companion animals. This is an ethical obligation, a vital part of good owner-pet relationships, and a legal duty in many countries. The broad aim of this book is to provide an introduction to the welfare of companion animals. This chapter covers the key concepts in animal welfare, general principles of care, and signs of welfare that can, and should, be applied to our pets. Given the wide range of animals kept as pets and the limited amount of scientific data on some animals, this book focuses on certain groups of animals. For other animals, owners can use Chapters 2, 6, 12, 14, 18, and 22 or cautiously apply data from similar species. However, this chapter provides general guidelines that can apply to all species.

1.1.1 Natural Histories

Pets are *animals* and so are members of species with wild or feral relatives that may share many characteristics with their captive counterparts. We can therefore use information about animals' natural biology and motivations to predict what pets need (in practice, this may sometimes be difficult when wild populations are rare or extinct). Where this information exists, it needs to be used intelligently, and there are several

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caveats to consider. First, animals may suffer welfare compromises while in the wild that owners should *not* replicate (e.g. predation and disease). Second, animals' motivations and needs may depend on their personal experiences and learning (e.g. natural early life experiences) and the captive environment in which they are kept (e.g. animals may need extra ultraviolet [UV]-B or vitamin D supplementation to compensate for insufficient sunlight). Third, many animals have been altered significantly from their wild ancestors, and animals kept as pets may have needs that differ from those of their wild ancestors (e.g. an altered tolerance of human company or a need for medical care to treat breed-related diseases).

1.1.2 Domestic Histories

Pets are also *companions*. Humans have kept pets for at least 12 000 years (Serpell 1986), and some species are popular and widespread (Table 1.1). Some companion animals have been adapted to human company or captivity by 'domestication' through selective breeding and 'taming' through exposure and training. Knowing about this history may also help to determine what care these companions should receive. However, this information also needs to be used intelligently, and there are other caveats to consider before trying to domesticate or tame animals. First, animals may suffer welfare compromises during those processes (e.g. as a result of dystocia, fear of humans, starvation, or separation from their mother). Second, changes from artificial selection are not necessarily associated with improved welfare (e.g. breeding animals for different colours may be irrelevant to their welfare, and some breeding may create breed-related diseases). Third, selective breeding may mean animals have particular needs that are harder to meet (e.g. stronger motivations for company).

1.1.3 Sentience and Welfare

The expression *animal welfare* has two distinct uses. The first is a factual description of what animals experience. The second is an ethical prescription of what animals *should* experience. These two concepts overlap because we are concerned with understanding how our actions can harm or benefit animals. There are several different concepts of animal welfare. A classic division is among 'feelings', 'function', and 'naturalness' (Fraser et al. 1997; Fraser 2008). *Function* refers to the efficiency and effectiveness of biological processes, with particular regard to deviations from normality, disease, and injury. *Naturalness* refers to how animals live unaffected by human control. *Feelings* are subjective experiences of sentient animals.

Sentience may be defined as the ability to experience 'feelings that matter' (Webster 2005). These include affective feelings (e.g. pain and pleasure), motivations (e.g. wanting something), or moods (e.g. depression or happiness). Such feelings might matter more if they are more intense, long-lasting, or frequent. Ultimately, companion animal welfare is about whether pets suffer or are happy, although scientific papers often avoid those terms.

Animals' feelings depend on the interaction between each animal and their environment. The external environment acts on various senses (usually mediated by chemicals, movement, or electromagnetism) and animals' bodies stimulate other senses (e.g. gastric stretching and proprioception). These external and internal inputs prompt various responses that may be pathological (e.g. diarrhoea), physiological (e.g. stress hormone

Table 1.1 Estimated pet populations worldwide.

