REPTILES AND AMPHIBIANS AS PETS

&

THE NORWEGIAN POSITIVE LIST PROPOSAL

ASSESSMENT

&

OPINION

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Background

At the request of the Animal Protection Agency (APA) a preliminary evaluation was conducted of the proposal to produce a 'positive list of reptiles, amphibians and salamanders' to be traded as pets in Norway, with particular reference to assessing whether or not a fuller investigation and report was warranted. The preliminary evaluation was carried-out by the senior author of the present report and based on supplied materials. The conclusions of this preliminary investigation were that the proposed 'positive list of reptiles, amphibians and salamanders' (hereinafter referred to as the 'positive list') did raise sufficient issues and questions that warrant further investigation and assessment. Numerous organisations including Advocates for Animals, Animal Protection Agency (APA), Born Free Foundation (BFF), International Animal Rescue (IAR), Norwegian Animal Protection Alliance (NAPA), and World Society for the Protection of Animals (WSPA) independently examined the Norwegian 'positive list' proposal and elected to fund this fuller report.

Introduction

In 1976 Norwegian authorities elected on animal welfare grounds to generally prohibit the buying, selling, disposal, and possession of exotic animals including 'reptiles, amphibians and salamanders' Anon (1974). Norwegian authorities have historically maintained a scientific evidence-based approach in their regard for animal

welfare, public health and safety, and environmental issues (Anon, 2003). Current modernisation of the Norwegian Government's formal approach to animal welfare, public health and safety, and environmental issues includes the consideration of a proposal to introduce a 'positive list of reptiles, amphibians and salamanders' to be traded and maintained as pets in Norway (Anon, 2003). This positive list proposal is supported by those with interests in buying and selling wildlife and also by some exotic pet hobbyists. In contrast, this positive list proposal is strongly opposed by groups which focus on animal welfare, species conservation, and environmental protection.

Aims

The aims of this report are to:

- examine in detail the proposal for a positive list of exotic animals to be traded and kept as pets in Norway
- scientifically assess the connotations of a positive list being introduced in Norway

Objectives

The objectives of this report are to:

- provide scientific evidence-based background information
- provide scientific evidence-based conclusions
- provide scientific evidence-based opinion

The areas of this report have been divided to rationally reflect contextualised subject flow although given the interrelated nature of the various issues there is inevitably occasional overlap. Public health is both a broad and specific consideration of importance at all levels of public and government responsibility. Zoonotic (animal-to-human) disease is a substantial concern related to the trading and keeping of exotic pets and therefore the subject has a particular significance in this report. Consequently, public health heads main subjects but it does not, however, diminish the importance of other areas covered by this document. Animal welfare subjects are then grouped together, and finally, meta-issues highlighting some potentially relevant further points including incidental introduction of non-native species.

Declaration of interest(s)

The Authors declare no vested interests in the subject of this report beyond commissioned work.

Public health

Zoonoses are diseases (pathogenic infections and infestations) that are transmissible from animals to humans. Around 200 zoonoses have been described (Krauss et al, 2003). Over 40 of these zoonoses are associated with reptiles and amphibians (see Table 1). The senior author's work commonly involves investigation of about 140 zoonoses, distributed across fish, amphibian, reptilian, avian and mammalian sources. Approximately 75% of emerging human diseases are zoonotic (Brown, 2004).

The highly interactive social and work lives of humankind readily facilitates cross-infection (Warwick, 2006). Further, introduced microbes of initially low pathogenic quality possess possible opportunities to elevate their role in morbidity once circulating in the human reservoir (Warwick, 2006).

Zoonotic disease is rapidly gaining acknowledgement and concern among the medical, veterinary and epidemiological disciplines. A survey of 1,410 human diseases found 61% to be of potentially zoonotic origin (Brown, 2004, Karesh et al, 2005). Many of these zoonoses, due to their remote indigenousness, might seem of unlikely relevance to the European medical or veterinary clinician but in practice few such diseases can be confidently ruled out on this basis given the interactive life of humans globally. This transmission concern is especially relevant and significant where exotic animals are introduced to the domestic environment. Table 1 itemises some relevant zoonotic infections and infestations transmissible to humans from reptiles and amphibians. It should be noted that 'new' reptile- and amphibian-associated zoonoses are often discovered (Brown, 2004, Karesh et al, 2005). Furthermore, for humans with medical conditions associated with compromised immunity, such as HIV/AIDS, the vast array of additional and usually unimportant innocuous microorganisms and macroparasites that reptiles and amphibians play host to adopt far greater significance as potential pathogens.

Table 1. Reptile- and amphibian-borne zoonotic infections and infestations

Derived from: 1. Pathogens as bio-weapons, F.L. Frye, unpublished. 2. Zoonoses: drawing the battle lines, C. Warwick, Clinical Veterinary Times, 2006. 3. Reptile and amphibian communities in the United States, V. Bridges, C., Kopral, R. Johnson, Centers for Epidemiology and Animal health, 2001.

Disease (major)	**Source**
Amoebiasis	Reptiles/Amphibians
Campylobacteriosis	Reptiles/Amphibians
Coccidiomycosis	Reptiles/Amphibians
Cryptococcosis	Reptiles/Amphibians
Cryptosporidiosis	Reptiles/Amphibians
Diphyllobothriasis	Reptiles/Amphibians
Dracunculosis	Reptiles/Amphibians
Endemic relapsing fever	Reptiles/Amphibians
Fascioliasis	Reptiles/Amphibians
Gastroenteritis	Reptiles
Hepatitis-A	Amphibians
Larval migrans	Reptiles/Amphibians
Loaiasis	Reptiles/Amphibians
Mycobacterium	Reptiles/Amphibians
Salmonellosis	Reptiles/Amphibians
Sparganosis	Amphibians
Streptococcus	Reptiles/Amphibians
Tapeworm	Reptiles/Amphibians
Tuberculosis	Reptiles/Amphibians
Western encephalitis	Reptiles/Amphibians
West Nile virus	Reptiles/Amphibians
Yersiniosis	Amphibians
Disease (minor)	**Source**
Adiaspiromycosis	Amphibians
Ancylostomiasis	Reptiles/Amphibians
Balantidiasis	Reptiles/Amphibian
California encephalitis	Reptiles/Amphibians
Chigger mite dermatitis	Reptiles/Amphibians
Coliform septicaemia	Reptiles/Amphibians
Dwarf tapeworm infestation	Reptiles/Amphibians
Echinostomiasis	Reptiles/Amphibians
Frog handler's nodes	Amphibians
Giardiasis	Reptiles/Amphibians
Gnathostomiasis	Reptiles/Amphibians
Melioidosis	Amphibians
Mycoplasmosis	Reptiles/Amphibians
Paragonimiasis	Reptiles/Amphibians
Rhinosporidiosis	Reptiles
Gland virus infection	Reptiles/Amphibians
Sarcocystitis	Reptiles/Amphibians
Streptothricosis	Reptiles
Thelaziasis	Reptiles/Amphibians
Vibrosis	Reptiles/Amphibians

Certain foreign and domestic sources may facilitate zoonotic pathogen transmission and these infection hubs include live and dead food markets, pet markets, pet shops, zoos and airports, and infection micro-hubs such as exotic pets in home or work environments such as farmyards (Brown, 2004, Karesh et al, 2005, Warwick 2006).

A significant source of zoonotic infection arises from human encroachment into formerly remote and relatively inaccessible regions (Karesh et al, 2005). Today, travellers frequently appreciate the prudence of prophylactic measures before going abroad, although this is not a certain safeguard again remotely-acquired infection. Purchasers of exotic animals from an apparently innocuous high street pet shop are likely unaware of the potential 'Trojan Horse' of infection and infestation each reptile or amphibian may represent. Further, unlike the often successful endeavours at educating prospective travellers, the education of exotic pet keepers against infection has been shown to be poorly successful (see Public health education).

In addition, endotherms (birds and mammals) procedurally undergo 30 days compulsory quarantine designed to identify in particular rabies and exotic Newcastle disease. This system, however, is now popularly known to be flawed with both mechanical and policy failures. Ectotherms (fish, amphibians and reptiles), despite harbouring a vast array of human and agricultural pathogens undergo no quarantine.

Air transport thus has the very viable capacity to carry people to disease and disease to people in an airborne super-express way for microbes (Warwick, 2006). Buying an exotic animal from a pet market, local pet shop or hobbyist inadvertently invites diverse pathogens direct to one's door. (However, no amount of quarantine will protect the public from some reptile- and amphibian-borne infections due to frequent pathogenic latency.) Absolute biosecurity is almost impossible where any trade in reptiles and amphibians exists.

Epidemiological monitoring and control

The introduction or exacerbation of reptile- and amphibian-borne zoonotic agents to Norway via the exotic pet trade warrants considerable concern. There are no scientific evidence-based reasons to believe that Norway would be unaffected by reptile- and amphibian-borne zoonotic disease. There are, however, major problems with regard to monitoring and controlling zoonotic disease in any country.

It may be reasonably surmised that any nation that currently permits exotic animals to be traded and kept in their jurisdiction already has significant related public health problems and that these problems are the subject of epidemiological 'under ascertainment'—that is, they are not formally recognised. Many of the more common zoonoses symptomatically superficially resemble common illnesses such as gastrointestinal, respiratory, influenzal, and dermatological disease. General medical practitioners are unfamiliar with zoonotic disease and do not typically enquire of patients whether they have had any direct contact with an exotic animal (Warwick, 2004). Accordingly, medical misdiagnoses are common (Warwick, 2004). Depending on the zoonosis the affected subject may spontaneously recover in time, respond incidentally to conventional treatment, fail to respond initially but respond after focussed treatment, or fail to respond and die.

Many cases of zoonotic disease are known to arise from indirect contact—that is not directly from animal-to-human but from intermediary surfaces such as door handles, clothes, table tops, walls, household utensils, shaking of hands, and so on (Anon. 1995, Mermin et al, 1997, Warwick 2001). Consequently, a zoonosis sufferer may be entirely unaware that they have been infected by an inanimate object or by another person. Therefore, even if asked by medical staff whether they have been in contact with an exotic animal the patient may genuinely not know that they have.

In addition, because doctors typically make little or no effort to source-trace an infection or infestation a potential epidemic may long go uncontrolled. Also, the vast majority of bacteria are presently non-cultivatable leaving diverse microbes and potential pathogens non-determined (Brown, 2004).

