**Reptile expos: an analysis and recommendations for control**

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**Abstract**

Reptile expos are typically itinerant events at which live wild-caught and/or captive-bred turtles, tortoises, crocodiles, lizards, and snakes are displayed, sold, or exchanged for pet keeping purposes. We conducted a literature review and analysis of reports regarding animal welfare and public health issues of concern associated with the display and sale of reptiles at expos in Europe and North America. We also conducted a limited survey of several relevant government authorities to briefly appraise existing situations regarding governance and law internationally, and performed a further limited examination of online advertisements in order to estimate the number of events. In addition, we conducted an analysis comparing husbandry standards for reptile expos versus other animal display or sale situations using UK formal legal guidance, which adopts the Five Welfare Needs as a basis. Finally, we also conducted a SWOT (strengths, weaknesses, opportunities, and threats) analysis of key features associated with reptile expos. We identified at least 10 animal welfare and 5 public health and safety problems as occurring and endemic to the typical operation of reptile expos. Comparisons between the ways in which animal welfare and public health issues are regarded or managed for reptile expos in relation to, for example, traditional zoos, mobile zoos, and pet sales are stark and concerning, with expos constituting the least protective and potentially most harmful situations out of all captive reptile-keeping scenarios. The lack of monitoring and control of reptile expos, combined with their frequent occurrence, strongly indicates the requirement to urgently control and prohibit these events. We recommend that where reptile expos are already essentially prohibited such bans should be immutable and not subject to any weakening provisions. Where reptile expos are permitted and/or subject to limiting conditions, or where reptile expos are not subject to limiting conditions, then our recommended 40 stipulations and overarching control principles should be applied as interim mitigating measures pending the introduction of prohibitions or ‘bans’. Governments should aim to ensure that enforcement of such measures is robust.

Key words: reptile expo, reptile show, exotic pet market, animal welfare, zoonoses, public health, government control, government legislation

**1 Introduction**

Reptile expos (also referred to as shows, markets, breeders’ meetings, or fairs) are typically itinerant events at which live wild-caught and/or captive-bred turtles, tortoises, crocodiles, lizards and snakes are displayed, sold, or exchanged for pet keeping purposes (Arena et al., 2012; Altherr, 2014; Schoonover, 2019; D’Cruze et al., 2020; Warwick and Steedman, 2021b). Whilst some entirely non-trade-related events may occasionally occur, reptile expos are frequently and largely commercial, although often portrayed as ‘hobbyist’ gatherings by some organisers in order to avoid trade-relevant laws (Arena et al., 2012; Altherr, 2014; D’Cruze et al., 2020). There can be some similarity between reptile expos as characteristically observed in Europe and North America and wildlife markets that occur in, notably, Asia and South America. In particular, European and North American reptile expos almost exclusively sell animals for pets, whereas in Asia and South America, animals may be offered or acquired for purposes including human food, traditional local medicines, curio products, or pets (Warwick and Steedman, 2021b). Some expo events involve animal classes other than reptiles (e.g., invertebrates, fishes, amphibians, and mammals) and may be broadly described as featuring exotic animals (Arena et al., 2012).

Reptile expos have raised several major and recurring concerns as expressed by non-governmental organisations as well as the scientific community, notably regarding poor animal welfare (Arena et al., 2012; Altherr, 2014; D’Cruze et al., 2020), threats to public health and safety, from zoonotic infections (Arena et al., 2012; Warwick et al., 2012b; Warwick and Steedman, 2021b), propagation of emergent disease spill overs (Warwick and Steedman, 2021b; Vora et al., 2023), introduction of invasive alien species (Arena et al., 2012; Altherr, 2014; Warwick and Steedman, 2021b), trading of threatened or endangered species (Arena et al., 2012; Altherr, 2014; Nijman and Stoner, 2014; Auliya et al., 2016; Hruby, 2019; Altherr and Lameter, 2020; Das and Auliya, 2021), selling of wild-caught animals (Arena et al., 2012; Altherr, 2014; Auliya et al., 2016; Altherr and Lameter, 2020), and misrepresentation of operational status to avoid legal controls (Arena et al., 2012; Auliya et al., 2016). Relatedly, the overall ethics of trading and keeping of reptiles generally has also been challenged (Warwick, 2014).

Reptiles are accepted to possess sentience, as well as the abilities to sense pain and stress (Lambert et al., 2019; Learmonth, 2020; Arena et al., 2023; Font et al., 2023; Lillywhite, 2023); thus, as for other animals, they warrant concern for their welfare and life quality. Moreover, contrary to some perceptions, many if not most reptilian lifestyles manifest complex behavioural repertoires and psychological performances, including sociality, play, environmental awareness, self-awareness, sensory perception, and mental abilities to problem-solve and numerically count that frequently competes with or exceeds birds and mammals [e.g., (Burghardt, 1998; Manrod et al., 2008; Wilkinson and Huber, 2012; Burghardt, 2013; Szabo et al., 2020; Arena et al., 2023; Burghardt and Layne-Colon, 2023; Doody, 2023; Font et al., 2023; Gillingham and Clark, 2023)]. However, although there is some overlap with other animal classes, reptilian biology and welfare is also strongly dominated by certain highly specialised features, notably ectothermy and thermoregulation, metabolic and energetic rate, innateness and ancestral traits, and nocturnality. Reptile expos involve environments that are notably deprived in respect of, for example, positive stimulation and habitat diversity, and also overly represented by negative stimulation, for example, severe spatial restriction and disturbances. These issues imply significant impacts on welfare and disfavourably weigh against any perceived strengths promoted for reptile expos, as further indicated in our SWOT analysis.

Reptilian life under natural conditions is complex, and whilst little is known regarding biological histories in the wild for most reptile species, no information is comprehensive for any reptile species (Warwick et al., 2023a). Importantly, as objective data regarding reptile biology in the wild is increasing, this knowledge confirms that these animals are highly evolved in terms of environmental, physiological, behavioural, and psychological developments and requirements (Warwick et al., 2023a). Below, we present very brief summary comparisons between selected features of natural biology for two reptile species that are commonly kept as pets, and which offers insight into some marked differences between wild *versus* captive lifestyles.

For example, bearded dragons (*Pogona vitticeps*) are members of the Agamid lizard family native to eastern and central Australia, and are one of the most commonly sold and kept pet reptiles, and frequently occur at reptile expos. Free-living bearded dragons occupy large home ranges of up to 45,000 m2, which involves diverse habitat types including desert, scrubland, and dry forest (Craig et al., 2007). These lizards, which may reach approximately 60 cm in length, are opportunistic omnivores consuming a wide variety of invertebrates and vegetable matter, and occasional small mammals or reptiles (Kubiak, 2020). Although not highly social, their behaviour is significantly hierarchical and territorial (Oonincx et al., 2015; Kubiak, 2020). Formal government guidance for pet selling establishments in the UK advises spatial provisions of 4 x snout-to-vent length by 2.5 x snout-to-vent length as being suitable to house 2-3 adult lizards (DEFRA, 2023b). The formal guidance also stipulates suitability of environment, enrichment accessories to stimulate natural behaviour appropriate to the species, substrate, temperatures, humidity, light, water quality, ability to hide, and ability to bathe.

Corn snakes (*Pantherophis guttatus*) are members of the Colubrid family native to North America, and are one of the most commonly sold and kept pet reptiles. Free-living corn snakes occupy large home ranges of up to approximately 79,000 m2, which involve diverse habitat types including fields, trees, open habitat, and dry forest, and a range of altitudes to 1800 m (Conant and Collins, 1991; Hedley and Eatwell, 2018). These snakes, which may reach approximately 150 – 180 cm in length, are carnivorous and ovivorous, feeding on a variety of herpetofauna, mammals and birds as well as birds’ eggs (Conant and Collins, 1991; Rush et al., 2014). The snakes are largely solitary and crepuscular or nocturnal (Conant and Collins, 1991). Formal government guidance for pet selling establishments in the UK advises spatial provisions of 2/3 x 1/3 snake length as being suitable housing (DEFRA, 2023b). The formal guidance also stipulates suitability of environment, enrichment accessories to stimulate natural behaviour appropriate to the species, substrate, temperatures, humidity, light, water quality, ability to hide, ability to bathe.

The examples above only minimally summarise factors relevant to life in the wild; thus far greater complexity can be assumed. Indeed, life under natural conditions may be regarded as being incalculably more complex than currently understood by science, which raises major questions regarding the extent to which the biological requirements of animals may be significantly under-appreciated and unmet at reptile expos.

Public health and safety issues associated with reptile keeping generally, which is relevant to expos, include risks of injury (such as bites, scratches, envenomations, associated infections and allergic reactions) (de Haro and Pommier, 2003; Schaper et al., 2009; Warwick and Steedman, 2012). However, for this report we will focus on the public health issues of zoonoses, which are infections transmissible from animals (here reptiles) to humans, because little information appears to be available regarding injuries from animals to people. Approximately 200 zoonoses are known, of which at least 40 are associated with pet reptile species, and involve bacterial, viral, fungal, and parasitic pathogens (Warwick et al., 2012a). Despite the diversity of zoonotic agents linked to reptiles, *Salmonella* spp. constitute the most commonly reported infections (Mermin et al., 2004; Zając et al., 2021), with approximately 70,000 occurring in the United States, and 6,000 in the United Kingdom annually (Woodward et al., 1997; Mermin et al., 2004; Toland et al., 2012). Among more than 1,400 surveyed human diseases, over 60 % have been identified as being of potentially zoonotic origin (Karesh et al., 2005), and at least 40 are associated with reptiles (Warwick et al., 2012a). Also, among global emerging human diseases, 75 % have a wild animal link (Brown, 2004). Accordingly, based on the diversity of species involved and the accessibility of the public to these animals, their environments, and the probability of widespread contamination, reptile expos can be considered significant hubs of potential zoonotic infection.

The probable presence of atypical or exotic pathogens at reptile expos has been highlighted as an important concern (Warwick et al., 2012a; Warwick et al., 2012b; Zając et al., 2013). A recent large-scale study sampled 731 reptiles and their environments at exhibitions to determine the presence or otherwise of *Salmonella* (Zając et al., 2021), and found *Salmonella* to be present in 92 % of snakes, 84 % of lizards, and 60 % of turtles. *Salmonella* was also found in 82 % of swabs from table and floor surfaced post reptile exhibition. In total, the study found 918 strains of *Salmonella* belonging to 207 serovars and serological variants, including types of high public health significance. Whilst there are relatively few case reports [e.g., (Weiss et al., 2011)] of infection directly attributable to attendance at reptile expos, this situation is likely symptomatic of classic under-reporting due to habitual disassociation – infections occurring without determining a causal link, which is exacerbated by inadequate investigation of patients by health care professionals (Warwick and Corning, 2013).

The global numbers of reptile expos are unknown. The number of reptiles presented at each event is variable, but it has been estimated that tens of thousands of animals may be displayed or sold at a single venue (Hruby, 2019). A considerable diversity of animals is frequently available at reptile expos, and one study identified at least 148 species at three individual events across Spain, The Netherlands, and United Kingdom (Arena et al., 2012). In some countries or regions, reptile expos that include a commercial nature are effectively prohibited (e.g., in UK), whereas in others they are either legally permitted (e.g., regions of Canada, the United States, Belgium, Germany, Spain, The Netherlands), or otherwise continue to manifest regardless of intended controls (e.g., UK, regions of the USA) (Arena et al., 2012; Altherr, 2014; Auliya et al., 2016; Altherr and Lameter, 2020).

This report focuses on animal welfare, including relevant key biological factors, and public health and safety issues pertinent to expos in Europe (Belgium, Germany, Spain, The Netherlands, United Kingdom), and North America (Canada and the United States), which are known to host many examples, as well as some relevant management concerns. We also present examples of legislation and / or regulations and their ability or otherwise to control relevant problems associated with these events. In addition, we also present a SWOT (strengths, weaknesses, opportunities, and threats) analysis of key features associated with reptile expos. We aim to summarise the key characteristics of reptile expos as well as the concerns and problems associated with their operation. Finally, given the lack of objective guidance or controls pertaining to reptile expos, this report also aims to produce recommendations and stipulations that may be widely applied to the wide range of problematic issues using existing frameworks or where regulation is absent.

**2 Methods**

We conducted a literature search using the engines Scopus and Google Scholar (Box 1) for peer-reviewed reports published between 2010 and present, with a view to collating, in particular but not exclusively, reported information and concerns regarding animal welfare, public health and safety, general management issues, and governance and law internationally. A number of reports were unavailable due to inaccessibility or irrelevant due to their peripheral nature as indicated by their titles or abstracts. Google scholar also includes non-peer reviewed material and secondary sources, which contributed to the requirement for removal. Google scholar searches for words that are contained anywhere in an article, which leads to identification of significant numbers of both relevant and irrelevant reports. Numerous reports were captured that constituted duplicates held within the authors’ own libraries and are effectively contained under the ‘removal of duplicates’ in Box 1. Relevant reports were analysed by comprehensive examination to identify any cited concerns arising from reptile expos. Each concern was listed sequentially in a table, such as “lack of water” or “barren environment” along with its reference or source. When all papers had been analysed, similar concerns were grouped together and tabulated. Our literature review followed the guidelines for rapid reviews (Khangura et al., 2012; Dobbins, 2017). From the literature review we identified and categorised reports regarding animal welfare and public health issues of concern associated with the display and sale of reptiles at expos.

Also, to briefly appraise existing regulations, we conducted (via email) a limited survey of several relevant government authorities in Europe (Belgium, Germany, Spain, The Netherlands, United Kingdom) (some regional data was further obtained from Germany and Spain on reference from national departments) and provincial/state government departments in North America (Canada and the United States). We sought information from relevant departments by describing the nature of reptile expos as: *“Events of interest are those typically named or referred to as: reptile shows, reptile expos, reptile markets, reptile trade fairs, reptile fairs, reptile breeders’ meetings. These events characteristically include the display and sale of reptiles (whether wild-caught of captive-bred) by commercial or non-commercial entities. Events are usually itinerant, occur over one or two days, and may occur infrequently or regularly at venues accessible to the public”* and asking the following questions: “*1. How many, if any, of these events do you experience in your jurisdiction annually? 2. What, if any, formal or informal regulations do you have to manage animal welfare and public health and safety at these events?”* We contacted 88 government authorities and received 43 responses. The survey was emailed to at least one relevant government authority in each country or region with a request to either supply contact information for, or forward the email to, a contact most able to answer the questions. Responses were summarised by documenting the numbers of events as estimated or known by each relevant authority, and whether or not an authority operated particular legislation, or issued guidance. We also performed a limited examination of online advertisements in order to estimate the number of events using Google (for Europe and Canada) and Opera (for US) search engines. The name of the region followed by ‘reptile expo’ was used to make each search and the number of relevant expos advertised collated from the first page-scroll, which included approximately 50-60 entries after which results were found to be of low relevance or repetitious. We also used the Five Welfare Needs model to analyse key comparisons regarding legal stipulations for animal husbandry, as well as public health and safety, at four display and sale situations. Finally, we also conducted a SWOT (strengths, weaknesses, opportunities, and threats) analysis of key features associated with reptile expos. Each key feature was itemised by reading all relevant reports and including any or all issues that were clearly identifiable within the remits of the four SWOT criteria. Strengths imply areas that work well or function, although these relate to factors that benefit organisers and attendees of expos. Manifestly, many people obtain some benefits, for example, financial or enjoyment. Weaknesses imply areas of under-performance or failure and that require change. Because weaknesses imply problems, they are also indirectly related to threats. Opportunities imply areas where improvements or changes can or should be made in order to ameliorate or resolve weaknesses and threats. Threats imply areas of actual or potential problems of concern, which in some respects also relates to weaknesses.

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| **Box 1. Search results from Scopus and Google Scholar for reptile expos.** | |
| Search terms: "reptile show" OR "reptile expo" OR "reptile breeders meeting" OR "reptile fair" OR "reptile market" from 2010 to the present day. Total retrieved from search SCOPUS: 228 Total retrieved from Scholar: 223  Total retrieved: 451 | |
| Results | |
| Removed as unavailable, irrelevant or not in English\* | 365 |
| Downloaded for further examination | 86 |
| Remaining after removal of irrelevancies or duplicates | 13 |
| Removal of irrelevancies or duplicates | 73 |
| Added from authors’ libraries | 27 |
| Total used in review | 40 |

\* Due to the search algorithm in Google Scholar, the search identified many papers not all of which were relevant.

**3 Results**

3.1 Animal welfare

Table 1 provides information from the published literature regarding animal welfare issues of concern associated with the display and sale of reptiles at expos. The body of evidence in the table presents both hazards and welfare consequences, and relate to housing, management, and behaviour, as well as health parameters of the animals.