	Approximate Estimated Numbers (in Millions) of Owned Pets (2011–2016)								
Group	Australia	Brazil	China	Europe[b]	Japan	New Zealand	South Africa	UK	USA
Carnivorans[a]	8	45	80	185	21–25	2	9	17	145–179
Glires[a]	—		—	27		2		2	18
Ungulates[a]	—		—			3		0.4	8
Birds	5		—	55		5		2	21
Reptiles[a]	—		6	7		—		1	12
Amphibians	—		—			—		0.2	—
Fish	11		—	17		9		40–45	159
Humans	24	200	1382	508	126	5	55	65	324

Source: American Health Alliance (Australia) (AHA 2014), American Pets Product Association (APPA 2014), Caixong (2015), Dray (2016), European Union (EU 2016), European Pet Food Industry Federation (FEDIAF 2017), Goldman Sachs (2014), New Zealand Companion Animal Council (NZCAC 2011), Pet Food Institute (PFI 2014), Pet Food Manufacturers Association (PFMA 2014), Zenoaq (2008).
[a]Carnivoran figures based on reports on cats and dogs numbers; Glires figures for New Zealand are specifically for rabbits; Ungulates figures generally exclude 'farm' or 'working' animals (i.e. often relate to horse numbers); Reptile figures for China are specifically for tortoises. All figures to nearest whole million (except where less then 1)
[b]Historic figures for Europe include the UK (accepting the discrepancy regarding fish).

levels), or behavioural (e.g. aggression). These responses may then alter the animal's environment (e.g. scaring off a competitor) and internal states (e.g. filling their stomach). These changes may, in turn, further affect the animal's future interactions with their environment. Such perceptions and responses may be associated with pleasant or unpleasant feelings.

Exactly what feelings each animal experiences, and how they respond, may depend on their particular needs, senses, and cognitive processes – and these may depend on their species, breed, age, sex, reproductive status, personality, abilities, learning, and personal preferences. This means animals cannot be treated as all the same. It also means there is debate about what forms of suffering different animals may experience and when. In fact, the ability to experience suffering need not actually require a high level of conscious cognitive reasoning, and there is increasing scientific evidence of subjective feelings such as pain in reptiles (e.g. Liang and Terashima 1993; Bennett 1998), amphibians (Machin 1999), and fish (e.g. Sneddon 2011, 2013). The evidence for invertebrates is less clear, but all pets should be given the benefit of the doubt (Figure 1.1).

The fact that all species differ in how they interact with their environment may also limit our ability to understand how other animals may be feeling. Our experiences of the world are probably different to our pets'. Animals' senses may have greater sensitivity (e.g. the ability to detect low concentrations of chemicals or quieter noises), extend outside humans' ranges (e.g. the ability to detect UV, infrared, ultrasound, and infrasound) or be senses that humans lack completely (e.g. the ability to detect particular chemicals or magnetic fields). Animals' responses may also differ, depending on their mental processes and their natural motivations. This makes it important to observe animals carefully, to avoid oversimplistic or uncritical anthropomorphism, and to have our views constantly challenged by ongoing scientific findings.

Figure 1.1 Pet invertebrates such as Giant burrowing cockroaches (*Macropanesthia rhinoceros*) should be treated as if they may suffer (*Source:* courtesy of Robert Johnson).

1.1.4 Stress and Suffering

Animals may be subjected to challenges, such as infections or the presence of potential predators. Within animal welfare, the term *stress* is used in a strict physiological sense, but in everyday language it is also used to refer to an unpleasant feeling. A stress response is related to a particular challenge and may not be associated with poor welfare as defined by feelings. Animals may attempt to adapt to challenges in their neurological (e.g. activation of the sympathetic nervous system), hormonal (e.g. secretion of glucocorticoids), immune (e.g. production of antibodies), or behavioural (e.g. elicitation of aggression) processes – all of which may or may not be associated with subjective experiences. Some responses return the animals to a set normal point (e.g. blood oxygen levels), but some lead the animal to a change (e.g. to survive periods of decreased food availability or low temperatures). When the animal's body is unable to re-establish acceptable levels, the animal's welfare may be seriously compromised.

Of particular significance to animal welfare are general physiological responses, including the release of hormones (e.g. cortisol, corticosterone, and noradrenaline), altered (e.g. heart rate), and associated changes behavioural changes (e.g. readiness for flight). These responses may occur in a wide range of situations and may also have a wide range of short- and long-term biological effects. However, the exact responses an animal makes may depend on the nature of the challenge (e.g. Maier and Watkins 2005; Lucas et al. 2014) and the animal (e.g. NRC 2008). For example, an animal's immunity may depend on the type of infection, animal (e.g. mammal versus reptiles), the animal's previous exposure (e.g. after vaccinations), and the presence of other challenges (e.g. malnutrition or pregnancy). This makes it impossible to find a single measure that universally and definitively indicates the absence or presence of stress in the everyday sense of poor welfare.