Zoonotic example—reptile-related human salmonellosis

Reptile-related human salmonellosis (RRS) is an established zoonotic disease. RRS has been described by US Government health authorities as a "significant and major public health problem" (Lamm et al, 1972, Mermin et al, 1977). Because RRS has been so well studied and documented, thus epidemiological questions and answers dealing with RRS are substantially clearer than for other zoonoses. However, this abundance of data on RRS does not imply that other reptile and amphibian zoonoses are less important, only that less study and thus less data exist at present regarding their pathological incidence, prevalence and epidemiology in general. Indeed, if

established data on general pathogenicity and epidemiological principles are applied to any of the infectious and infestive agents potentially carried by reptiles and amphibians then all of these agents may be considered potentially "significant" public health problems, and many may be considered potentially "major" public health problems.

Pet reptile-(turtle-) related salmonellosis was identified as an epidemiological problem in the United States in the 1960s and public health surveys in the early 1970s estimated that 280,000 cases of turtle-related human salmonellosis were occurring annually in that country (Lamm et al, 1972). Approximately 10 million pet turtles were in circulation during this study and their presence accounted for 14% of all sources of human *Salmonella* infection, and up to 18% for younger infected groups (Lamm et al, 1972). Given that *Salmonella* was diversely present in the general environment, 14% was an alarmingly high reptile-related cause of infection.

In 1975 the US Government banned the relevant national trade in turtles and the result was a 77% decrease in turtle-related salmonellosis the following year (Cohen et al, 1980). In 1976 Canada banned its market in 3—4 million pet turtles per year and likewise saw a dramatic reduction in human *Salmonella* infection (Cohen et al, 1980).

Since the North American (NA) pet turtle bans, the NA pet trade markets have gradually increased in the presence of alternative 'exotic pets', in particular, lizards, snakes and amphibians, in order to supplement its industry (Cieslak et al, 1994). As a result, and unsurprisingly, human salmonellosis cases have steadily increased (Cieslak et al, 1994), and although this new market represented a smaller turnover than that of the pet turtle trade, these 'alternative' reptile pets are estimated to be responsible for around 3--5% of all human *Salmonella* infections or 76—140,000 cases of human salmonellosis per year in the US (Mermin et al, 1997), and in specific types of infection this figure may be as high as 18% (Mermin et al, 2004).

Salmonella are natural floral inhabitants of the reptilian and amphibian gastrointestinal system and are not typically pathogenic in these animals. Approximately 90% of all reptiles harbour *Salmonella* (Koopman and Janssen 1973, Chiodini and Sundberg 1981) and while these strains may be non-pathogenic to the host reptile they are frequently pathogenic and sometimes highly virulent in humans (Chiodini and Sundberg 1981, Mermin et al, 1997). Often apparent absence of *Salmonella* is spontaneously replaced with presence of *Salmonella* as a result of

intermittent shedding (DuPonte et al, 1978), suggesting that all reptiles should be cautiously regarded as carriers of the pathogens (Warwick et al, 2001, Mermin et al, 2004). Several different *Salmonella* serotypes may be isolated from a single reptile (Seibling et al, 1975). *Salmonella spp* are highly durable outside of the host and may remain viable after 89 days in tap water and 30 months in reptile stool (Mermin et al, 1997). A consequence of failed industrial attempts to chemically eradicate *Salmonella* from pet reptiles is the emergence of antibiotic-resistant strains of the bacteria, which may prove more pathologically invasive and difficult to treat (Mermin et al, 1997, Warwick, 2001).

It is important to note that pet turtles were regarded as presenting a particular risk to human infection based on: a) the naturally associated and durable presence in excretion of *Salmonella* in these animals, b) the habitual occupation of water by these animals, and c) the ease with which bacteria are spread over these animals and thence to people and objects (Bartlett et al, 1977, Trust and Bartlett, 1979, Warwick, 2001, Mermin et al, 2004). However, snakes also prolifically harbour *Salmonella* (Schröter et al, 2004) and snakes are also more likely to be handled than are turtles (Mermin et al, 2004). Furthermore, lizards are believed to be the most efficient direct transmitters of *Salmonella* due to their ability to inflict infectious scratches—lizard claws are capable of introducing infection through human skin even during gentle handling (Frye, 1995). Both snakes and lizards are capable of introducing infection via bites. Therefore, it may be argued that snakes and lizards are more infectious than already known hazardous turtles (Frye, 1995, Warwick et al, 2001).

Transmission

As stated above, the presumed obvious primary transmission route for reptile- and amphibian-borne *Salmonella* infection is faecal-oral ingestion (Lamm et al, 1972). However, human skin scratches from the claws of lizards are considered a major route (Frye, 1995). Bites (even minor) from snakes and lizards also may transmit infection (Frye, 1995, Warwick et al, 2001). Direct contact between any contaminated reptile and open human lesions, such as sores, or via reptile debris penetrating human orbital (eye) or aural (ear) sites are further potential routes of infection (Warwick et al, 2001). In brief, aquatic turtles may contaminate large bodies of water—causing splashes, droplets, and smears to contaminate other areas and infect people; lizards

are handled more than turtles and are more likely to introduce bacteria via skin scratches; and snakes, while not possessing sharp claws, are handled far more frequently than even lizards and thus may spread bacteria more widely and consistently. As stated previously, diverse intermediary surfaces may act as carriers of *Salmonella* and once produced the bacteria are highly durable in the general environment.

Hygiene

A common misconception is that routine 'hand washing' is sufficient to eradicate *Salmonella* (Warwick et al, 2001). While the bacteria are sensitive to strong disinfectants, actual destruction of *Salmonella* requires decisive penetrative elimination of contaminated detritus, much of which is microscopic and therefore inestimable. For example, in order to adequately cleanse human hands alone a person needs to utilise the same rigorous hand-washing protocols adopted by pre-theatre surgeons. This is practically impossible in the domestic environment. Indeed, Frye (1991) recommends using sterile disposable surgical gloves when handling suspect reptiles. In addition, and in the 'real world', rarely are only a person's hands contaminated from contact with a reptile. Bacteria are easily spread over diverse surfaces from the individual's clothes (including into pockets), hair, and skin, as well as inanimate objects and other people around them (Warwick, et al 2001). Accordingly, even if hands are cleansed to 'surgical standards' all that is required to re-contaminate the hands is momentary contact with any previously touched and thus contaminated area (Warwick et al, 2001).

Public health education

Since the 1960s there have been substantial and ongoing efforts directed at educating the public regarding the potential threat of infection associated with keeping pet reptiles and amphibians. These endeavours have included government issued advice (via the general media), medical authorities (via the general media), veterinary authorities (via the general media and pet advice websites), animal welfare groups, as well as the more competent herpetological- (reptile-) based and batrachological- (amphibian-) based websites, and pet retail outlets. Specific educational advice involved, firstly, dissuading people from acquiring a pet reptile, and, secondly,

informing current reptile keepers who already have reptiles about practical hygiene--hand and environmental sterilisation.

Many exotic animal dealers, hobbyists and keepers have historically sought to diminish or dismiss the significance of exotic pet-linked human disease. Such 'educational' claims by pro-pet keepers are groundless, non-evidence-based, views that originate from either gross scientific ignorance or disproportionate vested interest or both.

The most powerful example of sustained formal and informal public education to reduce exotic pet-borne human infection relates to the United States' efforts to curtail turtle-related salmonellosis (TRS) in that country. Public health education was diversely multifactorial and multidisciplinary, and included all the above-described information routes. Indeed, it was even mandatory that pet shops issue Government health warnings and advice about reptile-linked disease.

However, despite these major efforts there was continued incidence and alarming prevalence of TRS. Formal and independent epidemiological recommendations strongly indicated that the most viable and efficient means of reducing TRS prevalence was for the US Government to impose a ban on the sales and keeping of pet turtles. The turtle-keeping ban was immediately effective and epidemiologically highly significant, reducing the prevalence of TRS by 77% within a year (Cohen et al, 1980).

In the UK sequential cases of human infant deaths from reptile-(lizard- and snake-) related salmonellosis prompted repeated Government health warnings from the year 2000 (Ward, 2000) to present regarding the keeping of reptiles. Despite these formal warnings reptile pet-keeping did not diminish, leading to Government agencies and independent epidemiologists recommending that the UK adopt a US-style ban on reptile pet-keeping.

It may not be possible to accurately state that the concerted efforts at public health education had no effect on public behaviour, but there is no scientific evidence that those efforts were significant.

Accordingly, based on historical and current evidence it may be surmised that public health education (including practical hygiene advice), no matter how comprehensive, does not significantly dissuade people from acquiring exotic pets, and does not significantly prevent transmission of potential pathogens from exotic pet to

human, and therefore would have no significant impact on alleviating threats to humans from exotic pet-linked disease.

Latest research

Recent research supports and reiterates the findings of epidemiological work conducted over the past 40 years, confirming the seriousness of the threat posed by zoonotic infection. Mermin et al, (2004) found that in the US 74,000 cases of reptile- and amphibian-human salmonellosis occur annually. Snakes and lizards relatively outweighed turtles (turtles were similar to amphibians) as sources of actual human *Salmonella* infection. According to this latest study, of all *Salmonella* infections in the US 6% are probably attributable to the keeping of reptiles and amphibians as pets. In young people (under 21 years), however, 11% of all *Salmonella* infections in the US are probably attributable to the keeping of reptiles and amphibians as pets. This figure reflects a changed pattern in reptile-keeping. For example, the former US turtle trade primarily affected young children within the 1—9 year-old bracket as these were the typical 'market' for those animals. More recently, the trend in keeping snakes, lizards and amphibians, however, affects people of a wider age range because young adults are now also keeping these animals.

The authors conclude that the current epidemiological problem is "comparable" to the major public health epidemic three decades ago. Consequently, a new ban on exotic pets for public health reasons, covering all reptiles and amphibians, has been suggested in the US (Mermin et al 2004) and is under consideration.

Summary of welfare considerations concerning reptiles as pets

A comprehensive scientific evidence-based review of reptile and amphibian biological (physical, physiological, functional anatomical, and veterinary medical) and behavioural (psychological and behavioural) aspects and other relevant welfare related-issues would require an examination of thousands of subjects and several hundred pages. Accordingly, in this report the authors have necessarily focussed on just a few examples that may be considered 'the tip of the ice-berg' and in these the authors have been very brief, especially given the broad over-arching remit of this report. Also, in order to enhance readability of the report, the authors have elected to

summarize the relevant material from the two major scientific texts in the field and cite the main works collectively in which further information may be found. The two texts are: *Health and Welfare of Captive Reptiles,* Eds Warwick, C, Frye FL & Murphy JB Kluwer Pubs, Amsterdam, London & New York, 2004; *Captive Management and Conservation of Amphibians and Reptiles*. Eds Murphy JB, Adler K. and Collins , JT. SSAR Pubs, New York, 1994.