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| **Table 1. Documented concerns regarding reptile expos: animal welfare.** | |
| Concern | References |
| Unenriched, barren, or deprived environments | (Arena et al., 2012; Sollund, 2017; D’Cruze et al., 2020; Warwick and Steedman, 2021b; Eurogroup for Animals, 2023) |
| Absence of food or water | (Arena et al., 2012; D’Cruze et al., 2020; Warwick and Steedman, 2021b; Eurogroup for Animals, 2023) |
| Severe spatial restriction | (Arena et al., 2012; Sollund, 2017; D’Cruze et al., 2020; Warwick and Steedman, 2021b; Eurogroup for Animals, 2023) |
| Crypto-overcrowding (inability for all animals to use any single provision at one time) | (Arena et al., 2012; Warwick and Steedman, 2021b; Warwick, 2023) |
| Held in accommodation designed as temporary, for prolonged periods of time | (Arena et al., 2012; Sollund, 2017; D’Cruze et al., 2020) |
| Invasive disturbances: transportation, handling, sound, noise, vibration, light, and observation stress | (Arena et al., 2012; Sollund, 2017; D’Cruze et al., 2020; Warwick and Steedman, 2021b) |
| Psychological stress and abnormal behaviour | (Arena et al., 2012; D’Cruze et al., 2020; Warwick and Steedman, 2021b) |
| Injury and disease | (Arena et al., 2012; Borza et al., 2012; Schoonover, 2019; Hellebuyck et al., 2021; Warwick and Steedman, 2021b; Vetere et al., 2022; Eurogroup for Animals, 2023) |
| Miseducation, deficient knowledge-bases, and impulse purchases | (Arena et al., 2012; Schoonover, 2019; D’Cruze et al., 2020) |
| Encouragement of impulse purchases | (Arena et al., 2012; Schoonover, 2019; D’Cruze et al., 2020; Warwick and Steedman, 2021b) |

3.2 Public health and safety

Table 2 provides information regarding reported health and safety issues of concern associated with the display and sale of reptiles at expos. The table presents issues relevant to pathogens, contagious diseases, resistance to (veterinary/human) drugs/medicines, disease threats, and control measures.

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| **Table 2. Documented concerns regarding reptile expos: public health.** | |
| Concern | References |
| Contact with animals and their environments, and dispersal of pathogens | (Arena et al., 2012; Warwick et al., 2012b; D’Cruze et al., 2020) |
| Poor or no hygiene control | (Arena et al., 2012; Warwick et al., 2012b; D’Cruze et al., 2020) |
| Presence of antimicrobial-resistant pathogens | (Zając et al., 2013) |
| Probable presence of atypical/exotic zoonotic pathogens | (Arena et al., 2012) |
| Pandemic threats | (Arena et al., 2012; Warwick, 2020a; Warwick, 2020b; Warwick and Steedman, 2021b) |

3.3 Governance, law & number of events

In respect of our survey of government authorities, minimal responses were received from agencies. Most countries and regions have generalised animal protection regulations under which, theoretically, most or all captive situations fall, although these may not specifically relate to reptile expos but retain relevance. General legislation also applies to the movement, sale, and keeping of listed threatened, injurious, invasive, and, sometimes, native species in Europe and North America. Specific regional responses regarding number of events and applicable legislation are provided in Appendix 1.

Amongst the responding governments the estimated numbers of reptile expos per region were up to: Europe *n* = 56, and North America *n* = 196 (Canada *n* = 15, US *n* = 181). Survey responses were received from 29 of 50 US States, 6 of 13 Canadian Provinces and Territories and 6 of 7 European countries. However, various government departments in any region may be involved in the regulation of expo type events depending on, for example, the individual species involved (e.g., native or non-native, invasive or not), importation regulations, or public health risks (e.g., large or venomous reptiles or zoonotic risks). Not all relevant departments were contactable via the email survey because some regions and/or government departments either do not have publicly accessible emails or block emails from out-of-country sources, leading to incomplete data. However, due to the incomplete responses received, variability of type of information provided by respondents, and challenges to standardisation, the information summarised below and in Appendix 1 should be regarded as offering only very approximate examples of legislative approaches or their absence regarding reptile expos, as well as the number of events occurring.

From limited examination of events advertised online, we identified that at least 61 reptile expos occur annually in Europe (Belgium *n* = 6, Germany *n* = 33, Spain *n* = 5, The Netherlands *n* = 15, United Kingdom (England) *n* = 2), and 161 reptile expos in North America (Canada *n* = 21, United States *n* = 142).

We also compared husbandry standards for reptile expos versus other animal display or sale situations using UK formal guidance in relation to the Five Welfare Needs model (Appendices 2a – e). Our analysis identified no specific governmental guidance provisions for the welfare or management of reptiles at expos. In addition, we used English Government legal provisions to provide comparative examples concerning legal stipulations for public health and safety regarding four different animal display or sale situations: static zoos; mobile zoos; pet retail or wholesale sellers; and reptile expos (Appendices 3a – e). Our analysis identified no specific governmental guidance provisions pertaining to public health and safety at expos.

3.4 Our SWOT (strengths, weaknesses, opportunities, and threats) analysis of reptile expos is provided in Box 2 below.

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| **Box 2. SWOT (strengths, weaknesses, opportunities, and threats) analysis of reptile expos (no particular order).** | | | |
| **Strengths**  (Areas that ‘work well’ for these events.) | **Sources** | **Weaknesses**  (Areas of under-performance [‘Threats’ can constitute an implicit extension of this category].) | **Sources** |
| Commercial financial income for sellers. | Arena et al., 2012; Hruby, 2019; Altherr & Lameter, 2020; D’Cruze et al., 2020; Warwick & Steedman, 2021b; Eurogroup for Animals, 2023 | No governmental regulation. | Arena et al., 2012; Hruby, 2019; Warwick & Steedman, 2021b |
| Private financial income for sellers. | Arena et al., 2012; Hruby, 2019; Altherr & Lameter, 2020; D’Cruze et al., 2020; Warwick & Steedman, 2021b; Eurogroup for Animals, 2023 | Limited governmental regulation. | Arena et al., 2012; Hruby, 2019; Warwick et al., 2012a; Warwick & Steedman, 2021b |
| Abilities to obtain animals commercially. | Arena et al., 2012; Hruby, 2019; Altherr & Lameter, 2020; D’Cruze et al., 2020; Warwick & Steedman, 2021b; Eurogroup for Animals, 2023 | Non-specific governmental regulation | Arena et al., 2012; Warwick & Steedman, 2021b; Hruby, 2019 |
| Abilities to obtain animals privately. | Arena et al., 2012; Hruby, 2019; D’Cruze et al., 2020; Warwick & Steedman, 2021b; Eurogroup for Animals, 2023 | Minimal and/or erroneous local governmental managemental guidance for animal welfare. | Arena et al., 2012; Warwick & Steedman, 2021b |
| Enjoyment by reptile breeders and sellers. | Arena et al., 2012; Eurogroup for Animals, 2023 | No mandatory independent objective managemental guidance. | Arena et al., 2012; Warwick et al., 2012b; Warwick & Steedman, 2021b |
| Public entertainment. | Arena et al., 2012; Eurogroup for Animals, 2023 | Poor or no hygiene control. | Arena et al., 2012; Warwick et al., 2012b; Warwick & Steedman, 2021b |
| Social interaction. | Eurogroup for Animals, 2023 | Financial transactions often unrecorded. | Arena et al., 2012; Hruby, 2019 |
|  |  | Lack of ethical oversight. | Arena et al., 2012; Hruby, 2019; Eurogroup for Animals, 2023 |
| **Opportunities**  (Areas offering improvement or resolution.) | **Sources** | **Threats**  (Areas of actual or potential problems of concern.) | **Sources** |
| Introduction of immediate or future bans. | Arena et al., 2012; Warwick & Steedman, 2021b | Animal welfare. | Arena et al., 2012; Warwick, 2014; Hruby, 2019; Warwick et al., 2019; D’Cruze et al., 2020; Warwick & Steedman, 2021b; Eurogroup for Animals, 2023 |
| Introduction of interim specific governmental regulation pending bans. | Arena et al., 2012; Warwick & Steedman, 2021b |  |  |
| Introduction of ethical oversight. | Arena et al., 2012; D’Cruze et al., 2020 | Public health (epidemic or pandemic). | Arena et al., 2012; Warwick et al., 2012a; Warwick et al., 2012b; Warwick & Steedman, 2021b; Eurogroup for Animals, 2023 |
| Development and introduction of mandatory independent objective managemental recommendations and stipulations. | Altherr & Lameter, 2020; Jessop et al., 2023; D’Cruze et al., 2020; Warwick & Steedman, 2021b | Animal health (epidemic or pandemic). | Arena et al., 2012; Warwick & Steedman, 2021b; Eurogroup for Animals, 2023 |
| Monitoring of all financial transactions. | Arena et al., 2012; D’Cruze et al., 2020 | Promotion of anti-microbial resistant pathogens. | Warwick et al., 2012a; Warwick & Steedman, 2021b |
|  |  | Public safety. | Arena et al., 2012; Warwick et al., 2012a; Warwick & Steedman, 2021b; Eurogroup for Animals, 2023 |
|  |  | Release of invasive species and threats to biodiversity. | Arena et al., 2012; Warwick & Steedman, 2021b; Eurogroup for Animals, 2023 |
|  |  | Miseducation. | Arena et al., 2012; Warwick et al., 2012b; Jessop et al., 2023 |
|  |  | Encouragement of impulse purchases  Illegal trading of wildlife. | Arena et al., 2012; Warwick & Steedman, 2021b |
|  |  | Illegal trading of threatened and endangered species. | Arena et al., 2012; Hruby, 2019; Warwick & Steedman, 2021b; Altherr, 2014; Altherr & Lameter, 2020 |
|  |  | Promotion of activities with threats to habitat ecology, biodiversity, and species conservation. | Arena et al., 2012; Hruby, 2019; Warwick & Steedman, 2021b; Altherr, 2014; Altherr & Lameter, 2020 |

**4 Discussion**

Animal welfare and public health issues are increasingly recognised as importantly integrated under the ‘one-health’ umbrella, which summarises a paradigm in which environment, animals, and people are interconnected (Rabozzi et al., 2012; Cantas and Suer, 2014; Garcıá-Pinillos, 2021; Broom, 2022; CDC, 2022). For example, chronically stressed animals may be more likely to shed potentially zoonotic and other cross-species infections that may negatively and diversely affect animals, people and ecologies. Relatedly, collection of wild animals for the pet trade can involve major disturbances to habitat ecologies and contribute to emergent diseases and pandemics (García-Moreno, 2023). Therefore, reptile expos encompass a range of issues that collectively come under the one-health paradigm. Our investigation identified numerous specific animal welfare and public health and safety concerns, as well as general management concerns, associated with reptile expos. For our SWOT analysis (Box 2) we drew together key aspects mentioned in the literature and categorised these according to strengths, weakness, opportunity, or threat, as implied in the test. Evidently, overall, far more areas were associated with problems than with benefits. Below, we further examine each of these concerns.

4.1 Animal welfare

The animal welfare concerns that we identified were, in particular: unenriched, barren, or deprived environments; absence of food or water; severe spatial restriction; crypto-overcrowding (inability for all animals to use any single provision at one time); animals held in accommodation designed as temporary, for prolonged periods of time; invasive disturbances: transportation, handling, sound, noise, vibration, light, and observation stress; psychological stress and abnormal behaviour; and injury and disease (Table 1). Animal welfare issues also featured negatively within our SWOT analysis (Box 2).

4.1.1 *Unenriched, barren or deprived environments; absence of food or water; severe spatial restriction, crypto-overcrowding*

Unenriched, depauperate and deprived environments are commonly present at reptile expos, for both solitary or multiple occupant situations, including inadequate or no provision or management for climate control within enclosures or opportunities for basking, severe restrictions regarding mobility, inadequate shelter, lack or absence of water and food, lighting, and humidity needs, insufficient or absent substrate, inadequate burrowing facilities, and poor hygiene (Arena et al., 2012; D’Cruze et al., 2020), all of which are likely to cause stress (Burghardt, 2013).

Figures 1 – 4 provide examples of typical husbandry conditions for a variety of reptiles at expos.

The extremely restrictive spatial conditions affect most animals, in particular snakes, which are prevented from extending their bodies or engage in any locomotor movement (Arena et al., 2012; D’Cruze et al., 2020). The overwhelming objective scientific research and guidance stipulates that snakes must be able to fully stretch in their enclosures as part of essential normal behaviour and health maintenance [e.g., (Warwick et al., 2018; Warwick et al., 2019; Spain et al., 2020; Hollandt et al., 2021; Warwick et al., 2021; Cargill et al., 2022)]. A recent UK Government scientific review concluded that snakes should be able to fully stretch in all enclosures (AWC, 2023). Relatedly, at least 20 problematic clinical and 24 behavioural issues have been identified with the use of such diminutive enclosures for snakes, which is also relevant to conditions typical at reptile expos (Warwick et al., 2019; Arena and Warwick, 2023). Many other species, notably lizards, are also subject to severe spatial limitations at reptile expos, in which animals are incapable of fully extending their bodies (tip of snout to tip of tail) and freely moving around within their enclosures (Arena et al., 2012). Indeed, most animals are effectively forcibly coiled within diminutive plastic tubs or boxes. Accordingly, spatially overly-restrictive containers and major restriction of movement are a considerable concern (Arena et al., 2012; Arena et al., 2023).

Long periods without food, water, or exercise (e.g., including inter-state or international travel to and from venues) (Arena et al., 2012) are considered to constitute significant stressors, which may also become cumulative factors that negatively affect health (Arena et al., 2012; Arena et al., 2023; Mancera and Phillips, 2023; Warwick, 2023). Relatedly, crypto-overcrowding refers to situations where, regardless of available space, all animals cannot use any single provision at the same time (Warwick et al., 2018; Warwick, 2023). For example, any enclosure that contains a water vessel or basking area that all animals cannot fully utilise together and simultaneously infers crypto-overcrowding. Thus, whilst spatial factors may superficially appear adequate, closer inspection can reveal an overcrowded situation. The inherent use of diminutive enclosures and minimalist provisions at reptile expos directly promotes crypto-overcrowding.

Relatedly, reptiles, being ectothermic, are highly dependent on precise environmental conditions to control their body temperature to within fractions of a degree Celsius using behavioural thermoregulation in order maintain homeostasis and the maintenance of normal physiological states, digestion, metabolism, physical activities, immunological condition, and other factors (Frye, 1991; Arena et al., 2023; Gillingham and Clark, 2023; Lillywhite, 2023). Accordingly, highly complex captive conditions regarding artificial climate as well as habitat diversity are vital to promoting good health and welfare and avoiding harm in captive reptiles (Burghardt and Layne-Colon, 2023; Greenberg, 2023; Mancera and Phillips, 2023; Mendyk and Augustine, 2023; Warwick and Steedman, 2023).

4.1.2 *Prolonged and problematic ‘temporary’ accommodation; animals held in accommodation designed as temporary, for prolonged periods of time*

The captive conditions referred to previously, may be argued to constitute temporary arrangements, and thus may not involve enduring stresses for animals. However, such situations, even in the course of a single day, are capable of causing significant and major stress in reptiles, with potentially lasting consequences, such as behavioural frustration, immunological compromise, opoortunistic disease, and death (Arena et al., 2012; Warwick, 2023; Warwick et al., 2023c). Moreover, as discussed further below, allied to stressful conditions during the day(s) of display and/or sale, reptiles also frequently face extensive pre- or post-event stressors related to intensive breeding, transportation, handling (direct or indirect within containers or sacks), storage, and other issues (Arena et al., 2012; D’Cruze et al., 2020; Warwick et al., 2023c). Such cumulative stresses reasonably justify the need for even greater than normal relief than other situations; thus, the case can be clearly made that reptile expos have greater than normal obligations to provide enhanced conditions for rest and recovery for animals (Gangloff and Greenberg, 2023; Warwick, 2023). Accordingly, a maximum period of 24 hours has been proposed to define short-term housing (Warwick et al., 2023c). While reptile may experience captivity-stress under longer-term housing, such as general pet and hobby keeping and zoos, acute disturbances are particularly associated with expos.

4.1.3 *Invasive disturbances; transportation, handling, sound, noise, vibration, light, and observation stress*

The itinerant nature of reptile expos inherently involves the transportation of animals from holding sites to venues, encompassing handling, sound, noise, vibration, light, and observation stress (Arena et al., 2012; Sollund, 2017; D’Cruze et al., 2020; Mancera and Phillips, 2023). Transportation is typically achieved by confining animals to diminutive containers or sacks, and travel periods can measure hours to days (Arena et al., 2012). Such diminutive containers also frequently act as accommodation for the duration of expos, and then also for the return journey if unsold or onwards after sale, or to another venue, which may involve substantial transnational travel (Arena et al., 2012; Sollund, 2017). Accordingly, reptiles may be confined to such conditions for several days, and static/supply base facilities can also be similarly minimalistic (Arena et al., 2012; Sollund, 2017). Several welfare concerns regarding reptile expos relate to the issues of transportation conditions, the handling of animals and their containers by sellers as well as by many attendees (Arena et al., 2012).