Responses may allow the animal to adapt to the challenge (e.g. by flight) or to reduce its effects (e.g. by forming an abscess around an infection). Over time, animals may get better at meeting repeated challenges, through learning or adapting their physiology (e.g. their bone density, hormonal sensitivity, or immune system) or behaviour (e.g. through learning). Some unpleasant challenges may therefore help animals to cope with future stresses in the long term. Concern for companion animal welfare therefore does not mean that pets should never be challenged, but that the challenges should be the right ones, with which the animal can cope.

However, companion animals may be unable to cope with challenges if they are too severe, multiple, unpredictable, or uncontrollable; if the animal lacks particular capacities (e.g. juveniles may be immunologically or psychologically naïve); or if owners prevent them from responding (e.g. by confinement or limited resources). Others may face chronic or cumulative stress, which may lead to harmful changes such as muscle break down, gastric ulceration, and skin problems or to animals learning *not to* respond because previous attempts have proved useless.

In everyday language, *suffering* is a general term (like 'enjoyment') that includes a wide range of different unpleasant feelings. More specifically, pain is an unpleasant sensory and emotional experience usually associated with actual or potential tissue damage. Fear is an unpleasant psychological emotion, usually associated with an actual or potential threat to the individual (although some fear occurs without real threat, e.g. in some hyper-anxiety syndromes). Malaise is the feeling associated with illness

(in addition to any more specific feelings such as pain, nausea, etc.). Frustration is the feeling from unsatisfied motivations. Boredom is the feeling directly associated with a lack of challenge, interest, or stimulation.

The amount of suffering might be considered in terms of intensity, duration, number of animals affected, and frequency, while recognising that it is ultimately a subjective experience. Nevertheless, it is possible that animals may suffer while attempting to cope with challenges and may suffer more if they cannot cope or if challenges are sustained. Some processes may make animals more sensitive to suffering, for example when animals' injuries make animals more sensitised to pain or induce depression-like or anxiety-like moods. Conversely, drugs may also alter animals' propensity to suffer; for example, medical painkillers may reduce pain and tranquillisers may reduce anxiety.

1.1.5 Achievement and Enjoyment

Keeping pets is not all about avoiding them suffering. Owners want their pets not merely to cope but to flourish and to experience pleasant feelings. Animals may have positive motivations to achieve an outcome such as obtaining palatable food. They may experience short-term feelings of pleasure or enjoyment or longer-term moods that make them tend towards perceiving stimuli as positive (e.g. optimism). Such positive welfare may be associated with everyday sensational pleasures: engaging with their environment, their conspecifics, and their handlers and realising their own goals (Yeates and Main 2008). Many animals appear to play, including reptiles (Burghardt 2013) and fish (Burghardt 2014a, 2014b; Burghardt, Dinets, and Murphy 2014), and this may be associated with enjoyment.

Animals' capacity for pleasant experiences may relate to their genetics (Yeates 2010), although all species in this book can probably have enjoyable experiences. Capacity for pleasant experiences may also depend on animals' individual histories. Some processes may make animals more or less sensitive to pleasant experiences (e.g. optimistic cognitive biases) or to particular motivations (e.g. a pet may learn to associate human company with food). Perhaps most importantly, animals' enjoyment may depend on their opportunities to engage with rewarding stimuli. Animals need resources to be provided and not to be too inexperienced, scared, or ill to interact with them.

Often, pleasant experiences occur in the absence of suffering (Fraser and Duncan 1998; Spinka et al. 2001). Conversely, some positive experiences may reduce suffering, by improving animals' biological functioning and ability to cope with challenge and stress (Pressman and Cohen 2005; Kikusui, Winslow, and Mori 2006). Sometimes minor challenges may lead to pleasant experiences, for example in relief or the enjoyment of learning, and some stressors may be beneficial (e.g. Selye 1975). In other cases, achieving pleasant experiences may lead to later suffering; for example, the short-term enjoyment of high-energy foods may cause later obesity, and these competing issues need to be balanced.