Biological (physical, physiological and functional anatomical) considerations

In the context of this report biological considerations refer to physical, physiological and functional anatomical issues. Subjects such as the spatial needs of animals, thermal requirements, diet and nutrition, the chemical environment, handling stress, and photo-invasive environments all fit into this section. There is always some overlap between 'biological' and 'behavioural' issues—all are fundamentally biological—and an obvious example in the following sections is 'handling stress'.

Reptile and amphibian traders, breeders, and keepers commonly interpret signs in reptiles and amphibians such as 'good feeders', 'good bodyweight' and 'active reproduction' as being indicators of good welfare and adequate housing conditions. However, these signs are poor indicators of welfare that in the absence of an appropriate range of other indicators may be highly misleading (Broom and Johnson, 1993). In effect the husbandry provided for captive reptiles and amphibians by traders and keepers is typically no more than a poor caricature of a perceived lifestyle derived from what the keeper believes animals need. Also, the presence of 'positive' indicators, even in the presence of broader positive signs, should not be presumed to convey good welfare where any concomitant negative health or welfare sign is identified.

Spatial considerations

Contrary to beliefs commonly held by animal keepers, reptiles and many amphibians require substantial environmental space. Investigations of reptiles in nature show that these animals are highly active and regularly travel long distances in three dimensions as part of their home ranges and/or to defend territories. During daily activities, individuals often encounter diverse habitat. While the common perception is correct in that many animals in nature must travel long distances in order to obtain sufficient

nutrition it is not correct that the provision of water and food in captivity negates the need for greater space. Activity over great space is physiologically important to health and an essential component of normal behaviour. Small environments—for example, the typical vivaria used by almost all animal keepers are directly responsible for a myriad of physical problems as well as psychological and behavioural problems (see Captivity-stress related behaviour problems). An additional error commonly made by animal keepers is that juvenile or small animals require even less space than adult or larger species. Juvenile and small animals are often insectivorous and their prey highly active. Accordingly, they too must be highly active in order to pursue and successfully catch their prey. These activity patterns are not merely reactive behaviours but are inherited features and biologically anticipated activities.

It is arguably greater husbandry abuse to confine a reptile to a cage in the home than it would be to confine an active dog or a cat. The considerable natural activity of reptiles and amphibians as well as their innate requirement for habitat diversity means that, to be consistent with moderate-to-good animal welfare practice, spatial and habitat provisions should be a major concern and in practical terms this means no less space than that of a spacious conservatory and in many examples that too would be grossly insufficient.

Thermal considerations

Most reptile and amphibian keepers have some awareness of the thermal needs of these animals. However, this awareness is almost always extremely rudimentary and almost always leads to cases of stress, debilitation or death of the captive animal. Almost all reptiles and also possibly amphibians require both an appropriate ambient (background) temperature as well as the presence of a thermal range that involves achievable subtle gradient change for animals to select. These thermal needs are highly species-specific and entirely dependent on the physiological state of each and every individual animal according to its self-determined requirement at any point in time. Many factors underpin these auto-determined thermal needs that are essential to normal health: immune integrity; avoidance of stress; management of stress (such as handling or other disturbance-related propagation of ‘emotional fever’); and recovery from disease (‘immune-mediated behavioural fever’). Failure to provide for this thermal gradient range may result in stress, induction or prolongation of disease, or

death. It is not possible for a human to determine these important subtle thermal needs. It is also impossible to physically include a sufficient thermal range in an area of less than several linear metres, meaning that captive 'cage' conditions must be no smaller that the approximate dimensions of a moderate to large domestic conservatory. Indeed, it is virtually impossible to artificially replicate the myriad of thermal influences present in a reptile's natural habitat.

The scientific approach to reptile and amphibian thermal needs is conceptually unacceptable to animal keepers. An appropriate scientific understanding of the issue would automatically mean recognising that the practice of keeping vivaria-maintained animals is *de facto* inconsistent with good animal welfare.

Photo-invasive environments

The term 'photo-invasive environments' refers to either excess light or poorly phased light. Powerful electric light bulbs are commonly used to act as a sole heat source. An unfortunate consequence of these situations is that the light is effectively permanent, given that warmth is essential. The largely inescapable nature of the constant light source produces an invasive environmental disturbance that negatively impacts on rest and sleep patterns and various physiological processes. In the medium- and long-term these disturbances are highly significant and contrary to good welfare.

Poor light-phasing is most commonly observed where naturally nocturnal animals are subject to constant light invasion and/or reversed photophase/scotophase conditions that in effect severely disrupt natural rest-sleep /activity rhythms and cause stress (see also Thermal considerations).

Chemical cues in the artificial environment

Captive-breeding facilities and many vivaria in trade, hobbyist and domestic situations are maintained in 'minimalist' conditions preferred for their 'simplicity' of maintenance. However, such conditions by their very nature are typically deficient in important chemical cues (such as trace animal excreta) that are known to have a familiarising territorial scent for captive animals and that contribute favourably to minimise arousal stress.

Diet and nutrition

During the past two decades there have been many advances in the understanding of and provision for reptile and amphibian diet and nutrition. This has largely been due to a small number of dedicated veterinarians. However, inasmuch as these studies have identified numerous needs and increased awareness of better nutrition so too have these studies identified that nutritional subtleties are often highly important and that because little is known about natural diet for most reptiles and amphibians it is almost inevitable that captive diets are deficient in important features. Unfortunately, animal keepers pursue their hobbies on the basis of minimal dietary knowledge, artificial preparations, and many uncertainties. The result is that malnutrition and related clinical ill health remain commonly reported problems and causes of death in captive reptiles and amphibians.

Handling stress

Handling a wild animal is a poor practice. Unlike domesticated animals such as dogs and cats, that have dominant special traits that make them amenable to co-occupation in human society, reptiles and amphibians do not have relevant dominant traits and thus physical contact such as handling is not a socially assuring feature. Indeed, handling these wild animals (whether or not captive-bred) is typically a stressful process for the animal being handled because it probably perceives the handler as a predator. Handled reptiles are commonly observed displaying stress-related behaviour such as emotional fever after being handled, even by highly familiar persons. However, the subtlety of the stress-related behaviour is typically unrecognised due to the keepers' poor understanding of reptile ethology. Being caged compromises the welfare of these animals and being handled outside the cage also compromises the welfare of these animals, which highlights the general unsuitability of reptiles and amphibians as 'pets'.

Veterinary medical issues

It is beyond the scope of this report to outline the wide range of veterinary medical considerations relevant to reptiles and amphibians. Malnutrition, viral, protozoan, bacterial, and fungal infections, micro-and macro-parasitic infestations, systemic

disease, organ failure, and maladaptation syndrome are examples of gross mortality and cumulative common causes of morbidity and mortality. The key veterinary text (Frye, 1991) details hundreds of clinical problems affecting reptiles in more than 600 pages and two substantial volumes. It is, however, important to state that very many if not most diseases and post-mortem pathological findings result directly from the effects of captivity.

Behavioural (psychological and behavioural) considerations

In the context of this report four behavioural criteria need to be appreciated: first, 'normal behaviour'; second, 'injury- and disease-related (adaptive) abnormal behaviour'; third, 'captivity-stress-related behaviour', and fourth, 'behaviour-related self-injury and disease'.

In brief, normal behaviour is what healthy animals do based on natural conditions; injury- and disease-related (adaptive) abnormal behaviour is what damaged or unhealthy animals do and includes behavioural signs such as limping or lethargy; captivity-stress-related behaviour is abnormally maladaptive behaviour caused by unnatural stressors, and behaviour-related self-injury and disease refers to clinical injury or disease that arises as a result of captivity-stress.

Far more is known about captivity-stress-related behaviour problems in reptiles than in amphibians. This proportionate availability of reptile-based material does not suggest that amphibians are proportionately unaffected by captivity-stress, rather it reflects that more work has been done involving reptiles. Indeed, some provisional findings for amphibians suggest that these animals are subject to captivity-stress in similar ways to reptiles (J Casamitjana, pers. comm.).

Normal behaviour

Normal behaviour in reptiles and amphibians is essentially innately acquired and species-specific. Very few comprehensive behavioural studies have been conducted regarding reptiles and amphibians in nature. No reptile or amphibian has a known complete natural behaviour history. More significantly for the vast majority of reptiles and amphibians scant data exist concerning natural behaviour history, this includes even the most commonly traded and kept species.

Among reptile and amphibian traders and keepers common perceptions regarding necessary behaviours are typically extremely simplistic and seek to identify that an animal feeds voluntarily and sufficient for nutritional volume, shows periodic alertness, basking behaviour, some locomotor activity, reproduces, climbs, burrows, and swims (according to species). Empirical ethological data-based papers on reptile and amphibian behaviour are often beyond the educational background of amateur 'herpetologists' and 'batrachologists' and also such scientific data reporting rarely seeks to address matters such as captive animal husbandry. Accordingly, there is an endemic ignorance among animal keepers and related 'groups' or 'societies' concerning the science of behaviour. Consequently, often a reptile or amphibian keeper bases his or her evaluation of behaviour and behavioural needs on unscientific anecdotal accounts of other keepers obtained via the internet or amateur-written books and magazines and this promotes an unfortunate under-appreciation of important subjects. It is also worthy of note that misleading claims are commonly made by amateurs that they contribute to an understanding of animals in the wild, when in fact their 'contributions' are typically distorted by misperceptions based around artificial conditions of captivity. In essence, they contribute to a (mis)understanding of the species in a stressful captive environment, nothing more.

Injury- and disease-related (adaptive) abnormal behaviour

Injury- and disease-related (adaptive) abnormal behaviour although related to this report is not integral to it and thus warrants only brief mention. This is because injury- and disease-related (adaptive) abnormal behaviour essentially deals with natural behaviours that are employed under abnormal conditions, such as illness, and do not themselves constitute 'behavioural problems'. However, any artificial situation that effectively inhibits or prevents these adaptive behaviours imposes a negative, detrimental and potentially lethal set of deprivations and stressors on an animal. The unfortunate truth is that all captive conditions impose some inhibition or prevention of these behaviours and that most impose serious inhibition or prevention.