Consequently, reptiles may harbour significant stress burdens preceding, during, and after an expo, as have been identified through established specific behavioural indicators (Martínez-Silvestre, 2014; Benn et al., 2019; Mancera and Phillips, 2023; Warwick, 2013, 2023). These probable stress burdens infer that providing as comfortable conditions as possible for reptiles at expos warrant particular attention. In other transport and disturbance situations, following major confinement and transportation stresses, animals may be able to gain some degree of rest and recovery where promptly relocated to better conditions. However, for reptiles at expos, such potential respite is typically not available, which raises particularly serious welfare concerns.

Another issue associated with expos, disturbances and welfare monitoring is matter of nocturnality among reptiles, which has implications for both invasive disturbances, as well as opportunities to assess the condition of animals. Many species of reptile are nocturnal, and thus are typically active during the night, morning, or evening. Nocturnality strongly conflicts with normal human activity patterns. This conflict implies that human disturbances to animals (caused by noise, vibration, light, and general movement within the environment), may significantly and negatively impact the normal resting periods of reptiles (Mancera et al., 2023; Warwick, 2023). Also, observation of animals, especially, during their normal activity periods, is important in order for caretakers to assess emergent welfare issues (Warwick et al., 2018; Arena and Warwick, 2023; Warwick, 2023). It is probable that caretakers do not sufficiently observe nocturnal reptiles for potential welfare issues (Warwick et al., 2018; Arena and Warwick, 2023).

4.1.4 *Psychological stress & abnormal behaviour*

Psychological stress and abnormal behaviour are well documented for captive reptiles, including at expos (Arena et al., 2012; Warwick et al., 2013a; Grant et al., 2017; Benn et al., 2019; Warwick, 2023). A study of 1,533 amphibians and reptiles displayed and sold at pet expos in Spain, The Netherlands, and the United Kingdom found that the prevalence of stress-related behaviour was as follows: interaction with transparent boundary 27.5%; hyperactivity 11%; hyperalertness 1.8%; rapid body movement 2.1%; flattened body posture 2.4%; head-hiding 4.6%; inflation of the body 0.5%; other significant signs (e.g., rostral lesion) 1.0% (Arena et al., 2012). Given that observation periods for behaviour during the study were set at one minute, these findings indicate that stress-related behaviour is highly prevalent at reptile expos. Innateness is a significant factor related to aetiology of psychological stress and abnormal behaviour in reptiles. Innateness infers the presence of evolved ancestral, hard-wired, traits and drives that involve genetically programmed behavioural and psychological needs, such as long-distance and complex exploratory locomotor and transient activity, spatial and habitat expectations, prey acquisition, elective social interactions, and other factors (Gillingham and Clark, 2023; Warwick, 2023). Accordingly, reptilian life is adapted to involve these highly programmed features (i.e., to behave and mentally function in natural contexts), which means that in captivity, without their provision, a raft of stress-related behavioural and mental problems occurs due to inherent inabilities to adapt (Warwick, 2023). Within captive conditions numerous stress-related behavioural and mental problems are linked to conflicts between innate drives and depauperate environments (Arena et al., 2023; Warwick, 2023). Accordingly, causes of psychological stress and abnormal behaviour can be multifactorial, and include inappropriate habitats, inadequate space, imbalanced social structures, and extraneous disturbances.

The above issues are diverse in nature and frequently associated with reptile expos in the literature. However, within our SWOT analysis (Box 2) all these issues can be considered to fall within the criterion of ‘Animal welfare’ as presented under ‘Threats’.

4.1.5 *Injury & disease*

Injuries and disease among animals at reptile expos raise important concerns. Overly restrictive and inappropriate habitats, overcrowding, crypto-overcrowding, invasive disturbances, and behavioural drivers can each promote exploratory and escape activities in reptiles, which are typically frustrated due to confinement. However, such exploratory and escape activities can lead to physical injuries such as rostral abrasions, injured digits and tails, and aggression, all of which may further invite infection (Frye, 1991; Warwick, 2013). Captivity-stress generally can also increase risks of succumbing to opportunistic infection (Frye, 1991). Reptiles generally have relatively low metabolic and energetic rates; for example, energy expenditure may be approximately 2 - 5 % of that compared to similar sized birds and mammals (Nagy, 2005; Donoghue, 2006). Such low rates can have special significance regarding welfare in that the delayed onset of disease and the associated lag-phases regarding signs may obscure identifiable illnesses and their original causes, and complicate health assessment or remediation (Frye, 1991). Water and food are often not provided for animals of at reptile expos. While the energy and nutritional requirements for reptiles may be relatively low compared with, for example, many birds and mammals, and thus a lower required frequency of sustenance, small reptiles (whether juveniles or diminutive species) may still require frequent nutrition (Lillywhite, 2023). Thus, reptiles may misleadingly appear normal at observation, yet also be experiencing degeneration, latent disease and poor welfare (Frye, 1991). Thus, under-reporting of disease prevalence associated with reptile expos may be assumed. However, some cases of morbidity and mortality in reptiles have been linked to their acquisition at expos. For example, stress-related mortality was reported for a veiled chameleon (*Chamaeleo calyptratus*) (Borza et al., 2012), fatal mycobacteriosis was recorded in a sand boa (*Eryx colubrinus loveridgei*) recently acquired at a reptile show (Vetere et al., 2022), and pentastome infestation in a banded water snake (*Nerodia fasciata*) recently acquired at a reptile show (Farrell et al., 2023).

4.2 Public health & safety

The public health and safety concerns that we identified, association with reptile expos were, in particular: probable presence of atypical/exotic zoonotic pathogens; probable presence of antimicrobial-resistant pathogens; contact with animals and their environments, and dispersal of pathogens; poor or no hygiene control; and potential pandemic threats (Table 2). As with other subjects examined during our SWOT analysis (Box 2), public health and safety concerns dominated the weaknesses and threats elements of the text and appear to outweigh the potential human benefits offered by reptile expos.

4.2.1 *Contact with animals and their environments, and pathogen dispersal*

Handling of animals and contact with their environments are routine features of reptile expos (Arena et al., 2012; Warwick et al., 2012a; Warwick et al., 2012b; D’Cruze et al., 2020). The high prevalence of pathogens (notably, but not exclusively, *Salmonella* spp.) in reptiles implies strong risks regarding the presence of contamination in animals and their environments (e.g., enclosures, sellers, table surfaces, display paraphernalia), and thence to humans and their own items (e.g., clothes, carried items). Such prevalent contamination risks microbial transfer and disease in handlers, and also implies probable dispersal of contaminants to others and the wider environment (Warwick et al., 2012a; Warwick et al., 2012b; Zając et al., 2021). For example, an observational study of 813 attendees at three reptile expos found that 3.6 % had direct contact with an animal and 27.3 % had indirect contact with a presumed contaminated source, (Warwick et al., 2012b) within 5 minutes. Also, 18.7 % of people made contact in respect of hand-to-mouth, 52.2 % hand-to-body, and 19.9 % person-to-person (Warwick et al., 2012b). Accordingly, behaviour at reptile expos frequently involves potential or probable contaminated contact episodes to own mouth, hair, clothes, and pockets; person-to-person contact.

4.2.2 *Poor or no hygiene control; antimicrobial resistance; probable presence of atypical/exotic zoonotic pathogens*

Reptile expos involve inherent challenges to control microbial transfer associated with direct contacts and subsequent re-contamination (Warwick et al., 2012a; Warwick et al., 2012b; Zając et al., 2021). Regular cleaning of surfaces is not typically practiced; thus, there is little or no control of fomites (Warwick et al., 2012a; Warwick et al., 2012b). Information provided (if any) regarding hygiene control at venues and at point of sale or hand over is also poor, minimalist, or absent (Warwick et al., 2012a; Warwick et al., 2012b; Zając et al., 2021). When provided, hygiene advice is typically limited to very low-key guidance regarding voluntary hand-washing (Warwick et al., 2012a; Warwick et al., 2012b; Zając et al., 2021), which may be offered to avoid dissuading people from acquiring animals. Hand-washing, whilst recommended, has limited benefits for prevention and control of infections such as salmonellosis (Warwick et al., 2012a; Warwick et al., 2012b). Also, the fact that many people touch, for example, their own hair, clothes, or pockets (thus transferring and storing microbes into those areas), implies that even if such measures as hand hygiene were practiced, occult recontamination is likely, and difficult to control (Warwick et al., 2012a; Warwick et al., 2012b).

Antimicrobial resistance is a major and growing global concern (WHO, 2016). A study of reptile faecal samples conducted at pet stores, and private homes, as well as via fomite swabs at reptile exhibitions post-event in Poland identified contamination with atypical and drug-resistant Salmonella lineages (*S. kentucky*), and concluded that potential horizontal transfer of microbes may be facilitated by trade and exhibition practices (Zając et al., 2013). Accordingly, the authors cautioned that in particular carnivorous reptiles (which consume diverse animal-based microbiomes) should be regarded as vectors for multi-drug-resistant infections (Zając et al., 2013; Zając et al., 2021).

4.2.3 *Potential pandemic threats*

Since 1919 there have been at least 19 major global pandemics associated with wildlife resulting in over 600 million human (excluding Covid-19) and countless animal deaths worldwide (Warwick and Steedman, 2021b). Wildlife markets are frequently implicated in these data, and generally are regarded to constitute significant risks as sources of emergent pandemic diseases (Can et al., 2019; Kolby, 2020; Vora et al., 2023), and reptile expos have been categorised alongside these sources (Arena et al., 2012; Warwick, 2020a; Warwick and Steedman, 2021b). In addition to being carriers of many bacterial and other pathogens, reptiles are also potentially capable of acting as incidental vectors for important viral agents via ingested prey (Warwick and Steedman, 2021b). Few or no quarantine or other importation control are imposed on reptiles because, as ectotherms, they do not transmit certain notifiable pathogens, such as rabies and some agricultural diseases (Warwick and Steedman, 2021b). The nature of trading in and keeping of reptiles can frequently involve the wild capture, transport and delivery of animals into commercial hubs and private homes within periods as minimal as approximately 24 hrs (Warwick and Steedman, 2021b).

4.3 General management concerns

The general management concerns that we identified in association with reptile expos were lack of veterinary supervision; miseducation, deficient knowledge-bases and impulse purchases; and threats to biodiversity conservation (Table 1). Within our SWOT analysis (Box 2), several problematic weaknesses and threats relate to general management at reptile expos. Individually and cumulatively, these concerns strongly account for the weaknesses and threats identified during our SWOT analysis.

4.3.1 *Lack of veterinary supervision*

Veterinary supervision to ascertain the health and welfare of animals kept in a variety of situations is widely integral to whether or not they (individual animals or entire collections) can be displayed or sold (Warwick et al., 2013b; Warwick et al., 2018). Broadly, veterinarians hold an overriding duty of care to safeguarding welfare and, accordingly, to assessing the state of each animal as well as reporting honestly regarding its condition (Warwick et al., 2013b). However, significant issues are inherent to reptile expos and that severely complicate or negate the ability of veterinarians to perform normal inspection duties. To be effective, normal veterinary inspections require detailed examination of individual animals, or at least allow inspectors reasonable assessment enabled by accessibility and ease of observation. Reptile expos frequently involve thousands of animals and the inspecting veterinary team may be very small or even a single individual. Relatedly, many animals are confined in containers with highly limited access, meaning that normal conditions of veterinary inspection are greatly inhibited or impossible. In order to perform reliable and honest examinations and welfare assessments of animals, a high ratio of inspectors to animals would be required so that the health state of all animals could be ascertained prior to the commencement of any reptile expo. Veterinarians declaring animals fit for display and failing to conduct proper health and welfare assessments may constitute false declarations according to relevant codes of conduct, and potentially involve serious repercussions for attending inspectors.

4.3.2 *Miseducation, deficient knowledge-bases & impulse purchases*

Reptile expos are known to be associated with poor knowledge among exhibitors and sellers of animals, misleading education, poor husbandry, and encouragement of impulse purchases (Arena et al., 2012; D’Cruze et al., 2020). Lack of knowledge and the perpetuation of false or misleading information handed down from keeper to keeper (so-called ‘folklore husbandry’) among those displaying or selling and keeping animals is an increasingly reported concern, with major welfare implications [e.g., (Arbuckle, 2013; Williams and Jackson, 2016; Arena et al., 2023; Jessop et al., 2023; Mendyk and Warwick, 2023)]. Poor husbandry information prior to sale may encourage impulse purchases, and at point of sale or hand over lead to problematic care, animal welfare issues, and unwanted animals (Warwick et al., 2014). Poor information, combined with evolved biological requirements and adaptive limitations, has resulted in widespread recognition that reptiles frequently experience poor care. For example, a six-year study of reptile mortality in the home in the UK found that 75% of reptiles do not survive one year (Toland et al., 2012). Another study of snakes in the home found a mortality rate of 52% in 2 years (Cargill et al., 2022). A study at a commercial seller warehouse in the USA found a mortality rate of 42% in 10 days (testudines, lacertilians, serpents) (Ashley et al., 2014). Whilst tools are available to help would-be keepers make informed decisions regarding whether or not to undertake a pet reptile [e.g., (Warwick et al., 2014; Jessop et al., 2023)], uptake of (notably scientific) guidance is also frequently lacking or poor (Howell et al., 2020; Azevedo et al., 2021; Howell et al., 2022; Mendyk and Warwick, 2023).

Another factor that must be considered, is what care the animals will receive in their new homes. Reptile expos encourage impulse buys, sellers may not discriminate to whom they sell, and present examples of poor husbandry that may then be followed, along with the misconception that these are low maintenance pets (Warwick et al., 2014). In addition, inadequate or misleading information is frequently contained in husbandry ‘care sheets’ that are offered (Arena et al., 2012). Accordingly, the question of the welfare of the animals going forward is worthy of consideration. Although Crisante et al. (2023) found that owners of reptiles were more aware of their cognitive complexity and specialised requirements than non-owners, welfare problems in captivity persist, as documented, and can be caused in part by a lack of information and knowledge of how to meet these specialised needs. Research into how reptile expos encourage impulse buys by inexperienced owners and the extent to which they bear responsibility for providing accurate information on the complex needs of reptiles would be an interesting area for future research.

4.3.3 *Threats to biodiversity conservation*

Many reptiles sold by a variety of sellers are harvested from the wild (Böhm et al., 2013). The lack of regulation of the global reptile trade has caused significant declines and threats to very many species (Böhm et al., 2013). Despite regulatory mechanisms, such as the Convention on International Trade in Endangered Species (CITES) and other mechanisms, the illicit trade in reptiles is one of the largest illegal businesses in the world, with traders frequently ignoring regulations (Marshall et al. 2020). The effects of this issue are twofold – depletion of species in the wild, possibly leading to them becoming critically endangered or extinct (Marshall et al. 2020), and other species becoming invasive (for example the red-eared slider (*Trachemys scripta elegans*) has become globally invasive as a result of the pet trade (Espindola et al., 2022)). Reptile expos certainly contribute to this illegal trade and its associated issues, being a minimally regulated way for smugglers to sell reptiles (Arena et al., 2012).

4.4 Governance, law & number of events

Based on the minimal responses to our survey of governments in Europe and North America (Appendix 1), incomplete data and very few controls were identified for reptile expos. Accordingly, from the survey, it was not possible to offer precise figures of scale for reptile expos in Europe or North America. However, the estimates provided by responding governments for the numbers of reptile expos (Europe *n* = 56, North America *n* = 196) were not widely different from the numbers of events identified via our limited online survey of advertisements (for Europe and 61 for North America *n* = 163). In the US alone, it has been estimated that at least 300 itinerant animal events of various configurations, including reptile expos, occur annually (Collis and Fenili, 2011). Our survey of government authorities was limited to selected regions and countries where reptile expos are popular, although many other countries also host these events (Warwick and Steedman, 2021b); thus, the reach of this survey was incomplete. Several regional US governments (Alaska, Arizona, Iowa, Mississippi) were unaware of events within relevant jurisdictions, despite their occurrence. Therefore, it appears that there is some disconnect between formal knowledge of reptile expos and actual occurrence of these events. This disconnect emphasises the need for recognition and control of reptile expos in all relevant regions. During our SWOT analysis, problematic weaknesses as well as several opportunities regarding control were identified. Later, we provide detailed protocols for the control of reptile expos.

4.4.1 *Comparing husbandry standards for reptile expos versus other animal display or sale situations*

Comparing formal stipulations for husbandry between different animal use sectors provides insight into the proposed standards of animal care, which has implications for welfare. The information provided in Appendices 2a – e and Appendices 3a – e includes English Government legal provisions (slightly edited for conciseness) to provide comparative examples concerning legal stipulations for animal husbandry regarding four different animal display or sale situations. These situations were static zoos; mobile zoos (categorised in England as animals for exhibition); retail or wholesale sellers; and reptile expos. In the UK all relevant animals are protected under the provisions of the Animal Welfare Act (2006) (UK Government, 2023a), which adopts the principles of the Five Welfare Needs.

