Assessing a reverse approach to traded species protection

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Abstract
Growing concern over the scale of unregulated wildlife trade has led to calls for fundamental changes to systems of species protection. A proposed “reverse listing” approach would ban the harvest and trade of all wild species, except those for which trade can be demonstrated to be sustainable. We evaluate the feasibility of this approach on an international scale and discuss policy solutions. Adopting reverse listing would not be straightforward; key issues include the social legitimacy of resulting laws, ensuring effective law enforcement, and the treatment of trade from alternative (i.e., non-wild) sources. Reverse listing is not a panacea for protecting biodiversity from overexploitation, and a combination of approaches is needed to effectively regulate the world’s wildlife trade.

Main text
Tens of thousands of wild species are used or traded worldwide (*1*). Well-managed wildlife trade can be ecologically sustainable, benefit diverse stakeholders along supply chains, support local and national economies, and generate conservation finance (*2*). Overexploitation, however, threatens thousands of species (*2*). Poorly managed or unregulated trade in wildlife can lead to the spread of disease and invasive species, facilitate unsustainable harvesting, and have broader impacts, including on indigenous peoples and local communities who rely on wildlife to meet their daily needs (*1, 2*). Concern about the overexploitation of biodiversity, particularly the scale of unregulated wildlife trade, has led to increasing calls for the redesign of regulatory mechanisms, including CITES (the Convention on International Trade in Endangered Species of Wild Fauna and Flora) (e.g. *3, 4,* see SM1). A “reverse listing” approach, also known as a “positive” or “white” listing approach, would ban the harvest and trade of all wild species by default, unless it can be demonstrated empirically to be ecologically sustainable. We evaluate this approach on an international scale, including the likely risks and benefits involved, and discuss policy solutions.

International agreements (e.g. CITES) and national laws governing the harvest, use and trade of wild species predominantly apply a “negative” listing approach. Under this approach, the trade (and frequently the harvest, hunting, or use) of species on the list is either prohibited or closely regulated. Tools such as permits and quotas are used to ensure legality and sustainability, and to monitor trade in listed species only. The trade in species not included on the negative list is less stringently regulated, if at all. This system works well for regulating commerce in some species, such as vicuña *Vicugna vicugna*, which has seen high levels of legal compliance by harvesters, exporters, and other actors, due in part to other supportive conservation interventions (*5*). However, the current approach is failing to prevent both illegal and unsustainable extraction of thousands of species, with a major challenge being a lack of knowledge of which species are traded and to what extent (*6*). Other principal issues with the existing approach include weak legal frameworks, insufficient public awareness of which species are subject to trade regulations, perceived illegitimacy of laws (or parts thereof), lack of consultation with key actors during policy formulation, and resource deficiencies for law enforcement and management (*7*).

Under a reverse listing approach, qualifying species would be included on a list of species that *may* be traded. Species would qualify if harvest and trade can be demonstrated empirically to be ecologically sustainable, that is, offtake from target populations does not degrade biodiversity or ecosystem function. The trade of all other species would be prohibited and otherwise permitted only when, and if, sustainability can be demonstrated;

these species could then be listed and traded under agreed conditions. This approach is used in several sectors (e.g. drug approval in the pharmaceutical industry) and to manage invasive alien species, but its use in protecting biodiversity from overexploitation is limited. A few European countries use reverse listing to regulate the pet trade (e.g. Belgium and Italy [*4*]), while others are currently considering it – including the European Union (EU) – or are in the process of implementing the approach (e.g. France and the Netherlands) (*4*, see SM1). Despite its limited use to date, reverse listing is increasingly proposed as a policy solution to reduce unsustainable international wildlife trade, including through CITES (SM1).