1.2 Principles of Companion Animal Care

Humans determine most aspects of our pets' lives: often including their parentage, diet, environment, transportation, company, reproduction, health care, and death. Animals are given certain resources while being prevented from obtaining others.

This control makes it important for keepers to get it right by adequately meeting animals' needs while they are in the keepers' care.

Animals' needs may be considered using a framework such as the Five Freedoms. These were produced for assessing farm animal welfare but are also useful for companion animals if used alongside considerations of positive welfare and human company (Table 1.2). For each principle, there are a number of potential 'hazards' (good or bad) that risk suffering or enjoyment (Table 1.3). These are the bases for the principles around which this book's chapters are laid out. However, each principle cannot be considered in isolation because animals' needs may interact in complex ways. For example, how animals use environmental resources may depend on other animals, particularly if there is competition (e.g. in overstocked aquaria) or if animals are motivated to use facilities together (e.g. in communal nesting). There may also be conflicts between short- and long-term effects (e.g. eating versus obesity or surgery versus illness) or different principles (e.g. long-distance transportation versus being left at home alone). Mammals, birds, reptiles, amphibians, and fish are complex organisms with complex needs, which may depend on their species, personal history, and individual characteristics.

So how can keepers decide what is needed to meet animals' dietary, environmental, health, psychological, and other needs? There are three main approaches:

1) The first is to decide on specific provisions (e.g. providing hay to all rabbits).
2) The second is to let animals choose from a range of options (e.g. giving reptiles a thermal gradient).
3) The third is to assess the outcomes from the care given (e.g. monitoring body condition and behaviour).

Table 1.2 Five Freedoms and five opportunities.

Five Freedoms and Provisions	Five Opportunities and Provisions
Freedom from hunger and thirst – by ready access to fresh water and a diet to maintain full health and vigour	***Opportunity for dietary preferences*** – by provision of a varied diet from which to choose
Freedom from discomfort – by providing an appropriate environment and a comfortable resting area	***Opportunity for control*** – by allowing the achievement of motivations that alter the animal's environment
Freedom from pain, injury, and disease – by prevention or rapid diagnosis and treatment	***Opportunity for pleasure, development, and vitality*** – by providing enjoyable and beneficial interactions
Freedom and Opportunity *to express normal behaviour* – by providing sufficient space, proper facilities, and the company of the animal's own kind	
Freedom from fear and distress – by ensuring conditions and treatment which avoid mental suffering	***Opportunity for interest and confidence*** – by providing conditions and human interactions that allow mental enjoyment

Source: Adapted from Farm Animal Welfare Council (1993); Parker and Yeates (2012).

Table 1.3 Risks and hazards (good and bad) to companion animal welfare under each principle.

Principle	Hazard	Risk	Examples
Diet	Undernutrition	Hunger	Starvation in hibernating tortoises
	Overnutrition	Obesity-related disease	Type II diabetes in cats
	Specific malnutrition	Ill health	Calcium disorders in lizards
	Lack of enrichment	Boredom, frustration	Oral stereotypies in horses
Environment	Insufficient substrate	Frustration, fear	Inability to dig in gerbils
	Glass vivaria walls	Injury and pain	Rostral injuries in dragons
	Lack of security	Fear	Lack of hides for hamsters
	Extreme confinement	Frustration	Zebra finches in small cages
	Unpredictability	Anxiety	Variable light schedules in mice
	Barren environment	Boredom	Unenriched rat cages
	Toys	Play	Dogs playing with ball
Animal Company	Lack of company	Loneliness, fear	Isolation of rabbits
	Bullying	Fear, hunger	Bearded dragons of mismatched size
Human Company	Poor handling	Fear	Rough handling of parrots
	Pleasant handling	Tactile enjoyment	Stroking dogs and cats
Health	Poor hygiene	Infectious disease	Pigeon parasite infections
	Lack of foot care	Pain	Lameness in horses
	No vaccination	Infectious disease	Parvovirus in puppies
Euthanasia	Overhandling	Fear	Overhandling stray cats
	Stressful method	Pain, distress	Drowning kittens or freezing dragons

Which is the best approach depends on how much we can trust our judgement compared to that of the animals'. The first approach may be best when there is reliable scientific information about the necessary resources. The second may be best when the animals have evolved or learned adaptive behaviour. The third may be best when our information needs to be more tailored to the animal. We may also use the third approach to work out what resources to provide in the first two approaches.