Captivity-stress-related behaviour problems

Captivity-stress-related behaviour is a highly complex subject that necessarily combines a detailed scientific understanding of animal behaviour both under natural

and artificial conditions. The subject's inception as an organised study into ethology commenced around 25 years ago. However, it is only since the mid-1990s that scientific interest has led to the incorporation of awareness of captivity-stress behaviour into institutional facilities. Very few appropriately qualified and experienced behavioural scientists are available in professional circles. Accordingly, qualified understanding, identification and guidance on captivity-stress behaviour are absent from most reptile and amphibian husbandry scenarios. Instead, inappropriately qualified veterinarians, academics, and self-taught 'herpetologists' and 'batrachologists' remain common sources of (mis)guidance on captive animal behaviour which leads to the furtherance of gross misinterpretation of captive reptile and amphibian behaviour and the worrisome incidental failure to recognise significant behaviour problems.

There are more than a dozen primary captivity-stress-related behaviours in reptiles, and related findings in amphibians (J Casamitjana, pers. comm.) Table 2 lists some of the more apparent captivity-stress-related behaviour problems seen in hobbyist and pet animal situations.

Table 2. Captivity-stress related behaviour problems present in captive amphibians and reptiles

Exploratory and escape activity

Signs

Persistent activity, repeated attempts to push through air vents, scale walls, climb, burrow, boundary interaction, ITB (see below).

Aetiology

Stress
Associated with searches for more appropriate environments and food sources.
Also, hyperthermia and co-occupant aggression.
Overcrowding
Self-compounding and destructive
Overly restrictive, deficient, and inappropriate environments

Interaction with transparent boundaries (ITB)

Signs

Persistent (up to 100% activity period) attempts to push against, crawl up, dig under or round the transparent barriers of their enclosure.

Aetiology

Stress
Related to exploratory and escape activity.
Self-compounding and destructive.
Inherent psychological organisation and adaptational constraints result in failure to recognise abstract invisible barriers.

Hyperactivity

Signs

Abnormal high-level physical activity, surplus or redundant activity.

Aetiology

Stress
Often associated with ITB
Overcrowding
Self-compounding and destructive
Overly restrictive, deficient and inappropriate environments

Table 2…….continued 2/3

Hypoactivity

Signs
Long periods of reduced or no locomotor activity
Anorexia
Little sensory activity

Aetiology
Stress
Biological shut-down strategy to avoid rigors of hostile environment.
Overly restrictive, deficient and inappropriate environments

Disposition-related voluntary hypothermia

Signs
Persistent seeking of sub-optimal temperatures

Aetiology
Stress
'Mood'-associated 'hibernation'
Biological shut-down strategy to avoid rigors of hostile environment.
Overly restrictive, deficient and inappropriate environments

Social stress

Signs
Offensive and defensive behaviours
Anorexia
Emaciation

Aetiology
Inappropriate social grouping, sex, size /species mismatch
Individual dominance
Overcrowding
Self-compounding and destructive
Overly restrictive, deficient and inappropriate environments

Table 2…….continued 3/3

Aggression

Signs
Offensive behaviours, biting, scratching, tail-lashing, loop pushing,

Aetiology
Stress
Handling stress
Absence of live food
Self-compounding and destructive
Overcrowding
Overly restrictive, deficient and inappropriate environments

Cannibalism

Signs
Determined predatory attack-related injury and death

Aetiology
Stress
Inappropriate social grouping, size/species mis-match
Accident predation
Self-compounding and destructive
Overcrowding
Overly restrictive, deficient and inappropriate environments

Co-occupant harassment

Signs
Defensiveness during feeding
Hiding while feeding
Avoidance of food
Emaciation

Aetiology
Stress
Inappropriate social grouping, size/species mis-match
Self-compounding and destructive
Overly restrictive, deficient and inappropriate environments

Behaviour-related self-injury and disease

Behaviour-related self-injury and disease refers to clinical injury or disease that arises as a result of captivity-stress. Examples of behaviour-related self-injury and disease include:

- Friction lesions, usually on rostrum, due to interaction with transparent boundaries;
- Friction lesions on rostrum, damaged claws and abrasions to (usually) forelimbs which result from exploratory and escape activities;
- Friction lesions on rostrum, feet and underside of body and tail arising from hyperactivity;
- Dermal lesions arising from hypoactivity and associated prolonged contact with substrata;
- Thermal burns from too close proximity or prolonged contact with a heat source;
- Damaged claws from attempts to burrow into shallow or hard substrata;
- Impact injuries resulting from flight responses;
- Impact injuries resulting from rapid descents onto an insufficiently absorbent substrata or into an insufficiently deep water pool.

Behavioural indicators of other key psychological states

Behavioural and psychological considerations are interwoven. However, it may be useful to outline some indicators of psychological states, as these are important when discussing behaviour. Behavioural indicators of key psychological states have been divided into two categories (Table 3): 'Signs of psychological quiescence and comfort' and 'Signs' of psychological arousal and discomfort'.

Table 3. Behavioural indicators of psychological states in captive reptiles

Signs of psychological quiescence and comfort

Normal alertness
Relaxed interest/awareness in proximate or novel objects
Calmly smelling or tasting objects or the air
Subtle changes in body posture
Unhurried movement and locomotion
Moderate to relaxed grasp on handler or object
Relaxed drinking
Relaxed breathing
Physical quiescence
Relaxed immobility
Sleep
Absence of signs in following list

Signs of psychological arousal and discomfort

Hyper-alertness
Moderate (or greater) escape attempts
Mock or actual strikes using the jaws or tail
Clutching the handler or object
Death feigning
Head-hiding
Loop-pushing
Eye contact with observer/handler associated with freezing or arousal
Tense immobility
Grating of jaw plates
Hesitant mobility
Wincing
Prolonged retraction of head, limbs or tail
Hissing
Biting
Scratching
Inflation of the body
Repeated inflation and deflation of the body
Panting
Rapid gular pulsation
Open-mouth defence posture
Open-mouth breathing
Gasping
Laboured breathing
Defaecation
Urination
Excretion of malodorous material from cloaca
Projection of penis or hemipene(s)
Voluntary regurgitation
Tail autotomy
Pseudovocalisation
Venom-spitting
Squirting blood from eye region
Pigmentation change
Collapse
Absence of signs from previous list

As can be seen from the basic outline above and illustrated in Tables 2 and 3, scientific evidence-based behavioural and psychological considerations are highly diverse with each indicator requiring appropriate interpretive understanding. Behaviour and context must be assessed together as the presence of 'positive' behavioural signs without the absence of 'negative' behavioural signs is insufficient to conclude that an animal is in a behaviourally healthy state. There is a generalised absence of interpretive understanding of behaviour problems in the amateur 'herpetological' and 'batrachological' communities. Indeed, it may be reasonably stated that there appears to exist ignorance-based systematic denial that captivity-stress is almost completely pervasive in the reptile- and amphibian-keeping communities.

Summary--behaviour

- Normal behaviour is essential to good health and welfare and is always desirably observed.
- Injury- and disease-related adaptive abnormal behaviour is essential to recovery from trauma and sickness in either natural or unnatural environments regardless of whether the underlying cause (injury or disease) results from unavoidable or avoidable factors.
- Captivity-stress-related behaviour is abnormal, destructive, maladaptive (non-resolving), and is never desirably observed.
- Behaviour-related self-injury and disease is abnormal and is never desirably observed

The NHF document
&
the positive list

NHF document

The Norwegian Herpetological Foundation (NHF) produced a document entitled "Hold av herptiler i Norge; forslag til positivliste med kommentarer" that is intended to offer herpetological/batrachological and husbandry information supporting the

proposal to introduce a positive list. An English translation of this document was obtained for scrutiny. The NHF document does not purport to be a science-based report. Rather, it offers general guidance presumably derived from author(s) personal experience and opinion. The document understandably emphasizes the importance of animal welfare issues and other issues.

However, the NHF document contains numerous serious technical errors and misconceptions, including that: "…it is not difficult to keep the most common species in a satisfactory way…"; "Heat source placed in one end of terrarium so that the animal can regulate the temperature by moving between the hot and the cold part of terrarium.", and recommendations such as providing 'bark', 'plants', 'humidity', 'automated sprinkler systems', and '(cage) hygiene' etc. All these claims and statements are misleading or entirely false. Relevant scientific-evidence-based counter-commentary can be found elsewhere in the present report. The NHF unqualified statements serve no useful purpose. For example, bark is often poisonous to animals or obstructive to the gastrointestinal tract of reptiles and amphibians, many plants are poisonous, humidity should not be arbitrarily introduced with sprays or most automated systems, and regarding 'hygiene' there is no acknowledgement of positive versus negative faecal detritus inclusion among many other things.

Indeed, no part of the NHF guidance on keeping animals in captivity is sufficiently informed to be of genuine practical value. Much of this material is so technically misrepresentative of biological issues as to be considered dangerous to both the pet and human keeper. The authors of this report take account of the fact that the NHF advice is intentionally broad so as to 'introduce' husbandry to the document's readers. However, even in this context the NHF husbandry guidance does not represent responsible advice.

Arguably more significant than these defects is the fact that the NHF document is grossly ignorant of contemporary and advanced ethological science, including both modern behavioural and psychological principles as well as applied practices such as ethologically-informed design. The omission of peer-reviewed empirical data alone is not consistent with good science.

As detailed elsewhere in the report, modern evidence-based ethology recognizes that reptiles (less published data is currently available for amphibians) manifest a raft of behavioural problems related to captivity-stress. These behavioural problems and

captivity-stress occur in all the reptiles cited in the NHF positive list, and, further, they occur in all artificial terraria-based 'pet' reptiles. This represents a major animal welfare problem. The primary reason that reptile and amphibian traders and keepers do not refer to these problems is that they lack the scientific understanding necessary to recognize and interpret key ethological signs. Essentially, exotic pet trade and hobbyist practices are inconsistent with good animal welfare but these facts are unpopular with pet sellers and keepers due to an endemic resistance among that community to accept complex scientific rationale that does not favourably support their hobby.

The NHF document also states:

"The authorities have no control of animal welfare in connection with transport (often smuggling) and sales.

Authorities cannot influence which species are traded. One is not able to divert keeping of herps to more appropriate species because everything is "just as illegal"."

If these statements are correct then:

a. it is well established that increasing trade in animals and their diversity also increases animal welfare problems as well as the incidence of smuggling, making any control over the wildlife trade substantially more difficult and resource-demanding.

b. if "…authorities cannot influence which species are traded" then the introduction of a positive list is by inference a defective proposal. Either the Norwegian authorities can control which species are traded and kept or they cannot.

