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A single list for the single market?

Assessing the impacts of an EU positive list for pets

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Executive summary

Animal companions, or pets, are found in half of all European Union (EU) households. While cats and dogs are by far the most familiar species, EU households contain thousands of species of reptiles, mammals, amphibians, birds, and fish.

These 'exotic pets' touch our lives in diverse ways. Some impacts are obvious and direct, such as companionship (and conversely, harm). Other impacts are less direct, such as the employment provided by pet shops, or are hidden from view, such as zoonotic risks to public health, the impact of invasive alien species on local environments, and the threats to biodiversity when animals are removed from their native habitat. These impacts stretch across European borders and beyond.

Recognising these impacts, EU Member States have introduced national regulations on the trade and keeping of exotic pets. Some Member States regulate the keeping of exotic pets through a 'negative list' of species that *cannot* be kept in domestic households, while others oversee a 'positive list' of species that *can* be kept. This divergence in regulatory approach and species listing seriously undermines the effectiveness of all national lists as disallowed species can be easily (but illegally) transported across EU borders. It also undermines the functioning of the EU's single market. In light of this fundamental challenge, the European Commission is currently assessing the feasibility of an EU positive list for exotic pets.

This study focuses on the potential impacts of an EU positive list for mammals, reptiles, and amphibians. We approached this objective using the following methods:

- a literature review on the impacts of the trade and keeping of exotic pets;
- the creation of two EU positive list scenarios (one stringent, one permissive) based on existing positive lists in EU Member States;
- an evaluation of how the two EU positive list scenarios would impact the current exotic pet market (by applying the positive list scenarios to import and market data);
- an evaluation of how these changes to the exotic pet market would lead to corresponding changes in ecological, biodiversity, and public health impacts;
- an investigation into the impacts of existing positive lists in EU Member States using:
  - a survey of stakeholders involved in the trade and service of exotic pets;
  - a survey of government administrations that oversee the positive lists;
  - national datasets on the exotic pet trade after positive lists were introduced.

From this evidence, several conclusions can be drawn:

- **There are numerous ecological, public health, animal welfare, and other negative externalities from the exotic pet trade, making its regulation a policy area worth pursuing.** There is significant trade in exotic pets with an estimated 22 million mammals, reptiles, and amphibians in the EU. Research has linked exotic pets to conservation risks in their native habitat, invasive alien species risks in their new habitat, human health risks from disease and injury, and welfare issues for the animals themselves.

- **As exotic pet sales are concentrated in a few species that are likely 'listed', an EU positive list would have a small economic impact for most pet businesses.** The retail market data reveals a market that is highly concentrated in a few key species. Thus, while the EU positive list scenarios reduce the number of traded *species* by 61-76%, there

is only a 22-32% reduction in the number of traded *animals*. The likely effect is even lower as this estimate assumes no shift from unlisted to listed species. Where positive lists have been introduced in the EU, the majority of exotic pet businesses report that the effect has been neutral or absent and evidence on the overall level of exotic pet trade is either ambiguous or stable.

- **By reducing the level and diversity of exotic pet trade, an EU positive list would reduce the conservation risk for threatened populations.**
  The trade in exotic pets poses conservation risks through the removal of wildlife. A quarter (25%) of the species in the exotic pet market are classified as threatened. An EU positive is estimated to reduce the threatened species traded by 63-79%. A positive list (in contrast to a negative list) has the additional conservation benefit of protecting species that are not currently traded from establishing a market.

- **An EU positive list could reduce the costly impacts of invasive alien species, but the list would need to be more targeted than current positive lists.**
  The ecological impacts of invasive alien species (IAS) are significant and the exotic pet trade is a key contributor through the frequent release and unintentional escape of exotic pets. In economic terms, these impacts are estimated to cost EU governments €270 million per year. As IAS can produce catastrophic costs (one species can cost billions of euros in remediation and control measures), investing in prevention is cost-effective policy. A positive list could fill this role, but the evaluation of EU positive list scenarios reveals that IAS risk would need to be explicitly included in species listing or targeted through complementary policies.

- **By reducing the trade in viral-rich species, particularly mammals and imported wild animals, an EU positive list would reduce zoonotic risks to public health.**
  Zoonotic diseases related to pets are estimated to cause between 5,000 and 10,000 infections per year in the EU at a cost of between €30 and €100 million. The impacts from emergent zoonoses and more resistant pathogens, derived from the large and highly diverse population of exotic pets, can be several times higher. An EU positive list is estimated to reduce zoonotic risk between 32% and 89%.

- **There is widespread concern that existing positive lists in EU Member States are undermined by the (illegal) acquisition of unlisted species through online trade and cross-border transportation.**
  Concerns about the illegal acquisition of unlisted species mean that while a majority of stakeholders involved in the trade and service of exotic pets think that their respective positive list is working to some degree, a significant share do not. As this illegal activity is facilitated by differing lists in neighbouring countries and the ease of transport between them, an EU positive list could address one the most significant challenges with existing positive lists in EU Member States.

- **There is widespread agreement among stakeholders involved in the trade and service of exotic pets that an EU positive list would help their operations.**

  Support for EU harmonisation was clear across nearly all survey respondents, with no apparent connection to their views on the efficacy or effects of existing positive lists. Some of these respondents stressed that a positive list is not a panacea and complementary policies are required such as enforcement, information sharing and training, and support for animal rescue centres after the introduction of a new list.

1. Problem description and scope of the report

1.1. Study background

Animal companions, or pets, are found in half of all EU households (FEDIAF, 2024). While cats and dogs are by far the most familiar species, EU households contain thousands of different animal species from birds to reptiles and amphibians, fish to mammals.

Exotic pets[1] touch our lives in diverse ways. Some impacts are obvious and direct, such as companionship between humans and exotic pets (and conversely, harm). Other impacts are less direct, such as the employment provided by pet shops, or are hidden from view, such as the risk of public health epidemics, the impact of invasive alien species on local environments, and the threats to biodiversity when animals are removed from their native habitat. These impacts stretch across European borders and across the globe.

Recognising these profound impacts, EU Member States have implemented legislation to regulate the trade and keeping of exotic pets. Yet one of the most basic questions – which species of animals can be kept as pets – has yielded multiple, conflicting answers.

Most Member States regulate the sale and keeping of exotic pets through a 'negative list' of species that *cannot* be kept in domestic households. Alternatively, in 2009 Belgium implemented a 'positive list' of species that *can* be sold and kept as pets, and several other Member States are in the process of adopting or have already adopted their own positive lists. With thousands of animal species currently kept in EU households and many more species around the world that could potentially be kept, the vast majority of animals are 'unlisted species' and therefore the distinction between a negative and positive list approach is substantial.

This divergence in national regulatory approaches brings significant challenges. For national governments, the free flow of people and products between EU Member States means that an animal restricted from ownership in one Member State can simply be sourced in another, thus undermining control and enforcement efforts. For the animals themselves, this cross-border sourcing creates a race to the bottom in standards. For businesses, having a multiplicity of national regulations adds to the costs of adherence. And for the EU, this divergence of national approaches presents a direct challenge to the bloc's mission of frictionless trade between EU Member States and a harmonised approach to trade globally.

1 There is no widely accepted definition of 'exotic pet'. For this study, exotic pets cover all non-native species that are not commonly and historically domesticated, that is all species with the exception of cats, dogs, rabbits, and ferrets (Schuppli & Frasier, D., 2000; Warwick et al., 2018).

It is in this context that key EU institutions and stakeholders have called on the European Commission to assess the potential for an EU positive list. In May 2022, a position paper from the Agriculture and Fisheries Council (submitted by Cyprus on behalf of Cyprus, Lithuania, Luxembourg and Malta) called on the European Commission to *"explore the potential benefits of an EU positive list, in the light of the experiences gained by those Member States that have implemented this system"*. In October 2022, the European Parliament passed a resolution which *"reiterates its call for the EU Member States to establish a science-based EU positive list of animals allowed as pets, under appropriate welfare conditions, without harm to populations in the wild and to European biodiversity"*.

The European Commission has responded to these calls, commissioning a "Study on the need for, added value of, and feasibility of introducing a 'positive list of pets'" among other actions. The feasibility study is wide ranging, covering everything from the scientific basis for different species, to the impacts on key stakeholders, to the feasibility of control and enforcement. It is scheduled for completion in mid 2025.

1.2. Report scope and approach

This study will only focus on one theme of the feasibility study, namely the impact of potential EU legislation. Issues such as the scientific basis for inclusion/exclusion from a potential positive list or the feasibility of control and enforcement are therefore outside of the report scope.

The objective of this study is to assess the potential impacts of an EU positive list for exotic pets. To achieve this we first evaluate (ex ante) the potential impact of two hypothetical positive list scenarios on the level and composition of trade, using datasets on international trade and a data sample from the exotic pet retail market and estimate their potential impact on some of the most salient negative externalities associated with exotic pets, namely, ecological and health risks. Secondly, we evaluate (ex post) the experience of existing positive lists in EU Member States as perceived by commercial and non-commercial stakeholders in countries that have implemented this regulation, using national datasets and a survey of stakeholders involved in the trade and service of exotic pets.

The report proceeds as follows: **Section 2** summarises the existing literature and the status of exotic pet trade and populations in the EU, **Section 3** evaluates the potential impact of an EU positive list on key economic, ecological, and health impacts, **Section 4** evaluates the experience with existing positive lists in EU Member States, and **Section 5** discusses and summarises the findings.

2. A review of existing literature on the trade and keeping of exotic pets in the EU

According to the European Pet Food Industry Federation (FEDIAF, 2024), in 2022 over 100 million EU households had a pet, which amounts to 206.6 million animals, excluding aquaria. Of these, 147.7 million are cats and dogs and 58.9 million are "other animals" including ornamental birds (34 million), small mammals (17.6 million), and reptiles or amphibians (above the 7.2 million "terraria" reported). The category of "other animals" represents 29% of all pets. Considering that two common mammal species are not classified as exotic pets (rabbits and ferrets), but also that the number of terraria will underestimate the number of reptile and amphibian pets contained within them,[2] the number of exotic pets is estimated between 54 and 62 million, including birds. This is equivalent to one exotic pet for every 8-10 habitants (see section 3.2 for more details).

In order to address welfare, health, and environmental protection concerns, the trading and keeping of animals of wild and non-native species is regulated in the EU through several institutional mechanisms, formulated at the international, regional, national and subnational levels. The majority of these mechanisms are based on negative lists: the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 1975), which is implemented in EU legislation by the the EU Wildlife Trade Council Regulations (1996), the European Regulation on Invasive Alien Species (2015), as well as most national regulations. In addition, the Animal Health Law (2021) has a goal to prevent disease spread, and pertains to some animal species as pets by giving requirements for entry of animals and animal products into the EU and their movements within the EU. Negative lists have been preferred as the less restrictive approach to trade and consumer's freedom of choice (Toland et al., 2020). The underlying idea is that restricting trade produces economic losses (revenue and utility) that can be only justified with proof of negative impact.

On the other hand, in existing positive lists (like those introduced in Belgium, Cyprus, Lithuania, Luxembourg, and the Netherlands), listing a species requires proof of compliance with a set of criteria (for example suitability, safety, and/or sustainability). When introducing these positive lists it was argued that they are: a) more aligned with the precautionary principle, given the limited knowledge on the proper caring and suitability of many species traded as pets; b) more flexible, easier and cheaper to adapt to the inevitable cyclical shifts in trends in exotic animals and emerging risks (zoonotic, ecological, climatic, etc.); c) considerably easier to enforce, with arguably smaller monitoring costs, and d) shifting to the industry the burden of proof that its 'products' (live animals for sale) comply with health and environmental safety (ENDCAP, 2020; Toland et al., 2020; Warwick et al., 2018). In addition, positive lists enable the improvement of health services, as the number of allowed species is significantly reduced, facilitating veterinary specialisation in those species.

2 There may be several reptiles or amphibians living in one terraria.

Positive lists are indeed a restrictive legal tool, which can operate on a broad scale. Wildlife trade bans (which some refer to a positive list as) are disputed under the argument that, as demand is inelastic, trade will continue without change through illegal markets.[3] Negative impacts will continue, or even worsen as markets go under the radar. The opposite argument, i.e. that legal trade does not eliminate but rather sustains illegal trade, has also been made; under this perspective, supply-side policies like sale restrictions must be necessarily complemented with demand side policies (information, education, etc.). The outcomes of market dynamics are rather complex, and depend on multiple biological, ecological, institutional, as well as on market conditions (Nadal & Aguayo, 2014). Large scale supply-side interventions in wildlife markets have been highly successful in many cases, confirming that demand and supply are actually more dynamic and flexible than partial equilibrium economic theory assumes. An example of this is the European Wild Bird Ban, implemented 2005, which cut down 90% of the EU imports of wild organisms of this animal class. Contrary to some expectations, illegal trade did not flood the market, as local breeders gradually matched the requirements of local demand and even expanded sales to foreign markets, which at the same time reduced risks of invasive alien species (Cardador et al., 2019).

Assessment of positive and negative impacts of implementing a positive list for exotic pets requires reviewing in detail the multiple potential impacts and conditions associated with the trade and ownership of these animals as pets. Some assessments on suitability of pets have considered both advantages and disadvantages the ownership of exotic pets (Pasmans et al., 2017) and animal welfare criteria (Warwick et al., 2018) (Warwick, et al., 2018) involved, with an inevitable degree of subjectivity. To the extent that the involved network of agents and processes to consider is broad and complex (see section 3 below), an objective thorough assessment of the positive and negative impacts of adopting a positive list for exotic pets must necessarily weigh the potential economic losses (in revenue and consumer utility) with the broader set of potentially positive impacts derived from the reduction of associated ecological and health risks.

2.1 Economic dimensions

The economic significance of the trade and ownership of exotic pets in the EU has not been properly documented. Including the products for maintaining these pets industrial and service although data is scarce and unspecific. Data by the pet food industry and supporting services in the EU by the European Pet Food Industry Federation (FEDIAF, 2024) only reports aggregated revenue earned by the pet industry (that is, food, and related products and services) for Europe as a whole. Assuming a simple proportionality (huge assumption) between revenue and the size of the pet population in the EU countries, as well as the proportion of other animals (excluding dogs, cats, and aquaria), the industry data would imply annual revenue flows in the order of €8-€11 billion for exotic pet related products and services (see Annex 1, table A.3). Only a fraction of this revenue can be considered actual returns, as costs of general inputs are included in this revenue stream. The impact of introducing a positive list on that annual flow of revenue will in turn depend on the specific responses of consumers and exotic pet suppliers.

3 The basic economic model for this argument is (Bergstrom, 1990). More sophisticated extensions of this model (Bulte & Damania, 2005; Damania & Bulte, 2007; Fischer, 2004) have found that trade legalisation can either reduce or increase illegal trade, depending on whether bans effectively reduce demand through stigma effects, on the characteristics of substitute products, and on the degree of market concentration.

Introducing a positive list will expectedly produce a significant reduction in the number of species incorporated every year in the exotic pet population. The net impact on the number of introduced pets is however ambiguous, depending on the degree to which allowed species replace not allowed species in the annual trade flows. Agents involved in import, sales and breeding of pets will expectedly be more strongly impacted by these changes than stakeholders that produce a broader range of products and services. In turn, the total impact of the observed changes in flows will gradually change the level and diversity of the population of exotic pets, and consequently, the level of revenues from associated products and services.

Trade volume or revenue along the trade value chain is scarcely documented. There is evidence that the distribution of monetary benefits along the trade chain in range countries is highly concentrated at the end of the chain, with exporter capturing an overwhelming share of the exporting price, while direct collectors obtain marginal benefits, mostly seasonal (D'Cruze, Harrington, et al., 2020; Robinson et al., 2018). Marginal economic benefits for local communities and direct collectors have also been documented for different wild-sourced reptile markets (Lyons & Natusch, 2011).

Regarding potential benefits of introducing a positive list, the literature identifies at least five major branches of positive impacts: animal welfare, over-exploitation and extinction risks, invasive alien species, ecosystem services deterioration and public health risks.

2.2 Animal welfare and over-exploitation

Animal welfare along the wildlife trade is seriously under-researched, but even scattered evidence suggests that animals of wild origin used as pets are subjected to strong welfare stress during capture and trade (Baker et al., 2013). Other authors (Pasmans et al., 2017) argue that under certain conditions pet ownership can have positive effects on animal welfare (ensuring freedom from hunger and fear) and on enhancing scientific and veterinary knowledge. Other, stricter considerations of non-domestic animal welfare requirements (Schuppli & Frasier, D., 2000; Warwick et al., 2018) suggest that most exotic pets are unsuitable for being pets. Meeting the welfare requirements of exotic pets demands high standards of care and husbandry, which is very rarely met in reality. A recent survey in Portugal found that many pet reptiles live at best, in a state of "controlled deprivation" and are at risk of suffering poor welfare throughout their captive lives, and that behaviours indicative of poor welfare and captivity stress were considered "normal" by their carers (Azevedo et al., 2021).

The negative impact of exotic trade on local populations is mostly related to the **over-exploitation** of animals from the wild (Hughes et al., 2023). Beyond specific levels of threat at the species level, the overharvesting of wildlife must be put in perspective against the current trends of defaunation and massive extinction affecting vertebrates (Ceballos et al., 2015). The population of exotic pets is maintained through local breeding and imports, which are sourced in the wild, ranched or captive bred. While we found no data regarding the volume of exotic pets locally bred, there is substantive evidence that the European imports of exotic animals are a major driver of the international pet trade with a broad ecological footprint.

Auliya et al. (2016), for example, calculated that 20 million live reptiles were imported into the EU between 2004 and 2014. Many of those imports include animals of wild and threatened species or with decreasing populations, which poses significant conservation risks and associated ecological impacts in range countries (Altherr, 2020; Altherr & Lameter, 2020; Auliya, Altherr, et al., 2016; Kaczmarski & Kolenda, 2018; Marshall et al., 2020; Morton et al., 2021). While there is a decreasing trend in the absolute and relative size of imports of wild origin into

the EU (confirmed in both CITES and LEMIS imports data; see section 3 below), there is a large number of species that cannot be bred in captivity, and every year new species are brought into the market, sometimes within months of being discovered (Altherr & Lameter, 2020). Captive breeding and ranching of highly traded exotic pets can reduce the impact on wild populations, but not completely; even in highly regulated wildlife markets "laundering" of wild animals as being captive bred is not infrequent, neither export levels above quotas (D'Cruze, Harrington, et al., 2020; Lyons & Natusch, 2011).

The negative impacts of over-exploitation of wild populations are not restricted to particular species, but can also trigger negative effects that affect whole ecosystems. Vertebrates of the relevant animal classes play key ecosystem functions (Gallardo et al., 2024), and local extinctions of endemic species can alter the health of ecosystems of origin by causing the overpopulation of prey, extinction of symbiotic plant and animal species predators, triggering cascade processes of extinction and eroding the provision of local ecosystems services and destroying natural capital that has no substitutes.[4]

2.3 Invasive alien species

Invasive alien species (IAS) are the second leading cause of animal population decline and extinction worldwide, according to the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, IPBES (2022). IAS are non-native wild populations that have become established in new geographic areas due to their ability to grow fast and spread rapidly outcompeting local species, producing negative impacts on ecosystems, biodiversity, and local species (ibid). European Regulation 2016/1143 prohibits the acquisition and private ownership of some IAS. The EU's 'Union list' of IAS mandated by this regulation includes 88 species of concern from all biological classes (47 animals and 41 plants), which represent only a fraction of the identified IAS in the EU (see below). IAS negatively impact human and animal health, ecosystem functioning, economic activities and extinction of local species (Dickey et al., 2018). IAS are also responsible for the decline of 42% of threatened and endangered species in the U.S. (Crystal-Ornelas et al., 2021).

IAS are introduced by human activities as animals escape, are accidentally or intentionally released, or are inadvertently transported. The exotic pet trade is a major pathway of introduction of invasive alien species in the world (IPBES, 2022), and in particular in the EU (Filz et al., 2018; Goławska et al., 2017; Henry et al., 2023; Kaczmarski & Kolenda, 2018). Certain characteristics of exotic pets, like broad variety, and high volume of trade, adaptability, opportunistic behaviour multiply the risk of them as IAS (mammals and reptiles). IAS can powerfully affect the balance of local natural ecosystems, threatening the species they feed upon and those they compete with, as well as by the transfer of new and unknown pathogenic bacteria, viruses, parasites, or fungi (Goławska et al., 2017). In addition, IAS can also disrupt the provision of local ecosystem services.

There exist large data gaps, but a growing number of estimates have pointed at huge costs. Globally, it is estimated that over the past 50 years the economic cost of invasive species has been $1.3 trillion USD, an estimation that is continually increasing (Diagne et al., 2020). There are between 9.2 and 11.2 thousand non-native species (both plants and animals)

4 Environmental economists have coined these terms in order to link natural elements and processes to economic processes (Dasgupta, 2021). The use of these terms involves a significant degree of reductionism, conceptual imprecision, and even wrong assumptions. Costanza and Daly (1992) for example observed the limits of these concepts when confronted with cases of imperfect substitutability among resources and irreversible impacts.

recorded in the EU (Roy et al., 2020; Seebens & et al., 2021), and although the invasion pace shows signs of saturation, for many species damages and costs are ongoing (Haubrock et al., 2023). Estimates of the cumulative cost of biological invasions in Europe between 1960 and 2020 amount to $140 billion USD (€116.6 billion, in 2017 values; Haubrock, et al. 2021) and up to €138.6 billion for the EU Member States (Henry et al., 2023). The distribution of recorded costs of IAS shows that management and prevention costs amount to less than 5% of total costs, which indicates that a precautionary principle approach pays back in money terms (IPBES, 2023).

2.4 Public health and zoonotic diseases

Public health concerns are a well established factor in shaping policies of animal care and ownership. The 2005 EU ban on wild birds trade was mostly driven by the intention to dampen the spread of avian influenza to domestic animals and humans (Can et al., 2019). Many species used as exotic pets are known to be a factor of transmission of important diseases affecting humans, domestic, and wild animals (Goławska et al., 2019). Several parasites prevalent in reptiles and amphibians (like bacteria, protozoa and viruses transmitted by arthropod vectors) pose important health risks to their human carers (Ellerd et al., 2022; Goławska et al., 2019; Hidalgo-Vila et al., 2008, 2009; Mendoza-Roldan et al., 2020).