Proponents of reverse listing argue that current negative lists are reactive and too slow, and the growing number of species being added to the CITES Appendices suggests it is judicious to proactively transform the entire system (*8, 9*). The premise is that allowing trade in wild species inherently puts these species at risk and that suppressing trade through law is precautionary because it shifts the burden of proof onto the individuals wishing to trade (*3, 8, 9*, SM1). Evaluating the efficacy of a proposed alternative regulatory approach raises three key questions. The first question is whether, once in place, the alternative is necessarily superior as a conservation measure; the second concerns the feasibility and risks associated with the process of radical system change. The third concerns how wildlife traded from alternative sources, including commercial captive-breeding and synthetic production, is treated. The first question is more theoretical in nature, the second more practical, and the third has elements of both.

EVALUATION

The alternative end-state

Assuming a successful transition to an alternative regime in which international trade in wild species is illegal, except where it is demonstrably sustainable, proponents claim this end-state would have several benefits (*3, 4, 8, 9,* SM1). First, the problem of reactive negative listing delay is eliminated because newly described species would receive instant legal protection and could not be legally traded before sustainability has been determined (*3, 8*). Second, it is argued that enforcement would be strengthened, with the burden of proof transferred from enforcement officials to suppliers and traders (including importers and exporters), who would have to prove that species are on the positive list (*3*). Enforcement officers would no longer need to check the legality of species against numerous statutes, or correctly identify species from thousands in trade, streamlining customs and enforcement checks (*10*). Proponents also argue that compliance would be improved due to greater clarity among the public regarding the species that can, and cannot, be traded (*10*). For example, reverse listing could incentivize better trade management and compliance with applicable regulations for lower-value species traded as pets for which sustainability cannot currently be determined, and which frequently fall outside the remit of CITES (*9*). It is argued that these factors would ensure that international trade is ecologically sustainable and help alleviate the problems of invasive species and disease risks associated with wildlife trade.

There is, however, widespread evidence that awareness of wildlife trade regulations is not an automatic route to compliance, which is strongly influenced by perceptions of social legitimacy (*7, 11*). Optimistic visions of the end-state assume a greatly transformed society in which consumer preferences for wild products are radically reduced. But if consumer demand for wild products persists (the prevailing policies may not stigmatize consumption),

then illegal trade will likely continue because some actors will be willing to supply these products despite it being illegal; this is the case for several high-value CITES-listed species, including elephants (Elephantidae spp.) and pangolins (Manidae spp.). It also differs by sector, with some traders and consumers preferring wild-sourced products, others preferring captive-bred or artificially propagated alternatives, and unknown preferences for some sectors and species (*12*). For rare and high-value species, reinforcing feedback effects between increasing scarcity, consequent rising prices, and further harvesting pressure may cause species to be trapped in a "poaching pit" from which there is no escape under a trade ban (*13*). The existence of, or potential for, illegal activity is also used as an argument against allowing any legal trade, due to the possibility of laundering via legal supply chains (*14*). This would potentially preclude sustainable legal trade solutions in the future, even where they may be more effective in reducing illegal trade. In many developing countries, excessive wildlife trade restriction tends to reduce the perceived longer-term socio-economic value of terrestrial wild species and their habitats relative to other land uses (*15*). This has the potential to produce adverse systemic impacts on both biodiversity and economies – the latter, by limiting economic opportunities or otherwise by displacing activity from legal markets to illicit markets with added social costs. For many high-value CITES-listed species, increased criminalization of international wildlife trade in recent decades has been accompanied by increased involvement and expansion of transnational organized crime syndicates, with many other undesirable spill-over effects (*16*).

The impact on law enforcement would not be straightforward. The harvest and trade of many more species would be prohibited compared to current policies; this could incentivize the sustainable use of species and the eventual inclusion of additional species on the positive list but for high-value species it could result in price increases and (ongoing) illegal trade (*15*). Existing wildlife-related law enforcement efforts are persistently and chronically under-resourced in human, technical, and financial resource terms in many, if not most, parts of the world (*7*) and new economically viable systems would be needed to ensure effective law enforcement at scale. Customs and enforcement officers would still be required to accurately identify species to authorize trade and this may require new systems (e.g. certification and traceability using technologies such as DNA barcoding). Without adequate systemic support, law enforcement would remain challenging, especially for hybrids and the many "lookalike" species that present the greatest identification challenges under the current CITES negative-list approach.