Combined, these comparisons show that there is a dearth or absence of regulation or guidance for reptile expos compared with other animal activities. Essentially, beyond the elementary provisions of the UK Animal Welfare Act (2006) (UK Government, 2023a), there are no stipulations or other guidance specific to reptile expos. Sanctuaries or rescue centres would also add comparison to this discussion; however, there are currently no specific relevant legal guidance provisions in England, although a dedicated Bill may be under consideration (UK Parliament, 2001). Furthermore, the operating practices that are typically associated with reptile expos (and that result in the welfare concerns presented in Table 1) are inferior to and incapable of meeting husbandry provisions that are normally required for the display or sale of animals in other situations or the primary provisions of, for example, the Animal Welfare Act (2006) in England and Wales. Relatedly, because of the itinerant operational nature of expos as well as the large volumes of animals and people involved, extraordinary additional measures are required in order to mitigate relevant risks to animal welfare and public health and safety.

Current practices endemic to reptile expos may be most likened to wholesale or retail pet sellers in that they typically display and sell animals (albeit from market table tops rather than static stores) and to mobile zoos and related itinerant exhibitions in that they exhibit animals and allow their casual observation and handling. Whilst reptile expos fail to even approximately meet the relatively detailed provisions designed for retail pet sellers, expos also grossly fail to meet the broad guidance designed for mobile zoos and related itinerant exhibitions. Guidance provisions for static zoos have some peripheral relevance, in that zoos are generally required to adopt foundational scientific principles and provisions rather than itemised guidance (EAZA, 2022). However, in the UK, more specific husbandry guidance for zoos is currently in preparation and anticipated for publication in 2024. In the UK, current guidance for sanctuaries is only relevant only to Scotland. Guidance for England and Wales is still being formally developed, thus comparisons cannot at this stage be made.

4.4.2 *Development of new recommendations & stipulations*

In Table 3 we provide evidence-based safety-net recommendations for managing reptiles at expos in situations where such events are either currently permitted or where immediate controls are necessary to mitigate inherent animal welfare and public health problems, pending stricter measures. Included are key provisions derived from established legislative requirements set out for static zoos, mobile zoos, and wholesale and retail centres, which are conveyed elsewhere (i.e., in Appendices 2a – e). However, below we highlight some general points that provide context to recommendations contained in Table 3. As indicated previously, husbandry conditions at reptile expos typically fall substantially below those of the general pet selling community, which has in itself been highly criticised for poor practices [e.g., (Ashley et al., 2014; Warwick, 2014; Mendyk, 2018; Whitehead, 2018)]. Given the considerable risks to welfare and public health associated with reptile expos, selling or displaying animals in this way should not be allowed. However, this table can provide guidance on how to minimise risks wherever possible. Stipulations for control of reptile expos could be implemented in various ways, for example, via national, regional, or local governmental provisions or specific conditions attached to private venues by individual managers.

|  |  |
| --- | --- |
| **Table 3. Stipulations for control of reptile expos based on published scientific guidance.** | |
| Stipulation | Rationale |
| General | |
| 1. Animals must appear healthy and be free of obvious injury, disease or other signs of poor health. | To avoid animals experiencing negative states from enduring increased stress or suffering.  To avoid spread of animal-to-animal and zoonotic infections. |
| 1. Impulse purchasing of animals to be discouraged, e.g., not promoted at reduced costs or part of special offers or product sales such as starter kits complete with animals. | To avoid animals being acquired by people with inadequate knowledge of their needs.  To avoid people taking on an animal without fully considering the long-term care implications. |
| 1. Handling of animals to be discouraged. | To avoid causing unnecessary stress to animals.  To avoid spread of animal-to-animal and zoonotic infections. |
| 1. Purchased animals must not be carried around the venue, but collected just prior to leaving. | To avoid causing unnecessary stress to animals from movement, vibration or other disturbances. |
| Animal welfare: foundational | |
| 1. When on view for sale at the venue, animals must not remain in or be displayed in travel containers, e.g., Tupperware, other plastic containers/ boxes. | To avoid causing unnecessary stress to animals from cramped and uncomfortable conditions, and to avoid visitors perceiving such conditions to constitute acceptable housing conditions for animals. |
| 1. Within 24 hours all animals for display or sale must be transferred to conditions consistent with best practice standards, or be placed in transit to such conditions. | To avoid causing unnecessary stress to animals from cramped and uncomfortable conditions. |
| 1. Clean drinking water must at all times be available and presented in an appropriate form, e.g., bowls, shallow depressions, misters to create water droplets suitable for the species. | To avoid causing unnecessary stress to animals from thirst or dehydration. |
| 1. Where provided, food must be appropriate for the species. In general, food must be available, notably for herbivorous species. Insectivorous species should not be fed during exhibit time, but would be expected to be fed within 8 hours of transfer to the display enclosure. Carnivorous species should not be fed during exhibit time, but would be expected to be fed if contained in the display enclosure for longer than their usual feed interval. | Continued stable nutritional intake must follow the needs of the individual animal. When varied feeding should be guided by veterinary advice; e.g., feeding close to transportation may be detrimental to an animal’s welfare. |
| 1. Animal enclosures must not be situated too low down within an environment, e.g., at or near the floor.   Enclosures must not be able to be touched, moved or handled by visitors or passers-by.  Enclosures must not be positioned in narrow walkways or near doorways where they can be easily impacted or otherwise disturbed.  Enclosures must not be situated where they may be subject to direct sunlight through windows or in the vicinity of heating elements.  Enclosures must not be situated where they may be subject to door drafts. | To avoid causing unnecessary stress to animals through being viewed via multiple sides where animals may experience discomfort or fear from visitors or passers-by or  from situations where they can be easily contacted or inadvertently knocked or kicked by visitors or passers-by or  from light disturbance or overheating or  from sudden bursts of cold air or rapid temperature changes, especially when holding species that have thermal and/or humidity sensitivities.  To avoid spread of animal-to-animal and zoonotic infections. |
| 1. Invasive disturbances, e.g., such as noise, vibrations, and light, must be mitigated to the maximum extent possible, e.g., creation of a general low level of ambient sound in venue quiet zone, and careful positioning of animals to avoid strong light. | To avoid causing unnecessary stress to animals from disturbances. |
| 1. Enclosures with transparent sides should be masked wherever possible so that the boundary appears real and visible to the animal. | To avoid causing unnecessary stress to animals from abnormal interaction with transparent boundaries. |
| 1. Enclosures must be kept at an appropriate level of hygiene, e.g., absence of foul or atypical odours, overt debris on walls and furnishings, old and soiled substrata, pest invertebrates, dirty or contaminated water. | To avoid poor hygiene and infection or disease. |
| Animal welfare: space | |
| 1. Animals must not be displayed or otherwise held in overcrowded or crypto-overcrowded conditions - i.e., all animals must have access to sufficient space and to all resources in enclosure at any one time. | To avoid causing unnecessary stress to animals from cramped, and uncomfortable and deprived conditions. |
| 1. Animals must have sufficient space (terrestrial, fossorial, arboreal, aquatic) to achieve normal positional-postural adjustments and be able to move, e.g., walk, run, climb, swim, burrow, fully stretch, and move in all directions. | To avoid causing unnecessary stress to animals from deprived conditions. |
| 1. Animal enclosures must be at least 10 times body mass diameter lengths of largest animal; with no enclosure less being than 100cm X 40 cm X 40cm. | To avoid causing unnecessary stress to animals from cramped, and uncomfortable and deprived conditions. |
| 1. No enclosures (including housing very small animals) to be under 100 cm in length, 40 cm in width and 40 cm in height. | To avoid causing unnecessary stress to animals from cramped, and uncomfortable and deprived conditions. |
| Animal welfare: temperature, humidity, and lighting | |
| 1. Animals must be provided with thermal range levels consistent with an active lifestyle and the generalised climate ‘safety-net’ zone the species originates from. | To avoid causing unnecessary stress to animals from restrictions related to thermoregulatory behaviour and needs. |
| 1. Animals must not be subject to constant uniform temperatures, but must be provided with a reasonable variation of temperature, i.e., temperature gradient, within their enclosure. | To avoid causing unnecessary stress to animals from restrictions related to thermoregulatory behaviour and needs. |
| 1. Diurnal basking animals must be able to warm their bodies across their entire length. | To avoid causing unnecessary stress to animals from restrictions related to thermoregulatory behaviour and needs. |
| 1. Light management should be full spectrum and allow the choice of exposure or seclusion from the light source. | To avoid causing unnecessary stress to animals from restrictions related to light-interactive behaviour and needs. |
| 1. Animals must be provided with humidity levels consistent with the generalised climate zone the species originates from. | To avoid causing unnecessary stress to animals from poor humidity. |
| 1. Aquatic of semi aquatic species must have access to suitable, clean and tested swimming areas. | To better accommodate the health and welfare of these species, which are dependent on access to swimming water. |
| 1. A record of origin (date or hatching) or date acquired and from where must be provided for each animal. Each animal must have a weight, body condition assessment and body length record. For snakes body length infers the total body length from tip of snout to tip of tail. For lizards and crocodylians body length infers the both total body length and tip of snout to vent length. For chelonians body length infers infers the straight-line carapace length. | To ensure compliance with regular health checks and ensure enclosure size is suitable. |
| Animal welfare: habitat | |
| 1. Furnishings and other features must reflect the habitat and behavioural needs of animals, e.g., terrestrial, arboreal, climbing, hiding in crevices, burrowing, and encourage species-typical movements and behaviours. | To avoid causing unnecessary stress to animals from restrictions on essential behaviours. |
| 1. All animals must have opportunities for seclusion to remove themselves from public view as well as co-occupant activity, extraneous movement, handling through the provision of species-appropriate hiding places. | To avoid causing unnecessary stress to animals from restrictions on essential behaviours. |
| 1. Animals must have species-appropriate substrate/bedding materials that are safe. | To avoid causing unnecessary stress or to animals from toxic items, or items likely to be injurious if ingested. |
| 1. Substrate and/or bedding materials must be in and of sufficient quality and quantity so that it is not incidentally disarranged or dispersed by animal activities, e.g., attempts to escape or other movement within the cage, so as to leave the animal on bare floor surfaces. | To avoid causing unnecessary stress to animals from loss of locomotor traction, soiling of non-absorbent floor, deprivation of digging or borrowing. |
| Animal welfare: biology/behaviour | |
| 1. Nocturnal species not permitted for display or sale. | To avoid causing unnecessary stress to animals.  To avoid carers missing opportunities to assess welfare among sleeping animals. |
| 1. Fossorial (subterranean dwelling) not permitted for display or sale. | To avoid causing unnecessary stress to animals.  To avoid carers missing opportunities to assess welfare among sleeping animals. |
| 1. Species that may present an invasive risk not permitted for display or sale. | To avoid animals being incidentally released into unsuitable habitats for species.  To avoid incidental release of alien species into regional habitat. |
| Animal welfare: veterinary supervision | |
| 1. An adequate number of veterinarians familiar with exotic species should be onsite and be sufficiently informed to immediately assess all animals prior to public display: assess clinical illness, injury, and problematic and stress-related behaviour for all animals; honestly declare animals as being fit to be displayed or sold; and provide directions or relief regarding the resolution of problematic situations. An adequate number of veterinarians infers an inspectorate that is sufficient to confidently declare all animals fit/unfit for display based on the inspectors’ actual abilities to assess each individual animal’s physical and behavioural states. | To avoid under-assessment of animal health and welfare. |
| Public health & safety | |
| 1. Food for human consumption is not to be present or eaten at the event. | To avoid infection from transfer of potential pathogens between animals and people. |
| 1. Animal sellers and relevant employees or volunteers must be required to cleanse/sanitise hands when moving between animal enclosures, other seller / display stations, or other areas of the venue, to reduce risk of human infections, and cross-contamination of potential pathogens among animals, enclosures and the wider environment | To avoid spread of animal-to-animal and zoonotic infections. |
| 1. Animal displayers or sellers must regularly clean with a designated disinfectant surfaces that are potentially accessible to the public. | To avoid spread of animal-to-animal and zoonotic infections. |
| 1. Any hand contact with a seller, animal or its surrounds must be followed by hand cleaning. | To avoid spread of animal-to-animal and zoonotic infections. |
| 1. Independent hygiene information throughout venue. Signage must be in place at entrances to the event and throughout the venue cautioning the public with regard to zoonotic infections and the heightened risk to persons designated by health agencies as particularly vulnerable   e.g.:   1. children five years of age and under, pregnant women, the elderly, immune-compromised individuals, individuals on cancer drug therapies, developmentally challenged persons. 2. Not to consume food or drink whilst on the premises. 3. Clean hands regularly with designated disinfectant. 4. Not to touch display facilities, including tables sellers, animals, or animal enclosures. | To avoid spread of animal-to-animal and zoonotic infections. |
| 1. Hygiene information at point of animal sale or hand over to be passed to acquirer of animal. Information to state at minimum: 2. Households should not keep, have on the premises or be in contact with people of the following groups: children five years of age and under, pregnant women, the elderly, immune-compromised individuals, individuals on cancer drug therapies, developmentally challenged persons. 3. Hand washing, whilst helpful in reducing infection risk, not guarantee protection, e.g., clothes, pockets, hair, and general items may harbour or transfer contaminants. | To avoid spread of animal-to-animal and zoonotic infections. |
| 1. First aid or other medic onsite and available at all times. | To avoid or address emergent health and safety issues. |
| General safety & contingency planning | |
| 1. Event organisers must demonstrate written and practical protocols prior to the expo to the satisfaction of the local formal fire services. | To avoid or address emergent fire, smoke, or other issues and to ensure that all animals and people can be safely evacuated in a timely manner. |
| 1. Event organisers must have written contingency plans for significant events. These must to include:   Animal caused injury.  Exhibit Escapes.  Electrical failures such that the animal environmental control is lost.  Isolation of sick animals and potential contacts. | To risk assess the health and welfare of the animals and general public. |

Derived from: Warwick et al., 2012a; Burghardt, 2013; Warwick et al., 2013a; Martínez-Silvestre, 2014; Alligood and Leighty, 2015; Frye, 2015; Bashaw et al., 2016; Grant et al., 2017; Moszuti et al., 2017; Oonincx and van Leeuwen, 2017; Mendyk, 2018; Tetzlaff et al., 2018; Warwick et al., 2018; Whitehead, 2018; Benn et al., 2019; Warwick et al., 2019; Spain et al., 2020; Warwick et al., 2021; Cargill et al., 2022; Arena et al., 2023; Arena and Warwick, 2023; Burghardt and Layne-Colon, 2023; DEFRA, 2023b; Gangloff and Greenberg, 2023; Greenberg, 2023; Jessop et al., 2023; Mancera and Phillips, 2023; Maslanka et al., 2023; Mendyk and Augustine, 2023; Mendyk and Warwick, 2023; Warwick et al., 2023b; Warwick and Steedman, 2023; Warwick et al., 2023c. This Table also includes key provisions derived from established legislative requirements set out for static zoos, mobile zoos, and wholesale and retail centres, which are specified conveyed elsewhere (i.e., in Appendices 2a – e and Appendices 2a – e).

4.4.3 *Best practice standards*

The term ‘best practice’ is widely used for animal husbandry recommendations and stipulations, but its meaning is highly contextualised. For example, within the high-level zoo community, best practice may infer large and complex habitats [e.g., (EAZA, 2022; UK Government, 2023c)]. In contrast, within the context of pet selling and keeping, the term is used more restrictively to infer substantially smaller and less complex environments [e.g., (DEFRA, 2023b)]. However, such differences should not be taken to imply that the lower standard best practice conditions for pets are scientifically or ethically acceptable; rather that for sellers and private keepers of reptiles, an overall lower standard of husbandry is typically expected. Accordingly, here, best practice implies conditions for animals that are also consistent within the context of selling and privately keeping pet reptiles.

Best practice standards infer the requirement that at all times caretakers of reptiles for expos significantly exceed the conditions stipulated below for absolute minimum standards in order to conform to legally and ethically defensible husbandry. Significantly exceeding absolute minimum standard conditions implies, for example: spatial provisions that enable snakes to freely move rectilinearly (fully stretched posture) in all dimensions within an enclosure; to bask and warm their bodies whilst in this posture under a broad heat source; for startled lizards to be able to accelerate, decelerate and stop without impacting confining barriers or to be able to drop from a height onto deep substrate or water; for turtles to be able to swim freely without having to contact co-occupants; and to burrow entirely within substrates. At its least, best practice should infer husbandry conditions similar to those expected for reptiles within the private home environment.

**5 Conclusions**

Reptiles are sentient animals with the abilities to sense pain and stress. Accordingly, welfare needs at reptile expos can be reliably presumed to be notably unmet. Despite highly incomplete formal information regarding the prevalence of reptile expos, these events occur regularly and widely within Europe, North America, and elsewhere. No government reported maintaining accurate records of reptile expos and their activities. There is very little specific monitoring or control of reptile expos, which is concerning given the breadth of significantly problematic issues endemic to their operation.

Exotic pet trading and keeping, which is a component of the wildlife trade in general, is increasingly scrutinised and criticised in scientific, legal, and ethical literature, for reasons of animal welfare, species conservation, protection of indigenous ecologies, and public health and safety. Reptile expos arguably represent one of the most problematic and uncontrolled sectors of the wildlife industry, with implications for all the aforementioned issues, which emboldens our rationalisation for regulation by way of bans.