This also means we can continuously improve how we care for animals, starting with options we think will be appropriate and then learning more accurately what resources are chosen by animals and are beneficial. We learn more about types of animals through animal welfare science and more about individual animals through interacting with them. Keepers should combine information both from experience and scientific research in determining exactly what their animals need. Keepers may initially give animals a limited range of safe options, then refine them using knowledge of the individual and outcome-assessments. At the same time, we can work out what outcomes to assess by seeing how they change when different resources are provided.

However, given the range of species kept, there is limited information known or available about many animals to make reliably accurate guesses about how to care for them. This is a good reason to keep more common pets. But if rarer pets are kept, what information should owners use? Sometimes it is valid to use information about other animals (e.g. related species or how animals are cared for in zoological and laboratory conditions). Whatever one thinks about animal research, zoos, or nature, pets' welfare should be no worse than that of animals kept for other purposes. Alternatively, it may be best to replicate how those animals' relatives live naturally (Figure 1.2), while also minimising the risks to which wild animals are exposed (e.g. starvation or predation). However, owners' homes usually cannot perfectly recreate animals' natural environments. Owners' homes are set up for humans. They may lack animals' natural climates, ecosystem, and space. It is probably impossible for homes, kennels, or pet shops to meet animals' needs and motivations completely while containing them, especially within cages or tanks (Figure 1.3) – unless their enclosures are made so big and complex that they do not constitute containment. Keepers should therefore minimise any compromises.

Figure 1.2 Shingleback (*Tiliqua rugosa*) in a naturalistic outdoor enclosure (*Source:* courtesy of Robert Johnson).

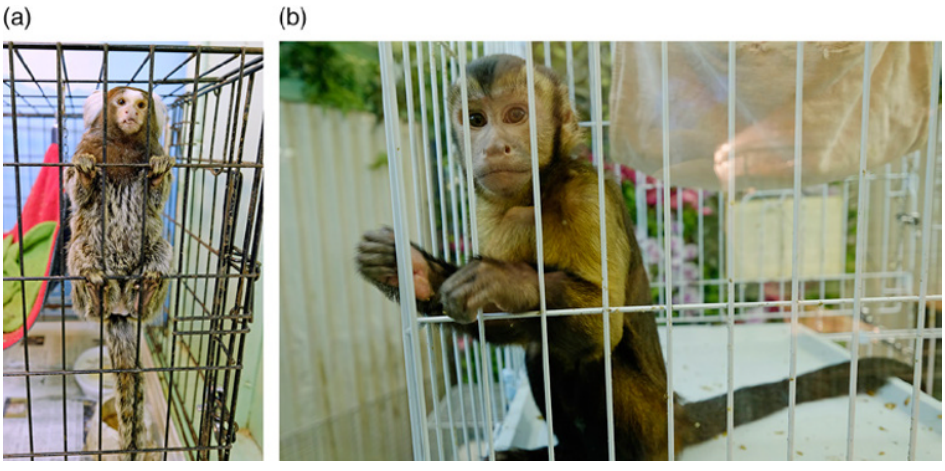

Figure 1.3 (a) Marmoset and (b) tufted capuchin in a pet shop in Hong Kong (*Source:* courtesy of Phillip Wilson).

1.2.1 Diet

All animals need a diet that ensures 'full health and vigour' and satisfies their motivations (Table 1.4). Pet animals may be carnivorous, omnivorous, or herbivorous, with the dietary proportion of meat comprising anywhere from 0% (excepting invertebrates in plants) to 100% (excepting vegetative matter in prey intestines). In general, each animal should take in a balanced supply of nutrients that is:

- Sufficient for the animal to maintain its body and meet any additional demands (e.g. reproduction and exercise),
- Ensures efficient, healthy digestion,
- Avoids excessive hunger and thirst,
- Adequately satisfies the animal's motivations to obtain and manipulate food, and
- Does no harm.