Accordingly, any problems that Norwegian authorities may presently face will be exacerbated by any increase in either number or diversity of animals traded and kept as pets. Contrary to the NHF view, imposing a ban is the simplest and most effective form of prevention and control of trade and pet keeping related problems--the fact that some individuals may flout the law is a simple matter of improving enforcement of the ban. Many laws are violated in society but this is not a logical argument for rescinding bans. Confusion is, however, likely to occur where lists of species become permissible and sellers and buyers misidentify (sometimes deliberately) species and thus 'widen' still further the actual range of animals entering the 'controlled' system.

The NHF document also states:

"At the same time, such a list will create greater understanding and respect for the regulations, because a number of common, and obviously well suited species, are included."

There is no evidence for this speculative improvement regarding regulations. In fact, it is in our view quite irrational to predict that respect for regulation will increase where a 'long list' of reptiles and amphibians to be traded is introduced. The NHF document effectively makes the point that respect for the law is sufficiently absent to abide by present regulations. It is overly optimistic, to say the least, to conclude that those who have historically disregarded the law would suddenly become compliant when presented with even less regulation.

The NHF document also states:

"The main focus for the choice of species has been animal welfare. By the term animal welfare, we mean the positive goal that animals should thrive and have wellbeing. This means that we take extensive consideration to the natural behaviour and needs of the individual species. These specific animals must be well adapted to keeping in private homes and it must be possible to provide for the species needs without detailed knowledge of the species, expensive special equipment and extensive work."

Using these three very basic NHF animal welfare criteria alone *de facto* determines that no reptile or amphibian can be kept as a pet.

Re: The statement that: "…the positive goal that animals should thrive and have wellbeing…" . There is no (even rudimentary) scientific evidence that suggests that any reptile 'thrives' or 'has good wellbeing' as a pet. Therefore, set in the context of modern scientific knowledge this would mean self-defeat of the NHF claim.

Re: The statement that: "…animals must be well adapted to keeping in private homes…" There is no (even rudimentary) scientific evidence that suggests that

any reptile is 'adapted' to captivity as a pet. Therefore, set in the context of modern scientific knowledge this would mean self-defeat of the NHF claim.

Re: The statement that: "…must be possible to provide for the species needs without detailed knowledge of the species, expensive special equipment and extensive work…" There is no (even rudimentary) scientific evidence that suggests that any reptile can be kept as a pet and its wellbeing safeguarded. The real-life scenario is that neither the sellers nor the keepers have the detailed scientific knowledge required to understand salient biological issues and animals that are often thought to be 'thriving' and 'easy to keep' are almost invariably suffering neglect due to a lack of scientific understanding. Therefore, set in the context of modern scientific knowledge this would mean self-defeat of the NHF claim.

Re: The statement that: "Herps are generally unsocial animal in nature that have limited contact with species individuals…" Although reptiles are reputed to be asocial many are actually highly social and gregarious. Sociality in reptiles is highly varied. Many reptiles live in social groups and exhibit post-natal parental care. Others form social groups with dominance hierarchies. Many more acknowledge each other's presence on an incidental basis, which forms a subtle yet important social structure even in those situations.

The NHF document also states:

"We have placed emphasis on the following criteria:

- *It should be easy to provide for the physical needs of the species in terrariums, including requirements for light, temperature, humidity and natural behaviour.*
- *Species should have nutritional needs that can easily be provided by most pet stores.*
- *The animals should have low stress levels, and thus be easy to handle.*
- *The animals should be a suitable size for keeping in private homes.*
- *The species should be established in captivity, meaning they have bred for several generations to a significant extent.*

- *There should be no animal welfare problems in terms unfortunate animal transport (eg green iguana imported from Latin America) and wild caught animals.*

In addition, we have seen it necessary to include other important criteria that we believe should be the basis for selection of species to a positive list:

- *Species should be considered based on their protection status (CITES lists and the Bern Convention).*
- *Species must not be able to establish themselves in Norwegian nature (see Game Act).*
- *Species must not be able to represent any threat to humans, because of toxicity or size."*

Re. the criterion: "*It should be easy to provide for the physical needs of the species in terrariums, including requirements for light, temperature, humidity and natural behaviour."*

It is a common misperception that the stated features can be 'easily' provided. The misperception derives from a grave lack of scientific understanding of the natural biological needs of animals (see General welfare considerations). Consequently, the criterion represents an artificial objective.

Re. the criterion: "*Species should have nutritional needs that can be easily provided by most pet stores."*

Despite numerous advances in reptile and amphibian nutrition it remains that a comprehensive understanding of their needs are. Accordingly, the stated objective is overly optimistic.

Re. the criterion: *"The animals should have low stress levels, and thus be easy to handle."*

This is a naïve objective both for 'herpetologists' and 'lay' people--neither of which typically possess appropriate scientific-evidence-based knowledge. Biochemical indicators of stress are impractical and few reptile or amphibian keepers possess a scientific understanding of behavioural signs of stress. Therefore, they cannot be expected to reliably interpret such behavioural indicators.

Re. the criterion: "*The animals should be a suitable size for keeping in private homes."*

This is an artificial objective that offers no founding scientific-evidence-based guidance or justification.

Re. the criterion: *The species should be established in captivity, meaning they have bred for several generations to a significant extent.*

This objective is presumably included to discourage the trade in wild-caught animals and to promote 'stronger', captive-bred examples. However, it is well established that a trade in captive-bred animals also leads to an expansion of trade in (cheaper) wild-caught animals. Also, the notion that captive-bred animals are stronger is also misleading (see Genetically engineered animals).

Re. the criterion: "*There should be no animal welfare problems in terms unfortunate animal transport (eg green iguana imported from Latin America) and wild caught animals."*

This is a commendable objective. However, even short-term transportation of animals within Europe is sufficient to cause unacceptable levels of stress. Also, regardless of the goal, it is inevitable that wild-caught animals will be acquired and transported

from South America and elsewhere because once trade routes are opened they are notoriously difficult to police.

Re. the criterion: *The species should be considered based on their protection status (CITES lists and the Bern Convention).*

Presumably, this objective is directed at avoiding trade in protected 'illegal' species. While commendable, this is a naïve goal, because once trade routes are opened they are notoriously difficult to police.

Re. the criterion: *"Species must not be able to establish themselves in Norwegian nature (see Game Act)."*

Again, this is a commendable objective but incidental introduction of non-native 'alien' species to Norway cannot be excluded. Superficially the positive list's 30 species would appear to contain no strong-probable candidates for incidental introduction to Norway. However, potential factors such as microclimate suitability, climate change, and species other than those on the positive list entering trade serve to offer possible complications and threats. (see Introduction of non-native 'alien' species)

Re. the criterion: *"Species must not be able to represent any threat to humans, because of toxicity or size."*

Presumably, this objective is directed at the issue of animals that may be dangerous, for example, due to poisons (whether introduced via bites or skin secretions), simple bite-related injuries, or constriction by large snakes.

None of the species on the positive list are considered significant in terms of being dangerously 'poisonous'. However, several species (eg *Varanus acanthurus, Chondropython/Morelia viridis, Boa constrictor, and Ceratophrys ornata*) on the positive list are capable of inflicting very painful bites and several amphibians (eg *Bombina orientalis, Epipedobates tricolor, and Salamandra salamandra*) present mild to moderate toxic risk to humans. More significantly, and without question, all

reptiles and amphibians represent a serious threat to human health via the transmission of zoonotic pathogens. (see Public health) Also, regardless of any intention to limit species to those on the positive list it is inevitable that other large, powerful, aggressive and poisonous species will enter the Norwegian market because once trade routes are opened they are notoriously difficult to police.

The NHF document then focuses its attention on the reported claim that: *"The Norwegian Food Safety Authority has requested an explanation of why the selected species is particularly well suited to captivity in Norway."*
The NHF document begins its 'explanation' by referring to the point that the 'animals' (the 30 species proposed for the positive list) are to be held in terraria and thus independent from the general environment. While correct, this claim has no relevance as to the 'suitability' of the animals as 'pets'.

The NHF document emphasises the apparent key requirement that their proposed list of 30 species achieves: *"…an overarching requirement that all the suggested species meet all the criteria that are set in accordance with animal welfare."*

Regardless of the NHF claim, no standardised guidance on fulfilling criteria for animal welfare is included in their document.

NHF 30 species proposed for the 'positive list'

The NHF have specified a 'long list' of 30 and a 'short list' of 10 reptile and amphibian species that they claim should be included in the positive list based on their perceived 'suitability' as a pet in the domestic environment. This NHF recommendation is presented in the form of simple tables containing species names and very brief comments that attempt to describe each animal and certain features that the NHF consider noteworthy.

The average amount of information provided by the NHF for each animal consists of approximately 15 words. It can be appreciated that the NHF document may be intentionally brief for formatting reasons. However, the tabulated material is not scientific evidence-based and the dearth of information contained in the tables,

regardless of its poor technical standard, negates the value of the NHF guidelines.

Hereunder is a closer evidence-based examination of the NHF 30 species list (note the critical comments are examples only and do not represent a full list of the possible critical comments).

REPTILIA

Sauria

Species: Eublepharis macularius
NHF comment: "Perhaps the most common lizard species in captivity. Bred in large numbers every year, also in Norway. Available in a variety of patterns and color variations."
Critical comment:

- Zoonotic risk (see Public health & Table 1)
- Nocturnal, particularly subject to photo-invasive environmental stress (see Biological [physical, physiological and functional anatomical] considerations) Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Behaviour-related self-injury and disease (see Behavioural (psychological and behavioural) considerations)

Species: Phelsuma madagascariensis
NHF comment: "The largest and most robust of geckoes. It should be handled carefully due to sensitive skin. Simplified feeding because of prefabricated food."
Critical comment:

- Zoonotic risk (see Public health & Table 1)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments,

Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Aggression, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Pogona vitticeps
NHF comment: "A robust and quiet natured species that in a few years has become one of the most popular and widespread hobby species."
Critical comment:

- Zoonotic risk (see Public health & Table 1)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Aggression, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Varanus acanthuru
NHF comment: "A suitable and popular species that is bred in increasing numbers. Requires some more space."
Critical comment:

- Zoonotic risk (see Public health & Table 1) Painful bites/other injuries to humans.
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and

functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Aggression, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Uromastyx ocellata
NHF comment: "Calm, herbivorous species. Requires high heat and light intensity."
Critical comment:

- Zoonotic risk (see Public health & Table 1) Painful bites/other injuries to humans
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Aggression, Cannibalism, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Lacerta lepida
NHF comment: "Robust species. Protected by the Bern Convention, but bred under license by European breeders."
Critical comment:

- Zoonotic risk (see Public health & Table 1) Painful bites/other injuries to humans
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour

problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Aggression, Cannibalism, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Tiliqua scincoides
NHF comment: "A calm species that is easy to handle, and eats practically anything."
Critical comment:

- Zoonotic risk (see Public health & Table 1) Painful bites/other injuries to humans
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Aggression, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Chamaeleo calyptratus
NHF comment: "One of the most well-established kameleon species in terrariums. Eats also some plants."
Critical comment:

- Zoonotic risk (see Public health & Table 1)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity,

Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Aggression, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Rhacodactylus ciliatus
NHF comment: "A relatively new, but suitable species. Showing increasing prevalence due to large scale breeding. Simplified feeding with prefabricated food."
Critical comment:

- Zoonotic risk (see Public health & Table 1)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Aggression, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Furcifer (Chamaeleo) pardalis
NHF comment: "Popular, colorful species that is now bred in significant numbers, also in Norway."
Critical comment:

- Zoonotic risk (see Public health & Table 1) Painful bites/other injuries to humans
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress,

Aggression, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Serpentes

Species: Pantherophis/Elaphe guttata
NHF comment: "Perhaps the most common snake species in the private ownership. Bred in large numbers every year, also in Norway."
Critical comment:

- Zoonotic risk (see Public health & Table 1)
- Nocturnal/crepuscular/seasonal nocturnal, particularly subject to photo-invasive environmental stress (see Biological [physical, physiological and functional anatomical] considerations)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Co-Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Lampropeltis getula
NHF comment: "Found in several sub-species and color variations, partly as a result of domestication. An species with a long history as a terrarium animal."
Critical comment:

- Zoonotic risk (see Public health & Table 1)
- Nocturnal/crepuscular seasonal nocturnal, particularly subject to photo-invasive environmental stress (see Biological [physical, physiological and functional anatomical] considerations)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments,

Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Aggression, Cannibalism, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Lampropeltis triangulum
NHF comment: "Colorful species with many sub-species. Many colour variations exist as a result of selective breeding."
Critical comment:

- Zoonotic risk (see Public health & Table 1)
- Nocturnal/crepuscular seasonal nocturnal/, particularly subject to photo-invasive environmental stress (see Biological [physical, physiological and functional anatomical] considerations)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Aggression, Cannibalism, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Corallus hortulanus
NHF comment: "Slim built, tree-living species that shows great variation in color and pattern."
Critical comment:

- Zoonotic risk (see Public health & Table 1) Painful bites/other injuries to humans
- Nocturnal/crepuscular, particularly subject to photo-invasive environmental stress (see Biological [physical, physiological and functional anatomical] considerations)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Aggression, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Epicrates cenchria
NHF comment: "Several sub-species of which 2 are common in terrariums."
Critical comment:

- Zoonotic risk (see Public health & Table 1)
- Nocturnal/crepuscular particularly subject to photo-invasive environmental stress (see Biological [physical, physiological and functional anatomical] considerations)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity,

Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Chondropython/Morelia viridis
NHF comment: "A popular species, suitable for biotope terrariums. Showing characteristic, coiled rest pose on branches. Should be handled as little as possible."
Critical comment:

- Zoonotic risk (see Public health & Table 1) Painful bites/other injuries to humans
- Nocturnal/crepuscular/seasonal nocturnal, particularly subject to photo-invasive environmental stress (see Biological [physical, physiological and functional anatomical] considerations)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Aggression, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Morelia spilota
NHF comment: "Perhaps the python species most often kept as a pet in Scandinavia. Available in a variety of sub-species and color variations. Very good feeding response requires more attention when you take the animal out of terrarium. Other management is normally problem free."
Critical comment:

- Zoonotic risk (see Public health & Table 1) Painful bites/other injuries to humans

- Nocturnal/crepuscular, particularly subject to photo-invasive environmental stress (see Biological [physical, physiological and functional anatomical] considerations)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Aggression, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Python regius
NHF comment: "A popular, easy to handle, unusually calm species, now found in a wide range of color pattern variations."
Critical comment:

- Zoonotic risk (see Public health & Table 1)
- Nocturnal/crepuscular particularly subject to photo-invasive environmental stress (see Biological [physical, physiological and functional anatomical] considerations)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Co-Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Boa constrictor
NHF comment: One of the earliest established species in captivity. They become relatively large, but normally have a peaceful manner. A sub-species (B. c. occidentalis) is on the CITES list. It, however, in bred in large numbers like the other sub-species."
Critical comment:

- Zoonotic risk (see Public health & Table 1) Painful bites/other injuries to humans
- Nocturnal/crepuscular, particularly subject to photo-invasive environmental stress (see Biological [physical, physiological and functional anatomical] considerations)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Testudines

Species: Testudo hermanni
NHF comment: "Because of widespread keeping in Norway, we have included this species. It is granted many exemptions from the ban (for people with allergies etc). The species is not particularly easy as a hobby animal, eg because it has special nutritional needs, and hibernates, and so on."
Critical comment:

- Zoonotic risk (see Public health & Table 1)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments,

Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Geochelone paradalis
NHF comment:" A robust species that is bred in significant numbers in Europe. Large species that requires much space."
Critical comment:

- Zoonotic risk (see Public health & Table 1) Painful bites/other injuries to humans
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Chinemys reevesii
NHF comment: "Simplified feeding with prefabricated feed for water turtles."
Critical comment:

- Zoonotic risk (see Public health & Table 1)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Photo-invasive environments, Chemical cues in the artificial environment, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour

problems, Interaction with transparent boundaries, Hyperactivity, Hypoactivity, Disposition-related voluntary hypothermia, Social stress, Cannibalism, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

AMPHIBIA

Species: Ceratophrys ornata
NHF comment: "Easy to maintain. Large appetite and quiet sitting lifestyle can give obesity problems. Not much private breeding, the species breeding is primarily commercial."
Critical comment:

- Zoonotic risk (see Public health & Table 1) Painful bites to humans
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Social stress, Aggression, Cannibalism, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Xenopus laevis
NHF comment: "Species have long history as both lab animal and that hobby animal. Aquatic life style makes species suitable for aquariums."
Critical comment:

- Zoonotic risk (see Public health & Table 1)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Social stress, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Bombina orientalis
NHF comment: "Well-established terrarium species with regular breeding in private homes. Secretes skin substance that causes local irritation."
Critical comment:

- Zoonotic risk (see Public health & Table 1), Mild toxic risk to humans
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Social stress, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Litoria caerulea
NHF comment: "Easy to maintain. Little private breeding, the species breed primarily commercially."
Critical comment:

- Zoonotic risk (see Public health & Table 1)
- Nocturnal/crepuscular subject to photo-invasive environmental stress (see Biological [physical, physiological and functional anatomical] considerations)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Social stress, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Trachycephalus resinifictrix
NHF comment: "Robust tree frog that is also bred in Norway."
Critical comment:

- Zoonotic risk (see Public health & Table 1),
- Nocturnal/crepuscular/seasonal nocturnal, subject to photo-invasive environmental stress (see Biological [physical, physiological and functional anatomical] considerations)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Social stress, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Epipedobates tricolor
NHF comment: "Colorful and day active small frog, suitable for rainforest terrariums."
Critical comment:

- Zoonotic risk (see Public health & Table 1), Moderate toxic risk to humans
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Social stress, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Cynops pyrrhogaster
NHF comment: "Aquatic species, suitable for aquariums."
Critical comment:

- Zoonotic risk (see Public health & Table 1)

- Nocturnal/crepuscular/seasonal nocturnal, subject to photo-invasive environmental stress (see Biological [physical, physiological and functional anatomical] considerations)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Social stress, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

Species: Salamandra salamandra
NHF comment: "Land living newt. Easy to maintain, but does not withstand high temperatures. Toxic skin secretion."
Critical comment:

- Zoonotic risk (see Public health & Table 1), Moderate toxic risk to humans
- Crepuscular, subject to photo-invasive environmental stress (see Biological [physical, physiological and functional anatomical] considerations)
- Subject to problems: Requires complex naturalistic environments, Spatial considerations, Thermal considerations, Diet and nutrition, Handling stress, Veterinary medical issues (see Biological [physical, physiological and functional anatomical] considerations), Captivity-stress-related behaviour problems, Interaction with transparent boundaries, Social stress, Co-occupant harassment, Behaviour-related self-injury and disease (see Behavioural [psychological and behavioural] considerations)

General comments

The NHF document also includes a section 'explaining' *"Key species that are not on the positive list"*. This section appears to be an attempt to 'critically' examine some species and outline why they are unsuitable as pets. The NHF discussion is not scientific but does present several very commonly known concerns about the several species listed, examples of which are as follows:

For *Python m. bivittatus* the animals' size and strength are cited as dangers, and the fact that the species often becomes an unwanted burden. However, large size and burdensome nature also apply to *Morelia spilota, Boa constrictor* and *Testudo pardalis* yet these appear on the 30 species positive list;

For *Iguana iguana* size and sensitivity to stress are cited along with difficulties in addressing nutritional needs. Again, all these points apply to *Testudo pardalis and others,* and sensitivity to stress as well as nutritional complications apply to *all* species on the positive list, yet these similarities are unrecognized in the NHF document;

For *Trachemys (Pseudemys) scripta* the NHF document acknowledges the unwanted possibility that the species may potentially have the capability of surviving in Norwegian natural habitat. However, the NHF document fails to recognize that the same argument applies to *Chinemys reevesii*, which is suggested for inclusion in the positive list. The NHF document then goes on to claim: *"Water turtles are the group of reptiles that pose the greatest risk for people with regard to salmonella infection, so keeping water turtles in an acceptable way requires an above average effort when it comes to cleaning and hygiene."* As stated elsewhere in this report (see Public health) aquatic turtles are known to constitute a 'significant' and 'major' public health hazard and have been banned in other countries for that reason. However, the public health threat is apparent with *all* turtles, *Chinemys reevesii* included. Further, and contrary to the NHF claim, while aquatic turtles are a definite and disturbing threat to public health, their infectivity is approximate to that of aquatic amphibians. Lizards and snakes are proportionately more severe threats to public health than are aquatic turtles—emphasising on public health grounds the strength of need *not* to promote trade in any of these animal groups.

'Common sense' has enabled the authors of the NHF document to correctly exclude

certain species from their suggested positive list. However, a lack of scientific knowledge has resulted in these exclusions being somewhat disjointed from a coherent technical theme. Further, a fuller scientific understanding among the authors of the NHF document would have enabled a more consistent and rigorous self-examination of their supposed 'suitable' positive list.

The NHF document concludes by presenting views regarding 'Work ahead', in which it emphasizes that 'to be successful' the positive list should be 'dynamic'—that is amenable to increasing the diversity of species on the list. One may reasonably anticipate that the 30 species positive list is the thin end of a much thicker predicted wedge.