This study identified numerous persistent and major animal welfare and public health and safety problems as occurring and endemic to the typical operation of reptile expos. Comparisons between the ways in which animal welfare and public health issues are regarded or managed for reptile expos in relation to, for example, traditional zoos, mobile zoos, and pet sales in the UK are stark and concerning, with expos constituting the least protective and potentially most harmful situations.

In order to alleviate historical and growing concerns regarding both animal welfare and public health and safety issues associated with reptile expos, we have developed two general recommendations based on our assessment of current control deficiencies, as well as 40 specific stipulations and overarching control principles derived from existing evidence-based guidance literature that are all designed to operate in unison and without selectivity. The underlying concepts and principles for these recommendations are that reptile expos currently cannot be assured to meet accepted best practice (and many lower) stipulations that are in place for other relevant events, and, thus prohibitions on their occurrence should be imposed where feasible. However, whilst prohibitions remain the key target, we adopt the pragmatic position that mitigating measures may be rapidly applied as interim measures pending pursuit of stronger legislative controls to protect animal welfare, public health, and other factors. Moreover, the recommendations we provide are all consistent with conventional minimum requirements established for the display or sale of reptiles; thus, they do not represent unreasonable provisions.

**6 Recommendations**

1. In situations where reptile expos are already essentially prohibited such bans should be immutable and not subject to any weakening provisions. Such actions are necessary because even robust permissive control measures will be unlikely to resolve the areas of concern raised in this report. In prohibiting reptile expos governments should aim to ensure that enforcement of such bans is robust. This recommendation is to ensure that the various risks associated with reptile expos are acted on comprehensively and preventatively.
2. In situations where reptile expos are subject to permissions and/or limiting conditions, or where reptile expos are not subject to permissions and/or limiting conditions, then the recommended 40 safety-net stipulations and overarching control principles that we provide in Table 3 should be applied as interim mitigating measures pending the introduction of prohibitions or ‘bans’. The 40 safety-net stipulations and overarching control principles are designed to operate in unison and without selectivity. In applying interim mitigating measures to reptile expos governments should aim to ensure that enforcement of all stipulations is robust. This recommendation is to ensure that absolute minimal ‘safety net’ conditions are met pending greater controls.

**Figures:**

Figure 1. Tortoises in display/sale containers at Hamm, Germany. (Credit: Phillip Arena)

Figure 2. Gecko lizards in display/sale containers at Doncaster, UK. (Credit: Animal Protection Agency)

Figure 3. Juvenile snakes in display/sale containers at Hamm, Germany. (Credit: Phillip Arena)

Figure 4. Adult pythons in display/sale containers at Sabadell, Spain. (Credit: Phillip Arena)

**Author Contributions:** Concept and design: C.W., R.G.; Literature research: R.G., C.W., Analysis and writing: C.W., C.S., R.G., M.J.

**Acknowledgements:** We are grateful to Dr Vanessa Cadenas Valdivielso for assistance with data collection in Spain, and to all governmental officials who assisted to provide relevant information. We are also most grateful to the reviewers and the Guest Associate Editor for their many constructive comments and suggestions.

**Funding:** This project was funded equally by the Animal Protection Agency (UK), Freedom for Animals (UK), World Animal Protection (UK, Netherlands, and Canada), and Zoocheck (Canada), which had no input regarding design, analysis, conclusions, recommendations, or other directional role in this report.

**Conflicts of Interest:** The authors declare no conflict of interest.

**References**

Alligood, C., and Leighty, K. (2015). Putting the “E” in SPIDER: Evolving trends in the evaluation of environmental enrichment efficacy in zoological settings. *Animal Behavior and Cognition* 2(3)**,** 200-217. doi: 10.12966/abc.08.01.2015.

Altherr, S. (2014). "Stolen Wildlife—Why the EU Needs to Tackle Smuggling of Nationally Protected Species". (Munich, Germany: Report by Pro Wildlife).

Altherr, S., and Lameter, K. (2020). The Rush for the Rare: Reptiles and Amphibians in the European Pet Trade. *Animals* 10(11)**,** 2085. doi: 10.3390/ani10112085.

Arbuckle, K. (2013). Folklore husbandry and a philosophical model for the design of captive management regimes. *Herpetol Rev* 44(5)**,** 448-452.

Arena, P.C., Bashaw, M.J., Grant, R., Howell, T., Martínez-Silvestre, A., and Warwick, C. (2023). "Miscellaneous factors," in *Health and Welfare of Captive Reptiles,* eds. C. Warwick, P.C. Arena & G.M. Burghardt.2nd ed (Cham, Switzerland: Springer), 583-617.

Arena, P.C., Steedman, C., and Warwick, C. (2012). "Amphibian and reptile pet markets in the EU: An investigation and assessment". (London: Animal Protection Agency,Animal Public,International Animal Rescue,Eurogroup for Animals,Fundación para la Adopción,el Apadrinamiento y la Defensa de los Animales, People for the Ethical Treatment of Animals).

Arena, P.C., and Warwick, C. (2023). "Spatial and thermal factors," in *Health and Welfare of Captive Reptiles,* eds. C. Warwick, P.C. Arena & G.M. Burghardt.2nd ed (Cham, Switzerland: Springer), 417-445.

Ashley, S., Brown, S., Ledford, J., Martin, J., Nash, A.E., Terry, A., et al. (2014). Morbidity and mortality of invertebrates, amphibians, reptiles, and mammals at a major exotic companion animal wholesaler. *J Appl Anim Welf Sci* 17(4)**,** 308-321. doi: 10.1080/10888705.2014.918511.

Auliya, M., Altherr, S., Ariano-Sanchez, D., Baard, E.H., Brown, C., Brown, R.M., et al. (2016). Trade in live reptiles, its impact on wild populations, and the role of the European market. *Biological Conservation* 204(5)**,** 103-119. doi: 10.1016/j.biocon.2016.05.017.

AWC (2023). *Opinion on the space requirements for snakes in vivaria within pet selling establishments.* [Online]. Animal Welfare Committee, UK Government (Defra). Available: https://www.gov.uk/government/publications/awc-opinion-on-the-space-requirements-for-snakes-in-vivaria-within-pet-selling-establishments [Accessed 2023 7 September].

Azevedo, A., Guimarães, L., Ferraz, J., Whiting, M., and Magalhães-Sant’Ana, M. (2021). Pet Reptiles—Are We Meeting Their Needs? *Animals* 11(10)**,** 2964. doi: 10.3390/ani11102964.

Bashaw, M.J., Gibson, M.D., Schowe, D.M., and Kucher, A.S. (2016). Does enrichment improve reptile welfare? Leopard geckos (Eublepharis macularius) respond to five types of environmental enrichment. *Applied animal behaviour science* 184**,** 150-160. doi: 10.1016/j.applanim.2016.08.003.

Benn, A.L., McLelland, D.J., and Whittaker, A.L. (2019). A Review of Welfare Assessment Methods in Reptiles, and Preliminary Application of the Welfare Quality® Protocol to the Pygmy Blue-Tongue Skink, Tiliqua adelaidensis, Using Animal-Based Measures. *Animals* 9(1)**,** 27. doi: 10.3390/ani9010027.

Böhm, M., Collen, B., Baillie, J.E., Bowles, P., Chanson, J., Cox, N., et al. (2013). The conservation status of the world’s reptiles. *Biol Conserv* 157, 372-385. doi: 10.1016/j.biocon.2012.07.015.

Borza, G., BolfĂ, P., Taulescu, M., Fărcaş, L., and Cătoi, C. (2012). Pathologic mineralization in captive reptiles. *Bulletin of the University of Agricultural Sciences & Veterinary Medicine* 69(1-2)**,** 54-57.

Broom, D. M. (2022). “Animal welfare concepts,” in Routledge handbook of animal welfare. Eds. A. Knight, C. Phillips and P. Sparks (London, UK: Taylor & Francis), 12– 21.

Brown, C. (2004). Emerging zoonoses and pathogens of public health significance--an overview. *Revue scientifique et technique-office international des epizooties* 23(2)**,** 435-442. doi: 10.20506/rst.23.2.1495.

Burghardt, G.M. (1998). "The evolutionary origins of play revisited: Lessons from turtles," in *Animal Play: Evolutionary, Comparative, and Ecological Perspectives,* eds. M. Bekoff & J.A. Byers. (Cambridge, UK: Cambridge University Press), 1–26.

Burghardt, G.M. (2013). Environmental enrichment and cognitive complexity in reptiles and amphibians: concepts, review, and implications for captive populations. *Applied Animal Behaviour Science* 147(3-4)**,** 286-298. doi: 10.1016/j.applanim.2013.04.013.

Burghardt, G.M., and Layne-Colon, D.G. (2023). "Effects of Ontogeny, Rearing Conditions, and Individual Differences on Behaviour: Welfare, Conservation, and Invasive Species Implications," in *Health and Welfare of Captive Reptiles*.2nd ed (Cham, Switzerland: Springer), 287-321.

Can, Ö.E., D'Cruze, N., and Macdonald, D.W. (2019). Dealing in deadly pathogens: Taking stock of the legal trade in live wildlife and potential risks to human health. *Glob Ecol Conserv* 17**,** e00515. doi: 10.1016/j.gecco.2018.e00515.

Cantas, L., and Suer, K. (2014). Review: the important bacterial zoonoses in “one health” concept. Front. Public Health 2. doi: 10.3389/fpubh.2014.00144

Cargill, B., Benato, L., and Rooney, N.J. (2022). A survey exploring the impact of housing and husbandry on pet snake welfare. *Animal Welfare* 31(2)**,** 193-208. doi: 10.7120/09627286.31.2.004.

CDC (2022) One health basics (Centers for Disease Control and Prevention, U.S. Department of Health & Human Services). Available at: https://www.cdc.gov/ onehealth/basics/index.html (Accessed 7 February 2024).

Collis, A.H., and Fenili, R.N. (2011). *The Modern U.S. Reptile Industry* [Online]. Georgetown Economic Services, LLC. Available: https://reptifiles.com/wp-content/uploads/2020/01/The\_Modern\_US\_Reptile\_Industry\_05\_12\_2011Final.pdf [Accessed 2 July 2023].

Conant, R., and Collins, J.T. (1991). *A field guide to reptiles & amphibians: eastern and central North America.* Boston, USA: Houghton Mifflin Harcourt.

Craig, M.D., Garkaklis, M.J., Hardy, G.E.S.J., Grigg, A.H., Grant, C.D., Fleming, P.A., et al. (2007). Ecology of the western bearded dragon (Pogona minor) in unmined forest and forest restored after bauxite mining in south-west Western Australia. *Australian Journal of Zoology* 55(2)**,** 107-116. doi: 10.1071/ZO07002.

Crisante, A., Burman, O. H., & Wilkinson, A. (2023). Does ownership impact perception of reptile cognitive abilities and welfare needs?. *Applied Animal Behaviour Science*, *268*, 106067.

Das, I., and Auliya, M. (2021). "Lanthanotus borneensis, Borneo Earless Monitor.", in: *The IUCN Red List of Threatened Species.* (Gland, Switzerland: International Union for Conservation of Nature and Natural Resources).

D’Cruze, N., Paterson, S., Green, J., Megson, D., Warwick, C., Coulthard, E., et al. (2020). Dropping the Ball? The Welfare of Ball Pythons Traded in the EU and North America. *Animals* 10(3)**,** 413. doi: 10.3390/ani10030413.

de Haro, L., and Pommier, P. (2003). Envenomation: a real risk of keeping exotic house pets. *Vet Hum Toxicol* 45(4)**,** 214-216.

DEFRA. (2019). *RE: Correspondence: UK Department for Environment, Food & Rural Affairs to D. Amess, 6th September.*

DEFRA (2023a). *Keeping or training animals for exhibition licensing: statutory guidance for local authorities* [Online]. Department for Environment, Food & Rural Affairs. Available: https://www.gov.uk/government/publications/animal-activities-licensing-guidance-for-local-authorities/keeping-or-training-animals-for-exhibition-licensing-statutory-guidance-for-local-authorities [Accessed 15 August 2023].

DEFRA (2023b). *Selling animals as pets licensing: statutory guidance for local authorities* [Online]. Department of Environment, Food and Rural Affairs. Available: https://www.gov.uk/government/publications/animal-activities-licensing-guidance-for-local-authorities/selling-animals-as-pets-licensing-statutory-guidance-for-local-authorities--2 [Accessed 15 June 2023].

Dobbins, M. (2017). Rapid review guidebook. Natl. Collab Cent Method Tools 13, 25.

Khangura, S., Konnyu, K., Cushman, R., Grimshaw, J., and Moher, D. (2012). Evidence summaries: the evolution of a rapid review approach. Systematic Rev. 1 (1), 1– 9. doi: 10.1186/2046-4053-1-10

Donoghue, S. (2006). "Nutrition," in *Reptile medicine and surgery,* ed. S.J. Divers, Mader, D. R,. (Philadelphia, USA: Saunders), 251–298.

Doody, S. (2023). "Social behaviour as a challenge for welfare," in *Health and Welfare of Captive Reptiles* eds. C. Warwick, P.C. Arena & G.M. Burghardt.2nd ed (Cham, Switzerland: Springer), 189-211.

EAZA (2022). "Standards for the Accommodation and Care of Animals in Zoos and Aquaria". (Amsterdam, The Netherlands: European Association of Zoos and Aquaria,).

England and Wales High Court (Administrative Court) Decisions (2006). *Haynes, R. v Stafford Borough Council EWHC 1366* [Online]. Available: https://www.bailii.org/ew/cases/EWHC/Admin/2006/1366.html [Accessed 10 August 2023].

England and Wales High Court (Administrative Court) Decisions (2015). *Kent, J. v Arun District Council EWHC 2295* [Online]. Available: https://www.bailii.org/ew/cases/EWHC/Admin/2015/2295.html [Accessed 10 August 2023].

Eurogroup for Animals (2023). *Review of investigations on wild animal pet markets* [Online]. Available: https://www.eurogroupforanimals.org/library/review-investigations-wild-animal-pet-markets [Accessed 2 July 2023].

Espindola, S., Vázquez‐Domínguez, E., Nakamura, M., Osorio‐Olvera, L., Martínez‐Meyer, E., Myers, E. A., ... & Burbrink, F. T. (2022). Complex genetic patterns and distribution limits mediated by native congeners of the worldwide invasive red‐eared slider turtle. *Molecular Ecology,* 31(6), 1766-1782.

Farrell, T.M., Walden, H.D.S., and Ossiboff, R.J. (2023). The invasive pentastome Raillietiella orientalis in a banded water snake from the pet trade. *J Vet Diagn Invest* 35(2)**,** 201-203. doi: 10.1177/10406387221147856.

Font, E., Burghardt, G.M., and Leal, M. (2023). "Brains, behaviour, and cognition: multiple misconceptions," in *Health and Welfare of Captive Reptiles,* eds. C. Warwick, P.C. Arena & G.M. Burghardt.2nd ed (Cham, Switzerland: Springer), 211–238.

Frye, F.L. (1991). *Biomedical and surgical aspects of captive reptile husbandry.* Florida, USA: Krieger Publishing.

Frye, F.L. (2015). *Reptiles and Amphibians: Self-Assessment Color Review.* Oakville, Canada: CRC Press.

Gangloff, E., and Greenberg, N.B. (2023). "Biology of stress," in *Health and Welfare of Captive Reptiles,* eds. C. Warwick, P.C. Arena & G.M. Burghardt.2nd ed (Cham, Switzerland: Springer), 93–142.

Garcıá Pinillos, R. (2021). One welfare impacts of COVID-19–A summary of key highlights within the one welfare framework. Appl. Anim. Behav. Sci. 236, 105262. doi: 10.1016/j.applanim.2021.105262

García-Moreno, J. (2023). Zoonoses in a changing world, *BioScience*, 73(10), 711–720. doi: 10.1093/biosci/biad074.

Gillingham, J.C., and Clark, D.L. (2023). "Normal behaviour," in *Health and Welfare of Captive Reptiles,* eds. C. Warwick, P.C. Arena & G.M. Burghardt.2nd ed (Cham, Switzerland: Springer), 143–188.

Grant, R.A., Montrose, V.T., and Wills, A.P. (2017). ExNOTic: Should We Be Keeping Exotic Pets? *Animals* 7(6)**,** 47. doi: 10.3390/ani7060047.

Greenberg, N. (2023). "Ethologically Informed Design and DEEP Ethology in Theory and Practice," in *Health and welfare of captive reptiles,* eds. C. Warwick, P.C. Arena & G.M. Burghardt.2nd ed (Cham, Switzerland: Springer), 379-416.

Hedley, J., and Eatwell, K. (2018). "Nonvenomous Colubrid Snakes (Colubridae)," in *Companion Animal Care and Welfare*.), 412-424.