All animals require sufficient vitamins, minerals, amino acids (Table 1.5), and energy to meet their basal metabolic rate (for mammals and birds) or standard metabolic rate (for reptiles and amphibians) to avoid starvation and malnutrition. For example, many species need a particular amount of calcium, often linked to the amount of dietary phosphorus (i.e. the calcium-to-phosphorus ratio), the amount of vitamin D (from the diet or sunlight), and the calcium requirements (e.g. for growth and milk or egg production) to avoid metabolic syndromes that can affect bones and neurological functions (Figure 1.4). Many animals need adequate nutrients, particularly sufficient water and fibre, to allow their intestines to function properly. Animals also need to avoid excesses, both of particular nutrients (e.g. some vitamins, minerals, and carbohydrates) and of energy overall, which may lead to obesity, 'fatty liver', or insulin-resistance syndromes. Obesity often restricts animals' behaviour, particularly reducing exercise, thereby creating a 'vicious circle' of insufficient exercise and increased bodyweight.

Individual chapters have tables of nutritional requirements, where there is sufficient scientific evidence. When owners feed home-mixed diets, it is especially important to ensure

Table 1.4 Aims of suitable diets.

General aim	Specific aim	Example risks of failure
Ensuring health	Adequate nutrients	Starvation Vitamin deficiencies
	Avoids excessive nutrients	Obesity Vitamin excesses
	Is digestible	Gut blockages Poor absorption syndromes
	Matches biological process	Dental malocclusion Gut stasis
	Is safe	Toxicity Intestinal blockages
	Is delivered safely	Injuries from competing animals Food 'poisoning', e.g. salmonellosis
Allowing motivated behaviour	Sufficient quantity and type to satisfy hunger	Severe or chronic hunger Frustration
	Allow behaviours involved in obtaining and consuming food	Lack of appetite Oral stereotypies
	Sufficient 'pleasure' and interest	Inappetance Boredom

Source: Adapted from Webster 2011b.

a balance of nutrients. Alternatively, commercial diets may be available for many species, although they may not state the exact nutritional composition (beyond caloric value and raw protein, fibre, and ash contents). The availability of nutrients from the food also depends upon the nature of the ingredients, the presentation of the food (e.g. pelleting), and the conditions and duration of storage. For those species where nutritional requirements are not well known, the best option might be to offer a wide variety of foodstuffs from which animals can choose. Such a variety may allow animals to select nutritious foods (Manteca et al. 2008). However, animals may also selectively choose an unbalanced diet or food containing toxins, bacteria, or that may cause intestinal blockages in that species.

The principles also relate to how the food is provided, in particular in terms of frequency and method of provision. Although it may be impossible to avoid any feelings of hunger, these should be minimised by providing adequate fibre and feeding frequently often. The methods of provision also need to be suitable for the animal, for example whether they drink water, take it from foliage, or absorb it through the skin (Figure 1.5). Satisfying motivations requires a diet that allows feeding behaviours such as foraging, hunting, obtaining, grazing, manipulating, chewing, and storing food, especially because these motivations may be so strong that animals may choose to perform these behaviours rather than take freely available food. These behavioural needs may be met by activities that encourage physical activity (e.g. playing with toys or foraging) or mental activity (e.g. puzzle feeders and training), and for carnivorous pets, toys should be used instead of feeding sentient live prey.

Table 1.5 Key nutrients for many species.