Transition issues

Transitioning from a negative to a positive list would require countries to revise existing laws or enact new laws that protect wildlife. If reverse listing were to be formally adopted within CITES, this would require amending the Convention text (see SM2). In such instances, it is unclear how countries would transition from negative to positive lists, and on what timeline, but there are several factors to consider. There would need to be a transition period during which species currently being traded sustainably could be included on countries' positive lists, to provide time to make the necessary structural, process, and listing changes within CITES (SM2). This would require developing sustainability criteria for different taxa. For well-studied species (e.g. rhinoceroses; Rhinocerotidae spp.), this may not be problematic, but for many traded species (e.g. virtually all medicinal plants), there is a lack of basic ecological knowledge, meaning that demonstrating sustainability empirically would be challenging.

Exemptions to reverse listing or separate systems for managing the harvest and trade of certain plant, animal, and fungal species may therefore be needed. Prohibiting harvest and trade in wild species could also raise pertinent ethical concerns. For example, restricting access to animal and plant species used for medicinal purposes could have implications for human welfare (e.g. access to health products). Ensuring laws are socially legitimate to key actors and stakeholders would therefore be crucial and public consultations or participatory governance processes would be needed to try and achieve this (*7*). Absent such processes, laws may be perceived as illegitimate, which could lead to harvesters and traders defying them, especially if law enforcement is inadequate (*7, 11*).

Reverse listing would entrench greater reliance on state-led law enforcement to prevent species from being overexploited. Insights from criminology suggest that to effectively deter illegal extraction of wildlife at the point of harvest requires an adequate probability of apprehension for would-be offenders, but this is expensive and rarely achieved, especially in open access conditions (*7*). Recognizing the current under-resourcing of law enforcement pertaining to wildlife, it is unclear how countries would transition to effective reverse listing models. With a larger number of illegal-to-trade species to monitor, ensuring an adequate probability of apprehension for (actual and potential) offenders would require substantial and sustained increases to law enforcement budgets, and would be prohibitively expensive unless new finance models are developed to support implementation. The extent of law enforcement effort would also need consideration when announcing new or revised laws due to the risk of accelerating the extraction of species before laws enter into force, even for species that may end up on the positive list (*17*).

Transitions to reverse listing would likely further complicate international law enforcement efforts. If the decision was made to implement the approach at the international level, some countries may simply not accept it. If the CITES Parties were to adopt reverse listing (by amending the Convention text) but only some Parties accepted the amendment, this would result in a “split-CITES” with Parties implementing very different versions of the Convention, further complicating supply chains and law enforcement efforts (see SM2).

Trade from alternative sources

A reversal of the current system would require careful evaluation before adoption to determine how it would treat wildlife from non-wild sources, such as captive breeding, artificial propagation, aquaculture, and synthetic production. This includes whether wildlife and derivative products from these sources would be included on positive lists alongside wild-sourced products of the same species, or prohibited from trade until ecological sustainability could be demonstrated, or whether other traceability systems would be needed. For example, would undomesticated species already produced in large volumes in captivity (e.g. crocodiles) and aquaculture (e.g. sea cucumbers) be automatically put on positive lists? It may be that different systems and criteria are needed for including terrestrial animals, plants, fungi, and aquatic species on positive lists. Debate over the positive or negative impacts of wildlife farming on influencing consumer demand for wild species is difficult to resolve without long-term studies of wild populations and consumer preferences, and such work may be needed prior to the adoption of reverse listing. The impact of other production systems on wild species also requires further investigation. If more calls emerge

for reverse listing, it will be essential to examine how trade from alternative sources would be affected, including whether criteria for inclusion on positive lists would apply.