Hellebuyck, T., Couck, L., Ducatelle, R., Van den Broeck, W., and Marschang, R.E. (2021). Cheilitis Associated with a Novel Herpesvirus in Two Panther Chameleons (Furcifer pardalis). *Journal of Comparative Pathology* 182**,** 58-66. doi: 10.1016/j.jcpa.2020.12.004.

Hollandt, T., Baur, M., and Wöhr, C. (2021). Animal-appropriate housing of ball pythons (Python regius) — Behavior-based evaluation of two types of housing systems. *PloS One* 16(5)**,** e0247082. doi: 10.1371/journal.pone.0247082.

Howell, T.J., Warwick, C., and Bennett, P. (2022). Pet management practices of frog and turtle owners in Victoria, Australia. *Veterinary Record* 191(12)**,** e2180. doi: 10.1002/vetr.2180

Howell, T.J., Warwick, C., and Bennett, P.C. (2020). Self-reported snake management practices among owners in Victoria, Australia. *Veterinary Record* 187(3)**,** 114. doi: 10.1136/vr.105409.

Hruby, D. (2019). *The world’s biggest reptile fair is also a hub for traffickers* [Online]. Mongabay. Available: https://news.mongabay.com/2019/05/the-worlds-biggest-reptile-fair-is-also-a-hub-for-traffickers/ [Accessed 4 September 2023].

Jessop, M., Pilny, A., Warwick, C., and Whitehead, M. (2023). "Evidential thresholds for species suitability in captivity," in *Health and Welfare of Captive Reptiles,* eds. C. Warwick, P.C. Arena & G.M. Burghardt.2nd ed (Cham, Switzerland: Springer), 509–534.

Karesh, W.B., Cook, R.A., Bennett, E.L., and Newcomb, J. (2005). Wildlife trade and global disease emergence. *Emerg Infect Dis* 11(7)**,** 1000-1002. doi: 10.3201/eid1107.050194.

Kolby, J. (2020). *To prevent the next pandemic, it’s the legal wildlife trade we should worry about* [Online]. National Geographic. Available: https://www.nationalgeographic.com/animals/article/to-prevent-next-pandemic-focus-on-legal-wildlife-trade [Accessed 7 September 2023].

Kubiak, M. (2020). "Bearded dragons," in *Handbook of Exotic Pet Medicine,* ed. M. Kubiak. (New Jersey, USA: Wiley-Blackwell), 219-240.

Lambert, H., Carder, G., and D'Cruze, N. (2019). Given the Cold Shoulder: A Review of the Scientific Literature for Evidence of Reptile Sentience. *Animals* 9(10)**,** 821. doi: 10.3390/ani9100821.

Learmonth, M.J. (2020). The Matter of Non-Avian Reptile Sentience, and Why It “Matters” to Them: A Conceptual, Ethical and Scientific Review. *Animals* 10(5)**,** 901. doi: 10.3390/ani10050901.

Lillywhite, H.B. (2023). "Physiology and functional anatomy," in *Health and Welfare of Captive Reptiles,* eds. C. Warwick, P.C. Arena & G.M. Burghardt.2nd ed (Cham, Switzerland: Springer), 7–44.

Mancera, K.F., and Phillips, C.J.C. (2023). "Effects of noise and light," in *Health and Welfare of Captive Reptiles,* eds. C. Warwick, P.C. Arena & G.M. Burghardt.2nd ed (Cham, Switzerland: Springer), 357–378.

Manrod, J.D., Hartdegen, R., and Burghardt, G.M. (2008). Rapid solving of a problem apparatus by juvenile black-throated monitor lizards (Varanus albigularis albigularis). *Anim Cogn* 11(2)**,** 267-273. doi: 10.1007/s10071-007-0109-0.

Marshall, B. M., Strine, C., & Hughes, A. C. (2020). Thousands of reptile species threatened by under-regulated global trade. *Nature communications*, 11(1), 4738.

Martínez-Silvestre, A. (2014). How to assess stress in reptiles. *Journal of Exotic Pet Medicine* 23(3)**,** 240-243. doi: 10.1053/j.jepm.2014.06.004.

Maslanka, M.T., Frye, F.L., Henry, B.A., and Augustine, L. (2023). "Nutritional Considerations," in *Health and Welfare of Captive Reptiles,* eds. C. Warwick, P.C. Arena & G.M. Burghardt.2nd ed (Cham, Switzerland: Springer).

Mendyk, R.W. (2018). "Challenging folklore reptile husbandry in zoological parks," in *Zoo Animals: Husbandry, Welfare and Public Interactions,* eds. M. Berger & S. Corbett. (New York: Nova Science Publishers), 265-292.

Mendyk, R.W., and Augustine, L. (2023). "Controlled deprivation and enrichment," in *Health and Welfare of Captive Reptiles,* eds. C. Warwick, P.C. Arena & G.M. Burghardt.2nd ed (Cham, Switzerland: Springer), 323–355.

Mendyk, R.W., and Warwick, C. (2023). "Arbitrary husbandry practices and misconceptions," in *Health and Welfare of Captive Reptiles,* eds. C. Warwick, P.C. Arena & G.M. Burghardt.2nd ed (Cham, Switzerland: Springer), 561-582.

Mermin, J., Hutwagner, L., Vugia, D., Shallow, S., Daily, P., Bender, J., et al. (2004). Reptiles, amphibians, and human Salmonella infection: a population-based, case-control study. *Clinical Infectious Diseases* 38(Supplement\_3)**,** S253-S261. doi: 10.1086/381594.

Moszuti, S.A., Wilkinson, A., and Burman, O.H. (2017). Response to novelty as an indicator of reptile welfare. *Applied Animal Behaviour Science* 193**,** 98-103. doi: 10.1016/j.applanim.2017.03.018.

Nagy, K.A. (2005). Field metabolic rate and body size. *J Exp Biol* 208(Pt 9)**,** 1621-1625. doi: 10.1242/jeb.01553.

Nijman, V., and Stoner, S. (2014). "Keeping an ear to the ground: Monitoring the trade in Earless Monitor Lizards ". (UK: TRAFFIC).

Oonincx, D.G., and van Leeuwen, J.P. (2017). Evidence-Based Reptile Housing and Nutrition. *Vet Clin North Am Exot Anim Pract* 20(3)**,** 885-898. doi: 10.1016/j.cvex.2017.04.004.

Oonincx, D.G., van Leeuwen, J.P., Hendriks, W.H., and van der Poel, A.F. (2015). The diet of free-roaming Australian Central Bearded Dragons (Pogona vitticeps). *Zoo Biol* 34(3)**,** 271-277. doi: 10.1002/zoo.21209.

Rabozzi, G., Bonizzi, L., Crespi, E., Somaruga, C., Sokooti, M., Tabibi, R., et al. (2012). Emerging zoonoses: the “one health approach”. Saf. Health Work 3 (1), 77–83. doi: 10.5491/shaw.2012.3.1.77

RSPCA (2006). *Animal Welfare Act - The five welfare needs* [Online]. Royal Society for the Prevention of Cruelty to Animals. Available: https://www.rspca.org.uk/whatwedo/endcruelty/changingthelaw/whatwechanged/animalwelfareact [Accessed 11th December 2023].

Rush, S.A., Sash, K., Carroll, J., Palmer, B., and Fisk, A.T. (2014). Feeding ecology of the snake community of the Red Hills region relative to management for Northern Bobwhite: assessing the diet of snakes using stable isotopes. *Copeia* 2014(2)**,** 288-296. doi: 10.1643/CE-13-083.

Schaper, A., Desel, H., Ebbecke, M., De Haro, L., Deters, M., Hentschel, H., et al. (2009). Bites and stings by exotic pets in Europe: an 11 year analysis of 404 cases from Northeastern Germany and Southeastern France. *Clin Toxicol (Phila)* 47(1)**,** 39-43. doi: 10.1080/15563650801954875.

Schoonover, I. (2019). *Implications and Solutions for the International Trade in Reptile Species* [Online]. Available: https://ingridthesnake.com/wp-content/uploads/2019/05/Implications-and-Solutions-of-the-Reptile-Trade.pdf [Accessed 1 October 2023].

Sollund, R. (2017). "Legal and illegal theriocide of trafficked animals," in *The Palgrave international handbook of animal abuse studies,* eds. J. Maher, H. Pierpoint & P. Beirne. (London, UK: Palgrave Macmillan), 453-474.

Spain, M.S., Fuller, G., and Allard, S.M. (2020). Effects of habitat modifications on behavioral indicators of welfare for Madagascar giant hognose snakes (Leioheterodon madagascariensis). *Anim. Behav. Cogn* 7**,** 70-81. doi: 10.26451/abc.07.01.06.2020.

Szabo, B., Noble, D.W., and Whiting, M.J. (2020). Non-avian reptile learning 40 years on: advances and promising new directions. *EcoEvoRxiv*.

Tetzlaff, S.J., Sperry, J.H., and DeGregorio, B.A. (2018). Captive-reared juvenile box turtles innately prefer naturalistic habitat: Implications for translocation. *Applied animal behaviour science* 204**,** 128-133. doi: 10.1016/j.applanim.2018.03.007.

Toland, E., Warwick, C., and Arena, P. (2012). The exotic pet trade: pet hate. *Biologist* 59(3)**,** 14-18.

UK Government (2023a). *Animal Welfare Act 2006* [Online]. Available: https://www.legislation.gov.uk/ukpga/2006/45/section/9 [Accessed 6 June 2023].

UK Government (2023b). *Pet Animals Act 1951* [Online]. Available: https://www.legislation.gov.uk/ukpga/Geo6/14-15/35 [Accessed 6 June 2023].

UK Government (2023c). *Zoo Licensing Act 1981* [Online]. Available: https://www.legislation.gov.uk/ukpga/1981/37 [Accessed 3 July 2023].

UK Parliament (2001). "Animal Sanctuaries (Licensing) Bill". (London: UK Parliament,).

Vetere, A., Bertocchi, M., Pagano, T.B., Di Ianni, F., and Nardini, G. (2022). First case of systemic fatal mycobacteriosis caused by Mycobacterium goodii in a pet Kenyan sand boa (Eryx colubrinus loveridgei). *BMC Vet Res* 18(1)**,** 291. doi: 10.1186/s12917-022-03351-z.

Vora, N.M., Hannah, L., Walzer, C., Vale, M.M., Lieberman, S., Emerson, A., et al. (2023). Interventions to Reduce Risk for Pathogen Spillover and Early Disease Spread to Prevent Outbreaks, Epidemics, and Pandemics. *Emerg Infect Dis* 29(3)**,** 1-9. doi: 10.3201/eid2903.221079.

Warwick, C. (2014). The morality of the reptile" pet" trade. *Journal of Animal Ethics* 4(1)**,** 74-94. doi: 10.5406/janimalethics.4.1.0074.

Warwick, C. (2020a). Wildlife markets: “Any single wild animal, at any single wildlife market, in any single country, could spawn the next pandemic” *Veterinary Practice* September.

Warwick, C. (2020b). Zoonoplasticity as an intuitive risk protocol for companion-animal-linked zoonoses. *Revue Scientifique et Technique (International Office of Epizootics)* 39(3)**,** 817-830. doi: 10.20506/rst.39.3.3180.

Warwick, C. (2023). "Psychological and behavioural principles and problems," in *Health and Welfare of Captive Reptiles,* eds. C. Warwick, P.C. Arena & G.M. Burghardt.2nd ed (Cham, Switzerland: Springer), 239-285.

Warwick, C., Arena, P., Lindley, S., Jessop, M., and Steedman, C. (2013a). Assessing reptile welfare using behavioural criteria. *In Practice* 35(3)**,** 123-131. doi: 10.1136/inp.f1197.

Warwick, C., Arena, P., and Steedman, C. (2019). Spatial considerations for captive snakes. *Journal of veterinary behavior* 30**,** 37-48. doi: 10.1016/j.jveb.2018.12.006.

Warwick, C., Arena, P., Steedman, C., and Jessop, M. (2012a). A review of captive exotic animal-linked zoonoses. *Journal of Environmental Health Research* 12(1)**,** 9-24.

Warwick, C., Arena, P.C., and Burghardt, G.M. (2023a). "Introduction," in *Health and Welfare of Captive Reptiles,* eds. C. Warwick, P.C. Arena & G.M. Burghardt.2nd ed (Cham, Switzerland: Springer), 1-6.

Warwick, C., Arena, P.C., and Steedman, C. (2012b). Visitor behaviour and public health implications associated with exotic pet markets: an observational study. *JRSM Short Rep* 3(9)**,** 63. doi: 10.1258/shorts.2012.012012.

Warwick, C., and Corning, S. (2013). Managing patients for zoonotic disease in hospitals. *JRSM Short Rep* 4(8)**,** 2042533313490287. doi: 10.1177/2042533313490287.

Warwick, C., Grant, R., Steedman, C., Howell, T.J., Arena, P.C., Lambiris, A.J., et al. (2021). Getting it straight: accommodating rectilinear behavior in captive snakes—a review of recommendations and their evidence base. *Animals* 11(5)**,** 1459. doi: 10.3390/ani11051459.

Warwick, C., Jessop, M., Arena, P., Pilny, A., and Steedman, C. (2018). Guidelines for inspection of companion and commercial animal establishments. *Front Vet Sci* 5**,** 151. doi: 10.3389/fvets.2018.00151.

Warwick, C., Pilny, A., Steedman, C., Howell, T., Martínez-Silvestre, A., Cadenas, V., et al. (2023b). Mobile Zoos and Other Itinerant Animal Handling Events: Current Status and Recommendations for Future Policies. *Animals* 13(2)**,** 214. doi: 10.3390/ani13020214.

Warwick, C., and Steedman, C. (2012). Injuries, envenomations and stings from exotic pets. *J R Soc Med* 105(7)**,** 296-299. doi: 10.1258/jrsm.2012.110295.

Warwick, C., and Steedman, C. (2021a). Exotic pet trading and keeping: proposing a model government consultation and advisory protocol. *Journal of Veterinary Behavior* 43**,** 66-76. doi: 10.1016/j.jveb.2021.03.002.

Warwick, C., and Steedman, C. (2021b). Wildlife-pet markets in a one-health context. *Int J One Health* 7(1)**,** 42-64. doi: 10.14202/IJOH.2021.42-64.

Warwick, C., and Steedman, C. (2023). "Naturalistic versus unnaturalistic environments," in *Health and Welfare of Captive Reptiles,* eds. C. Warwick, P.C. Arena & G.M. Burghardt.2nd ed (Cham, Switzerland: Springer), 487-507.

Warwick, C., Steedman, C., Jessop, M., and Grant, R. (2023c). Defining Short-Term Accommodation for Animals. *Animals* 13(4)**,** 732. doi: 10.3390/ani13040732.

Warwick, C., Steedman, C., Jessop, M., Toland, E., and Lindley, S. (2014). Assigning Degrees of Ease or Difficulty for Pet Animal Maintenance: The EMODE System Concept. *Journal of Agricultural and Environmental Ethics* 27(1)**,** 87-101. doi: 10.1007/s10806-013-9455-x.

Warwick, C., Steedman, C. and Nicholas, E. (2013b). Veterinarian accountability and the exotic pet trade. *AWSELVA Journal*, 17(1), 3-6. https://emergentdisease.org/assets/documents/Warwick\_et\_al\_2013\_vet\_accountability\_Awselva.pdf

Weiss, B., Rabsch, W., Prager, R., Tietze, E., Koch, J., Mutschmann, F., et al. (2011). Babies and bearded dragons: sudden increase in reptile-associated Salmonella enterica serovar Tennessee infections, Germany 2008. *Vector Borne Zoonotic Dis* 11(9)**,** 1299-1301. doi: 10.1089/vbz.2010.0239.

Whitehead, M.L. (2018). Factors contributing to poor welfare of pet reptiles. *Testudo* 8(5)**,** 47-61.

WHO (2016). *Global Action Plan on Antimicrobial Resistance* [Online]. World Health Organization. Available: https://www.who.int/publications/i/item/9789241509763 [Accessed 30 August 2023].

Wilkinson, A., and Huber, L. (2012). "Cold-blooded cognition: reptilian cognitive abilities," in *The Oxford handbook of comparative evolutionary psychology*. (New Jersey: Oxford University Press), 129-143.

Williams, D.L., and Jackson, R. (2016). Availability of information on reptile health and welfare from stores selling reptiles. *Open Journal of Veterinary Medicine* 6(3)**,** 59-67. doi: 10.4236/ojvm.2016.63007

Woodward, D.L., Khakhria, R., and Johnson, W.M. (1997). Human salmonellosis associated with exotic pets. *J Clin Microbiol* 35(11)**,** 2786-2790. doi: 10.1128/jcm.35.11.2786-2790.1997.

Zając, M., Skarżyńska, M., Lalak, A., Kwit, R., Śmiałowska-Węglińska, A., Pasim, P., et al. (2021). Salmonella in Captive Reptiles and Their Environment-Can We Tame the Dragon? *Microorganisms* 9(5)**,** 1012. doi: 10.3390/microorganisms9051012.