Given that much of the NHF guidance on the individual species is grossly deficient, misleading or false this presents the disturbing, yet unfortunately common scenario, that the advising 'herpetological' group itself does not appreciate the complexity of the biological subjects with which it seeks to be knowledgeable. Accordingly, it is most unfortunate that this same organization expresses a desire to establish itself as a guidance authority.

Meta-issues

Introduction of non-native 'alien' species

Norway has seven native species of reptile and five native species of amphibian. The introduction of non-native 'alien' species to Norway would represent an undesirable competition scenario. Norway's northern geography and climate means that few released non-endemic tropical and temperate species of reptiles would survive, however, some non-native reptiles and amphibian introductions potentially could survive to become competing species or 'pests'.

Of the 30 species proposed for the positive list the following are at least theoretical potential non-native invaders: *Chinemys reevesii; Lacerta lepida; Elaphe guttata; Lampropeltis getula; Lampropeltis triangulum; Cynops pyrrhogaster; and Salamandra salamandra*. These species have natural geographical and ranges and physiological tolerances that potentially may allow them occupy the most favourable regions of Norway. Further, conceivable potential factors such as climate change and aberrant microclimate conditions could contribute to enabling those animals listed

above, and certainly many species other than on the '30 list' to successfully establish in Norwegian habitats.

In addition to possible competing species is the issue of introducing destructive pathogens, harboured by traded reptiles and amphibians, to native species. Incidental introduction of non-native reptile- and amphibian-borne pathogens is a serious concern. Devastating infections of indigenous amphibian populations have occurred in other countries caused by Ranavirus and Chytridiomycosis, the vectors for which may be released pet ectotherms, notably *Xenopus laevis* amphibians.

Genetically engineered animals

The term 'genetically engineered' is most often used to describe biological products that have been artificially and intentionally (for example, by human intervention) manipulated at the genetic level. However, applied genetic engineering is not limited to the context of 'genetically engineered viruses' or 'genetically modified (GM) plants' and instead loosely includes any product (including live animals) that through human intervention is genetically altered. Such alteration includes 'selective breeding' of animals to intentionally produce unnatural forms with the purpose of producing desired traits.

In the context of the exotic pet trade genetic engineering through selective breeding has resulted in a wide variety of physically unnatural reptiles. These genetically altered animals include incremental albinistics, albinos, hyper-and hypo-melanistics, and many other so-called 'morphs'. Certain behavioural alterations are also noted with some engineered reptiles.

Practically, the production process involves the breeder identifying 'desirable' aberrant natural variants and 'crossbreeding' them. This is distinctly different from breeding two naturally indigenous aberrants and effectively results in a pseudo-subspecies. Through this engineering process the genetic 'purity' of the natural species may be reduced to a few ($\leq$6.5) percent original genetic composition.

There is increasing private scientific concern regarding the production of captive-bred altered animals. No detailed scientific study has been made of this issue, although biologists, geneticists and other scientists personally emphasize potential dangers inherent in the practice which include behavioural deprivation associated with intensive captive-breeding and rearing conditions, animal health problems

arising from genetically-related immunological compromise, artificial inheritance of unusual behaviour and risk of incidental contamination of zoo-maintained genetic lines from 'morph-related' infiltration.

Of the NHF list of 30 species proposed inclusion in the positive list most are subject to some genetic engineering through selective breeding.

Exotic and domesticated animals

The terms 'exotic' and 'domesticated' frequently arise when seeking to differentiate between two 'types' of animal which common sense suggests can be made based on their natural or unnatural history and general context. In the context of applied scientific terminology, however, these descriptions have particular connotations that are not always usefully transferable in the case of pet animals unless some further clarification is offered. Outlined below is a clarifying explanation for the terms 'exotic' and 'domesticated' as used in this report.

Exotic

"Any animal that is non-domesticated or non-native "

The term 'non-domesticated' is widely accepted to refer to the negative of being 'accustomed to home life'. In this context the term 'domesticated' refers to the home of the human.

The apparent absence of a clear definition of 'exotic' means we have to look to various specific-uses. An examination of various definitions of 'exotic' as used for both plants and animals for technical purposes reveals: 'originating in or characteristic of a distant foreign country'; 'characteristic of another place'; 'non-native'; 'non-indigenous'; 'introduced'; 'not common'; 'unusual'.

The term 'non-native' is widely accepted to refer to 'originating in another part of the world' or 'from an area other than where it naturally occurs' or 'born in another area whether or not acclimatised to that country'. Therefore, all animals that do not occur naturally, whether or not artificially introduced and living wild, and whether or not capable of domestication, are included by this term.

Accordingly, all amphibians and reptiles, in the context of them being a potential 'pet', are 'exotic' and are included by the term 'non-domesticated' as none are adaptable to captivity, plus most are also included by the term 'non-native'.

Domestic

Animals such as dogs or cats genuinely *share* the human home and, given the opportunity to do so, readily adapt to the human environment, display a preference for that environment, interact in major social ways with humans in that environment, and above all these animals possess dominant 'pre-adapted genetic traits' manifesting in biological, behavioural and psychological features that embolden their biological ability to thrive in the 'human home environment'. There is no doubt that, for example, dogs and cats are readily capable of becoming 'accustomed to human home life', and are therefore 'domesticated'. Similarly, cattle and horses share the features outlined above, although their physical size and other requirements prevent certain 'sharing' of human home life. Further, regardless of the pre-requisite dominant biological, behavioural and psychological (pre-adaptive) features necessary for an animal to be capable of domestication, *actual* domestication involves the specific and successful selection of features favourable to human home-life. True domestication reflects historically long and durable adaptation to human home life, a specific example of which would be the domestic dog, which has become adapted to human home life over approximately 15,000 years. Therefore, 'non-domesticated' is exclusive of animals that are not considered domesticated. All animals that do not adapt well to captivity are included by this term, whether or not they are native to Norway.

Conclusions and recommendations

Public health

The presence of exotic animals including, and in many cases especially, reptiles and amphibians in the domestic environment has historically generated, and continues to generate, a significant and major public health problem. Numerous major and minor diseases are already established as originating from reptile- and amphibian-keeping and emergent, 'newly' problematic, forms are being regularly identified.

The considerable evidence-base shows that public health education is almost entirely ineffective in the curtailment of exotic pet-linked human disease, both in terms of dissuading people from acquiring exotic pets and in terms of preventing

infection from already acquired animals. It is extremely unlikely that similar efforts (which would also be demanding and costly) would lead to the protection of Norwegian citizens from imported and novel disease.

Should reptile- and amphibian-keeping be permitted or encouraged in Norway, whether based on the 'positive list' or any other criteria then related human illness and in some cases death are almost inevitable. To the obvious issue of avoiding human health and life tragedies is the additional and important issue of monetary and resource costs to the Norwegian public health system of the medical management of these diseases.

Animal welfare

Poor animal welfare is endemic to reptile- and amphibian-keeping. The fact that hobbyist groups and individuals do not acknowledge this is testimony to their under-qualification to possess these animals and disseminate information on them.

Captive reptiles and amphibians are subject to diverse negative physical stressors ranging from handling stress to thermal stress, and no vivaria other than extremely large and naturalistic designs—as seen in a very few exemplary zoo facilities—can be considered conducive to good welfare. Also, where amphibians are concerned, one can argue that the very nature of these animals and their dependence on adequate and clean water means that even more physical 'care' is required or rather they are less tolerant of poor conditions.

All captive reptiles in the pet and hobbyist communities display captivity-stress related behaviour problems. These problems are directly due to the animals' presence in artificial conditions. In some cases such as interaction with transparent boundaries (ITB) almost 100% of captive reptiles alone manifest this behaviour in almost all vivaria. Regardless of whether or not they are wild-caught or captive-bred these animals possess highly specific and sensitive physiologies and behaviourally function predominantly on innate (inherited-acquired) characteristics. They are wild, not domesticated, animals.

Both biological and behavioural problems that are routinely found in captive reptiles and amphibians demonstrate and emphasise their unsuitability as 'pet' or hobbyist 'collector' animals.

NHF document and positive list

The NHF document while moderate in its approach is systematically flawed, lacking both a scientific evidence-base for most of its biological and husbandry content and claims as well as for its proposed policies referring to species conservation, trade protocols, manageability and enforcement, and habitat protection issues that are known to be ineffective or function entirely contrary to stated objectives.

A fundamental feature of information produced, disseminated and accepted by reptile and amphibian traders, breeders, keepers and the 'hobbyist' sector in general is that this information is typically generated and distributed by individuals who do not possess relevant scientific qualifications. Accordingly, information propagated by such amateur individuals is founded on a personal belief system. Herpetological and batrachological groups 'suffer' from the absence of proper and necessarily highly specific academic and professional training as well as a genuinely expert peer review system. This means that herpetological and batrachological groups, despite long histories and long descriptive titles, are essentially overpopulated with members who have either a livelihood in or a passion for, animals but who actually possess very little scientific knowledge about them. Among the amateur herpetological and batrachological communities there is a readiness to accept information—no matter how unsubstantiated—that enables their hobby to continue, and a readiness to reject information—no matter how substantiated—that threatens to disable their hobby.

The overriding matter pertaining to the positive list is the issue that regardless of the consideration that the NHF sought to apply when compiling the list, neither that list, nor any alteration made to that list is capable of itemizing reptile or amphibian species that are 'suitable' as pets because, under scientific evidence-based criteria and scrutiny, such reptiles and amphibians do not exist.

Introduction of non-native 'alien' species

Exotic animals are by definition unnatural to Norway. Many countries are already affected by the establishment of non-native species in their territories as a direct result of the exotic pet trade. Once established, alien species are difficult to predict and control. It would be most unfortunate for Norwegian wildlife to subject to the otherwise avoidable potential threat of non-native species by self-introducing a new trade in wild animals.

The authors understand that the Norwegian authorities have set certain priorities and objectives, notably:

* Public health protection
* Animals have an intrinsic value
* Everyone who has animals in their care have the responsibility to ensure the animals' basic needs and that they receive necessary treatment
* Animals shall be kept in conditions which give a good quality of life
* Protection of nature

These priorities and objectives are laudable and represent what is expected of responsible government. However, it is the firm view of all the authors that none of these priorities and objectives are achievable in the event that Norwegian authorities permit any expansion of trade in and keeping of reptiles and amphibians in Norway. Further, it is our firm view that in the event that Norwegian authorities permit any expansion of trade in and keeping of reptiles and amphibians in Norway then this would heavily and negatively impact against the stated priorities and objectives.