Many mammal, bird, reptile and frog species used as pets in the EU are natural reservoirs of Salmonella spp. (D'aoust et al., 1990; D'Cruze, Bates, et al., 2020; Dudek et al., 2016; Hidalgo-Vila et al., 2008; Johnson et al., 2020; Kanagarajah et al., 2018; Marin et al., 2016, 2021; Shivaprakash et al., 2021). There is no unified reporting system for reptile associated salmonellosis (RAS) in the EU. The EU One Health Zoonoses Report 2022 (EFSA & EUCDC, 2023, p. 31) acknowledged 65,208 cases of Salmonella outbreaks in the region and a 38.9% hospitalisation rate, but no identification of RAS. Dróżdż, et al. (2021) found an incidence of 3%-7% of RAS in all sporadic cases of this disease in Italy. Moreover, the common prevalence of diseases of zoonotic origin is further complicated by the development of antimicrobial resistance cases of *Klebsiella sp.*, Salmonella sp. and Cytrobacter sp. (Hossain et al., 2020; Hossain & Heo, 2021).

The pet trade is a relevant pathway for the contagion and emergence of zoonotic diseases that affect both humans and other animal species (Karesh et al., 2005; Kolby, 2020; Linder et al., 2023) Wild animals constitute a large virus reservoir, and play a key role in zoonotic emergence, spillover, and re-emergence of zoonotic infectious diseases with epidemic potential (Karesh et al., 2005). The estimated number of undetected viruses in mammals and birds alone is 1.7 million, of which 540,000 to 850,000 could have the potential to infect humans (Carroll et al., 2018; Shivaprakash et al., 2021). Live trade poses near perfect conditions for contagion and spillover through the sampling and storing together many species that would not have contact otherwise, under stress conditions (Walzer, 2020). New species introduced in the trade further increases risks of contagion and emergence of new zoonotic diseases, as many animals used as pets are known carriers of nocive pathogens (Johnson et al., 2020). While diseases are commonly understood as those transmitted between humans and animals, diseases transmitted only among animal populations also constitute risks. Examples of current major zoonotic risks are the epidemic spread of *Batrachochytrium dendrobatidis* and *Batrachochytrium salamanderis*, which produce mortal diseases in amphibians (frogs and salamanders) that are driving many native European species to the brink of extinction (Choquette et al., 2020; Fitzpatrick et al., 2018). As in the case of IAS, the costs associated with prevention and early response to zoonotic outbreaks of concern are several orders of magnitude smaller (and more effective) compared to the costs of disease contention and treatment, which also highlights the strategic and economic importance of a precautionary approach to zoonotic risk (IPBES, 2022).

The ecological and health impacts of trade and ownership of exotic pets are underpinned by a set of complex, interrelated processes that are poorly understood, difficult to disentangle and extremely difficult to predict with certainty. For example, the assessed impacts of invasive alien species are restricted to only a fraction of known IAS (Diagne et al., 2020) and there is a persistent lack of proven methodologies to predict the likely ecological impacts and invasion risks of species which have little or no informative invasion history (Dickey et al., 2018). Zoonotic risks, on the other hand, depend on specific ecological contexts, variety of species involved, and management conditions which are expected to vary strongly across regions and socio-economic sectors (Borsky et al., 2020). This imposes important limits to assessing the relationship between the levels and diversity of trade and their ecological and health impacts. However, the relevance and irreversibility of potential impacts on ecosystem and human health related to uses of exotic animals suggests that a preventive/precautionary approach should be strongly considered in policy design.

3. An evaluation of impacts from a potential EU positive list for exotic pets

This section estimates the potential impacts of an EU positive list by comparing the current exotic pet market with two policy scenarios.

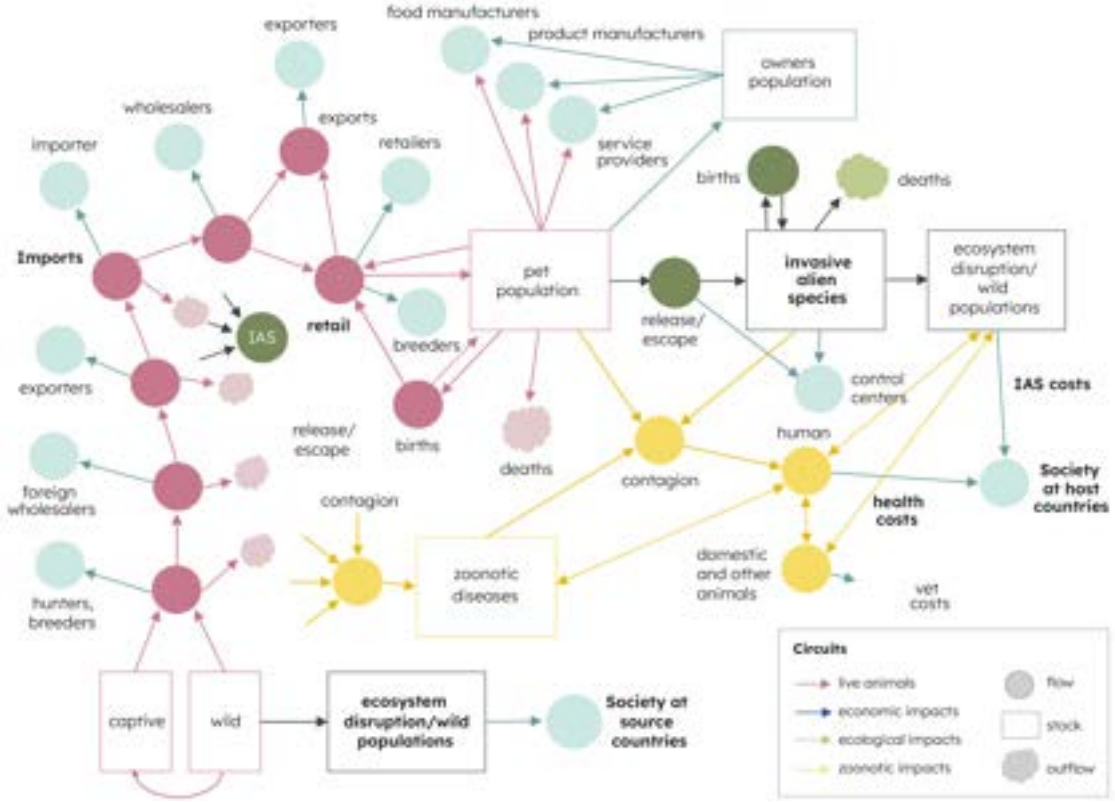
The estimation takes place in four stages. In Section 3.1 we establish an understanding of the exotic pet market in the EU and the sources of impact across different stakeholders. In Section 3.2 we assemble a baseline of the current exotic pet market by bringing together relevant datasets on the economic, ecological, and human health impacts associated with exotic pets in the EU. In Section 3.3 we develop two scenarios where a relatively permissive and a relatively restrictive EU positive list are introduced (i.e. a long list and a short list). In Section 3.4 we estimate the effects of the EU positive list scenarios based on changes to the level and diversity of exotic pet trade and the corresponding impacts on biodiversity and conservation, invasive alien species, and human health.

3.1. Sources of impact from the trade and keeping of exotic pets

The exotic pet trade involves a chain of actors from wild capture or breeding through to the end consumer in European households. There are also associated actors to support the keeping of exotic pets, regulate the system, and house escaped or unwanted animals. Other stakeholders do not have a formal role in the system but are nonetheless affected (e.g. European households that do not house exotic pets, the natural environment).

This system of stakeholders and impacts is represented schematically in Figure 1, where each step of the trade flow is associated with particular stakeholders and impacts. The system is set in motion through the circulation of live animals, money/satisfaction, invasive species, and pathogens. Each of these circuits is represented by circles of different colour that accumulate in respective deposits or stocks (rectangles). The flow of live animals (represented in red) begins with sources of origin (wild or captive, bottom left in the figure) and ends with the pet population in EU households or release to the wild. Animals leave the circuit when they die (outflow). Associated with this flow of live animals is a flow of economic impacts (blue), ecological impacts (green), and zoonotic impacts (yellow) that are felt by different stakeholders.

Figure 1: A model of the exotic pet trade and population system



Note: The release or escape of exotic animals, as well as contagion of zoonotic diseases, can occur along the trade circuit as from the existing population of exotic pets. | **Source:** Own illustration

The distinction between flows and stocks is important, because the introduction of new regulation will immediately affect the flow and sale of live animals (and the respective impacts), but the size and diversity of the exotic pet population will only change gradually as existing exotic pets die and are replaced. Thus the impacts of an EU positive list would be gradual for any of the stock impacts identified in the schematic. In this study we concentrate our analysis on a smaller set of potential impacts (highlighted text in figure 1).

3.2. The EU exotic pet market

The complex impacts of exotic pets in the EU have received some research attention but many uncertainties remain. This section assembles a baseline of the current exotic pet market by bringing together relevant datasets and studies. The economic impacts include import and retail trade, the ecological impacts include costs to biodiversity and invasive alien species (IAS), and the human health impacts include costs of Salmonellosis, Campylobacteriosis, and other zoonotic diseases with an origin in exotic pets. These impacts were identified as having some of the largest estimated impacts but offer only a partial snapshot of the relevant impacts from the trade and keeping of exotic pets in the EU.

Species classifications

For this assessment, a standardised taxonomy of species classifications was applied to ensure consistency across different datasets. For each dataset, species named were matched to the ASM Mammal Diversity Database, the Reptile Database, and AmphibiaWeb as of August 2024. This standardisation of species names also applies to the species in existing positive lists that are included in the analysis section (Section 3.3).

EU pet population

The total number of exotic pets in the EU is not specifically or systematically measured and can only be approximated indirectly. FEDIAF data, the most comprehensive source on pets in the EU to our knowledge, reports 17.6 million small mammals and 7.3 million terraria (no actual animals) for the year 2022 (FEDIAF, 2024). The amount of pets among these that qualify as exotic must then be inferred with some assumptions. Amphibians and reptiles are likely underestimated by the number of terraria, which may house more than one animal. For example, while FEDIAF reports 153,000 terraria in the Netherlands, the Pet Association in that country reports 0.5 million reptile pets in the country (DIBEVO, 2024). Also, two common mammal species are not classified as exotic pets (rabbits and ferrets).

Assuming that between 10 and 25% of small mammals are rabbits or ferrets, and that there are 1.7 amphibians or reptiles per terrarium,[5] we estimate the exotic pet population in the EU to be around 13.1 to 15.8 million small mammals, and between 7.3 and 12.3 million reptiles and amphibians, for a total of 20-28 million exotic pets, excluding birds. For comparison, consider that this is similar to the EU population under five years old (25 million).

The EU import market of exotic pets

The EU plays a major role in the international market for exotic pets. Since the 2005 ban on the import of wild birds, reptiles represent the bulk of EU imports with estimates of around 2 million reptiles imported per year from 2004 to 2014 (Auliya, Altherr, et al., 2016).

To examine the EU import market of exotic pets we rely on two data sources that allow an analysis at the level of species. The first is the trade of species listed on the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). This regulatory framework is meant to protect species from overexploitation through international trade.[6] Our second source for the import market of the EU are the imports from the United States as reported by Lemis. The U.S. is one of the largest import and export markets of wildlife and an international trade hub, and an important source of imports for the EU. For this we rely on the Law Enforcement Management Information System (LEMIS, United States Fish and Wildlife Service) database, one of the few systematic, species-level national sources on international trade. They capture a small fraction of the larger imports market, as it includes both CITES and non-CITES listed species. The small time series we used to build a baseline (2016-2020 for LEMIS and 2017-2022 for CITES) shows no clear time trend in terms of the level of trade in either dataset.

5 FEDIAF's figure on the number of terraria (7.3 million) underestimates the number of reptiles and amphibians, as they can (and frequently do) house more than one animal. As an upper bound to the number of these two animal classes we assume that 50% terrariums house 1 animal, 30% two, and the remaining 20% three or more (0.5*1+0.3*2+0.2*3 = 1.7).

6 Species are listed in CITES according to a three-level listing system based on Appendices. Appendix I includes species threatened by extinction, for which trade is only allowed under exceptional circumstances. Appendix II includes threatened species with reduced populations, and allows trade subject to controls (e.g. export quotas). Appendix III includes species threatened in at least one country, and the trade in which must also be strictly monitored.

For CITES-listed species, the import of live animals from 2003-2022 include 388 species, of which 5,173,000 were reptiles, 107,000 amphibians, and 26,000, mammals. Over the past six years (where trade flows were lower than the preceding years), CITES records for the EU report average annual import flows of 255,000 animals from 388 species, of which 20% are reported as having a wild origin (with the remaining animals either captive bred or farmed/ranched) (Table 1a). One in every five mammal or reptile (22.8% and 20.4% respectively) imported under CITE' Appendices is sourced from the wild, as are one in every eight amphibians (12.6%).

Table 1a: EU exotic animals import markets: Annual imports of CITES-listed species

Class	Species	Animals	Wild origin (%)
Mammals	41	83	22.8%
Reptiles	299	250,982	20.4%
Amphibians	28	4,139	12.6%
Total	388	255,204	20.3%

Source: Own calculations based on CITES | **Notes:** Average 2017-2022

Table 1b: EU exotic animals import markets: Annual imports from the US

Class	Species	Animals	Wild origin (%)	Average price	Value
Mammals	23	506	0%	127.9	64,647
Reptiles	498	148,765	85.4%	4.6	679,250
Amphibians	138	13,194	72.2%	8.0	105,409
Total	659	162,464	84.3%	5.2	849,305

Source: Own calculations based on LEMIS | **Notes:** Average 2016-2020

Annual EU imports from the US amount to 162,455 animals (812,000 thousand for the whole period). Although there is a similar proportion between classes compared to CITES regulated trade, imports from the US show greater diversity (666 species) and a much higher proportion of animals of wild origin in the case of reptiles (85.4%) and amphibians (72.2%) (Table 1b). Only in two cases were mammals from a wild source reported.[7]

In terms of value, EU imports from the US reached over €848 thousand per year. Overall prices reflect the fact that both reptile and amphibian markets are dominated by high volume/low price shipments (that is, they are mostly wholesale imports), with prices averaging €4.6 and €8.0 respectively. Mammals in imports from the US are higher priced (€127.9 in average), less diverse (only 24 species) and predominantly captive bred. But around these averages there is a long-tailed distribution of individual prices, with most animals traded in large, low priced batches (wholesale), most species traded in very small quantities and at much higher prices, and a large spectrum of species in between (see section A.3 in Appendix 1). This price structure matches the high concentration of trade in a few species found in the retail market and confirms the segmented nature of demand for exotic pets, discussed in the next section.

7 Coendou prehensilis and Petrogale xanthopus, with four organisms imported from each species.

The EU retail market for exotic pets

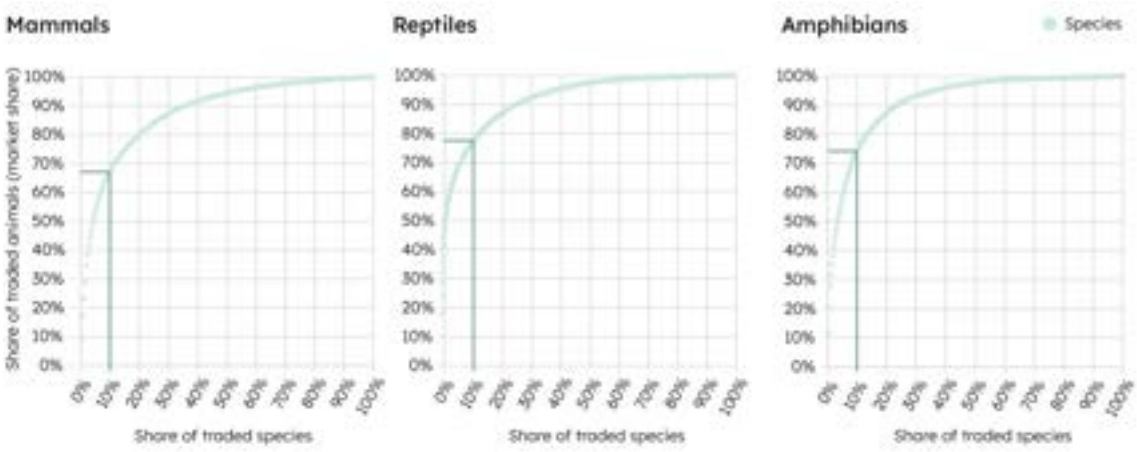
As a main source for retail market data, we relied upon a 2020 study by ProWildlife for the German Federal Agency for Nature Conservation (Altherr, 2020). The dataset was compiled by recording online advertisements for exotic pets from five major platforms with a presence in Germany[8] (terraristik.com, eBay-kleinanzeigen.de, enimalia.com, cms.exoticanimal.de, reptilienserver.de) posted from September 2017 to March 2018. Full details of the methodology are available in the original study. This dataset was matched to our species list and contributed 100,091 animals from 2,031 species.[9]

To supplement this dataset and ensure updated market coverage, we recorded nearly 20,000 advertisements from three of the same platforms (terraristik.com, kleinanzeigen.de, mammals on enimalia.com) from September 2024 to October 2024. These advertisements were matched to our species list and contributed 9,333 animals from 740 species.

Combined, our retail trade dataset covers 109,424 animals from 2,163 species. There is therefore a much broader range of species in the retail market dataset than what is provided by the CITES and Lemis databases on animal imports, suggesting that both captive breeding and imports from other regions supply a considerable size and variety of exotic pets. The retail market also includes an undetermined quantity of animals bred in captivity within the EU. The relative share of the three animal classes in the retail market is similar to that of the import market, with 84% reptiles (92,250), 5% mammals (5,262) and 11% amphibians (11,912).

From the retail market dataset it is clear that the market for exotic pets is highly concentrated in a few main species. The top 10% of traded mammal species (24) cover 67% of the market, the top 10% of traded reptile species (157) cover 76% of the market, and the top 10% of amphibian species (35) cover 75% of the market. The ball python, the single most sold reptile species, accounts for nearly 18% of the retail trade in reptiles.

Figure 2: The concentration of the exotic pet market across traded species



8 For the purposes of this study, the focus on the German market is a limitation, but not a severe one as the German market is not only the largest exotic pet market of any EU Member State, the country also operates as a key import for the rest of the EU market and the market operates with relatively few restrictions.

9 Due to species matching, the number of species and animals differs in this study compared to the original study.

The high concentration of the exotic pet market in a few species has been previously identified (Altherr, 2020; Auliya, Altherr, et al., 2016). It suggests that demand in this market is differentiated as preferences differ among consumers. At one extreme, there is a large group of first-time and "conventional" exotic pet owners, who focus on "convenience" and general characteristics of animal types, who tend to buy popular species; 2) at the other extreme, there is a smaller group of specialised and more knowledgeable consumers, interested in collecting rare and exclusive animals, who tend to buy a large variety of species in small numbers, some of which may become breeders. In between, we find consumers who gain experience and develop collectionist preferences.[10] As we show below, the estimated effects of implementing a positive list for exotic pets will be strongly influenced by this underlying structure of the market.

Impacts on biodiversity conservation

Despite the diminishing trend in the share of wild animals imported as exotic pets in the EU, the size and diversity of the EU market of exotic pets pose important risks to the conservation of traded species (Auliya, Altherr, et al., 2016; Auliya, García-Moreno, et al., 2016). For assessing these risks at the level of species we rely on the conservation status as assessed in the IUCN's Red List of Endangered Species.

According to our estimated baseline, 25% of species currently in trade are threatened species corresponding with 38% of traded animals (Table 5). Particularly important is the share of endangered (7.2%) and critically endangered species (4.3%) and animals belonging to those species (3.9% and 3.1% respectively). Almost 40% of reptiles, which comprise 84% of the total number of animals traded, are under some level of threat, while 10.5% of amphibians are critically endangered.

Table 2: Impacts on species in the retail market by IUCN status

	All three classes		Mammals		Reptiles		Amphibians	
IUCN category	Traded species	Traded animals	Traded species	Traded animals	Traded species	Traded animals	Traded species	Traded animals
Threatened	25.1%	38.0%	16.4%	16.2%	26.5%	39.7%	24.5%	33.3%
Extinct in the wild	0.0%	0.0%	0.4%	0.2%	0.0%	0.0%	0.0%	0.0%
Critically endangered	4.3%	3.1%	3.1%	2.6%	4.6%	2.2%	3.7%	10.5%
Endangered	7.2%	3.9%	4.9%	8.1%	7.6%	3.4%	6.7%	6.4%
Vulnerable	7.1%	10.1%	3.5%	2.7%	7.3%	10.2%	8.9%	11.7%
Near threatened	6.5%	20.9%	4.4%	2.5%	7.1%	23.9%	5.2%	4.7%
Least concern	73.2%	61.4%	81.0%	82.4%	71.6%	59.7%	75.5%	66.7%
Data deficient	1.6%	0.5%	2.7%	1.4%	1.9%	0.6%	0.0%	0.0%
Not defined	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

10 This range and development of consumer preferences and consumer types is described, for the case of reptile pets, by Collis and Fenili (2011).

Impacts of invasive alien species

According to Delivering Alien Invasive Species Inventories for Europe (Roy et al., 2020), 11,195 IAS have at some point been established in the region (similar to the 9,200 reported in Haubrock, 2023). Of these, 2,125 IAS are mammals, reptiles, or amphibians and present in 26 EU countries.[11] Impacts from this subset of three animal classes of IAS represent 12.7% of the cumulative economic costs from IAS reported for EU Member States between 1960 and 2022 (Haubrock et al., 2021). Out of these, 139 species have actively established populations. The impacts of many of these species have not been assessed, so the estimates below must be considered as a lower bound to the real impacts of IAS in the region.

The global database on economic costs of IAS Invacost, provides estimates for 35 species of mammals, reptiles and amphibians. This database records costs of management actions and of damages of known IAS for the period 1960-2022 (see Appendix 1 for details). Based on Invacost records, the economic cost of IAS broadly associated with the exotic pet trade between 1990 and 2022 can be estimated at €15 billion, or €452.3 million per year (Table A1.1 in the Appendix). Of this cost, 64% is attributed to mammals, 0.005% to reptiles, and 36% to amphibians.