Zając, M., Wasyl, D., Hoszowski, A., Le Hello, S., and Szulowski, K. (2013). Genetic lineages of Salmonella enterica serovar Kentucky spreading in pet reptiles. *Vet Microbiol* 166(3-4)**,** 686-689. doi: 10.1016/j.vetmic.2013.07.023.

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| **Appendix 1. Governance, law & number of events survey.** | |
| **Europe** | |
| Flanders (Belgium) | Reported 4-5 reptile expos annually, and there were no controls reported other than for prohibited species (those not on the positive list). |
| Germany | Oversight of reptile expos is performed regionally; two of the 16 regional states responded to our survey: The district of lower Saxony reported around 50 events potentially occurring annually, although these may include animals such as birds, small animals generally, aquarium clubs, and horses. Events must comply with general animal health and welfare law.  The City of Bremen Government confirmed that a reptile expo takes place twice annually, and that some guidance on animal welfare and sales management is available (although this was inaccessible during this study), but not regarding public health and safety. |
| Spain | Regionally several provisions are in place regarding reptile expos. For example, the Madrid Government requires sanitary controls for disease prevention, and prohibits sale of native or recognised invasive species. The Catalonian Government requires attendance of a veterinarian, registration of sellers, and provision of independently produced care information. |
| United Kingdom | English and Welsh Governments stated that they do not collate information regarding reptile expos, and referred enquiries to local government (of which there are 650 departments – and therefore beyond the scope of this survey). The Scottish Government was unaware of any relevant events to be occurring in its jurisdiction, and had no direct provisions for addressing reptile expos. |
| **Canada**  Canadian Federal Government does not collate relevant information, nor possess any specific controls. | |
| Ontario | Deferred to non-government organisations such as animal welfare entities for records of events. Restrictions on certain species permitted to be sold or kept. Certain regional controls, for example, the municipality of Clarington governs “Exotic Animal Entertainment Events” through permit approvals. |
| New Brunswick | Does not regulate reptile expos and has no data regarding any events, although does have controls on importation and possession of prohibited, including native, species. |
| Quebec | Reported several events occurring in their jurisdiction, and relevant controls being restrictions on species permitted and general animal housing conditions. |
| Northwest Territories | Reported minimal representation of reptile expos in its territories, and no specific controls. |
| Manitoba | Reported knowing of approximately 12 reptile expos occurring, and that the events are not regulated. Restrictions on native species to be sold or kept. |
| Saskatchewan | Reported up to two events as occurring annually some years, and controls include general legal limitations on species that may be imported, sold, and kept. |
| **United States**  United States Federal Government does not collate relevant information, nor possess any specific controls. | |
| Alaska, Arizona, Iowa, Mississippi, Montana, Nebraska, New Jersey, New Mexico, Oklahoma, Texas, Wisconsin | No records of reptile expos nor reported controls. |
| California | No records of reptile expos nor reported controls but suggested that individual municipalities may regulate events in their jurisdiction. |
| Kansas | No records of events nor specific controls, but does issue licences for temporary pet shop sales, which may or may not relate to reptile expos. |
| Minnesota | No record of events, and some control via an application process for commercial display. |
| Washington (State) | No records of reptile expos, limited control via certification/permit for certain species, issues relevant general public health advice. |
| Delaware | Does not permit reptile expos. |
| Hawaii, Wyoming | Reported that they do not have any events. |
| Vermont | Reported no events for 12 years and regulations regarding the sale of wild animals. |
| Colorado | No record of number of events, requires reptile shows to be licenced and comply with state regulations regarding prohibited species and public health advice. |
| Illinois | Reported several reptile expos each month, some specific events occurring twice each month, and up to 100 annually; controls on handling methods for boas and pythons and prohibitions on sale of crocodilians, venomous reptiles and threatened and native species. |
| Maine | Reported one event annually with prohibition on specific species. |
| Maryland | Reported that some events occur but that there had no specific numbers nor regulations, permit required for allowed native species. |
| Massachusetts | Reported one event occurring twice annually, pet shop regulations may apply, public health advice relating to handling of reptiles and amphibians. |
| Michigan | Reported at least 35 events since 2019, [notification requirement](https://urldefense.com/v3/__https:/www.michigan.gov/invasives/laws/selling__;!!HXCxUKc!xsY9sVgogs21R6uISvK9SUEP7Hckw9DxwoR5BabFjOH_L9RWhsqBxl9E6-RG-l0QE-xw9mH39dykboHiF1Bn$) for trade shows/auctions/swaps that involve the sale of non-native aquatic organisms, which includes reptiles and amphibians . |
| North Dakota | Reported less than six events, and some controls regarding large boas and pythons as well as venomous species. |
| Rhode Island | Reported one or two events annually, limited licensing for sellers, some restricted or prohibited species. |
| South Carolina | Reported 10 – 20 events annually, and some restrictions regarding invasive, injurious and native species. |
| Tennessee | Reported 36 – 40 events annually, permits required for native species, salmonella warnings for all turtle/tortoise species. |

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| **Appendix 2a.** **Selected key comparisons regarding legal stipulations for animal husbandry at four display and sale situations.** [Derived from: (DEFRA, 2023a; b; UK Government, 2023c), which incorporates the Five Welfare Needs (RSPCA, 2006)].  Need for a suitable environment  (Space, habitat, enrichment) | | | |
| *Static zoos*  (UK Government, 2023c) | *Animals for exhibition (‘Mobile zoos’)*  (DEFRA, 2023a) | *Retail or wholesale sellers*  (DEFRA, 2023b) | *Reptile expos*  (DEFRA, 2023b) |
| Animals in outdoor enclosures must be provided with sufficient shelter for their comfort and well-being. Refuge areas must be provided for nervous animals to escape the permanent gaze of the public. Enclosures must also be designed to allow for animals’ normal defence reactions and appropriate “flight‟ or escape distances.  The temperature, ventilation, lighting (both levels and spectral distribution) and noise levels of enclosures must be suitable for the comfort and well-being of the particular species of animal at all times. In particular:  a) consideration must be given to the special needs of pregnant and newly-born animals;  b) newly-arrived imported animals fully acclimatised into their new environment. In some cases, this may be a gradual process;  c) tanks for aquatic animals need to be adequately aerated, heated or cooled. Environmental parameters (e.g., salinity, water quality) must be suitable for the species;  d) indoor housing must protect against extremes of sunlight, heat, draughts and cold, and provide appropriate humidity.  Additional requirement centred on hazards within the enclosure.  Enclosures must be of a size and design, and animals and enclosures must be managed so as to:  a) avoid animals within herds or groups being unduly dominated by individuals;  b) avoid the risk of persistent and unresolved conflict between herd or group members, or between different species or age groups in mixed exhibits;  c) ensure that the physical carrying capacity of the enclosure and/or system is not over-burdened;  d) prevent an uncontrolled build-up or spread of parasites and other pathogens;  e) remove any refuse and allow drainage of waste water.  Distance or barriers between animals and between enclosures and visitors must be sufficient to minimise transmission of disease or of potential pathogens. | Animals must be kept at all times in an environment suitable to their species and condition (including health status and age) with respect to:  (a) their behavioural needs; (b) its situation, space, air quality, cleanliness and temperature; (c) the water quality (where relevant); (d) noise levels; (e) light levels; (f) ventilation.  Animals must be given suitable housing and rest areas. These will depend on the species or species group.  Ventilation must be provided to all interior areas, as appropriate to the species. It must have no harmful effect on temperature or humidity.  Light must be provided in suitable light and dark cycles for the species. If natural light is insufficient, suitable artificial lighting must be used.  The licence holder must be able to show the inspector that there is appropriate lighting for the species. For example, if specific waveforms of light, such as ultraviolet B (UVB), are integral to the life support of a species, this must be shown to the inspector.  Animals must be able to move away from direct lighting.  Noise disturbance must be reduced. The licence holder must be able to show what steps will be taken if noise becomes a problem.  Animals must not be exposed to draughts, when appropriate.  All housing must allow an animal to: lie stretched out fully; rest comfortably; stand in their natural posture; be comfortable in their environment; be kept in appropriate social groups; to move around freely - examples include climbing, swimming or jumping; have separate areas for sleeping, toileting and exercising; have the ability to move away from the social group, where appropriate; hide from human view or other animals in the enclosure, where appropriate; hide from potentially frightening stimuli (anything that triggers a physical or behavioural change)  The enclosure size must be suitable for the species. It must be adjusted according to its size as the animal grows. It must also be adjusted if a group of animals are kept together. Any changes to the group dynamics may need separation facilities or bigger enclosures.  Whilst being temporarily exhibited, enclosure sizes that are smaller than that considered best practice for long term husbandry can be used.  Suitable temporary housing must be provided for all the animals at any venue where they are exhibited.  If animals are in a temporary enclosure and cannot move fully, for example, when being exhibited, they must be given the chance to move fully at least once a day. A record must be kept of this.  All animals involved in an exhibit for more than one day must be provided with on-site housing or rest areas. These areas must allow a range of movement and natural behaviours.  Animals may need environmental enrichment such as objects and substrates. For example, giving bedding material or designing housing to provide: physical requirements, such as perches; environmental requirements, such as humidity levels  As appropriate to the species, enrichment objects must be changed on a regular basis to introduce novelty and maintain interest. When adding new enrichment devices, staff must make sure the animal is closely monitored for signs of distress.  The animal’s normal housing should be used if possible;  The design and layout of the premises must allow animals to see their surroundings and any animals in other enclosures. When staff are removing individual animals, the design and layout should minimise any disturbance to other animals;  If animals are displayed to the public, signs must be placed on enclosures to stop anyone from: tapping on the glass; putting their fingers into cages. | All areas, equipment and appliances that animals can access must present minimal risks of injury, illness and escape.  They must be constructed in materials that are: robust; safe and durable; in a good state of repair; well-maintained.  Housing must be secure in order to prevent injuries and reduce risk of disease transmission. The housing must be secure and kept in good repair. It must be designed to ensure dry, and easily cleaned surfaces, including junctions where parts of the housing join. This does apply to non-aquatic species. Materials must be non-toxic and constructed of non-porous materials, or be appropriately treated.  Hazards must be minimised.  All licence holders must be able to show that they have considered both environmental and biosecurity (including zoonotic disease) risks in their choice of enclosure, and how they use it.  Animals must be kept at all times in an environment suitable to their species and condition (including health status and age) with respect to:  a) their behavioural needs;  b) its situation, space, air quality, cleanliness and temperature;  c) the water quality (where relevant);  d) noise levels;  e) light levels;  f) ventilation.  Animals must be able to climb, fly, swim, jump and move around freely where appropriate, and exhibit normal behaviour in their environment.  Where appropriate, animals must have separate areas for hiding, sleeping, toileting and exercising. Sleeping areas must be dry, draught-free, well ventilated and clean a s well as large enough to allow all the animals housed to rest together fully outstretched where appropriate and turn around unimpeded. Any substrate used must be appropriate to the species concerned.  Licence holders must ensure that environmental conditions such as temperature, relative humidity, ventilation, lighting conditions are carefully controlled at all times. Conditions must be monitored and remain within the appropriate range for the species housed.  Over-exposure to direct sunlight and other unintended heat sources must be avoided.  Noise and vibration must be maintained at levels appropriate to species. Enclosures must be situated away from noise sources likely to cause stress or disturbance.  Light must be provided in a suitable natural cycle for the species. If there is not enough natural light there must be suitable artificial lighting.  All inside areas must be well ventilated, but animals must not be exposed to draughts. The ventilation must not make areas too cold, hot or humid.  Humidity must be appropriate for the species.  Staff must ensure that the animals are kept clean and comfortable  Where appropriate for the species, a toileting area and opportunities for toileting must be provided.  The animals must be transported and handled in a manner (including for example in relation to housing, temperature, ventilation and frequency) that protects them from pain, suffering, injury and disease.  Consideration must be given to the specific requirements of nocturnal species.  All resources must be provided in a way (for example as regards. frequency, location and access points) that minimises competitive behaviour or the dominance of individual animals.  Resources include, but are not limited to: food; water;  enrichment items, such as toys and blankets; resting and sleeping areas.  There must be sufficient resources for each individual animal in any shared enclosure. This is to minimise dominant behaviour. Where this is identified, more resources must be provided or dominant animals must be removed.  Feeding and play must be separate or supervised where necessary.  Animals must be kept in housing which minimises stress from other animals and the public.  The design and layout of the premises must allow animals to be able to choose what they can see and who or what, for example they should be able to hide. It should also minimise the number of animals that staff disturb when removing any individual animal.  Predators and prey should not be able to see, hear or smell each other.  Where members of the public can view or come into contact with the animals, signage must be in place to deter disturbance of the animals.  If animals are on public display, signs must be displayed on enclosures to deter members of the public from tapping on glass or poking fingers into cages.  Clear signs must be in place at all times outlining:  health and safety risk to customers  appropriate behaviour around the specific species  Space  Terrapins & turtles: 5x plastron length.  Crocodylians: 2-2.5 x X 1.4-2x snout to vent length.  Lizards: not less than 4x X 2.5x snout to vent length.  Snakes: not less than 2/3 x 1/3 straight line length.  Habitat/enrichment  Allow animals to exhibit natural behaviour, e.g., climb or hide, hides or shelters, substrate/bedding, thermal gradient & basking provisions, maintained water quality, dedicated lighting. | None. |

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| **Appendix 2b.** **Selected key comparisons regarding legal stipulations for animal husbandry at four display and sale situations.** [Derived from: (DEFRA, 2023a; b; UK Government, 2023c), which incorporates the Five Welfare Needs (RSPCA, 2006)].  Need for a suitable diet  (Food, water, manner of presentation) | | | |
| *Static zoos*  (UK Government, 2023c) | *Animals for exhibition (‘Mobile zoos’)*  (DEFRA, 2023a) | *Retail or wholesale sellers*  (DEFRA, 2023b) | *Reptile expos*  (DEFRA, 2023b) |
| Food provided must be presented in an appropriate manner and must be of the nutritive value, quantity, quality and variety appropriate for the species, and for the condition, size and physiological, reproductive and health status of the individual animals.  Sufficient fresh, clean drinking water must be available at all times for all animals requiring it.  Supplies of food and drink must be kept and prepared under hygienic conditions, in particular:  a) food and drink must be protected against dampness, deterioration, mold or from contamination by insects, birds, vermin or other pests;  b) supplies of perishable food and drink, other than those brought into the premises fresh on a daily basis, should be kept, where appropriate, under refrigeration;  c) preparation of food and, where appropriate, drink should be undertaken in a separate area suitably designed and constructed;  d) staff should be instructed to observe strict standards of personal hygiene and should conform to good hygiene practice in the preparation of food, having due regard to the risk of cross contamination between equipment, utensils and surfaces;  e) receptacles for food and drink must not be used for any other purposes.  The natural behaviour of the animals, particularly social aspects, should be considered when offering food and drink.  Feeding and drinking receptacles, when used, should be of appropriate design and placed so as to be accessible and available to every animal kept in an enclosure.  Feeding methods must be safe for animals and staff.  Live feeding of vertebrate prey actively discouraged and only after full veterinary and ethical review.  Food and drink, and feeding and drinking receptacles when used, must be placed in positions which minimise the risks of contamination from soiling by the animals, wild birds, rodents or other pests.  Food, water and other drinking receptacles, where used, must be regularly cleaned.  Self-feeders, where used, should be inspected twice daily to ensure that they are working effectively and do not contain caked or unfit food. Water lines should also be checked twice a day.  Uncontrolled feeding of animals by visitors must not be permitted.  Uneaten food must be removed as appropriate to maintain hygiene.  A record of all diets and dietary changes must be maintained. | Animals must be provided with a suitable diet in terms of quality, quantity and frequency.  Constant access to fresh, clean drinking water must be provided in a suitable receptacle for the species that requires it.  Access to water for bathing or swimming must not be withheld for longer than is normal for the species. | The animals must be provided with a suitable diet in terms of quality, quantity and frequency. Any new feeds must be introduced gradually to allow the animals to adjust to them.  The quantity and type of food, frequency of feeding and how animals are fed must be appropriate for the species, the individual’s behavioural and nutritional needs.  Staff must know the requirements for all the species for which they are responsible.  Food supplements, including vitamins and minerals, must be provided if necessary.  Fresh foods must be kept refrigerated where necessary. Frozen foods intended for use must be stored in a deep freeze and defrosted thoroughly.  Live food must be housed in suitable escape proof containers. If it is not eaten by the animal in a short period, it must be removed so that it cannot harm the species housed (for example, crickets biting reptiles).  Animals should only be fed live vertebrate prey in exceptional circumstances.  Feed and (where appropriate) water intake must be monitored, and any problems recorded and addressed.  Constant access to fresh, clean drinking water must be provided in a suitable receptacle  Where feed is prepared on the premises used for the licensable activity, there must be hygienic facilities for its preparation, including a working surface, hot and cold running water and storage.  Species specific, feeding records, water available at all times (except for certain desert dwellers) and suitably provided for each species, ability to bathe, | None. |