Prevention and control of exotic pet trade-related problems is best served by way of bans on the trading in and keeping of these animals. Bans on wildlife trade are known to be effective. Claims made, usually by proponents of trade, that bans lead to more destructive 'underground markets' and a larger problem have been shown to be false. Public acceptability of bans has been shown to be good and historically established bans demonstrate best practical effectiveness and durability.

Accordingly, we recommend that Norwegian authorities:

1. wholly reject the introduction of the 'positive list' and any similar or derivative system
2. maintain the present ban on keeping reptiles and amphibians in Norway
3. where necessary consider obtaining additional advice on prevention and enforcement of the present ban to enhance jurisdictional robustness against exotic pet trading and its diverse problematic issues

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References and further reading

Anon. Preparatory document on the Norwegian Animal Welfare Act of 1974: Ot prp nr 27 for 1973-74, page 22; The Ministry is in agreement that from an animal welfare perspective, very strong reasons can be given against attempts to introduce certain foreign animals to the country. The actual regulations that impose the ban on reptiles, amphibians and salamanders: Norwegian ministry of agriculture, Forskrift om forbud mot at fremmedartede (eksotiske) dyr innføres, omsettes eller holdes som husdyr, selskapsdyr eller i fangenskap på annen måte av 20.11.1976 nr. 3.).

Anon. Centers for Disease Control and Prevention: Reptile-associated salmonellosis--selected states 1994—1995 MMWR, 1995:44;347—351.

Anon. St.meld. nr. 12 (2002-2003) Om dyrehold og dyrevelferd, 2002-2003.

Anon. Hold av herptiler i Norge; forslag til positivliste med kommentarer . Laget av Norsk Herpetologisk Forening (NHF) pa foresporsel fra Mattilsynet, August (2008)

Bartlett KH, Trust TJ, Lior H. Small pet aquarium frogs as a source of *Salmonella*. Applied Environmental Microbiol, (1977) 33:1026—9.

Broom, D and Johnson, KG. Stress and Animal Welfare. Chapman and Hall, London (1993).

Brown C. Emerging zoonoses and pathogens of public health significance-an overview. Rev Sci Tech Off Int Epiz, (2004) 23:435-442.

Cieslak PR, Angulo FJ, Dueger EL, Maloney EK, Swerdlow DL. Leapin' lizards: a jump in the incidence of reptile-associated salmonellosis [abstract J226]. In: program and abstracts 34th Interscience Conference on Antimicrobial Agents and Chemiotherapy, Washington DC Am Soc. Microbiol, 1994:270.

Cohen ML, Potter M, Pollard R, Feldman RA. Turtle-associated salmonellosis in the United States: effect of Public Health Action. JAMA, 1980;243:1247-9.

Feder, ME and Burggren, WW Eds Environmental Physiology of the Amphibians. Univ. of Chicago Press, (1992)

Frye FL. Biomedical and Surgical Aspects of Captive Reptile Husbandry, 2 Vols, Krieger Publishing, New York, (1991)

Frye FL. Salmonellosis. Reptilian, (1995): 1.

Hillman SS, Withers PC, Drewes RC and Hillyard SD. Ecological and Environmental Physiology of Amphibians. Oxford Univ Press, (2008)

Krauss H, Weber A, Appel M, Enders B, Isenberg,H.D, Shiefer HG,

Schröter M, Roggentin P, Hofmann J, Speicher A, Laufs A and Mack D. Pet Snakes as a Reservoir for *Salmonella enterica* subsp. *diarizonae* (Serogroup IIIb): a Prospective Study. Appl and Environ Microbiol, (2004) 70:613-615.

Slenczka W, von Graevenitz A, Zahner H. Zoonoses: Infectious Diseases Transmissible from Animals to Humans Third Ed Am Soc for Microbiol, (2003)

Lamm SH, Taylor A, Gangrosa E, et al Turtle-associated salmonellosis 1, An estimation of the magnitude of the problem in the United States, 1070—1971. Am J Epidemiol, (1972) 95:511—17.

Karesh W, Cook RA, Bennett EL and Newcombe J. Wildlife Trade and Global Disease Emergence. Emerging Infectious Disease, 11:1000—1002, Centers for Disease Control, Atlanta, (2005)

Mermin J, Hutvwagner L, Vugia D, Shallow S, Daily P, Bender J, Koehler,J, Marcus R, Angulo FJ. Reptiles, amphibians, and human *Salmonella* infection: a population-based, case-control study. Clinical Infectious Disease, (2004) 38:S253—261.

Murphy JB, Adler K, and Collins JT. Captive Management and Conservation of Amphibians and Reptiles. Eds SSAR Pubs, New York, (1993).

Scheld WM, Craig, WA, Hughes JM. (Eds) Emerging Infections. Am Soc for Microbiol, Washington, DC, (1999)

Trust, TJ and Bartlett, KH Aquarium pets as a source of antibiotic-resistant salmonellae. Can J microbial, (1977) 33: 1026–1029.

Warwick, C. Zoonoses: drawing the battle lines. Veterinary Times, (2006) 36:26—28.

Warwick C. Gastrointestinal disorders: are healthcare professionals missing zoonotic causes? J Roy Soc Health, (2004) 124:137—142.

Warwick C Frye FL and Murphy, JB. Health and Welfare of Captive Reptiles, Eds Kluwer Pubs, Amsterdam, London & New York, (2004).

Warwick C, Lambiris AJL, Westwood D and Steedman C. Reptile-related salmonellosis. J Roy Soc Med, (2001) 93:124-126.

http://www.dirnat.no/wbch3.exe?p=2558&sec=Hoved del&secnr=1#§3,47%20og%2048

http://www.cdc.gov/ncidod/EID/vol10no12/03-0804.htm

http://www.froglife.org/Disease/Diseaseranavirus.htm

http://www.regjeringen.no/en/dep/lmd/Documents/Reports-and-plans/Plans/2006/norwegian-action-plan-on-animal-welfare.html?id=456113

Mini-biographies of authors

Clifford Warwick DipMedSci EurProBiol CBiol FRSPH FIBiol

Clifford Warwick trained in primary health care at The University of Leeds School of Medicine, specialising in zoonoses—infectious disease transmission from animals to humans. His numerous professional qualifications have been granted specifically for non-invasive research work in reptilian biology, and biological strategies, and human medical science.

His specialised areas of herpetology include normal ethology, captive reptile behavioural problems, and captivity-stress and stressors. Clifford is regarded by many to be the world's leading authority on captive reptile behavioural problems. Additional research projects and publications include euthanasia, anatomy, physiology, wildlife biology, ecology, and species and environmental conservation. His work in human medicine has involved zoonoses prevention education, epidemiological research, primary care management of gastrointestinal disease, fever, and biological strategies

in health and disease.

He was made a Fellow of The Institute of Biology for his ‘distinction in biological research'. He is also a Fellow of The Royal Society of Public Health.

He has produced innumerable publications in biology, behaviour, reptile well-being, and human medicine, a substantial number of which are published in scientific journals and proceedings around the world. Among his publication projects is what is probably the definitive advanced scientific reference book on reptile health and welfare for which he was senior editor and which he co-edited with Prof. Fredric L. Frye (the world's leading authority on reptile medicine) and Dr. James B. Murphy. Clifford is a biological consultant to no less than fifteen scientific, environmental and animal welfare organisations worldwide, as well as governmental departments and scientific advisory panels. He has held several honorary editorial positions, including being a board member of Elsevier's Applied Animal Behaviour Science, and is currently an editorial board member for the Institute of Biology's Biobits publication. In addition, he provides regular specialist advice to veterinarians and independent scientists concerning captivity-related abnormalities and other issues.

In 1992 he received the Intervet/British Veterinary Association Animal Welfare Award.

Phillip C Arena BSc(Hons) PhD

Phillip Arena has a diverse background in biology, anatomy and physiology, animal welfare, conservation biology, education and philosophy. Following his honours on the ecology of insular lizard populations, he gained his PhD in herpetology, studying aspects of the form and function of the alimentary tract of large Australian skinks. His work on the anaesthesia of reptiles was instrumental in influencing the health and treatment of captive individuals.

In collaboration with Clifford Warwick and Professor David Duvall, he produced a renowned treatise on the status of rattlesnake roundups and the treatment of rattlesnakes in the USA. He continues to foster this interest in investigations of wildlife and environmental abuse.

In 1998, as co-founder and co-leader of Project Eakehei, an international expedition to assess the zoological diversity and human use of resources in protected regions of southern Ecuador, Phillip and his colleagues were awarded a BirdLife BP

Conservation Award. This was the first time such an award was presented to Australian scientists. His work in Ecuador contributed data to the global phenomena of amphibian declines and provided information on previously unrecorded species of both vertebrates and invertebrates.

With vast experience as a field biologist, he continues to act as a consultant and carries out flora and fauna surveys throughout the state of Western Australia. Phillip continues to act as a consultant to numerous scientific and animal welfare organisations locally and internationally and provides specialist advice to wildlife keepers including zoological gardens and other 'sanctuary' based institutions.

Currently, Phillip teaches science at all levels from pre-primary groups through to technical colleges and university. With a background in histology, anatomy, anaesthesia, ecology, conservation and ethology, Phillip has been effective in providing sound education whilst maintaining his interest in human attitudes towards non-human species (in particular, ectotherms) and the environment.

Catrina Steedman BSc(Hons) AMIBiol

Catrina Steedman completed a BSc in psychology at Plymouth University in 1987. Being particularly interested in behavioural problems associated with animals in captivity she then worked for the Zoo Check Charitable Trust and assisted with their European Survey of Zoos. Catrina became particularly interested in reptile biology and conservation and was referred to Clifford Warwick to pursue practical work. Following several months of biological data processing within Warwick's consultancy she was invited to participate as an assistant field researcher studying ecological effects of the human harvesting of freshwater terrapin populations in North America, crocodilian slaughter methods used within ranching operations, and reptile behavioural problems in zoos.

In 1989 Catrina helped to establish the Reptile Protection Trust and acted as one of its Trustees and Treasurer. She was the primary person responsible for project co-ordination, information collation and dissemination, as well as most management responsibilities. She became heavily involved with both field and laboratory studies including species status and environmental alteration from snake hunting, biological considerations of reptiles in laboratory projects, monitoring the human culinary markets in turtles and snakes, and the biological considerations of wildlife trade and

non-indigenous invasive species. She has co-authored scientific papers and reports that have been published in journals and by the European Commission. Her research work and other professional responsibilities earned her post-graduate AMIBiol status from the Institute of Biology.