To provide an estimate of the economic cost of IAS by animals (currently) traded as exotic pets, we limited the cost estimates to the 13 species in the IAS cost dataset that are currently traded in the exotic pet retail market (Table 3).[12] Calculations are based on Invacost using "Observed" and "Potential" costs that have been classified as "High reliability". All monetary figures in 2017 real values. We found 20 species of IAS in the list of current species in the retail trade, but for 7 of them there are no assessments of economic costs. With this stricter criteria, the economic cost associated to exotic pets is estimated as €7.9 billion between 1990 and 2022, or an annual rate of €240 million per year. As such, more than half of the IAS cost from the animal classes is likely due to the exotic pet trade. These costs are mostly produced by amphibians (67%) and mammals (33%), and include both management and damage costs.

Table 3: The economic cost of invasive alien species traded as exotic pets in the EU (million €)

Period	Total	Mammals	Reptiles	Amphibians
1990-1994	3.1	3.1	-	-
1995-1999	20.0	20.0	-	-
2000-2004	2,196.2	2,195.3	-	1.0
2005-2009	32.6	32.4	0.1	0.2
2010-2014	5,422.0	80.4	0.2	5,341.4
2015-2019	7.3	6.8	0.2	0.3
2020-2022	254.6	254.6	-	0.0
Total all years	7,935.8	2,592.5	0.4	0.0
Average all years	240.5	78.6	0.0	161.9

Notes: Millions of EUR, 2017 prices | **Source:** Own calculations based on Invacost. Calculations use "Observed" and "Potential" costs with "High reliability" estimates.

11 There is an absence of records for Estonia.

12 These species are Atelerix albiventris, Graptemys pseudogeographica, Lithobates catesbeianus (Rana catesbeiana), Myocastor coypus, Nasua nasua, Neovison vison, Nyctereutes procyonoides, Oryctolagus cuniculus, Procyon lotor, Rattus norvegicus, Sciurus niger, Trachemys scripta, and Xenopus laevis.

Impacts on human health

Zoonotic risks, generally defined, refers to the probable outbreaks of diseases of concern, both known and unknown. The causal mechanisms by which zoonotic diseases' outbreaks occur are complex and involve both humans, exotic pets, and other domestic and non-domestic animals (that is, vectors like ticks or mosquitoes). While some known zoonotic diseases are monitored systematically in the EU, their linkages to exotic pets are not (see Appendix 1 for details), so we only estimate the costs of a few key diseases. These estimates do not include the costs of potential *emerging* zoonoses, which are by their nature unknown.

Although most exotic pets belong to a few dozen popular species, the actual number of species is over 2,000 species, a diversity that is renewed every year with imports of millions of animals every year. Both the increased diversity of species, most of which are reservoirs of known viruses and other parasites of zoonotic concern, and the population, which in turn increases the opportunity and frequency of human-animal interactions are both associated with an expansion of zoonotic risk.

According to the EU CDC's Surveillance Atlas for Infectious Diseases, there are about 70,000 cases of Salmonellosis reported in the EU every year (average 2019-2023, see Appendix 1 for details). Assuming incidence rates of Reptile Associated Salmonellosis (RAS) in the range of 2%-5%, our estimates of the costs from Reptile Associated Salmonellosis (RAS) indicate 1,640-4,100 number of cases, 640-1,600 hospitalisations, and 2-3 deaths per year. Including the costs of treatment, hospitalizations, and productivity loss, this single zoonotic disease costs between €13 - €34 million per year in the EU 27 Member States (for details, see Appendix 1).

Table 4: Cost estimates for reptile-associated salmonella in the EU

			Non-hospitalised		Hospitalised	Post-hospitalisation outcomes	
Cost component		**Total cases**	**Didn't visit physician; recovered**	**Visited physician; recovered**	**Hospitalisation**	**Recovery**	**Death**
Number of cases	Low	1,646	100	902	644	643	2
	High	4,116	250	2,254	1,611	1,608	3
Medical costs	Low			€485,524	€12,296,460	€96,568	
	High			€1,213,819	€30,741,149	€241,421	
Productivity loss	Low		€6,754	€202,182	€390,916	€195,145	
	High		€16,884	€505,456	€977,289	€487,863	
Total cost by outcome	Low	€13,673,549	€6,754	€687,706	€12,687,375	€291,713	
	High	€34,183,872	€16,884	€1,719,266	€31,718,438	€729,284	

Source: Own calculations, see Appendix 1.2 for details.

The costs of RAS are just a fraction of the total current costs of zoonotic diseases on human health. For example, Campylobacteriosis (with average 180,000 cases per year in the EU) is associated to exotic pets in similar percentages to Salmonella (Masila et al., 2020) and with similar rates of hospitalisation, according to EU CDC data. Other zoonotic diseases of importance in the EU include Giardiasis (12,000 cases per year), Cryptosporidiosis (6,200 cases), Hantavirus (2,801 cases), Leptospirosis (700 cases). If we assume that all other zoonotic disease associated with exotic pets may have an impact of half of RAS, and that the latter is similar to that of Campylobacteriosis, we get a conservative estimate of the zoonotic impact of exotic pets of around 5,000-10,000 cases per year, with costs in the range of €30-€100 million per year for this group of normal/endemic zoonotic diseases with an origin in exotic pets.

The costs of outbreaks of *emergent* zoonotic diseases (either new variants of known pathogens or, more radically, the mutation of pathogens and their spillover from their original hosts into humans and other animals) are likely higher by orders of magnitude, as normal treatment, contention, and prevention measures are ineffective on new pathogens. In the 1970s the multi-stage outbreak of RAS that occurred in the U.S. is estimated to have infected about 100,000 people (Bosch et al., 2016; Cohen, 1980; Lamm, 1972). A similar outbreak in the EU would cost hundreds of deaths and around €800 million in a single year. Moreover, the well documented emergence of antibiotic-, and antiviral-resistant variants of known pathogens (Marin et al., 2021; Pathirana et al., 2018) means that health risks also accumulate in time.

Furthermore, as the historical record of pandemic outbreaks demonstrates, the risks of emerging zoonoses derived from pathogen spillover from wild species to humans (with or without an intermediate species) can reach catastrophic proportions (in the order of millions of deaths and trillions of euros), even when probabilities of occurrence appear to be relatively small. From this vantage point, the accumulation of a sizable population of highly diverse exotic species in the same territory with 490 million humans and 460 million domestic animals is not very different from an uncontrolled experiment in zoonotic spillover.

3.3. Developing EU positive list scenarios

For the analysis of an EU positive list, two scenarios are developed to illustrate the range of potential impacts: a more permissive 'long list scenario' and a more stringent 'short list scenario' (Table 5). The long and short list scenarios are hypothetical, a heuristic model meant to estimate the effects of two extreme structures of an EU positive list, strictly for the purposes of this socio-economic assessment. They are in no way intended to represent recommendations or predictions on what an EU positive list should or would consist of. That process would be undertaken by independent scientific bodies, based on a set of criteria, yet to be decided on. However, since the EU process is likely to be driven by Member State experiences, it is defensible to use existing Member State lists to build scenarios for the current study.

For mammals and reptiles, where there are existing positive lists in EU Member States, the long list scenario was constructed by taking the existing positive lists and including any species that is included on *any* positive list. In contrast, the short list scenario was constructed by taking the same existing positive lists but only including species that are included on *all* positive lists. These two scenarios represent the difference between hypothetical situations where species only being added to an EU positive list if unanimously agreed (short list) or species being added to an EU positive list with a single nomination (long list).

There is no existing positive list in EU Member States for amphibians, but there was a proposal for the Council on Animal Affairs for the Dutch Ministry of Agriculture, Nature and Food Quality in 2006. This list, which is relatively permissive as it lists whole families of amphibians, is used for both the long and short list scenarios.

Birds and fish are not included in the policy scenarios due the lack of existing positive lists in EU Member States to develop scenarios as well as a lack of baseline data on retail trade (Section 3.2).

Table 5: Construction of the long list and short list scenarios

Animal class	Long list scenario	Short list scenario
Mammals	Species on any existing list	Species on every existing list
Reptiles	Species on any existing list	Species on every existing list
Amphibians	Proposal in the Netherlands (2006)	

Note: The species in the scenarios, as well as their listing on individual positive lists in EU Member States can be viewed in this online workbook.

3.4. Evaluating the potential impacts of an EU positive list

This section evaluates the potential impacts of an EU positive list on the level and diversity of trade in the retail market for exotic pets. Potential impacts are estimated for the two positive list scenarios (long and short) and the three animal classes (mammals, reptiles and amphibians).

3.4.1. The impact of an EU positive list on the exotic pet import market

Tables 6 and 7 below show the baseline and alternative scenarios of the import markets of the EU, both for CITES-listed species and for imports from the U.S. Number of species and of traded animals, and the percentage changes are shown for each taxa in each scenario.

Import markets can be expected to be strongly affected by the introduction of positive lists. In the baseline for the retail trade segment of Mammals, Reptiles and Amphibians, 33% of traded species 56% of traded animals are regulated through CITES. While its appendices offer a certain degree of protection, CITES listing does not always ensure sustainable levels of extraction of wild species. 10 out of the 20 most traded species are listed in one of CITES' Appendices, and among them are near threatened, vulnerable and even critically endangered species.[13]

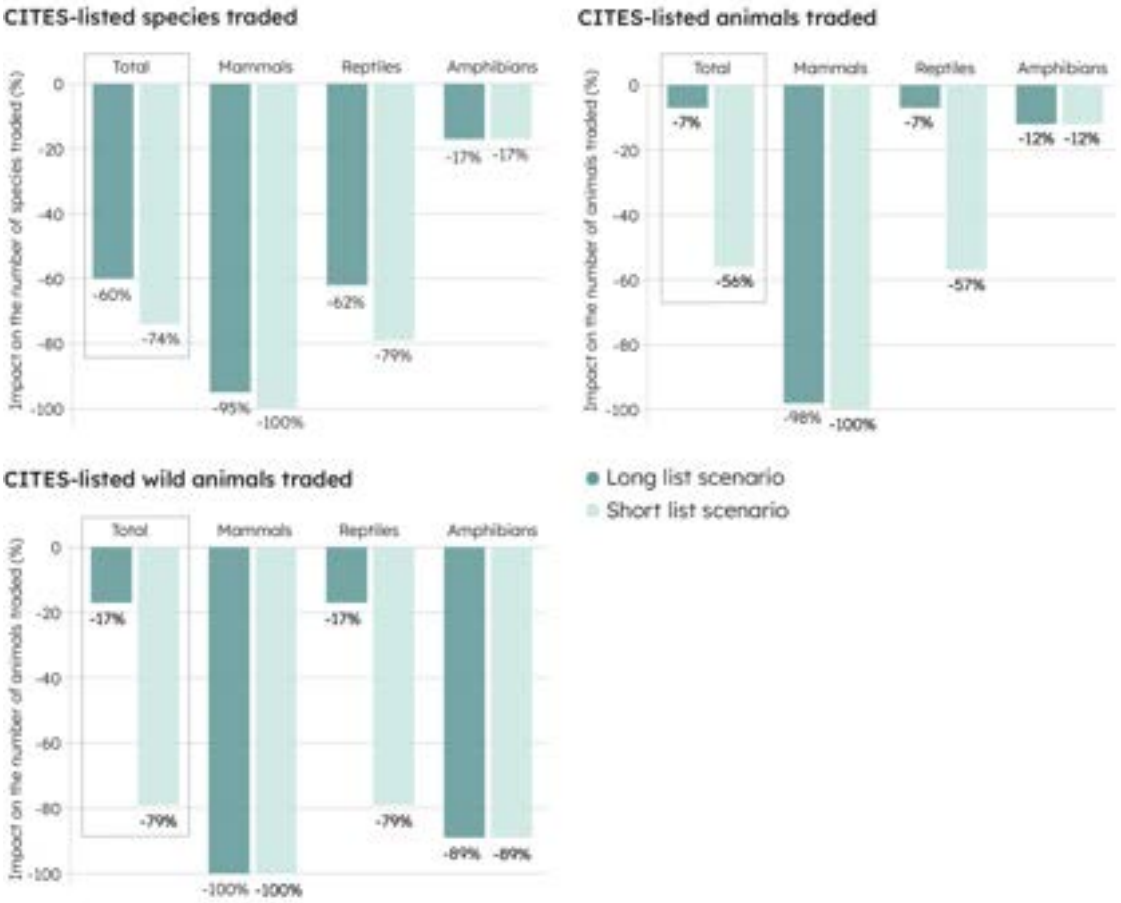
The long list scenario has a relatively strong effect on the number of CITES-listed species, (which is reduced by 60%), but barely significant in terms of traded animals (7% reduction). This is due to the fact that 10 of 20 most traded CITES-listed species are species allowed in the long list. The short list on the contrary does have a stronger impact, eliminating 74% of CITES-listed species and 56% of the trade, a much larger effect compared to the effects on the retail trade. The strongest impact in terms of the variety of species in the CITES-regulated import markets supplying the EU trade is most important on mammal and reptile species (-95% to -100%, and -62% to -79% respectively in each scenario). For amphibians, the reduction in both lists is comparatively much smaller, of -17%.

Table 6: The impact of an EU positive list on the import of CITES-listed species

Class	Traded species			Traded animals			Traded wild animals		
Scenario	Current	Long list	Short list	Current	Long list	Short list	Current	Long list	Short list
Mammals	41	2	0	83	2	0	19	0	0
Reptiles	299	115	62	250,982	233,741	107,882	51,228	42,688	10,840
Amphibians	48	40	40	4,139	3,625	3,625	522	57	57
Total	388	157	102	255,204	237,368	111,507	51,768	42,745	10,897

13 These are Python regius, Boa constrictor, Pantherophis guttatus, Eublepharis macularius, Correlophus ciliatus (Vulnerable), Dendrobates tinctorius, Testudo graeca (Vulnerable), Testudo hermanni (Near Threatened), Ambystoma mexicanum (Critically endangered) and Dendrobates auratus.

Figure 3: Effects of the EU positive list scenarios on imports of CITES-listed species



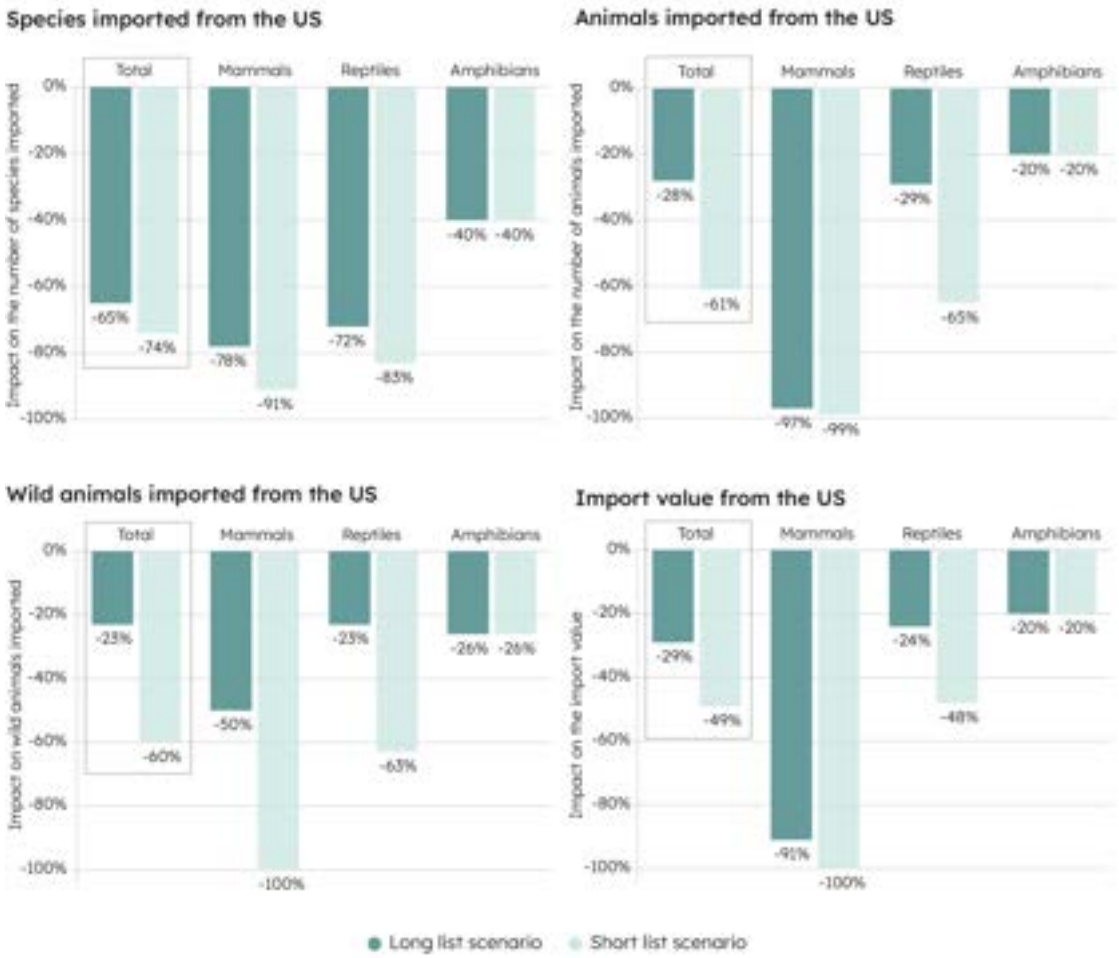
Imports from the US are impacted in similar magnitudes as the retail trade and trade in CITES-listed species. For the long list scenario, the number of species imported from the US would be reduced by 65%, and the number of animals by 28%. In the short list scenario these magnitudes are 74% and 61%. The value of imports is reduced in basically the same proportion as the reduction in the number of animals, although in the short list scenario the fall in value is 10% less than the reduction in number of animals. Likely, allowed species in this latter case are slightly more valuable than the average in the baseline. Finally, positive listing reduces the imports of animals from a wild source in proportion to the reduction in the number of animals (23% and 60% for the long and short list scenarios, respectively.

Table 7: The impact of an EU positive list on EU imports from the US

Class	Species imported			Animals imported		
Scenario	Current	Long list	Short list	Current	Long list	Short list
Mammals	23	5	2	506	15	4
Reptiles	498	141	85	148,765	105,816	52,574
Amphibians	138	83	83	13,194	10,540	10,540
Total	659	229	170	162,464	116,371	63,118

Class	Wild animals imported			Import value (€)		
Scenario	Current	Long list	Short list	Current	Long list	Short list
Mammals	2	1	0	€64,647	€5,743	€89
Reptiles	127,022	97,677	47,306	€679,250	€513,683	€350,503
Amphibians	9,522	7,082	7,082	€105,409	€84,746	€84,746
Total	136,546	104,759	54,388	€849,305	€604,172	€435,338

Figure 4: Effects of the EU positive list scenarios on EU imports from the US

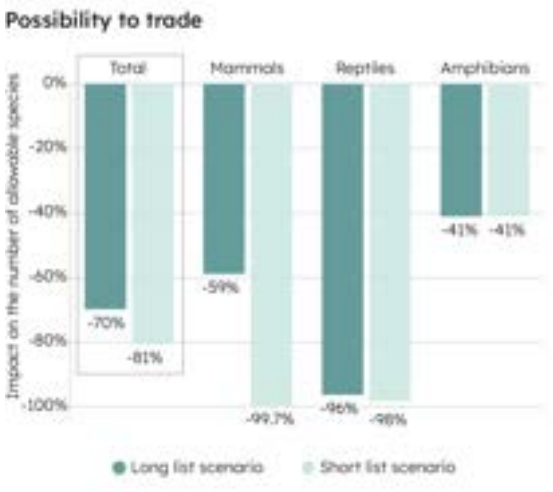


3.4.2. The impact of an EU positive list on the retail market for exotic pets

To estimate the impact of an EU positive list, we apply the positive list scenarios to the current retail market as a static model. In other words, if the positive list scenario excludes 20 species that currently trade 1000 exotic pets a year, then trade under the positive list scenario reduces by exactly 20 species and 1000 animals. This implies that we are assuming that consumers in the exotic pet market will not shift from unlisted to listed species (i.e. that there is no substitutability of demand between species). This strong assumption is more likely to hold for collectors and highly specialised consumers, but less likely to hold for new and more conventional pet owners, attracted by broader categories like "*lizards*" or "*geckos*" rather than individual species. The implication of this assumption is that our estimates of the impact of an EU positive list on the number of animals sold exotic pet retail market is most likely overestimated, as it is more realistic to expect that at least some consumers would shift (at least partially) from unlisted to listed species.[14]

A first dimension to assess the effects of positive lists is the level of protection they offer in terms of the universe of known species. Every year new species are discovered and the collector market offers a premium for rare, novel species (Altherr & Lameter, 2020; Auliya, Altherr, et al., 2016). Positive lists ensure that no new species would enter the market (unless qualified under listing criteria). Positive lists look from that perspective like an effective tool for providing in a simple way a broad range of protection to global biodiversity. Of the 27,752 species of mammals, reptiles, and amphibians that have been identified in the wild, the long list scenario allows the trade and keeping of 8,388 (19%) and the short list scenario allows 5,394 (30%). By animal class, the positive list scenario is more permissive for amphibians (59% of known species) than mammals (0.3% to 41% of known species) or reptiles (2% to 4% of known species). All species from these animal classes that are not on the positive list cannot be kept as domestic pets – a feature of positive lists that leads to a large reduction in the number of allowable species (-70 to -81%, see Figure 5a).

Figure 5a: The impact of an EU positive list on the possibility to trade known species



Source: Own calculations

14 This may also impact the ecological, environmental and health effects in the following sections, although to a lesser extent if unlisted species carry lower risks.

On the retail market side, our assembled dataset on the EU for exotic pets (described in Section 3.2) documents 2,162 species that are traded as exotic pets (243 mammals, 1,573 reptiles, and 346 amphibians), meaning 92% of known species were not in the exotic pet retail market sample (although under the current regulatory regime, nothing prevents them to be included in the future). Table 8 below shows the 25 most traded species in this sample of the retail market, showing their current conservation and IAS status.