Nutrient/requirement	Key functions
Energy	Fuel for biological processes, including active physiological processes and behaviour
Protein	Principal structural component of body organs, tissues (e.g. muscle), enzymes, signalling (e.g. hormones), and antibodies Energy production
Essential amino acids	Protein subunits that need to come from the diet
Carbohydrate	Short- and mid-term energy storage Source of glucose for energy and as building block of other nutrients
Fibre	Gut motility and water reabsorption; fermentation to short chain fatty acids and to help provide a feeling of stomach satiation
Fat/Lipid	Essential constituent of cell membranes, long-term energy storage, neuron and body insulation; production of steroid hormones; to allow absorption of fat-soluble vitamins
Calcium	Cellular signalling; ion gradients; body stability (bone and teeth); muscle contraction; blood clotting
Phosphorus	Production of DNA (for cell division), NADPH (for some body-building processes), and ATP (i.e. energy production); acid–base balance; body stability (bone, tooth enamel); muscle and reproductive functions
Magnesium	Skeletal and teeth structure, DNA and RNA metabolism, protein synthesis
Sodium	Acid–base balance, extracellular volume regulation; neuron/synapse functioning
Potassium	Acid–base balance; ion gradients for nerve transmission
Iron	Production of haemoglobin: Enzyme cofactor in O_2 transport and redox reactions
Copper	Production of enzymes (e.g. for respiration); iron metabolism and red blood cell production
Iodine	Production of thyroid hormones
Zinc	Enzyme component, cell replication, skin function, wound healing
Selenium	Antioxidant
Fat- and Water-soluble vitamins	Various enzymatic and transport functions
Water	Main solvent of life processes

ATP, adenosine triphosphate; NADPH, nicotinamide adenine dinucleotide phosphate.

Figure 1.4 Green tree frog (*Litoria caerulaea*) with metabolic bone disease causing a deformed mandible (*Source:* courtesy of Robert Johnson).

Figure 1.5 Magnificent tree frog (*Litoria splendida*) absorbing fluid through ventral drink patch (*Source:* courtesy of Robert Johnson).

Both nutritional needs and motivations may differ, depending on the animal's age, lifestyle, exercise, pregnancy, lactation, and diseases, whereas predation and competition may affect how much food each animal gets. So owners need to feed the right food in the right way. For rarer pets, a useful rule of thumb is to mimic natural diets as closely as possible. For more popular pets, owners can now buy commercial diets for many animals to reduce the risks of major errors or 'food poisoning' (e.g. salmonella

or botulism), although these animals still need to be fed correctly to prevent boredom, dental problems, and obesity. Owners should also monitor each animal's intake, body condition, and body weight and compare these to ideal values, expected growth rates, the animal's normal (seasonal) weight, or generic body-condition scoring systems. They should also look for behaviour and health measures that might suggest malnutrition, disease, or other problems, such as not eating, oral stereotypies, and eating nonfood items.

1.2.2 Environment

Owners should have four key aims regarding their pets' environment:

- To ensure safety: Avoiding threats both real and perceived;
- To maintain hygiene: Minimising the risks of infection and feelings associated with being ungroomed;
- To provide comfort: Facilitating animals' use of their senses, movements, and resting;
- To provide stimulation: Allow (nonharmful) motivated behaviour.

Each should be considered from the owner's and the animal's point of view; animals need both to *be* and to *feel:* safe, clean, comfortable, and stimulated and to minimise disease, stress, and frustration. Better environments may also make animals respond better, physiologically and behaviourally, and thereby cope with other challenges. Various provisions help to meet these needs (Table 1.6).

A general environmental requirement is sufficient three-dimensional space. All animals need sufficient space to stretch to their full length in all dimensions and for enough movement and exercise. For many animals, this includes swimming and climbing. The space also needs to be large enough to allow other needs to be met, such as hiding, digging, burrowing, foraging, scatter-feeding, and company. For example, animals need to be able to maintain adequate distances from one another when they choose, and resources need to be spaced out and positioned to minimise competition. Some animals may not use all the available space frequently; for example, some animals may choose to sleep in contact with one another or to hide within smaller units, but this is not a reason to prevent access to enough space to perform other, less common needs. Indeed, animals should be given smaller shelters in which to hide and feel safely enclosed *within* larger spaces. Many animals may divide their space into different areas (e.g. for eating, sleeping, and toileting).

Within this space, there are certain physical requirements, such as temperature, humidity, ventilation, and lighting. These often interact, for example temperature, humidity, and ventilation interact, and owners need to ensure all three are correct. Physical requirements sound simple, but they can actually be complicated. For example, the right lighting depends on many factors. In many cases, animals should not be given a single ambient climate, but be allowed to choose between different environments. Environments also need to be appropriate in terms of the animals' senses, allowing them to use their senses, avoiding excessive stimulation (e.g. overly loud noises or unpleasant smells), and maintaining some familiar smells. Cleaning therefore needs to ensure adequate hygiene without impoverishing or oversanitising the space.