SOLUTIONS

Concerns about the scale of unregulated and potentially unsustainable international wildlife trade are legitimate. Trade in a broad range of species is not regulated (*18*), and current approaches are failing to prevent the unsustainable trade of thousands of species (*6*). However, reverse listing is not a panacea. The approach could address the negative listing delay and potentially benefit species not currently protected (e.g. under CITES), which are vulnerable to exploitation for trade. For example, cave geckos (*Cyrtodactylus* and *Goniurosaurus* sp.), for which short bouts of high-intensity collection could pose a major threat. Whether such species would benefit, and to what extent, would depend on the effectiveness of law enforcement along supply chains and other supportive conservation and management measures (see *5*).

Nevertheless, reverse listing would not solve many of the problems with existing wildlife trade regulations and is unlikely to be a superior blanket approach at the international level. It would not necessarily result in stronger law enforcement or better compliance by actors with applicable laws. To achieve this – as with the current approach – would require increased and sustained financing for law enforcement, improved enforcement mechanisms, and traceability systems, if the aim is to ensure an adequate probability of apprehension to deter the illegal extraction and trade of species (*7*). Using the approach but failing to mitigate offtake also risks undermining the conservation and management of many species. Ensuring that laws enacting reverse listing are socially legitimate, especially among key actors and stakeholders, and addressing the issue of trade from non-wild sources are key challenges that would need to be overcome.

Formulating effective laws and policies to protect biodiversity from overexploitation requires evaluating how these measures will likely affect outcomes on the ground. This requires knowledge of the species concerned and the threats they face; an understanding of the relevant wildlife trade systems, including institutional arrangements, incentives for managing and conserving the species, and possible feedback effects; and whether such laws will be perceived as socially legitimate (*1, 7, 11*). An assessment of the resources needed to effectively enforce applicable laws is also needed. Plausible and proportionate policy options can then be formulated, likely including diverse provisions for different taxa and the identification of suitable management tools (e.g. quotas), which consider the burden (and standard) of proof related to particular decisions (*19*).

Reverse listing may have a role in regulating international wildlife trade, but would necessitate large scale systemic changes to be realized. Several European countries use the approach to regulate the trade in pets, but this involves only a small number of species and efficacy may vary. The approach may benefit wild species, but like current systems of species protection this would depend on effective law enforcement twinned with broader conservation and management measures (*5*). Context-specific solutions are needed to avoid overutilizing wild species because billions of people rely on them for food, income, and other needs at different scales (*1*). Many forms of regulation are used to achieve this and, while

reverse listing may have *a* role, more nuanced and equitable laws and policies are needed to effectively regulate the world's wildlife trade.

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Supp Mat 1 – Background.

Supp Mat 2 – Amendments to CITES if the Parties were to adopt reverse listing.

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Supplementary Material 1 – Background

Table S1. Literature and policy documents proposing "reverse listing" or similar for regulating wildlife trade.

Source (chronological order)	Proposal/discussion	Justification
CITES (1981)	Recommends that a sub-committee of experts be appointed to examine whether other methods of classification may offer better administrative procedures and more effective management of endangered species and subspecies. Recommends that the sub-committee examine the implications of the general concept of listing on schedules species in which commercial trade is permitted (as compared to the current system, in which trade in listed species is restricted), and examine all ramifications (including legal problems, if any) in implementing any changes they might wish to put before a future meeting of the Conference of the Parties.	Increasing practical problems involved in identifying the numerous species listed for varying degrees of control on the appendices of the Convention. Noting discussions at CoP3 indicating difficulties in identifying particular subspecies that require management and limitations in trade. Noting that listing species to be controlled by name has made problems with taxonomic synonyms, taxa validity, etc., and has created enforcement difficulties. Aware that other means of presenting the appendices might solve these problems.
Ditkof (1982)	Discusses proposal submitted by Australia to CoP3. Parties should adopt reverse listing only after careful scrutiny and consideration and…only if reverse listing affords easy enforcement of trade restrictions and satisfies the objectives of CITES…more effectively than does direct listing.	Regarding the justification made by Australia: Reverse listing would help resolve identification problems by shifting the burden of proving that a species is listed from the customs official to the importer/exporter, who would then have considerable incentive to cooperate in the identification process (but acknowledges that illegal traders would attempt to categorize specimens as from listed species). Regarding subspecies, reverse listing would alleviate this problem by requiring an affirmative showing no restriction or only a limited restriction on trade in a particular subspecies is necessary for the protection of that subspecies. Also notes that reverse listing would not be helpful concerning classification and validation because many species are similar and customs officials would still need to identify species and determine whether they are listed or unlisted.