By applying the positive list scenarios to the retail trade dataset, changes in both the number of species and the number of animals from those species that would be allowed to be traded and kept as pets can be analysed for policy impact. The number of species that can be traded describes the *diversity* of trade, whereas the number of animals that can be traded describes the *level* of trade.

Table 8: Sample of the top 25 species from the retail trade dataset

Scientific name	English name	Animal class	Traded animals	Short list	Long list	IUCN status	Known IAS	Potential IAS
Python regius	Ball python	Reptilia	16,897	X	X	NT		
Pantherophis guttatus	Corn snake	Reptilia	5,343	X	X	LC		
Boa constrictor	Boa constrictor	Reptilia	3,870	X	X	LC		
Eublepharis macularius	Leopard gecko	Reptilia	3,761	X	X	LC		
Correlophus ciliatus	Crested gecko	Reptilia	2,974	X	X	VU		
Malayopython reticulatus	Reticulated python	Reptilia	2,156			LC		
Heterodon nasicus	Western hognose snake	Reptilia	1,919	X	X	LC		
Pogona vitticeps	Central bearded dragon	Reptilia	1,730	X	X	LC		
Dendrobates tinctorius	Dyeing poison dart frog	Amphibia	1,381	X	X	LC		
Testudo graeca	Greek tortoise	Reptilia	1,276	X	X	VU	X	
Testudo hermanni	Hermann's tortoise	Reptilia	1,241	X	X	VU	X	
Ambystoma mexicanum	Axolotl	Amphibia	1,057	X	X	CR		
Rhacodactylus auriculatus	Gargoyle gecko	Reptilia	1,028	X	X	LC		
Furcifer pardalis	Panther chameleon	Reptilia	916	X	X	LC		X
Dendrobates auratus	Green and black poison dart frog	Amphibia	891	X	X	LC		
Python molurus	Indian python	Reptilia	750			NT		
Morelia spilota	Carpet python	Reptilia	749	X	X	NT		X
Eryx colubrinus	Kenyan sandboa	Reptilia	673	X	X	LC		
Testudo marginata	Marginated tortoise	Reptilia	533	X	X	LC		
Paroedura picta	Paroedura	Reptilia	523	X	X	LC		X
Octodon degus	Common degu	Mammalia	486		X	LC		
Chamaeleo calyptratus	Veiled chameleon	Reptilia	482	X	X	LC		X
Morelia viridis	Green tree python	Reptilia	471	X	X	LC		
Python bivittatus	Burmese python	Reptilia	457			VU		
Sternotherus odoratus	Common musk turtle	Reptilia	446	X	X	LC		X

Notes: LC: Least concern; NT: Near threatened; VU: Vulnerable; CR: Critically endangered.| **Source:** Retail trade from Altherr, et al., (2020) and own downloads (2024) from terraristik.com, kleinanzeigen.de, enimalia.com; EU positive list scenarios developed for this study; conservation status from IUCN as of October 2024; known IAS risk from DAISIE (Roy et al., 2020); and potential IAS risk from Kopecky et al. (2013, 2016, 2019).

The results show that the number of traded species is reduced by 61% under the long list scenario and 76% under the short list scenario (Figure 3b). These reductions in traded species are smaller than the reductions in known species (Figure 5a) as the positive list scenarios are more likely to list species that are currently traded and kept as pets.

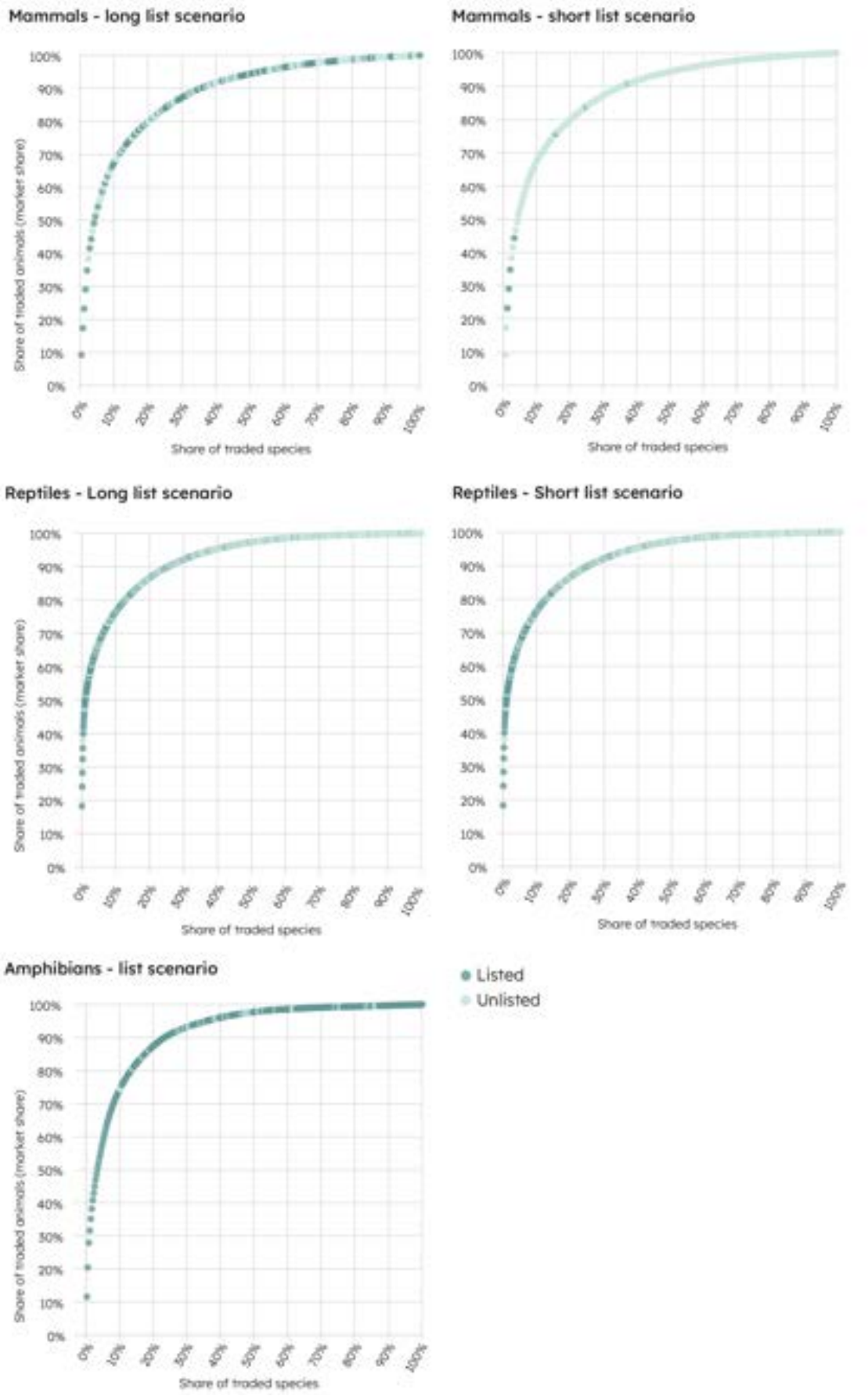
Figure 5b: The impact of an EU positive list on the diversity and level of trade

Source: Own calculations

The number of traded animals has an even smaller reduction: 22% under the long list scenario and 32% under the short list scenario (Figure 5b). This result follows from the concentration of the exotic pet market (detailed in Section 3.2) and the trend that the small number of species that are frequently traded are generally included in the positive list scenarios (dots on the left side of Figure 6) whereas the many many species that are rarely traded are generally not included (dots on the right side of Figure 6). The impact of an EU positive list therefore has a small impact on the trade of many familiar exotic pet species but a large impact across the 'long tail' of the species distribution. This result is evident across all three animal classes and both policy scenarios, even for mammals where the level of trade is significantly reduced under the short list scenario.[15]

15 The significant reduction in the trade of mammals under the short list scenario follows from the fact that several of the most traded species mammals are not included in this list (e.g. Octodon degus, Mastomys natalensis, Atelerix albiventris, Mus minutoides, and Echinops telfairi), but are included in the long list. These species are included on some, but not all, existing positive lists.

Figure 6: The concentration of the exotic pet market across traded species and the inclusion of these species in EU positive list scenarios



Note: Dots on the left are species with a large share of the exotic pet market; dots on the right are species with a small share | **Source:** Own calculations.

As noted, these estimates were derived using a static model of direct effects on the exotic pet market. While our estimates point to a 22% to 32% reduction in the level of trade (depending on the scenario), the actual result would likely be smaller as the market would shift from unlisted to listed species, thus reducing the negative economic impact. This substitution effect is explored further in the analysis of evidence from existing positive lists (Section 4.2).

3.4.3. The impact of an EU positive list on threatened species and biodiversity

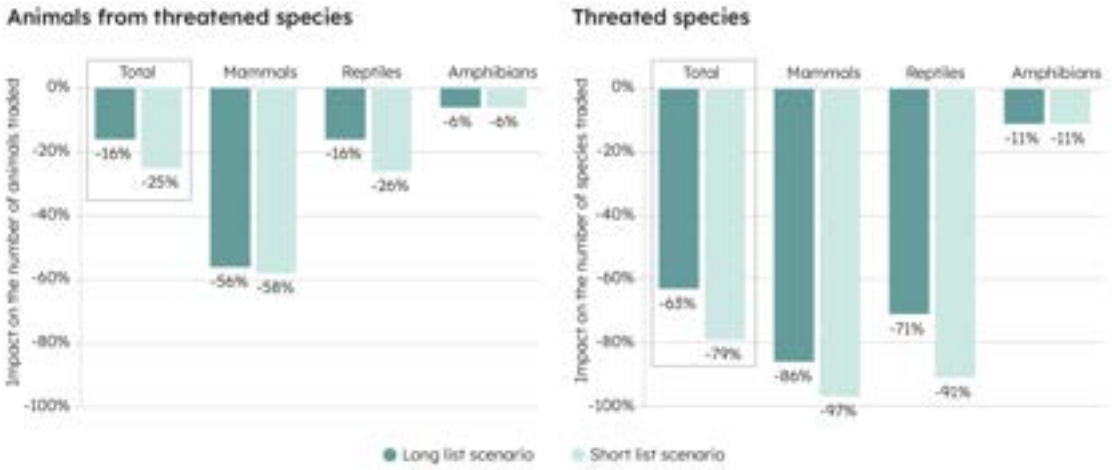
With the direct market effects analysed at the species level in the previous subsection, it is possible to extend the analysis to include how an EU positive list would impact species conservation. This was accomplished by analysing the change in trade in the EU exotic pet retail market with the IUCN conservation status of each species.

Based on this analysis, the number of threatened species traded is reduced by 63% under the long list scenario and 79% under the short list scenario (i.e. 37% and 21% of threatened species continue to be traded) (Figure 7). The reductions are much smaller for the number of animals from these threatened species: 16% under the long list scenario and 25% under the short list scenario.

The difference in between the reduction in traded species and the reduction in traded animals again highlights the 'long tail' of exotic pet trade where the positive list removes a large share of species but allows a large share of animals to continue (the highly traded species).

By animal class, the reduction in trade in threatened species is largest for mammals and smallest for amphibians.

Figure 7: The impact of an EU positive list on the trade in threatened species



Source: Own calculations | **Note:** Defined as the IUCN statuses "Extinct in the wild", "Critically endangered", "Endangered", "Vulnerable", and "Near threatened"

The positive list also reduces the trade in non-threatened species, termed "species of least concern" (-59% to -74% of species and -25% to -36% of animals), meaning the positive list scenarios impact not just threatened species but all species to a fairly proportional degree.

3.4.4. The impact of an EU positive list on invasive alien species

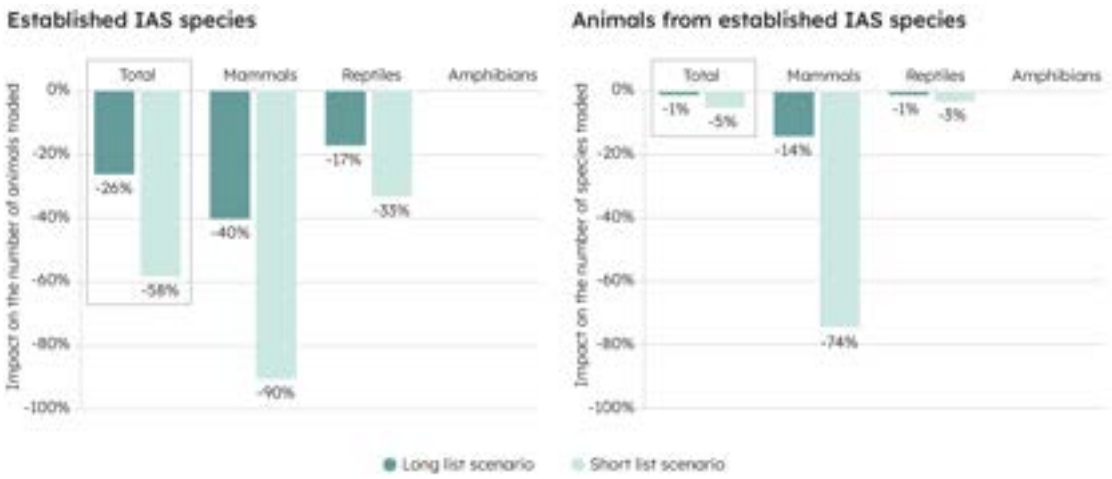
As another criteria to assess the potential benefits of positive list scenarios, we estimated the effect of the long and short list scenarios on two subsets of exotic pet species currently in trade: those reported to be established invasive alien species (as reported in the DAISIE database) and those species with a strong invasive potential (see Appendix 1.2 for details on this selection criteria).

As noted in section 3.2, there are 13 species of established IAS present in the retail trade (see footnote 10 above). In addition, we identified 114 species of reptiles and 16 species of amphibians in the retail trade that have been assessed as potentially invasive, following Kopecky et al. (2013, 2016, 2019). The impact of positive list scenarios was measured by how positive listing affects the number of species and animals of these IAS species, with respect to their level of trade in the baseline. Results are presented separately for established and potential IAS respectively. The percentage changes reported in each scenario are summarised in table 6 below. Two of the three established IAS detected in trade are actually in the Union List of IAS, and should in principle not be traded.[16] The other species is *Discoglossus pictus*, which is allowed in the two alternative scenarios, so positive lists have no effect on Amphibians in terms of known, established IAS of this class.

Under the long list scenario, the number of established IAS would be reduced by 26%, but barely reducing the trade of established IAS by 1%. The short list scenario would reduce in 5% the level of trade of IAS organisms, removing 58% of the species known to be established IAS.

Using the criteria of species with significant invasive potential, the reductions in the level of trade are 17% and 22% respectively for the long and short list scenarios, derived from removing 57% and 64% of the traded species with invasive potential. In sum, we conclude that, assuming that the risk of IAS derived from the trade in exotic pets depends only on the number of animals traded (of established and potential IAS), introducing an EU positive list can reduce the risks of IAS from 1% to 17% in the long scenario, and from 5% to 57% in the short list scenario.

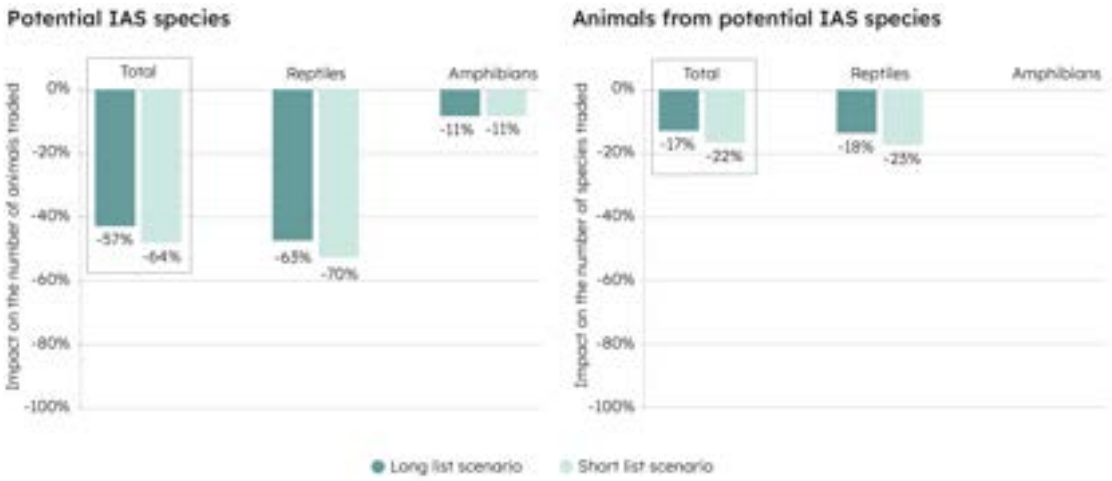
Figure 8a: The impact of an EU positive list on the trade in established IAS



Source: Own calculations based on DAISIE and the exotic pet retail trade dataset

16 The African clawed frog (Xenopus laevis) and the American bullfrog (Rana catesbeiana or Lithobates catesbeianus).

Figure 8b: The impact of an EU positive list on the trade in potential IAS



Source: Own calculations based on Kopecky et al. 2018 and the exotic pet retail trade dataset

An EU positive list, as designed in our scenarios, does not appear to be efficient in terms of traded numbers, but it is in terms of diversity. Both dimensions of the trade appear to be relevant for determining levels of risk of biological accidents caused by IAS.

3.4.5. The impact of an EU positive list on zoonotic risk

Zoonotic risks are linked to the level trade and to the total population of exotic pets currently living in the EU, as well as to their biodiversity. Positive lists are then expected, on the one hand, to reduce in the short term after its implementation, to reduce the probability of contagion and zoonotic spillover *along* the trade chain. This reduction can be expected to be driven both by the reduction in the level of trade (15% and 36% for long and short lists respectively), and by the reduction in the diversity of species in trade (between 63% and 74% respectively). Conversely, positive lists are not likely to have an immediate effect on the level and diversity of the exotic pet population, which will only change gradually after years of implementation (the length of the process would be approximated by the weighted average lifetime of exotic pets). In other words, the population component of zoonotic risk will reduce at a much slower pace. While the specific reduction of zoonotic risk associated with trade or with the exotic pet population is currently unknown, we can use as a proxy for zoonotic risk the number of zoonotic viruses associated by mammal species present in the exotic pet retail trade.

To get a sense of the importance of reducing diversity of species in trade for zoonotic risk, we calculated the impact of positive lists on the level and diversity of mammals currently in the retail trade, by weighting the viral richness of mammals species and their load in trade, according to viral richness as reported in Johnson et al. (2020). Note that the baseline and scenario calculus of risk is a number that measures both the number of zoonotic pathogens associated to each mammal species and the number of each species traded every year (see details in Appendix 1). If this criteria of zoonotic is applied, we estimate that positive lists of exotic pets would reduce zoonotic risk from mammals in between 32% and 89% with respect to the baseline.

Table 9: The impact of an EU positive list on zoonotic risk from exotic mammals

Zoonotic criteria	Baseline	Long scenario	Short scenario
Viral load	7,926	5,409	872
% of baseline	100%	-32%	-89%

It is important to note that these reductions are particularly relevant when considering risks of new, emerging diseases, the impacts of which can be catastrophic (both in terms of human lives, animal lives, as well as in economic costs). To the extent that normal/endemic zoonotic diseases (like Campylobacteridosis, Salmonella, and other reported above in the baseline estimates) depend on the total exotic pet population rather on trade, we can expect that introducing a positive list will not have a strong effect on the outbreak frequencies of zoonotic diseases and on health costs in the short term. For example, the annual costs of Salmonella associated with reptiles (detailed in table 5 above) are unlikely to change if the total numbers of reptile pets do not diminish, as positive list scenarios include reptiles that are known carriers of the causing pathogen. However, reduced zoonotic risks along the trade chain are to be expected as a positive impact of positive lists, as the diversity of species will be reduced to a large extent.

3.4.6. Summary of impacts

The number of species and level of trade currently present in the retail market of exotic pets in the EU has important negative impacts to the environment, to people and to other animals by affecting biodiversity conservation, invasive alien species, and zoonotic risks. These impacts occur both at source countries and ecosystems as in host countries. In general, positive lists have potential positive effects in reducing all of these impacts, although at different levels.

Millions of exotic animals of more than 2,000 species are traded every year in the EU, hundreds of thousands of which come from abroad. Positive lists will have important reduction effects on both the retail and import markets. The expected reduction of trade derived from implementing positive lists is stronger on the range of species than on the level of trade. This reflects the fact that a few species are traded in large numbers, and a very long list of species is traded in very small numbers. Positive lists tend to reduce the long tail of rare (low frequency) species that are traded in low volumes, thus reducing the number of species faster than the number of animals in trade. Impacts on level of trade and diversity are the largest for mammals, and much higher for reptiles than for amphibians. The impact on trade of the single positive list scenario for amphibians is much smaller in terms of both range of species and level of trade.

Trade of threatened animals will not reduce much with the implementation of a positive list (by -15% and -25% for long and short lists respectively), but the number of threatened species in trade will reduce significantly (by -63% and -79%, respectively). Positive lists have the additional effect of reducing as well the amount of imported animals from a wild origin, at least in CITES-listed species and imports from the U.S.

Table 10: Summary of impacts of the exotic pet trade and ownership: baseline and positive list assessment

Impact category	Impact criteria	Variable	Baseline	Long list impact	Short list impact
Population		Exotic pet population	20 to 28 million (54 to 62 million including birds)	-	-
Trade	Retail trade	Animals	millions	-22%	-32%
		Species	>2,000	-61%	-76%
	Imports	Animals	160,000 to 250,000	-7% to -28%	-56% to -61%
		Species	380 to 660	-60% to -65%	-74%
		Value	€850,000	-29%	-49%
Biodiversity conservation	Imports of wild animals	Animals	50,000 to 136,000	-17% to -23%	-60% to -79%
	Threatened species	Animals	38.4%	-16%	-25%
		Species	25.1%	-63%	-79%
Invasive alien species	Established IAS	Costs	€240 million	-	-
	IAS present in trade	Animals	-	-1%	-5%
		Species	>13	-26%	-58%
	Potential IAS	Animals	-	-17%	-22%
		Species	-	-57%	-64%
Zoonotic risk	Human cases of zoonotic diseases	Costs	€30 to €100 million	-	-
		Cases	5,000 to 10,000	-	-
	Zoonotic risk	Viral load of mammals	-	-32%	-89%

Notes: Animals = Number of animals in trade; Species = Number of species in trade. Baseline refers to annual flows or percentages. Ranges indicate differences between CITES data and LEMIS data (imports from the US).