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| **Appendix 2c.** **Selected key comparisons regarding legal stipulations for animal husbandry at four display and sale situations.** [Derived from: (DEFRA, 2023a; b; UK Government, 2023c), which incorporates the Five Welfare Needs (RSPCA, 2006)].  Need to be able to exhibit normal behaviour patterns  (Natural behaviour, expression of preferences) | | | |
| *Static zoos*  (UK Government, 2023c) | *Animals for exhibition (‘Mobile zoos’)* (DEFRA, 2023a) | *Retail or wholesale sellers*  (DEFRA, 2023b) | *Reptile expos*  (DEFRA, 2023b) |
| Provision of opportunity to express *most* normal behaviour  Captive breeding should be encouraged where appropriate  Animals of different taxa should not normally be allowed to inter-breed  Zoos must keep up-to-date with information on biology and husbandry  Accommodation must take account of the natural habitat of the species and seek to meet the physiological and psychological needs of the animal.  Enclosures must be equipped in accordance with the needs of the animals with bedding material, branch-work, burrows, nesting boxes, pools, substrates and vegetation and other enrichment materials designed to aid and encourage normal behaviour patterns and minimise any abnormal behaviour.  Facilities must take into account growth of animals and must be capable of satisfactorily providing for their needs at all stages of their growth and development.  Animals of social species should normally be maintained in compatible social groups. They should only be kept isolated for the benefit of the conservation and welfare needs of the group, and where this is not detrimental to the individual specimen. | Animals must be kept at all times in an environment suitable to their species and condition (including health status and age) with respect to behavioural needs.  Animals must be able to express natural behaviours in their living environment. | In addition to the above,  active and effective environmental enrichment must be provided for the animals in inside and any outside environments.  For species whose welfare depends partly on exercise, opportunities to exercise which benefit the animals’ physical and mental health must be provided, unless advice from a vet suggests otherwise.  Allow animals to exhibit natural behaviour, e.g., climb or hide. | None. |

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| **Appendix 2d.** **Selected key comparisons regarding legal stipulations for animal husbandry at four display and sale situations.** [Derived from: (DEFRA, 2023a; b; UK Government, 2023c), which incorporates the Five Welfare Needs (RSPCA, 2006)].  Need to be housed with, or apart, from other animals  (Sociality, contact avoidance) | | | |
| *Static zoos*  (UK Government, 2023c) | *Animals for exhibition (‘Mobile zoos’)*  (DEFRA, 2023a) | *Retail or wholesale sellers*  (DEFRA, 2023b) | *Reptile expos*  (DEFRA, 2023b) |
| Animals of social species should normally be maintained in compatible social groups. They should only be kept isolated for the benefit of the conservation and welfare needs of the group, and where this is not detrimental to the individual specimen.  Animals temporarily accommodated away from others should not be separated for such a period of time that there would be difficulties in their re-introduction to the group.  Animals which may interact in an excessively stressful way must not be maintained in close proximity. | Animals showing signs of aggression, fear or distress must not be used in an exhibit.  Predators and prey must not be kept within sight, sound or smell of each other.  All persons likely to come into contact with the animals during an exhibition must be briefed about how to behave around the animals so as to minimise anxiety, fear and stress in the animals.  No-one other than the staff responsible for the animals must be allowed to pet, handle or play with animals during the working day unless supervised and directly involved with the required action and consistent with the best interest of the animal.  People exhibiting animals must tell the event manager to alert them to any other activities that may cause anxiety for the animals. This could include loud noises or showing other animals.  Exhibitors must reduce any anxiety by moving the animals as far away as possible from the activities. | Animals must be kept separately or in suitable compatible social groups appropriate to the species and individual animals.  No animals from a social species may be isolated or separated from others of their species for any longer than is necessary.  Shared habitat for compatible and/or non-cannibalistic species only, predators and prey not in sight of each other. | None. |

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| **Appendix 2e.** **Selected key comparisons regarding legal stipulations for animal husbandry at four display and sale situations.** [Derived from: (DEFRA, 2023a; b; UK Government, 2023c), which incorporates the Five Welfare Needs (RSPCA, 2006)].  Need to be protected from pain, suffering, injury, and disease  (Safe conditions, veterinary supervision) | | | |
| *Static zoos*  (UK Government, 2023c) | *Animals for exhibition (‘Mobile zoos’)*  (DEFRA, 2023a) | *Retail or wholesale sellers*  (DEFRA, 2023b) | *Reptile expos*  (DEFRA, 2023b) |
| Animals must be handled and managed only by, or under the supervision of, appropriately qualified and experienced staff.  Handling must be done with care, in order to protect the animals’ well-being, and avoid unnecessary discomfort, stress or physical harm.  Any direct physical contact between animals and the visiting public must only be for restricted periods of time and under conditions consistent with animals’ welfare, and not likely to lead to their discomfort.  Animals must not be provoked for the benefit of the viewing public.  Animals which may interact in an excessively stressful way must not be maintained in close proximity.  Suitable, separate if appropriate, accommodation for pregnant animals and animals with young should be available in order to minimise unnecessary stress.  Animals temporarily accommodated away from others should not be separated for such a period of time that there would be difficulties in their re-introduction to the group.  Routine observation at least twice daily.  Thorough assessment of any animal unduly distressed, sick or injured.  Daily records to be maintained.  Enclosures to be a suitable size to avoid overcrowding and conflicts, free from hazards and designed to minimise disease transmission.  A comprehensive programme of care must be established and maintained under the supervision of a veterinary surgeon who is familiar with current practice in the care of zoo animals.  Active veterinary involvement (to be maintained) in:  a) routine inspections of the collection;  b) directing or carrying out treatment of all sick animals;  c) administration of vaccines, worming and other aspects of preventive medicine;  d) health monitoring of animals including submission of blood and other samples for laboratory examination;  e) safe and proper collection, preparation and dispatch of diagnostic and other samples.  f) training of zoo personnel in health and hygiene;  g) post-mortem examinations where necessary;  h) supervision of quarantine  i) the nutrition and the design of diets;  j) planning and exhibit design;  k) the establishment of written procedures to be followed in the event of the accidental use of dangerous drugs.  Comprehensive veterinary records must be kept  Isolation accommodation must be available and managed with correct protective clothing. | For each/all animals:  a register of animals must be kept; veterinary records to be kept (e.g., medical and behavioural history);  distance to and times taken for it to travel to and from each exhibition event, when the animals are exhibited must be kept and an animal rotation policy must be put in place to ensure that the animals have enough rest between and during exhibition events.  Animals must have clear breaks from exhibits that allow them to perform normal behaviour in their home environment. This includes sleeping, feeding and play, and must have sufficient breaks.  All animals used in exhibition events must be in good physical and mental health.  All animals used in exhibition events must be allowed to acclimatise when they arrive. This must be before the exhibition starts.  Moved to a suitable, secure designated place.  Exercised if suitable, unless it would damage their welfare more so than remaining in the exhibition area.  Exhibited animals must be suitable for the specific conditions, type of enclosure and actions involved in the exhibition.  Animals must be transported in suitable, secure and appropriately labelled carriers; carriers must be suitable for the species & must be large enough to allow the animal to move around, but small enough to reduce any injury during transit. If movement must be restricted to avoid injury, the reasons must be stated in the written transport procedure.  The behaviour of individual animals must be monitored each day. Any changes in behaviours that show stress, fear, pain and anxiety must be recorded and acted on.  Any signs of pain, suffering, injury, disease or abnormal behaviour must be recorded and the advice and further advice (if necessary) of a vet (or in the case of fish, of an appropriately competent person) must be sought and followed. | Written procedures must:  a) be in place and implemented covering  i) feeding regimes  ii) cleaning regimes  iii) transportation  iv) the prevention of, and control of the spread of, disease  v) monitoring and ensuring the health and welfare of all the animals  vi) the death or escape of an animal (including the storage of carcasses)  b) be in place covering the care of the animals following the suspension or revocation of the licence or during and following an emergency.  Written procedures should be proportional to the size, and reflect the complexity of, the business. The written procedures must be made available to the inspectors. All people responsible for the care of the animals must be made fully aware of these procedures.  Isolation facilities must be available and include a written procedure.  Waste disposal must be approved by the local authority.  Premises and animals must be registered with a veterinarian qualified in the species kept.  Cleaning protocols and products used must be appropriate to the known risks.  All animals must be checked at least once a day  Animals must be allowed to acclimatise before being offered for sale. Where animals are obtained for sale to a specific client it may be acceptable for the animal to be sold immediately. For reptiles – until feeding and behaving normally. | None. |

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| **Appendix 3a.** **Selected key comparisons regarding legal stipulations for public health and safety at four display and sale situations. [**Derived from: (DEFRA, 2023a; b; UK Government, 2023c)] | | | |
| *Static zoos*  (UK Government, 2023c) | *Animals for exhibition (‘Mobile zoos’)*  (DEFRA, 2023a) | *Pet retail or wholesale sellers*  (DEFRA, 2023b) | *Reptile expos*  (DEFRA, 2023b) |
| Hygiene guidance & disease prevention (human) | | | |
| Dead animals must be handled in a way which minimises the risk of transmission of infection.  Animals that die at the zoo should be examined post-mortem in accordance with veterinary advice.  Clinical waste and refuse must be regularly removed and disposed of in a manner approved by the local authority.  Risk assessments relating to public safety must be undertaken where appropriate and significant findings should be available for examination by the Inspector.  Training of zoo personnel in health and hygiene. | People coming into contact with exhibited animals must be told how to prevent the risks of diseases that can be passed between humans and animals.  Handwashing facilities must be available for people coming into contact with animals. | Staff must be trained and be able to carry out the following tasks:  cleanliness and hygiene;  preventing and controlling disease;  giving first aid.  Staff must maintain high standards of personal hygiene. They must follow good hygiene practices when preparing food. They need to be aware of the risk of cross contamination between equipment, utensils and surfaces. There must be appropriate disinfectants available to clean the food preparation area immediately following its use.  A separate hand wash basin with an adequate supply of hot and cold water must be provided for staff to wash their hands. This must be connected to a suitable drainage system.  The food preparation area must be kept clean and vermin free.  Human and animal food preparation must not take place in shared preparation areas at the same time or using shared utensils.  All licence holders must be able to show that they have considered both environmental and biosecurity (including zoonotic disease) risks in their choice of enclosure, and how they use it. | None. |

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| **Appendix 3b.** **Selected key comparisons regarding legal stipulations for public health and safety at four display and sale situations. [**Derived from: (DEFRA, 2023a; b; UK Government, 2023c)] | | | |
| *Static zoos*  (UK Government, 2023c) | *Animals for exhibition (‘Mobile zoos’)*  (DEFRA, 2023a) | *Pet retail or wholesale sellers*  (DEFRA, 2023b) | *Reptile expos*  (DEFRA, 2023b) |
| Hygiene guidance & disease prevention (animal) | | | |
| The veterinary surgeon should be responsible for, or actively involved in, the following:  routine inspections of the collection;  directing or carrying out treatment of all sick animals;  administration of vaccines, worming and other aspects of preventive medicine;  health monitoring of animals including submission of blood and other samples for laboratory examination;  safe and proper collection, preparation and dispatch of diagnostic and other samples.  training of zoo personnel in health and hygiene.  ensuring that post-mortem examinations of animals are carried out where necessary;  supervision of quarantine premises and other such tasks required by law or as part of good zoo veterinary practice.  The level of veterinary facilities must be consistent with the welfare needs of the animals. | Staff must be trained and be able to carry out the following tasks:  recognising poor welfare;  cleanliness and hygiene;  preventing and controlling disease.  There must be a documented system to record observations of illness, injury or behavioural problems. This documented system must be maintained. | Staff must be trained and be able to carry out the following tasks:  recognising poor welfare;  cleanliness and hygiene;  preventing and controlling disease;  recognising sick or injured animals.  Housing must be cleaned and disinfected with products effective against likely pathogens. At normal usage levels, disinfectants must be non-toxic to the species housed and used at an appropriate dilution and as per the manufacturer’s instructions. There must be the correct length of time between disinfection and introduction or reintroduction of livestock.  Soiled bedding must be removed promptly and immediately replaced.  Empty enclosures must be fully cleaned, disinfected and allowed to dry when vacated and before new stock arrives. Substrate must be replaced as appropriate, and enclosure fixtures and fittings must be adequately disinfected.  Enclosures must be spot-cleaned at least daily and more so if necessary, unless this has negative effects on the welfare of the animals. | None. |

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| **Appendix 3c.** **Selected key comparisons regarding legal stipulations for public health and safety at four display and sale situations. [**Derived from: (DEFRA, 2023a; b; UK Government, 2023c)] | | | |
| *Static zoos*  (UK Government, 2023c) | *Animals for exhibition (‘Mobile zoos’)*  (DEFRA, 2023a) | *Pet retail or wholesale sellers*  (DEFRA, 2023b) | *Reptile expos*  (DEFRA, 2023b) |
| Monitoring and control of potential pathogens | | | |
| Dedicated accommodation, off-show where necessary, should be available for the isolation and examination of newly arrived animals, and for the quarantine and care of unduly distressed, sick or injured animals.  Newly arrived animals should be kept isolated for as long as is necessary to ensure proper examination, acclimatisation and quarantine before introduction to other animals in the collection.  Particular attention must be paid to hygiene in the quarters where isolated or quarantined animals are kept. | Cleaning products must be suitable, safe and effective against pathogens that pose a risk to the animals. | Procedures must be in place to make sure housing and any equipment within it is cleaned as often as necessary and good hygiene standards are maintained. The housing must be capable of being thoroughly cleaned and disinfected.  Housing must be cleaned and disinfected with products effective against likely pathogens.  Cleaning products must be suitable, safe and effective against pathogens that pose a risk to the animals. | None. |

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| **Appendix 3d.** **Selected key comparisons regarding legal stipulations for public health and safety at four display and sale situations. [**Derived from: (DEFRA, 2023a; b; UK Government, 2023c)] | | | |
| *Static zoos*  (UK Government, 2023c) | *Animals for exhibition (‘Mobile zoos’)*  (DEFRA, 2023a) | *Pet retail or wholesale sellers*  (DEFRA, 2023b) | *Reptile expos*  (DEFRA, 2023b) |
| Protocols for addressing animal disease and risk | | | |
| Comprehensive records must be kept – where possible on computer – and be made available to inspectors covering the following:  preventive medicine;  clinical medicine and surgery;  pathological findings from ante-mortem testing;  results of post-mortem examination and testing.  There must be systems for regular review, by the relevant veterinary and curatorial staff, of clinical, behavioural and pathological records and mortality.  Dead animals must be handled in a way which minimises the risk of transmission of infection.  Animals that die at the zoo should be examined post-mortem in accordance with veterinary advice. Where appropriate, samples for diagnosis or health monitoring should be taken for laboratory examination.  Retained samples must be stored in conditions advised by the veterinary surgeon and away from animal feeding substances. The establishment of a reference collection should be encouraged. | The licence holder must ensure that at any time all the records that the licence holder is required to keep as a condition of the licence are available for inspection by an inspector in a visible and legible form or, where any such records are stored in electronic form, in a form from which they can readily be produced in a visible and legible form. | The licence holder must ensure that at any time all the records that the licence holder is required to keep as a condition of the licence are available for inspection by an inspector in a visible and legible form or, where any such records are stored in electronic form, in a form from which they can readily be produced in a visible and legible form.  Isolated animals must be kept in a secure, comfortable location where their condition and needs can be monitored and a record kept of their treatment.  Any signs of pain, suffering, injury, disease or abnormal behaviour must be recorded | None. |

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| **Appendix 3e.** **Selected key comparisons regarding legal stipulations for public health and safety at four display and sale situations. [**Derived from: (DEFRA, 2023a; b; UK Government, 2023c)] | | | |
| *Static zoos*  (UK Government, 2023c) | *Animals for exhibition (‘Mobile zoos’)*  (DEFRA, 2023a) | *Pet retail or wholesale sellers*  (DEFRA, 2023b) | *Reptile expos*  (DEFRA, 2023b) |
| Protocols for addressing human disease and risk | | | |
| Appropriate risk assessments, particularly regarding zoonotic diseases and direct or indirect contact with animals, should be undertaken and reviewed regularly by a suitably qualified person (this would usually be a veterinary surgeon). These will be dependent on animal species and exhibit design and should cover risks to both public and animal safety;  numbers of people allowed in the exhibit at any time, and allowable visitor behaviour and activities, should be consistent with the animals‟ welfare;  appropriate staffing must be available, and protocols in place for staff to intervene in defence of either the visitor or animal if any conflict arises;  staff and/or visitors should have a clearly indicated means of contacting assistance if required, including that of trained first-aiders;  feeding of animals should only take place under supervision by staff. | The licence holder must ensure that at any time all the records that the licence holder is required to keep as a condition of the licence are available for inspection by an inspector in a visible and legible form or, where any such records are stored in electronic form, in a form from which they can readily be produced in a visible and legible form. | The licence holder must ensure that at any time all the records that the licence holder is required to keep as a condition of the licence are available for inspection by an inspector in a visible and legible form or, where any such records are stored in electronic form, in a form from which they can readily be produced in a visible and legible form. | None. |