Established IAS impose very important costs, in the order of €240 million every year. Positive lists will reduce the risks associated with established and potential IAS, but their effects are more strongly felt in the number of traded species of IAS, than in the number of traded animals of this type. Effects on potential IAS are stronger, reducing by around -20% and -72% the trade and diversity of species with IAS potential of concern.

Zoonotic diseases associated with exotic pets cause between 5 and 10 thousand infection cases per year, producing medical, hospitalisation, and productivity costs of between €30 and €100 million per year. Outbreaks of new variants, including antibiotic resistant pathogens or emergent diseases can potentially cause damages several orders of magnitude larger. While a component of zoonotic risk associated with exotic pets is locked-in to their population level and current diversity, positive lists are expected to reduce zoonotic risks associated with mammals currently present in the trade. In addition, the reduction of imports of wild animals is also expected to reduce zoonotic risks, as they are perhaps the most important source of diseases and variants of concern regarding new, emergent diseases.

Limits and known biases

This assessment is limited and subject to several biases, derived from both data and theoretical gaps. Among data limitations we can mention the difficulty of distinguishing the trade of live animals strictly destined to the pet markets in all data sources (which may overestimate the level of trade), the fact that imports are better reported than exports and the unavailability of data on illegal and online-trade (both of which may under-estimate the actual level and diversity of trade), the scarcity and uncertainty of information about the impacts of IAS, the prevalence of zoonotic diseases in EU Member States and their associated costs, or of specific impacts, like animal control, and burden on rescue centres (all of which will translate of under-estimates of impact). In addition, we faced serious difficulties in measuring key social variables, like the value of conservation and ecological impacts in source and host countries.

4. An investigation of impacts from existing positive lists in EU Member States

The potential impacts of an EU positive list can be greatly informed by the experience of positive lists that have been introduced in EU Member States. There are seven such positive lists that have been introduced: those in Cyprus, Lithuania, Luxembourg, the Netherlands, and the three regions of Belgium (where the issue is a devolved competency): Brussels, Wallonia,[17] and Flanders.[18] Most of these positive lists are limited to mammals, with only the three Belgian regions extending beyond mammals to cover reptiles (Table 1). No positive lists have been introduced in EU Member States for amphibians, birds, or fish.

Table 11: Introduction of positive lists in the EU

Country/region	Mammals		Reptiles	
	Date of introduction	Species listed	Date of introduction	Species listed
Brussels (BE)	1 October 2009	120	1 June 2021	416
Flanders (BE)	1 October 2009	121	1 October 2019	417
Wallonia (BE)	1 October 2009	122	7 February 2021	255
Cyprus	4 March 2021	2,757		
Lithuania	1 April 2024	136		
Luxembourg	24 November 2018	111		
Netherlands	1 July 2024	30		

Note: The number of listed species may differ from the number of listed entries as a listed entry may refer to a genus, family, or order which covers multiple species, or a listed entry may refer to a subspecies or a synonym, which would not be counted as a duplicate species. The species list is from mammaldiversity.org and reptile-database.org. The individual positive lists in EU Member States can be viewed in this online workbook.

The existing positive lists differ in how they were constructed from the criteria used for listing species, the evidence used to assess these criteria, the use of experts, the involvement of relevant stakeholders, and the process for implementation. These differences have led to non-identical positive lists for the same animal class and range from 30 mammal species in the Netherlands to 2,757 mammal species in Cyprus (where all rodents are listed).

This section compiles evidence regarding the implementation and effects of existing positive lists in EU Member States. The evidence is compiled from existing studies and reports, national datasets, communications with the relevant government departments, and – due to lack of comprehensive study to date – a detailed survey carried out as part of this study.

The survey was conducted with relevant stakeholders in the seven EU countries/regions that have introduced positive lists. The focus of the survey was on stakeholder groups operating in the EU exotic pet industry: pet shops, suppliers of pet products, commercial breeders,

17 At the time of writing the positive list has been annulled but was still in effect prior to the study period and thus relevant to the study.

18 This list differs from previous studies by Eurogroup for Animals ("Analysis of national legislation related to the keeping and sale of exotic pets in Europe" published in 2020 and "EU positive list: A proposal to regulate the trade in animals destined for life as a pet" published in 2023) as some additional positive lists have been established in the last year (Netherlands, Lithuania), while other lists previously included were determined not to meet the definition of a positive list for pets (a species-level classification of pets traded and kept without authorisation) used for this study (Croatia, Italy, Malta).

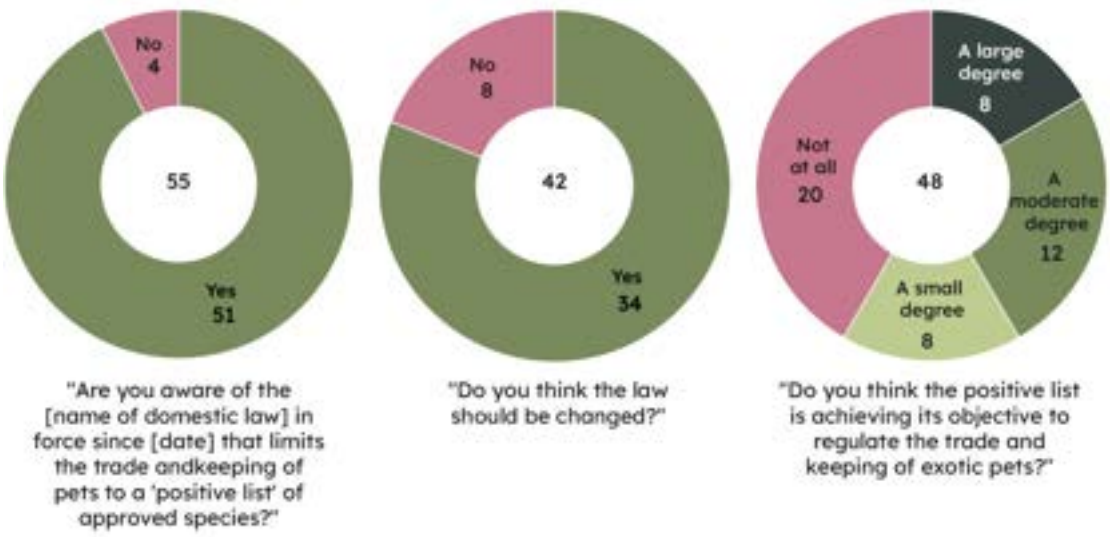
private breeders, wholesalers, animal law enforcement agencies, border control posts, animal rescue centres, animal parks/zoos, and veterinary clinics. These stakeholders are identifiable, directly affected by the positive lists, and have the ability to respond on their own behalf, making them ideal stakeholder groups to survey (in contrast to, for example, the natural environment, citizens, or the pets themselves). The composition of the survey respondents is not representative of all potential groups affected by positive lists. The details of the survey methodology are included in Appendix 2.

A few strong caveats are required in interpreting the results of the survey. Firstly, that the sample size is small and is not intended to be either representative or statistically significant. Secondly, several of the positive lists are new regulations and in the case of the Netherlands and Lithuania, less than a year has passed for stakeholders to judge aspects such as the efficacy or effects. This means there has been little time to gather observations, although the observations are perhaps more apparent.[19] Thirdly, statements by stakeholders are reported as they were provided without any attempt to determine their veracity.

4.1. The efficacy of existing positive lists

The efficacy of existing positive lists is mostly informed by the survey results. These results show that first and foremost, awareness of the positive list is very high among stakeholders involved in the trade and service of exotic pets, with 93% of the respondents (51/55) reporting knowledge of the positive list (Figure 9). Secondly, there is a perceived need for reform, with 81% of the respondents (34/42) reporting that the law should be reformed.[20] And thirdly, there are mixed views on the degree to which the positive list is achieving its objectives, with a slight majority of respondents (28/48) reporting that the positive list is working to some degree.

Figure 9: How respondents involved in the trade and service of exotic pets perceive their national positive list



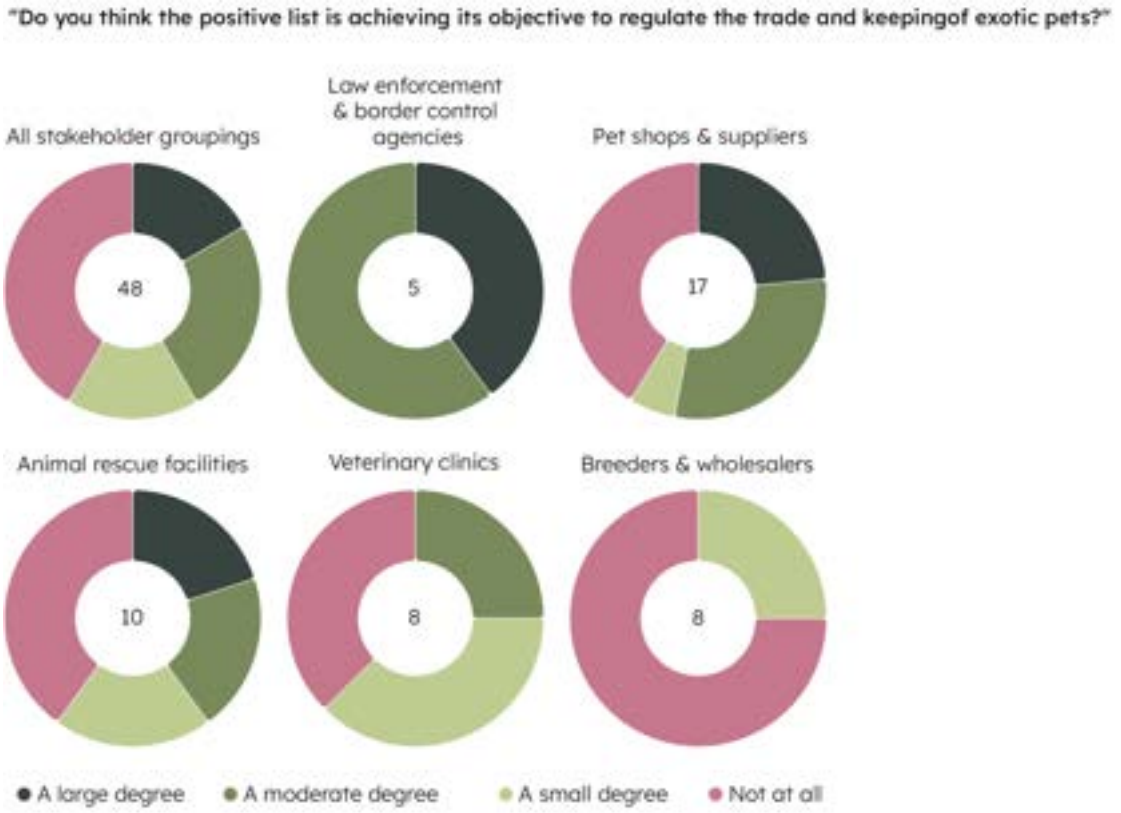
Note: The number of respondents may be less than 55 as not all respondents received every survey question (e.g. awareness of the positive list was a precondition to receive questions about the efficacy and effects of the positive list) and the "Don't know" responses are not displayed in the figures.

19 Conversely, stakeholders may not remember or were not working in their position when the Belgian positive list for mammals was implemented in 2009.

20 The number of respondents will fluctuate by question as some respondents declined to comment or the question was not deemed relevant to them (e.g. if they did not have awareness of the positive list then they were not asked about efficacy or reform).

Views on the efficacy of existing positive lists appear to be related to the type of stakeholder, although the sample size is small and conclusions uncertain. Grouped by five major stakeholder categories,[21] all law enforcement & border control agencies reported that the positive list is working to some degree while a strong majority of the breeders & wholesales reported that the positive list is not working at all.[22] A slight majority of the respondents reported that the positive list is working to some degree in the three remaining stakeholder categories: pet shops & suppliers; animal rescue centres, zoos & parks; and veterinary clinics (Figure 10).

Figure 10: How respondents involved in the trade and service of exotic pets perceive the efficacy of their national positive list, grouped by stakeholder category

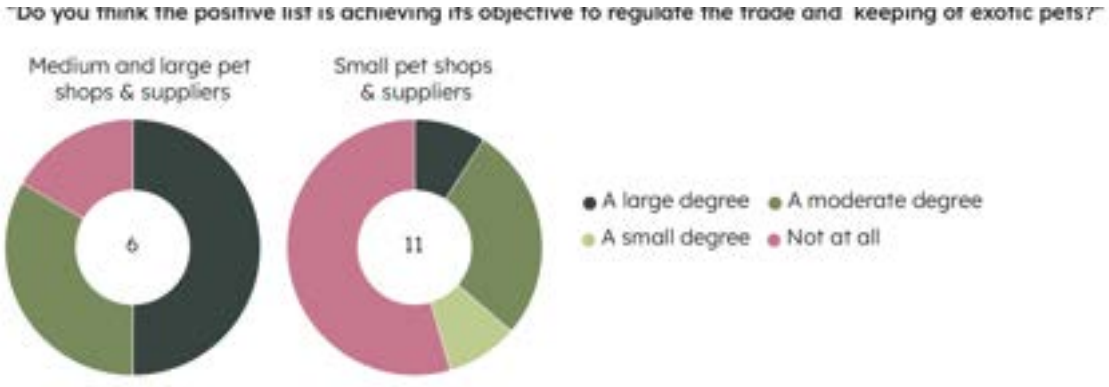


The 'pet shops & suppliers' stakeholder grouping is composed of diverse businesses and some views on the efficacy of the positive lists diverge when split by sub-categorisation. For small businesses (5 employees or less), less than half of the respondents reported that the positive list is working to some degree, whereas for medium and large businesses (6 employees or more), nearly all respondents reported that the positive list is working to some degree and half of these respondents reported the highest level of efficacy in the survey question (Figure 11). This trend by business size may be due to the specialisation of smaller businesses and their connection to specific exotic pet supply chains. It may also be related to the fact that these two sizes of business also reported experiencing different *effects* of the positive list on their operations (see Section A.3) in the same direction (e.g. small pet shops & suppliers reported experiencing negative effects due to the positive lists).

21 A combination of stakeholder groups to increase reliability with a small sample size.

22 One law enforcement respondent noted that they "now have a legal tool" that allows them to intervene and that "thanks to legislation, some vivariums have finally been able to be controlled objectively". Conversely a wholesaler noted that "People were going abroad to buy what they want" and a private breeder that "It is precisely the responsible hobbyists who suffer under the law. The irresponsible keepers just continue."

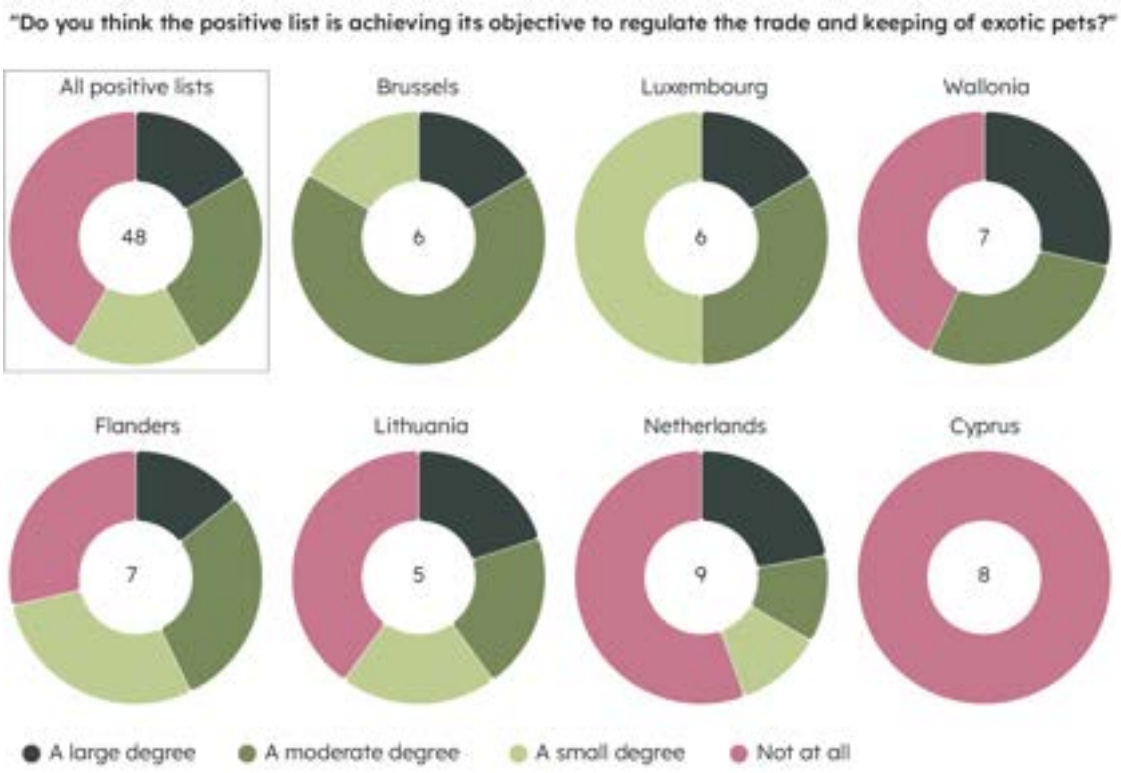
Figure 11: How pet shop and pet product supplier respondents perceive the efficacy of their national positive list, grouped by business size



Regarding the efficacy of positive lists, results grouped by country suggest significant differences in impact depending on national contexts. All of the respondents in Brussels and Luxembourg (regardless of stakeholder group) reported that the positive lists are achieving their objective to some degree, as did the majority of the respondents in Wallonia, Flanders, and Lithuania, but only a small minority in the Netherlands, and none of the respondents in Cyprus (Figure 12).

There may be an element of timing affecting the results. Positive lists have been in place for the longest period in the three Belgian regions (Brussels, Flanders, Wallonia), whereas the positive lists have only been introduced in the last year in Lithuania and the Netherlands. This may indicate that the perceived effectiveness of a positive list increases over time and that there is a particularly challenging period immediately following the introduction of a positive list. It may take time for businesses to adjust to the introduction of a positive list and for law enforcement to develop systems to ensure that the law is being respected.

Figure 12: How respondents involved in the trade and service of exotic pets perceive the efficacy of their national positive list, grouped by national positive list



The illegal trade and keeping of unlisted species

This stark divide between different areas may be related to the functioning of the positive list in different areas. When asked to explain their rating of efficacy, the most common statement by a wide margin was to highlight the existence of the illegal acquisition of unlisted species, meaning that unlisted animal species are still being kept domestically. Respondents frequently pointed to cross-border trade from other EU countries and/or trade through the internet as a key source of unlisted species (as opposed to continued sales through domestic pet shops).

> *There is a black market in Cyprus with no law enforcement and trading runs regularly.*
> **Pet shop, Cyprus**

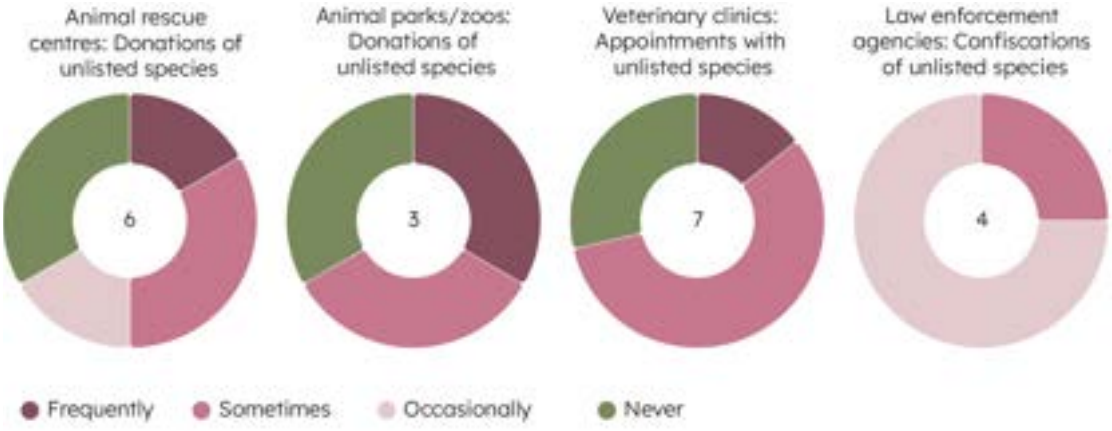
> *People have gotten used to buying their animals on the internet and not worrying about the legislation.*
> **Supplier of pet products, Brussels**

> *Since the positive list, there is a parallel (illegal) market which has been created from Germany or the Netherlands.*
> **Wholesaler, Wallonia**

> *The law in Luxembourg is good here, but the Internet should be more controlled and / or monitored even if it is more difficult.*
> **Pet shop, Luxembourg**

The comments from stakeholders about the lack of enforcement and the continued acquisition of unlisted species are also supported by responses to specific survey questions about the exposure of different stakeholder groups to unlisted species (those species not on the positive list) (Figure 13).

Figure 13: Respondents' contact with animals from unlisted species, grouped by stakeholder category



The responses show that the majority of animal rescue facilities (animal rescue centres/ sanctuaries and animal zoos/parks) are still receiving donations of unlisted species and the majority of veterinary clinics are still treating unlisted species. The law permits the keeping of unlisted species that were acquired before the positive list was introduced (i.e. grandfathering), so this is only partial evidence of illegal keeping.

The responses from law enforcement agencies are more definitive proof as they reveal that confiscations of unlisted species are occurring (indicating that these animals are not in accordance with the law), although most law enforcement agencies indicated that this happened only "occasionally".

There have also been several news stories of unlisted species that are still being found despite the positive list and that other elements of the law, such as declarations of unlisted species acquired before the positive list was introduced, are not being respected (Charalambous, 2022). A 2023 study analysing the online exotic pet market found "that it is easy to purchase animals that are illegal in the country of the buyer, showing that part of this market is essentially illicit (Sapience, 2022).

A 2016 study specifically analysed the implementation of the positive list for mammals in Belgium six years after the law was introduced. The study found that some unlisted mammal species were still being donated to rescue facilities or found stray (22 animals and 15 animals respectively), were still being advertised online (12 advertisements of 23 animals), and were still being confiscated by law enforcement agencies (92 animals from 22 cases). However, as the numbers of animals were relatively small in comparison to the total exotic pet population, the study concluded that "the present research demonstrates that the adoption of a Positive List in Belgium has been very effective in regulating the trade of the exotic mammal pets (Di Silvestre & van der Hoeven, 2016)."

Evidence of behavioural change in the exotic pet market

There is also evidence from the stakeholder survey of changes in market behaviour (Figure 14). Of the respondents who sold pets or pet products, the majority reported that they had stopped selling certain pets or pet products due to the positive list (14/24).

Figure 14: The removal of pets and pet products by respondent pet businesses due to the positive list

When the respondents who stopped the sale of certain pets or pet products were asked to identify the products, the respondents mentioned sugar gliders, sugar glider products, pythons, iguanas, kangaroo food, chinchillas, and frozen rabbits. This result indicates that at least for these stakeholders the positive list is contributing to its objective.

Separately from the stakeholder survey, interviewed government departments were also asked to respond to a series of questions about the creation and operation of their positive list, including a question about their perception of its efficacy. In their comments, most government departments reported a perceived efficacy for the positive list, although there was also a degree of uncertainty as public complaints appear to be a key method of enforcement as well as a key metric of success.

Summary of evidence on the efficacy of existing positive lists

In summary, perceptions of the efficacy of existing positive lists vary by stakeholder category (law enforcement and border control - high; breeders and wholesalers - low) and vary strongly by country/region (Brussels and Luxembourg - high; Netherlands and Cyprus - low).

Comments from stakeholders highlight that the continued acquisition of unlisted species is undermining efficacy and unlisted species are still being acquired through online sale or cross-border transportation. Government departments note that awareness of the positive lists is high and there is a changing mentality. Some of the results suggest that the perceived effectiveness of a positive list increases with time since the implementation date.

Evidence on the topic of positive list efficacy is limited but generally conveys a complex state where the majority of pet shops have removed pets or pet products due to the positive list, while at the same time contact with unlisted species continues (albeit generally in small numbers).

> *"The positive list is largely achieving its goal in the sense that it regulates the entry of exotic pets to Cyprus. Currently, animals that are listed cannot enter through the legal entry points (airports and ports). There are limitations, however, because authorities cannot always safeguard the illegal breeding of exotic animals that takes place within the country, unless a complaint is made by the public."*
> **Natural Resources and the Environment, Ministry of Agriculture, Cyprus**

> *"The list did not achieve its objective for reptiles: Many owners did not register their animals when the legislation was published. We believe that some owners are keeping animals without registering them.*
> *Regarding mammals, after several years, the objectives have been achieved, mainly because the trade in prohibited animals is prohibited. People have become aware of the ban and there are fewer and fewer animals that are not included on the lists. We did not have the resources to carry out impact studies. However, we evaluate the positive impact by the number of complaints and seizures of animals which have decreased over the years concerning mammals."*
> **Department of Quality and Animal Welfare, Wallonia**

> *"Overall goal for our lists is a change in mentality, people no longer consider it normal to keep or sell forbidden animals (for example primates). We see that this shift has come about because people send complaints to us when they see exotic animals being kept as pets."*
> **Animal Welfare Department, Department of the Environment, Flanders**

> *"With a positive list you can still get the animals, but you need authorisation. So in that sense, in the view of the administration it works. High risk species are not allowed. But people are getting pets without authorisation."*
> **Animal Welfare Service, Luxembourg**

In the Brussels Capital Region (BCR), there have been no studies on the effect or impact of the positive list on the trade or keeping of reptiles. Therefore, it is difficult to say if the positive list is achieving its goal. As far as I know, the same goes for the positive list of mammals.
Department of Animal Welfare, Brussels Environment, Brussels

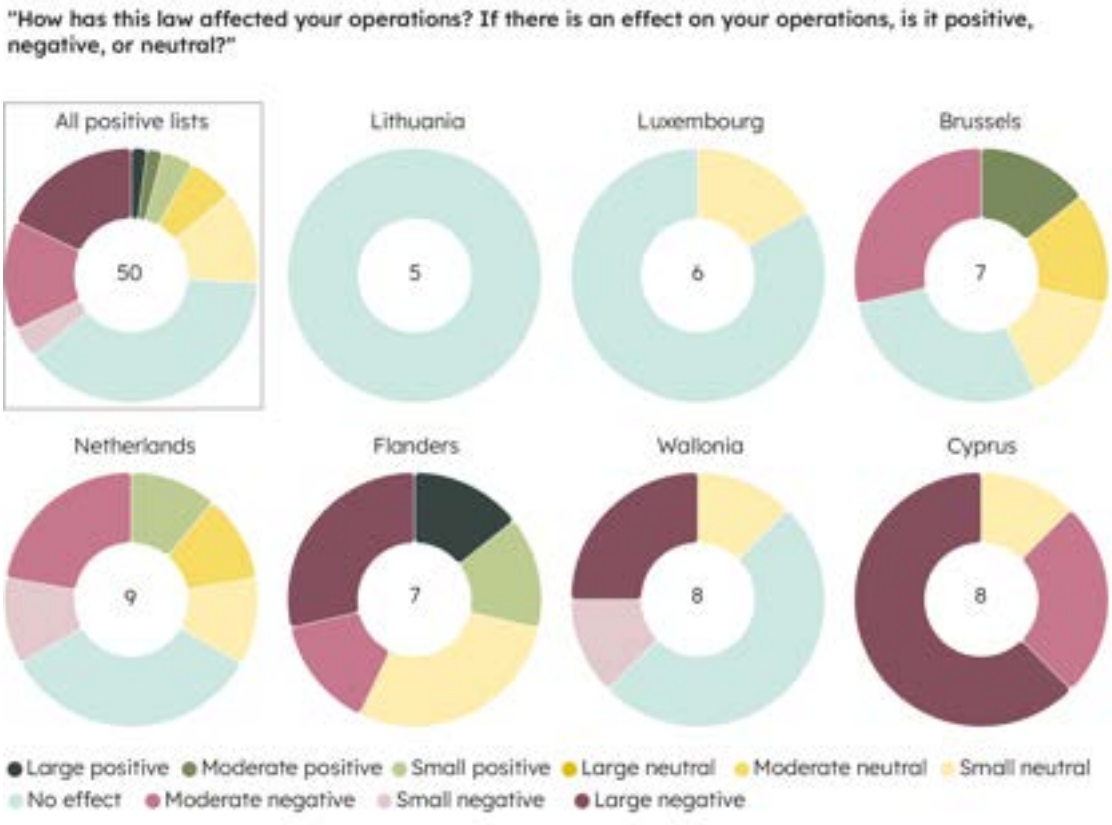
4.2. The effects of existing positive lists on stakeholders

The efficacy of existing national positive lists is crucial in determining the likely efficacy of an EU positive list for exotic pets and therefore the *effects* such a law would have on exotic pet populations as well as the environment, human health, and economic effects that extend from the trade and keeping of these animals. For other effects, particularly the economic effects – which are more concentrated and easily observed – stakeholders involved in the trade and service of exotic pets can be directly surveyed on the effects they have experienced.

In the stakeholder survey, respondents were asked to what degree the positive list affected their operations, and, if there was an effect, whether it was positive, negative, or neutral. Of the 50 respondents who were aware of the positive list, the majority (28) either reported that they were not affected at all (19) or that the effect was neutral (9).[23] Many more respondents (18) reported being negatively affected than positively affected (4).

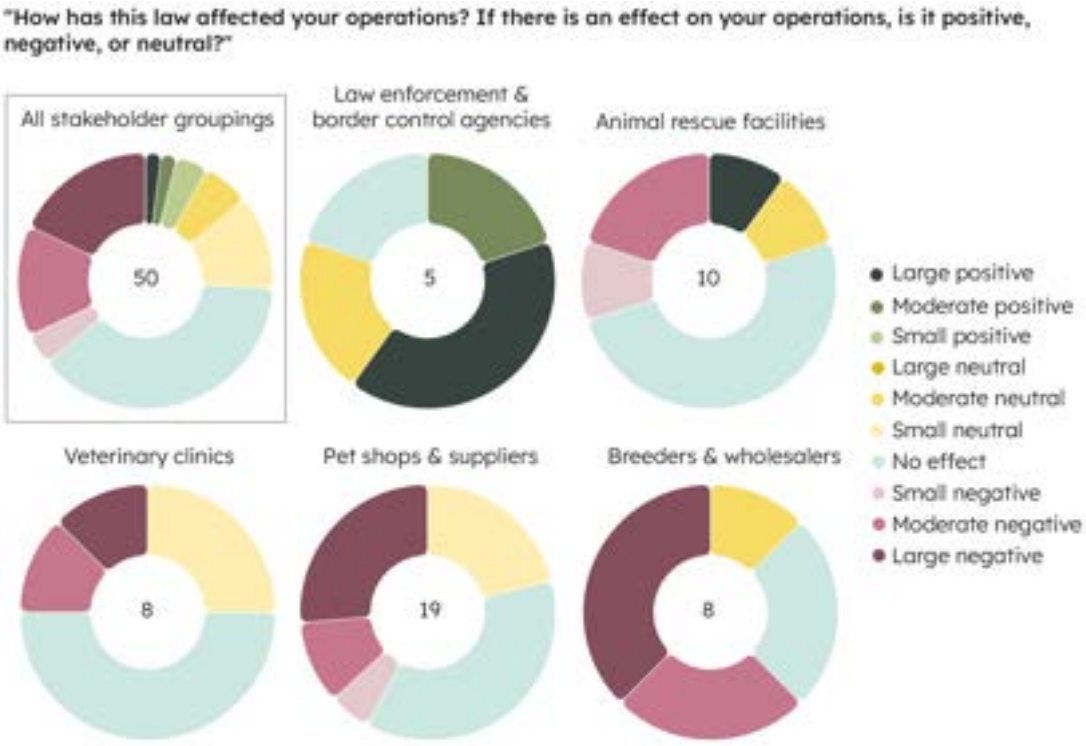
The reported effects varied by area, as respondents in Cyprus reported a clear and negative effect of the positive list, respondents in Wallonia and Flanders reported slightly negative effects, and respondents in Netherlands, Brussels, Luxembourg, and Lithuania reported a neutral effect or no effect (Figure 15). Negative views from stakeholders involved in the trade and service of exotic pets in Cyprus was a recurring theme in the survey results (see Section 4.1).

Figure 15: How respondents involved in the trade and service of exotic pets feel affected by their national positive list, grouped by national positive list



The reported effects also varied by stakeholder category (Figure 16). The responses about the effects of positive lists closely mirror to the earlier question on efficacy of the positive lists (see Section 4.1) as law enforcement and border control agencies reported the most positive effects of the positive list (and that the law is working), while breeders and wholesalers reported the most negative effects of the positive list (and that the law is not working).

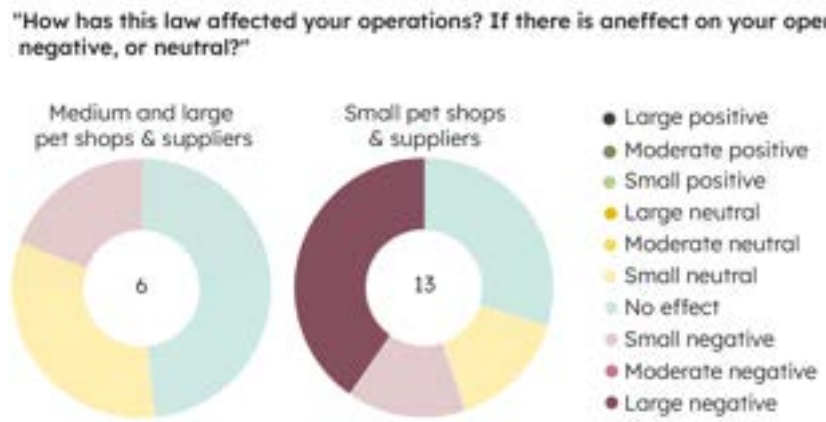
Figure 16: How respondents involved in the trade and service of exotic pets feel affected by their national positive list, grouped by stakeholder category



Again, echoing the survey results on efficacy, there is a divide between pet shops & suppliers depending on their business size. Whereas less than most of the small businesses (5 employees or less) reported that the positive list affected them negatively, nearly all medium or large businesses (6 employees or more) reported no effect or a neutral effect (Figure 17).

This trend in effects by business size is likely due to the ability of larger businesses to offer a more diverse catalogue of products and to potentially shift to other products if some are no longer permitted or viable due to new legislation.

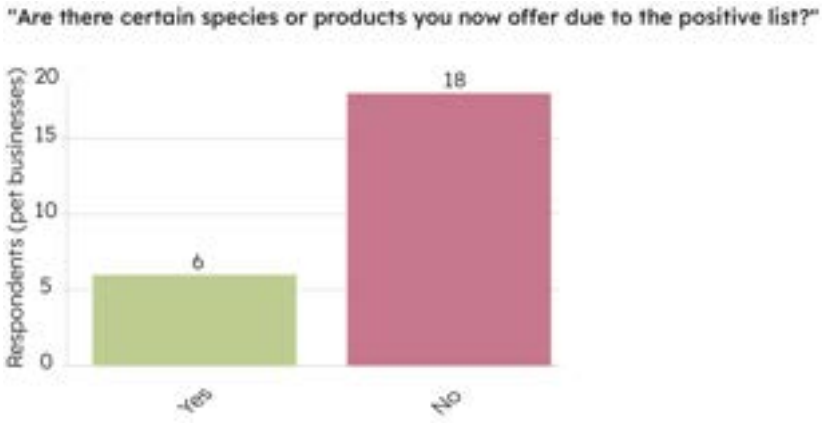
Figure 17: How respondent pet shops and pet product suppliers feel affected by their national positive list, grouped by stakeholder category



Evidence of list effects on pet businesses

There is some evidence of this business dynamism, as a quarter of the pet businesses (6/24) reported that they now offer new products due to the positive list (Figure 18). However, less than half as many businesses reported the *addition* of new products due to the positive list than reported the *removal* of certain products due to the positive list (14/24).

Figure 18: The addition of new pets and pet products by respondent pet businesses due to the positive list



When asked which pets or products are now offered due to the positive list, respondents mentioned ferrets, kingsnakes, mice, hamsters, guinea pigs, and invertebrates (e.g scorpions, tarantulas).

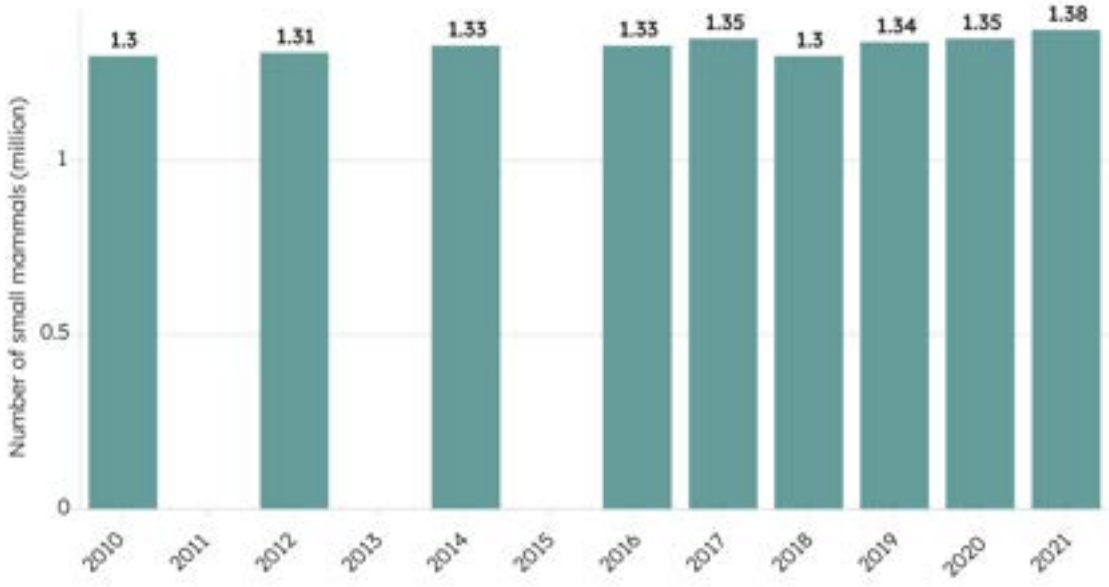
This evidence of businesses shifting the species and products they offer leads to a question of whether the *overall* trade in pets and pet products has changed since positive lists have been introduced. This overall trend is also ambiguous given that there is some evidence of product shifting (Figure 10), that the majority of pet shops and suppliers report being unaffected or neutrally affected by the positive list (Figure 8), and that broader economic trends may drive the economics of the pet industry more than the existing positive lists (e.g. interest in pet ownership, income levels, trade patterns).

There is no official dataset from either EU or national government agencies on the pet population or pet sales.[24] FEDIAF, which represents the European pet food industry, produces the most detailed statistical account across 24 EU Member States, however two of the EU Member States with existing positive lists – Luxembourg and Cyprus – are two of three EU Member States that are not covered. Furthermore, the positive lists in Lithuania and Netherlands have only been introduced in the last year, meaning they can not be analysed using FEDIAF data.

The FEDIAF data for Belgium, which goes back to 2010, reveals that despite the introduction of the positive list for mammals in 2009, the number of small mammal pets[25] in Belgium has remained largely stable at 1.3 million, even increasing slightly in recent years (Figure 19). This resilience of pet ownership could be evidence that since the introduction of the positive list the market for small mammals has shifted from unlisted to listed species. More broadly, the pet population in Belgium has been increasing due to strong growth in the number of cats and dogs (which represent the majority of the Belgian pet population by number and the vast majority of households with a pet).

Another indication of effects comes from registrations of pet shops. Reliable registration data was only identified for one positive list: Flanders 2015-2024. The pet shop registrations, which are recorded by the types of species sold, reveal that since 2019 when the positive list for reptiles was introduced, the number of pet shops selling reptiles declined slightly more than other species categories (-22% vs 18%). The number of pet shops is declining as a general trend as more pet trade takes place online. One of the smallest reductions is for amphibians (-7%), which suggests that the positive list may have generated a market shift from reptiles to amphibians.

Figure 19: Number of small mammal pets in Belgian households

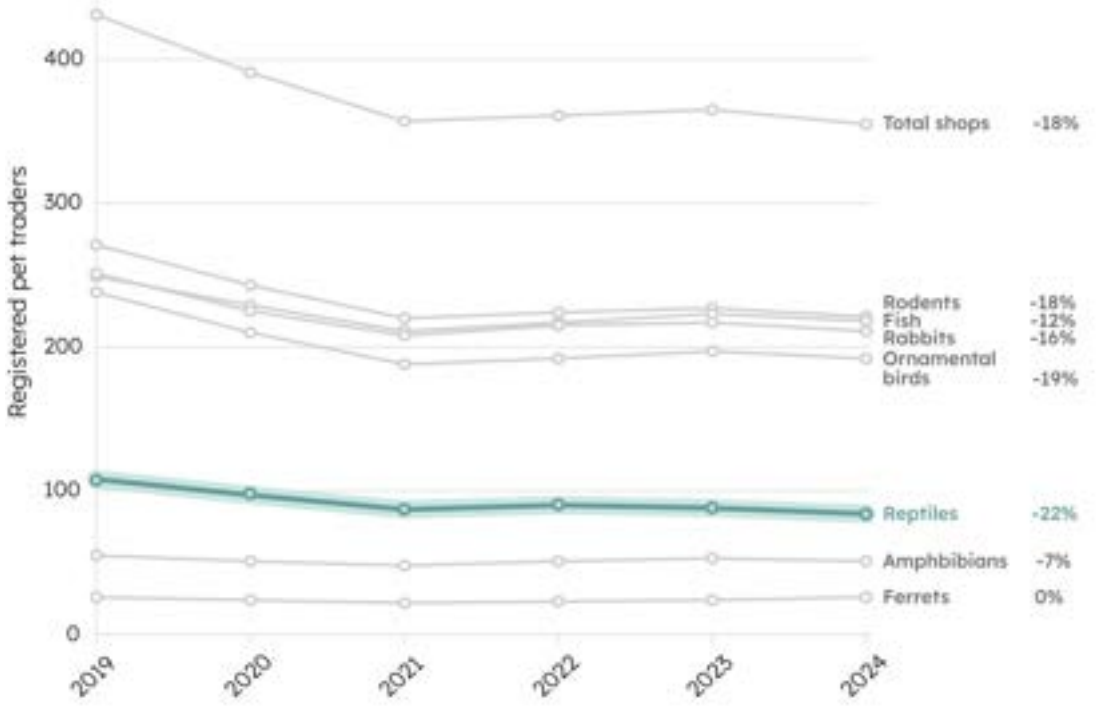


Source: FEDIAF Fact & Figures 2010-2021. **Note:** 2022 was excluded from the figure due to a revision of FEDIAF data making 2022 incomparable to previous years (see FEDIAF 2022 Appendix).

24 Enquiries were sent to the seven national government departments that oversee the existing positive lists for time series data on the size of the exotic pet population and/or the size of the exotic pet industry. Five replies were received, all noting that no such information is collected.

25 As there is no FEDIAF data on large mammals the 'small mammal' category is the only relevant data to assess the 2009 positive list for mammals. Note that the small mammal category includes rabbits and ferrets which are not considered exotic pets for this study.

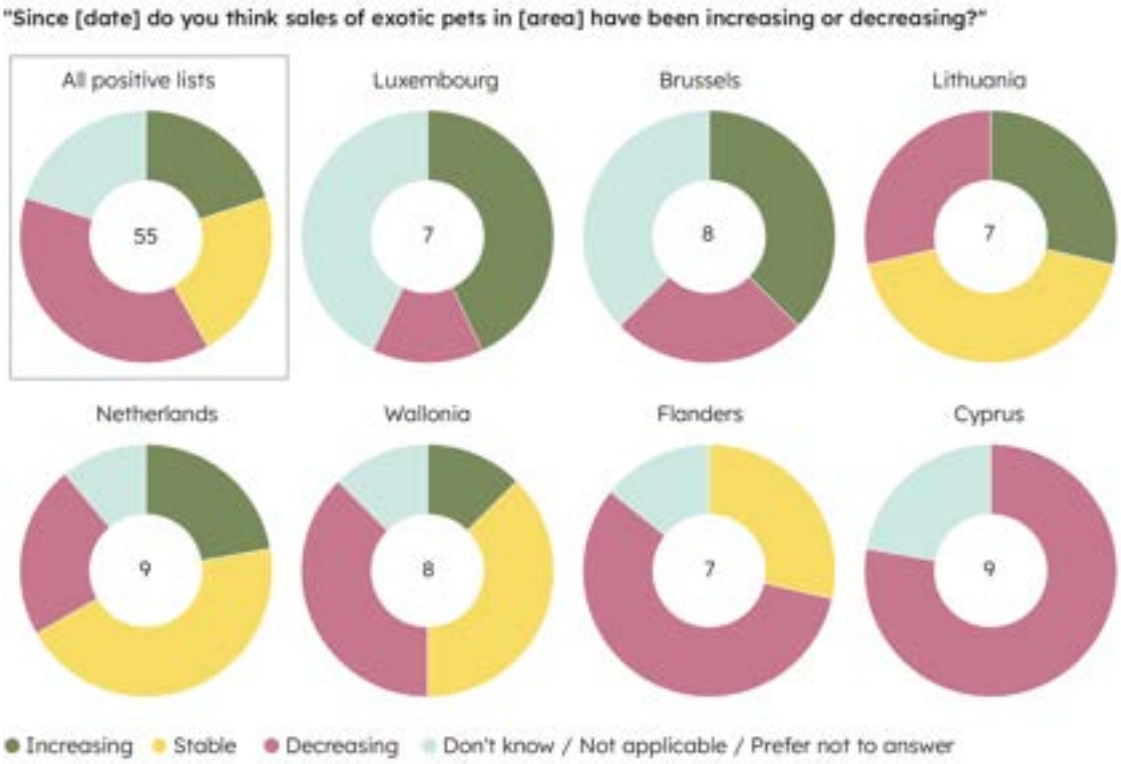
Figure 20: Number of registered pet traders in Flanders and species categories offered



Source: Data shared by the Animal Welfare Department, Department of the Environment, Flanders
Note: A registered pet shop could sell multiple species groups and therefore count for multiple lines in the figure.

With few official datasets to rely on, the stakeholder survey also asked about the trend in exotic pet populations since the positive list was introduced. Here, again, no clear trend emerged with respondents in most areas (with the exception of Cyprus) were divided on the trend in exotic pet sales and many respondents unsure (Figure 21).

Figure 21: How respondents involved in the trade and service of exotic pets perceive the trend in sales of exotic pets since the introduction of the positive list



Taken together, the limited data available (the pet population in Belgium, registered pet shops in Flanders, views of stakeholders on sales trends) does not provide clear evidence on whether the overall level of trade in exotic pets and pet products have changed since positive lists have been introduced. The limited data does suggest, however, that the sale of pets in general (exotic and non-exotic) is continuing to increase year-on-year.

Summary of evidence on the effects of existing positive lists on stakeholders involved in the trade and service of exotic pets

In summary, most stakeholders involved in the trade and service of exotic pets report that the existing positive lists affected them "not at all" or that the effect is "neutral". Where effects are reported, they vary by stakeholder category (law enforcement and border control - positive; breeders and wholesalers - negative) and by country/region (Lithuania and Luxembourg - no effect; Cyprus - negative).

Stakeholder comments from some pet businesses point to a reduction in sales. Some pet businesses reported both a negative effect and a negative view of efficacy which is explained by the sentiment that they had to change their practices because of the positive list but others (e.g. breeders in other countries) did not and cross-border trade continues.

This negative effect on pet businesses may be expected as a positive list reduces the number of species that can be sold, however there is also some evidence that businesses have shifted their product offer and now offer different species due to the positive list. The limited data available suggest that the sale of exotic pets is stable or ambiguous and that the sale of pets in general (exotic and non-exotic) is continuing to increase year-on-year in areas with existing positive lists.

4.3. The desirability of an EU positive list

The experience of existing positive lists can also provide evidence on good policy design and implementation. Here, again, the stakeholder survey is the key source as there are no studies on this specific topic in the academic or grey literature and the questions raised do not lend themselves to analysis of quantitative datasets.

In the survey of stakeholders involved in the trade and service of exotic pets, respondents frequently commented on policy design and implementation as an explanation for why they thought the law should be reformed (Figure 1). These responses typically took two forms: a call for complementary policies, or an opposition to positive lists in principle.

Many respondents noted the need for complementary policies. Just as the continued acquisition of unlisted species was the most common response to explain lacking efficacy, greater enforcement of the positive list was the most common response to reform the existing law. The second most common response was to call for increased training on exotic pets, although there was no consistency in which group should be the focus of such training. Breeders, pet shops, law enforcement, pet owners, and policymakers were all mentioned. Lastly, two animal rescue facilities noted that there was a difficult transition when the positive list was introduced as the number of unlisted species they received increased and thus additional support for animal rescue facilities is required when a positive list is introduced.

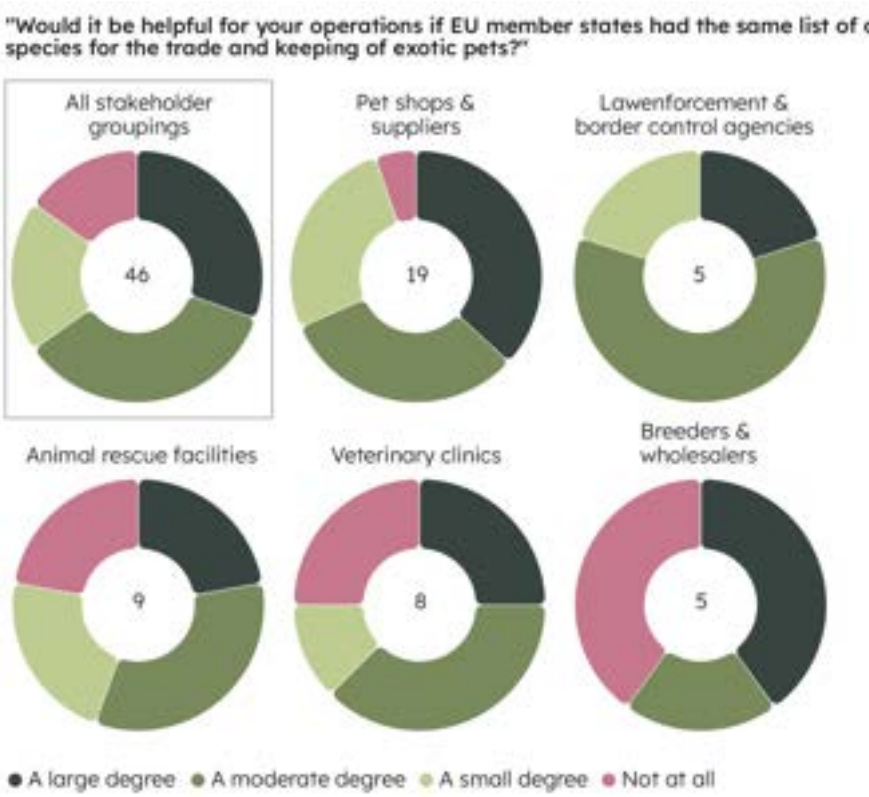
Many respondents were critics of positive lists in general. These respondents frequently commented that the positive lists were too strict and thus prompted illegal trade. Some positive list critics noted that they preferred alternative legislative approaches such as negative lists,

housing requirements, and/or registration/licensing. Lastly, some positive list critics did not see the need for any legislation, noting that "loving should be simpler", that "there is no issue", or that "the current law already states that animals must be kept properly, so where is the problem?".

The potential harmonisation of positive lists at the EU level

The stakeholder survey asked respondents specifically about the introduction of a harmonised positive across the EU – the topic of this study. On this policy design issue the vast majority of stakeholders involved in the trade and service of exotic pets were in agreement that an EU positive list would be helpful for their operations (Figure 22).

Figure 22: How respondents involved in the trade and service of exotic pets perceive the desirability of an EU positive list



Survey respondents – across stakeholder groups and areas – were unequivocal in explaining their views on an EU positive list.

> *There should be one unified list for all EU countries.*
> **Pet shop, Cyprus**

> *It would be much better and clearer for the keepers and for the welfare of the kept animals if the regulations were uniform EU regulations.*
> **Veterinary clinic, Netherlands**

> *The same law for all countries in Europe without exceptions.*
> **Pet shop, Flanders**

> *It would be perfect to have a clear list at EU level.*
> **Commercial breeder, Lithuania**

It is only once it is implemented at the European level that it will become well regulated in the Grand Duchy. A Luxembourger who wants to get an animal that is not on the positive list will go to Germany or Belgium and will come back without problem.
Animal park/zoo, Luxembourg

We are in Europe, I don't see why we would do it differently.
Wholesaler, Wallonia

A positive list at EU level that would minimise the differences between Member States would facilitate the application.
Law enforcement agency, Brussels

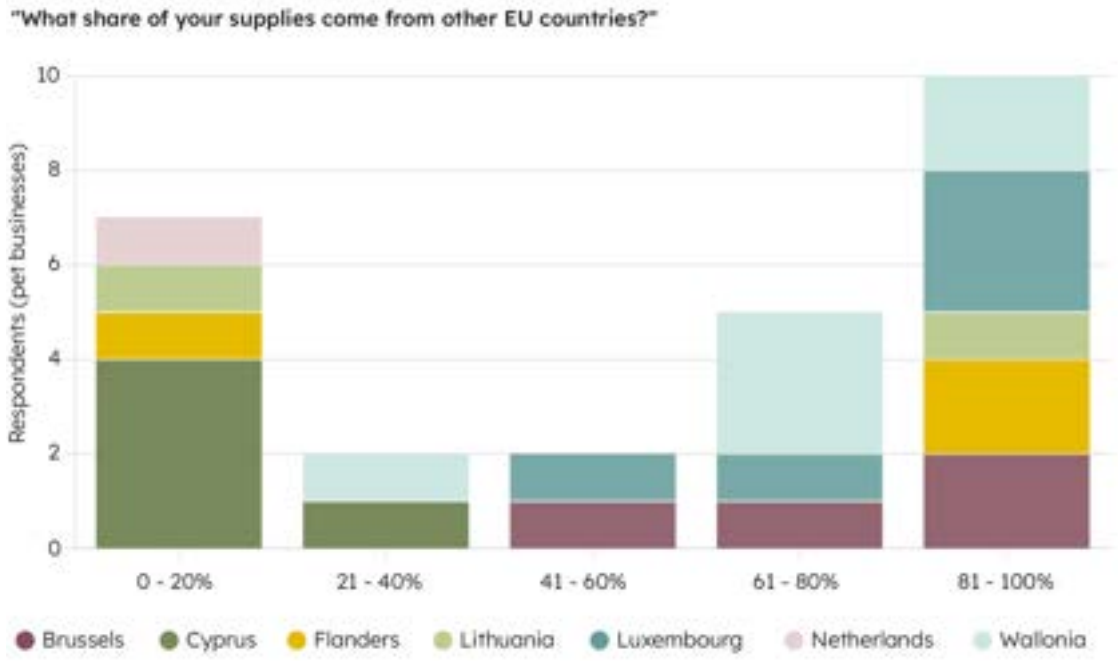
This desirability of an EU positive list was fairly consistent across stakeholder categories and areas – in contrast to views of the efficacy and effects of existing positive lists (see Sections 4.1 and 4.2 respectively).

Of the different stakeholder groups involved in the trade and service of exotic pets, pet shops & suppliers viewed an EU positive list as the most helpful to their operations. One chain of pet shops that operates across multiple areas with multiple positive lists noted in their response that they have already implemented an 'internal positive list' based on the strictest governmental list to ensure that products can move between their shops while respecting existing legislation.

Some respondents who were critics of their national positive list or even positive lists in general were among those who viewed an EU positive list as helpful. This apparent contradiction may be explained by the view that *if* there is to be a positive list for exotic pets, it ought to be at the EU level.

There is also some evidence on the desirability of an EU positive list as the EU pet market is highly integrated across borders (Figure 23). In the stakeholder survey the majority of pet businesses reported that 81-100% of their supplies come from other EU Member States (as opposed to trade within the country or outside the EU). Again, Cyprus was the exception where the majority of pet businesses reported that only 0-20% of their supplies come from other EU Member States.

Figure 23: The level of intra-EU trade in the supply chains of respondent pet businesses



Summary of evidence on the design and implementation of positive lists

In summary, stakeholders frequently reported that existing positive lists should be reformed and had clear suggestions to offer. While some survey respondents pointed to complementary policies (most often related to enforcement), other survey respondents disagreed with the positive list approach more fundamentally. Nearly all respondents, with no apparent trends to their responses to other survey questions, agreed that an EU positive list would be helpful to their operations.

This support for an EU positive list also has relevance for the earlier consideration of positive list efficacy (Section 4.1). While many of the respondents highlighted cross-border trade as a channel for illegal trade and a significant failing of the existing positive lists, an EU positive list would be more effective in this respect. It would not be a panacea, however, as the illegal acquisition of unlisted species might still occur through online trade, private breeding, or other channels. Based on the experience of existing positive lists, complementary policies would almost certainly be required for a positive list to be implemented with a high degree of effectiveness.

5. Discussion and conclusions

The objective of this study was to assemble and assess the evidence on the potential impacts of an EU positive list for exotic pets, first through an evaluation of a potential EU positive list (ex ante) and secondly through an evaluation of existing positive lists introduced in EU Member States (ex post).

As the literature review documents significant ecological, health, animal welfare, and other negative externalities of the exotic pet trade, the scope for positive impact by reducing the range of allowed species is substantial. There is significant evidence that welfare conditions of traded animals are inadequate along the trade chain and in households; that due to its size, variety, and the continuous introduction of new and rare species, the EU market for exotic pets is a driver of over-exploitation and degradation of wild populations; that zoonotic risks of traded species are real and significant; and that ecological impacts of invasive alien species related to the pet trade produce important costs and damages. Our estimates of these negative impacts confirm those findings.

In our evaluation of EU positive list scenarios we find that an EU positive list would reduce negative impacts along these dimensions, even when impacts cannot be fully or accurately measured and forecasted. We also find that positive listing is expected to have negative economic impacts to the private sector involved in the trade, although smaller than expected given the concentration of the market. These findings are validated and nuanced by the evidence assembled on existing positive lists in EU Member States.

We also highlight that there are very important research gaps critical to a more thorough and accurate assessment. National administrations have not conducted studies on the impact of positive lists, and there is a general lack of data on fundamental dimensions of the trade, the supply, demand, and population of exotic pets and their impacts. Further monitoring and research attention is required to attend these fundamental knowledge gaps.

Impacts of an EU positive list on the exotic pet retail market

Applying the potential policy scenarios to a sample of data from the exotic pet retail market reveals that an EU positive list would constrain and reshape the current market. This effect has two distinct elements, with changes to both the *level* of trade and the *diversity* of trade. This distinction is significant as the exotic pet retail market is shown to be highly concentrated in a few key species. The top 10% most traded species represent 67% of the market for mammals, 76% for reptiles, and 75% for amphibians.

The policy scenarios (which are constructed from existing positive lists) generally allow trade in the most commonly traded species to continue, but do not allow trade in the ‘long tail’ of diverse species that are traded in small numbers. As a result, while the two positive list scenarios reduce the trade of 61-76% of species, there is only a 22-32% reduction in the trade of animals.

However, whereas the Section 3 evaluation assumed a static market, the results from the investigation in Section 4 indicate a different dynamic based on the evidence from existing positive lists. In the survey of stakeholders in EU Member States where positive lists have been introduced, most respondents reported that the effect has been neutral or entirely absent. While wholesalers and breeders reported negative impacts (one mentioning a reduction

of 10% to their revenues), other pet businesses such as pet shops and pet businesses mostly did not, and some reported shifting their product offerings from unlisted to listed species, suggesting that the challenges for businesses in general are within the reach of their capacities. This may also indicate that the markets for wholesalers and breeders may have been more affected by asymmetric competition from countries without positive lists and online platforms, than retail pet shops, who tend to focus on more popular species that are not affected by the positive lists.

These modest economic impacts are also supported by the few national datasets on exotic pet trade. Since the Belgian positive list for mammals in 2009 (the first in the EU), the number of small mammals in Belgian households appears stable. Since the Flemish positive list for reptiles in 2019, the number of registered reptile traders has reduced slightly more than other animal classes.

Impacts of an EU positive list on the exotic pet import market

Despite the important volume of captive, locally bred species for the exotic pet trade, imports remain a major source of exotic pets for the EU market. Around 250,000 live animals of more than 380 species are imported every year through CITES regulated markets; imports from the US involve more than 160,000 animals of more than 600 species. These numbers suggest that total imports are in the order of millions of animals per year. EUROSTAT, for example, reports extra-EU imports in 2022 of over 650 thousand live specimens of reptiles alone.

Our scenario analysis reveals that the long list scenario (species from any existing positive list) is not very effective in reducing the level trade of CITES regulated species (-7%). While CITES-listed species tend to be more closely monitored and enjoy a certain degree of protection, our results reveal that CITES imports for the pet trade include vulnerable and endangered species. Our scenario analysis suggests that an EU wide positive list would need to include stricter levels of protection for CITES listed species than reflected in current positive lists to have a large impact on this group of heavily traded species. Complementary measures in addition to a positive list approach could also help to achieve the same result while staying fitting with the existing legal frameworks as mentioned in Section 2.

Imports from the US are smaller but more diverse than CITES imports, and this larger range makes imports from this source more sensitive to both EU positive list scenarios. The long list scenario would reduce 28% the level of imports from the US. Interestingly, the value of US imports will be reduced slightly less than proportionally compared to the reduction in trade.

Finally, an important effect of positive listing is the significant reduction in imports of animals of a wild source (-17% to -79% in CITES listed species, -23% to -60% in imports from the US). This effect has very important, positive effects for both biodiversity conservation (as it reduces pressure to wild populations), for zoonotic risk (as wild animals are more likely to bring in new pathogens) and also for IAS (as wild animals are more likely to establish in the wild in their host environments).

Impacts of an EU positive list on threatened species and biodiversity

Given the concentrated nature of the EU exotic pet market, effects on the *diversity* of trade are expected to be larger than effects on the *level* of trade for all variables examined. This is verified in the evaluation results as an EU positive is estimated to reduce the threatened species traded by 63-79%. The short list scenario has a strong impact in reducing species at risk of overexploitation (by over 90%) and trade of endangered animals (by over 60%).

Positive lists have the additional value of protecting species from entering the trade, thus neutralising the feature of markets where rarity and exclusivity play a role in determining consumer preferences, as in the exotic pet market.

While most effects of positive listings reduce, at least in static terms, the risks of over-exploitation, the impacts on species remaining in trade may need to be revised and reassessed at the level of individual species. As noted, many species allowed under positive lists face some level of threat of over-exploitation, and if the level of trade in these species increases by a substitution effect, a higher demand may increase the pressure on some of these highly traded and allowed species (as is the case for *Python regius*, species of the genus Testudo, *Trachemys scripta*, etc.).

An important caveat when considering the conservation impacts of positive lists is that listings are not a sufficient condition for legality. Illegal markets (as well as laundering through legal markets) will continue to pose threats to wild populations of exotic pets, especially those that reach high prices due precisely to their rarity. Conversely, this very argument reveals that an EU policy can be expected to reach a much higher level of efficacy than local positive lists, possibly increasing the costs of illegal trade and likely decreasing enforcement costs.

Impacts of an EU positive list on invasive alien species

Invasive alien species (IAS) put stress on local ecosystems and the services they supply to human societies and are a factor of degradation of natural capital and the quantity and quality of ecosystem services. IAS produce direct and significant damages with very high management costs derived from efforts to contain the spread of damages. We estimated that the costs of established IAS introduced through the pet trade may be taking a high toll on EU public budgets, in the order of €7 billion since 1990, or €270 million per year.

These figures may be disputed by emphasising that an important portion of these estimated costs are not observed, but potential. Potential costs are however not imaginary or unreal, but rather estimates of very real cleaning and remediation actions.

Both long and short EU positive list scenarios reduce the risks of trading with established IAS, although impacts are lower in terms of traded species (a reduction of -1% to -5%), compared to more significant reductions in the number of species (-26% to -58%). Positive lists are on the other hand more effective in reducing the trade of potential IAS in both the number of animals (-17% to 22%) and the number of species (-57% to -64%). Indirectly, positive lists also reduce risks of IAS by reducing the imports of animals of wild origin and by stopping any new species with an IAS potential to enter the trade.

We can't provide an estimate of these changes upon the baseline level of current or future IAS costs, due to lack of data and knowledge about the relevant probability distributions of animals escaped/released, adaptation, and establishment. We can however make a qualitative approximation to risk reduction. Firstly it seems plausible to assume that both genetic diversity and level of trade are positively related to risks of IAS becoming established and increasing damage and control costs. Further, it seems fair to assume that the probability of success of an IAS in producing an established population increases with the number of "trials" (the number of released animals) and with the probability of every "trial" to "match" to local conditions (which increases with the genetic variety of animals in trade and in households). Which effect will have a stronger impact is difficult to predict, just as the overall changes in IAS risks derived from changes in variety and number of animals traded. Positive lists may reduce both dimensions of risk at the same time, even when the probability or escape (ruled by the level

of trade) is reduced to a smaller extent than the probability of adaptation to local environments (ruled by diversity of trade). To calculate a precise risk reduction would require to weight the differential effects of diversity and level of trade.

To the extent that IAS can produce catastrophic costs (one species can be responsible for billions of euros in damages and control measures), investing in prevention is more cost-effective than facing damage costs or incurring in remediation expenditures. From this perspective, business costs that arise from a stringent positive list can be viewed as a more cost effective approach to reduce IAS risks. However the positive lists scenarios reveal that IAS risk would need to be explicitly included in the construction of the positive list. Complementary measures in addition to a positive list approach could also help to achieve the same result while staying fitting with the existing legal frameworks as mentioned in Section 2.

Impacts of an EU positive list on human health

Zoonotic diseases associated with exotic pets cause between 5 and 10 thousand infection cases per year, producing medical, hospitalisation, and productivity costs of between €30 and €100 million per year. These impacts are likely a lower bound impact, associated with pathogens that cause well known diseases (Campylobacteriosis, Salmonellosis, Giardiasis, Cryptosporidiosis, Hantavirus, Leptospirosis), with rather low, constant rates of incidence. On top of this group of regular, low impact zoonotic diseases we must consider the risks of outbreaks of new variants, including antibiotic resistant pathogens or emergent diseases, which can potentially cause damages several orders of magnitude larger.

While a component of zoonotic risk associated with exotic pets is locked-in to their population level and current diversity, positive lists are expected to reduce zoonotic risks associated with mammals currently present in the trade. Zoonotic risk is present all along the wildlife trade chain, where conditions that favour disease contagion and zoonotic spillover are frequent, like crowding together wild and farmed animals from very different environments, under stress and most likely with depressed immune systems (Walzer, 2020). There are many reported cases in which exotic pets have been the channel through which virus “spillover” from host species into humans and other species; for example, the first cases of monkey-pox in humans, occurred in the U.S. through prairie dogs used as pets, which in turn acquired the disease from imported African rodents (the original carriers) they were transported or stored with at some point (Chomel et al., 2007).

While a component of zoonotic risk associated with exotic pets is locked-in to their population level and current diversity, positive lists are expected to reduce zoonotic risks associated with mammals currently present in the trade. In addition, the reduction of imports of wild animals is also expected to reduce zoonotic risks, as they are perhaps the most important source of diseases and variants of concern regarding new, emergent diseases.

Comparison, likelihood, and distribution of impacts

Due to the uncertainties in measurement and the unmeasurability of some impact components, no attempt was made in this study to compare the positive and negative impacts of an EU positive list to produce one headline figure of net impact (e.g. a cost-benefit ratio). What is clear from the findings, however, is the potential impact that policy could have given the significant – and often hidden – impacts of the EU exotic pet market. The estimated annual costs of IAS, in the order of €270 million euros per year, or the health costs of €30 to €100 million per year are one or two orders of magnitude larger that the likely value of imports (€8 to €10 million, if US imports are €800,000), and also likely higher than the value of the retail trade (which can be guessed at 10 times the wholesale/import price, that is, €80-€100

million). If positive lists reduce the level of trade by 15-36%, the value costs of positive lists would be around €12 to €36 million. By these raw estimates, one can conclude that positive lists may be expected to be cost-effective if they reduce IAS and zoonotic risks by just 10%. The comparison gains relevance when considering that this represents only a small fraction of total externalities. Conversely, the €8.5-€11.7 billion in revenues for the industry as a whole (see Appendix 1.4), are a function of the pet population, not of the annual trade. Actually the level of revenue of the pet industry (including food, products, services) will most likely be only marginally affected by a positive list in the short term, as this will not directly impact the exotic pet population.

The evaluation of EU positive list scenarios was based on existing positive lists in EU Member States. In constructing these lists, governments used different criteria which lead to different impacts. If the impacts covered in this study were more explicitly incorporated into the creation of a positive list (i.e. the biodiversity, IAS, and human health), the expected impacts would increase. This is particularly the case for IAS risks.

The impacts of an EU positive list would not be felt equally across stakeholders. In general, the (negative) economic impacts would be concentrated in a small group of exotic pet breeders, importers, and wholesalers, while the (positive) conservation, ecological, and health impacts would be dispersed across whole populations and ecosystems.

Summary of findings on policy design

Although this study focused on the potential impacts of an EU positive list rather than the design of such legislation, some key lessons on policy design emerged from the findings.

The most striking finding is the widespread agreement among stakeholders involved in the trade and service of exotic pets that a harmonised EU positive list would be helpful for their operations. This support was clear across nearly all survey respondents, with no apparent connection to their responses to other survey questions such as their opinion on the efficacy or effects of the existing positive list(s) in their Member State.

Some of these stakeholders also stressed that a positive list is not a panacea and complementary policies are required such as enforcement, information sharing and training, and support for animal rescue centres after the law is introduced. Moreover, it must be stressed that the exotic pet market is driven by demand, and therefore demand-reducing policies are a fundamental complement to supply restrictions like positive lists.

Our study shows that while positive lists can have very important benefits in terms of biodiversity conservation and reduction of zoonotic risk, and marginal benefits in reducing the risks of enabling new IAS, mitigating such impacts requires specific complementary policies focusing on their particular causes. Equally important is the need to implement policies focused on providing consumer information on animals' needs and care requirements. Finally, the fact that several health and ecological risks are a function of the level and diversity of the exotic pet population calls for designing and implementing demand reduction policies, in complement to positive listing.

Conclusions

From these results, several key conclusions can be drawn that are pertinent to the potential development of an EU positive list for exotic pets:

- There are numerous ecological, public health, animal welfare, and other negative externalities from the exotic pet trade, making its regulation a policy area worth pursuing.
- As exotic pet sales are concentrated in a few species that are likely 'listed', an EU positive list would have a small economic impact for most pet businesses. These businesses may also shift from unlisted to listed species.
- By reducing the level and diversity of exotic pet trade, an EU positive list would reduce the conservation risk for threatened populations.
- An EU positive list could reduce the costly impacts of invasive alien species, but the list would need to be more targeted than current positive lists.
- By reducing the trade in viral-rich species, particularly mammals and imported wild animals, an EU positive list would reduce zoonotic risks to public health.
- There is widespread concern that existing positive lists in EU Member States are undermined by the (illegal) acquisition of unlisted species through online trade and cross-border transportation.
- There is widespread agreement among stakeholders involved in the trade and service of exotic pets that an EU positive list would help their operations.
- An EU positive list does not offer a solution to mitigate all impacts of trading and owning exotic pets. Complementary policies would be required to align wildlife policies (e.g. invasive alien species and health risks) and reinforce general policy goals, like biodiversity and ecosystem-services conservation at home and abroad.

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Appendix 1. Methods and data sources

A.1.1. Baseline of trade and impacts

Retail market

As a main source for retail market data, we relied upon the ProWildlife database on exotic pets (Altherr et al., 2020). This dataset was compiled by recording online advertisements for exotic pets from five major platforms with a presence in Germany (terraristik.com, eBay-kleinanzeigen.de, enimalia.com, cms.exoticanimal.de, reptilienserver.de) posted from September 2017 to March 2018. Full details of the methodology are available in the original study. This dataset was matched to our species list and contributed 100,091 animals from 2,031 species. Due to species matching, the number of species and animals differs in this study compared to the original study.

To supplement this dataset and ensure updated market coverage, we recorded nearly 20,000 advertisements from three of the same platforms (terraristik.com, kleinanzeigen.de, and mammals on enimalia.com) from September 2024 to October 2024. These advertisements were matched to our species list (first using a 'fuzzy lookup' to scientific, German, and English names and then checked manually) and contributed 9,333 animals from 740 species.

Import market

CITES data includes trade of live animals of 4 classes (Mammalia, Reptilia, Amphibia and Aves). Only the first three were analysed, as Aves are not listed in any existing positive list (which formed our criteria for determining positive list dimensions). We filtered records with "Purpose: P (Personal) and T (Commercial)", and restricted "Reporter.type" to "Importer" countries. After eliminating import records with units specified as "kg" or "g", we included records with Units == "Number of specimens" & Units == "NA", assuming all unspecified quantities refer to the number of specimens. The baseline includes EU 27 current Member States and the UK. We opted for keeping the UK after Brexit in 2020 for the CITES 2017-2022 baseline as a large share of UK imports are re-exported to the EU.

Law Enforcement Management Information System (LEMIS, United States Fish and Wildlife Service) data for live animal exports from the United States into EU countries was obtained for the period 2016-2020 (Center for Biological Diversity, 2nd release, 2023). We used the following filtering parameters: Wildlife description: Live animals (Wildlf_Desc == "LIV"); Animal Classes: Mammals, Reptiles, Other birds, Amphibians (Wildlf_Cat == "MAM", "REP","MNG","OBR", "AMP"); Purpose: Personal (P), Commercial (T). Original baseline value figures in current US$ were first converted to constant US$ at 2017 prices (using the US GDP consumer price deflator) and then converted into € (using an average exchange rate of €1=US$1.03).

In both Lemis and CITES databases we eliminated rabbits (Oryctolagus cuniculus) and ferrets (Mustela putorius furo (for consistency with our definition of exotic pets) and species not likely traded as pets as Ursus americanus (from Lemis) and the genus Macaca (in CITES data).

Conservation status

To assess the impacts on wild species we relied on the risk categories as defined in the IUCN Red List of Threatened Species, Version 2022-2. Following Munstermann et al. (2022) we calculated the percentage of threatened population by species as % threatened = (CR+EN+NT+VU)/(N-DD), where CR= Critically endangered, EN= Endangered, NT=Near threatened, VU= Vulnerable, N=total number of organisms, DD=data deficient.

Invasive Alien Species

Estimates of the dimensions of invasive alien species are based on the Inventory of alien invasive species in Europe DAISIE database (Roy et al., 2020). We initially considered four animal classes (Amphibia, Aves, Mammalia, Reptilia). Species with active populations were filtered using the status of occurrence: “rare”, “present”, “common”, and “irregular”. The range of available years is 100-2011. Data was extracted for the 27 Member States of the European Union.

Economic costs of Invasive Alien Species were obtained from the INVACOST database version 4.1. (“The invacost R Package: Global Costs of Biological Invasions”, Leroy, B., Kramer, A.M. Vaissière, A.C., Kourantidou, M., Courchamp, F. and Diagne, C. 14 April, 2023). We extracted from this database all reports of costs of invasive alien species (IAS) of the four animal classes (Mammals, Reptiles, Birds and Amphibians), for the EU 27 Member States (excluding the UK). Following best practice, we cleaned the data by removing “NA” values and records with uncertain time periods, and expanded the database along impact years before applying functions for summarising costs. We included both observed and potential costs, but only estimates of high reliability. Only species reported as traded in the ProWildlife database were included in the final calculation of costs. The total time period of analysis is 1990-2021.

Estimates of the effects of positive lists on invasive alien species traded as pets were calculated by identifying two subsets of exotic alien species traded in the baseline for the retail market. The first subset corresponds to species listed as IAS with active populations in the EU region from the Inventory of alien invasive species in Europe (Roy, et al, 2020, DAISIE database). The second subset comes from a list of reptile and amphibian species assessed and ranked in three consecutive papers by Kopecky et al. (2013, 2016, 2019). Only species with establishment risk scores serious and extremes were selected. These both lists of species were later searched in the baseline of species traded in the baseline scenario for the retail market.

Health and zoonotic risks

Data on total reported cases, proportion of hospitalisation cases, and death rates of Salmonellosis in the EU 27 region (without the UK) was obtained from the EU CDC Surveillance Atlas of Infectious Diseases). Due to the SARS-CoV-2 pandemic in 2020, the reported cases of Salmonella in the region diminished sharply in 2020, but have been recovering since to reach the pre-pandemic level of 80,000 cases per year. For this reason we used the average of the five pre-pandemic years (2015-2019) for the three variables (number of cases, hospitalisation rate, death rate). Data for Giardiasis, Cryptosporidiosis, Hantavirus, and Leptospirosis correspond to the last year available.

To calculate the number of cases of Reptile Associated Salmonellosis (RAS) we assumed, following the relevant literature, incidence rates of 2%-3% of RAS in total Salmonellosis cases. Dróżdż et al (2021) refer to studies in Europe that report incidence rates of RAS that go from 2% in the Netherlands to 27.4% in the UK. The latter figure is likely an overestimate (comes from a small sample and a short period of time, probably during an outbreak), while the former covers 30 year and over 70,000 cases. Data on the U.S. indicates RAS incidence rates of around 2%,

although older studies reported rates of 6% at the beginning of the century (Mermin et al., 2004). To make a conservative estimate we opted for a 2%-3% incidence rate.

To calculate hospitalisation, productivity, and illness costs we used the Cost of foodborne illness estimates for Reptile Related Salmonella spreadsheet by the U.S. Department of Agriculture's (USDA) Economic Research Service (ERS). As noted above, we fed this spreadsheet with the total Salmonella cases, hospitalisation and death rates as reported by the European Centre for Disease Prevention and Control in the Surveillance Atlas of Infectious Diseases. It is important to stress that these cost estimates are based on U.S. costs, which may overestimate actual costs in the EU, given the differences in the respective Health Systems. Cost figures were first obtained in US$ and updated by adjusting for inflation, using specific items of the US Consumer Price Index, and then converted into euros at the average exchange rate of 2022 (€1=$1.05). U.S. health valuation methods also include costs of premature deaths, based on the average Value of Statistical Life (VSL) calculated every year by the Department of Agriculture, which was $11.3 million US$ in 2023. This monetized value is controversial (Ackerman & Heinzerling, 2004) and not common in the EU, so we use the number of deaths instead.

To assess the impact of positive lists on the zoonotic risk we used the viral richness as a proxy for zoonotic risk at the level of species (Johnson et al., 2020). This variable measures the number of viruses with zoonotic potential detected for particular species. To control for the importance of each species according to the numbers they are traded, we multiplied the viral richness per species by the number of animals in trade, and aggregated these into a general "viral load" for mammals offered for sale in the retail market (which is the one that provides the most complete range of mammal species in the pet trade).

A.1.2. Total economic costs of IAS of three animal classes

Costs of invasive alien species in EU Member States for all available species (35) in the Invacost database, three animal classes. This can be interpreted as an estimate of the risks of IAS of animals in the exotic pet trade at the retail level in a worst case scenario.

Table A1: IAS costs* for EU 27 (all species of the three animal classes)

(millions of €, 2017-prices)								
	Total cost				Average annual cost			
period	Total	Mammals	Reptilians	Amphibians	Total	Mammals	Reptilians	Amphibians
1990-1994	**€112.9**	€112.9			€22.6	€22.6		
1995-1999	**€388.8**	€386.9			€77.8	€77.4		
2000-2004	**€8,467.1**	€8,465.9		€1.0	€1,693.4	€1,693.2		€0.2
2005-2009	**€174.5**	€168.6	€0.1	€0.2	€34.9	€33.7	€0.0	€0.0
2010-2014	**€5,441.7**	€92.2	€0.3	€5,341.4	€1,088.3	€18.4	€0.1	€1,068.3
2015-2019	**€82.1**	€75.9	€0.4	€0.3	€16.4	€15.2	€0.1	€0.1
2020-2022	**€258.5**	€254.7	€0.0	€0.0	€86.2	€84.9	€0.0	€0.0
1990-2022	**€14,925.6**	**€9,557.2**	**€0.7**	**€5,342.9**	**€452.3**	**€289.6**	**€0.0**	**€161.9**

Notes: Millions of EUR, 2017 prices. **Source:** Own calculations based on Invacost. Calculations use "Observed" and "Potential" costs with "High reliability" estimates.

A.1.3. Import prices of EU imports from the U.S.

Figure A1a: Average price of the top 20 reptile and amphibian species imported from the US

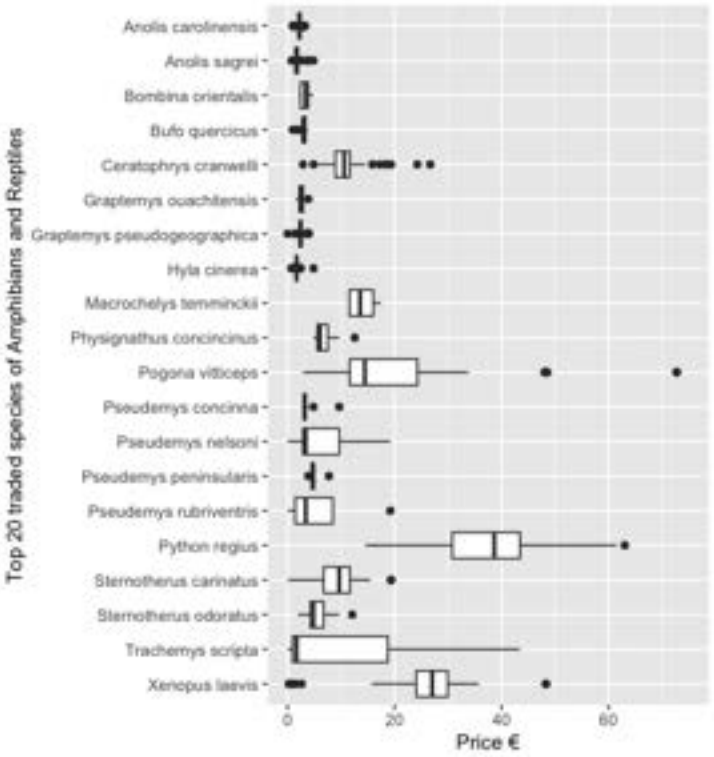
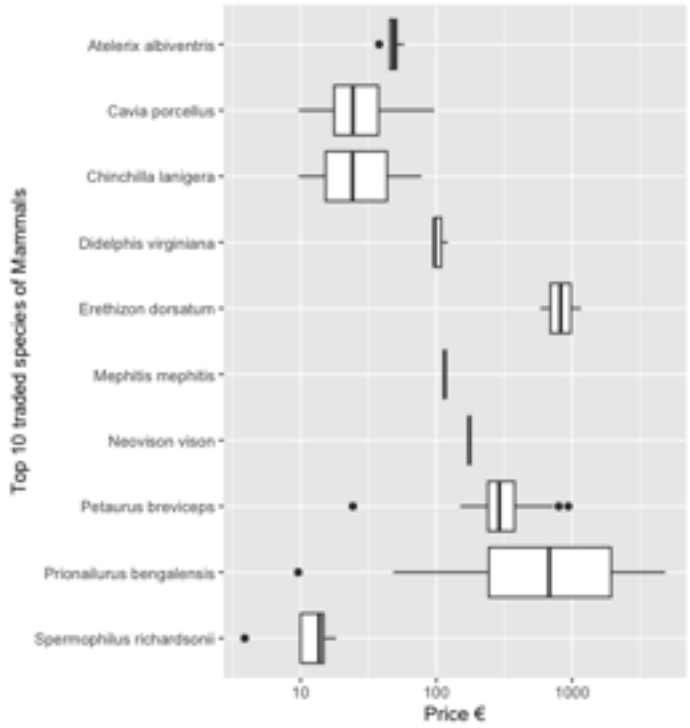


Figure A1b: Average price of the top 10 mammal species imported from the US



Source: Own calculations based on LEMIS (2016-2020).

A.1.4. Estimated value of the exotic pet industry

Table A2: The size of the EU exotic pet industry for small mammals, reptiles, and amphibians

Measure	Central value	High	Low
Population (incl. birds)	58,424,000	62,292,000	54,556,000
Population	24,300,000	28,198,020	20,461,725
Average expenditure per pet (€)	€417.2 (s.d. 152.8)	€570.0	€264.3
Total revenue (million €)	€10,149	€11,763 (s.d. €4,309)	€8,536 (s.d. €3,127)

Sources: Own calculations based on FEDIAF, 2022; APPA, 2022-2023. | **Notes:** High and low scenarios consider as exotic 90% and 75% (respectively) of the total population of small mammals reported by FEDIAF (2022) as exotic (i.e. not rabbits or ferrets). In addition, we consider 1.7 reptiles or amphibians per terrarium. Average expenditure per pet is based on the average value of annual expenses in food, supplies, non surgical veterinary expenditures, medication and toys for small mammals and reptiles as reported by the American Pet Product Association Survey for the US.

Appendix 2. Survey methodology

To ensure that the views of potential respondents were relevant to this study, only stakeholders with an exotic pet component to their operations were contacted. Additionally, each respondent verified at the start of the survey that they met three conditions:

1. The survey respondent is the owner, manager, or an officer of the named organisation;

2. The products or services of the organisation relate to animal species beyond cats, dogs, rabbits, or ferrets;

3. The organisation has existed since before [date of the relevant positive list]

For each positive list there were 7-9 respondents, producing 55 survey responses in total (Table A3). The largest stakeholder groups by number of respondents were pet shops (16), veterinary clinics (10), animal rescue centres/sanctuaries (7), and breeders (4 private and 3 commercial).

Table A3: Overview of survey respondents

	BE-B	BE-F	BE-W	CY	LT	LU	NL	Total
Pet shops	3	3	3	4	1	2	0	16
Veterinary clinics	1	1	0	3	1	2	2	10
Animal rescue centres/sanctuaries	0	1	1	0	1	1	3	7
Law enforcement agencies	3	1	0	0	0	0	1	5
Suppliers of pet products	1	0	1	0	0	1	1	4
Private breeders	0	0	0	1	1	0	2	4
Commercial breeders	0	1	0	0	2	0	0	3
Animal parks/zoos	0	0	0	1	1	1	0	3
Wholesalers	0	0	2	0	0	0	0	2
Border control posts	0	0	1	0	0	0	0	1
Total	8	7	8	9	7	7	9	55

Note: To ensure consistency in the stakeholder group classifications, three respondents that identified as pet shops but do not sell animals were reclassified as suppliers and one respondent that identified as a supplier but does sell animals was reclassified as a pet shop. These two stakeholder groups were combined in the survey results so the reclassifications have no bearing on the results.

The survey was conducted either online or over the phone from 9 August 2024 to 16 September 2024. The question list differed depending on the stakeholder group identified and the respondent's answers to previous questions. On average, respondents answered 20 questions with phone interviews lasting around 30 minutes.

The survey used a mix of closed questions (e.g. Are there certain species or products you previously offered but stopped due to the positive list? Yes / No / Don't know) and open questions (e.g. If yes, which species or products?). The questions covered four themes: information about the respondent, the efficacy of the positive list, the effects of the positive list, and EU harmonisation. The survey questions can be viewed in this online workbook.