Beissinger (2001)	CITES to switch from long “dirty lists” of species that are too threatened to harvest to short “clean lists” of species that are safe to import and whose quotas have been scientifically set at conservative levels.	To recreate a trade that conserves birds and ecosystems. To avoid the problem of introducing exotic species and diseases.
Pain *et al.* (2006)	Citing Beissinger (2001) suggests a switch in the CITES appendices from long lists of species that are too threatened to be in trade, to short lists of species that can be traded, with quotas set scientifically at conservative levels.	For trade to connect to resource conservation requires quotas to be established at the site level, to tie in with local conditions, to help ensure that local people accrue a higher proportion of the economic benefits of trade, and to provide a local impetus for conservation and sustainable exploitation. Until such conditions exist, sustainable trade in parrots, and indeed other avian species if conducted on any significant scale, is unlikely.
Couzens (2013)	White-listing species that *may* be traded and black-listing other taxa, even if on a limited basis to start with.	Could assist with many of the problems commonly associated with the enforcement of CITES such as “look-alike species”, disguised species, fraudulently used or forged permits and poorly trained customs officials. If CITES’ parties could be persuaded to prohibit all commercial trade in wildlife, except for specific listed species in respect of which trade is considered environmentally acceptable, enforcement and implementation would become more manageable. By whitelisting, a certain focus on individual endangered species might be lost; but greater respect for, and appreciation of, the value of biodiversity might be gained. Citing Ditkof (1982) “it would probably be easier to enforce trade restrictions under reverse listing” but acknowledges that reverse listing “de-emphasises the protection of endangered species”. Citing Ditkof (1982) also notes “[d]irect listing focuses attention on individual species that are endangered or threatened, while reverse listing relegates those species to the background”.
Warwick (2014)	Discusses the merits of “positive” and “negative” listing.	States that where the positive listing system is used, it is significantly superior to the negative-list principle of CITES.
(*8*)	Only collection and trade in wildlife that has been proven to not be detrimental to wild populations should be allowed.	Trade in the vast majority of reptile and amphibian species is not regulated because they are not included in the CITES Appendices and because of the slow process of listing species, a reversal of the burden of proof for international wildlife trade should be considered.

(*9*)	Study examines online trade in reptiles and proposes reassessing how international trade in reptiles is regulated. The burden of proof should be shifted to demonstrate sustainability before species or populations can be traded. Trade under a precautionary scenario could be governed by an approved-list of tradable species with adequate population data to ensure trade does not pose a major risk to their survival.	The scale of the trade and limited knowledge of the direct impact on wild populations justifies reassessing how we regulate international reptile trade. The reversal of current regulations to a precautionary system, where no-trade is the default, would relieve pressure to keep pace with taxonomic changes or descriptions, as new species would automatically be protected from trade. By regulating what can rather than what cannot be traded internationally, we can considerably reduce the pressures on wild reptile populations.
(*10*)	Reviewed international, national, and regional legislation in Europe, the United States, and Canada and determined that largely unpublished and often inconsistent criteria are used for developing negative and positive lists relating to regulating the trade in pets. Discusses key issues and perceived advantages of positive lists and associated challenges. Compared the functions of positive and negative lists. There is a substantial body of research to demonstrate that the predominantly negative list-based regulations used by most governments are largely ineffective at controlling a raft of issues associated with pet trading and keeping. In contrast, indications support the effectiveness of positive lists for regulating pet trading and keeping, and we found no evidence to suggest that positive lists worsen current problems.	*Negative lists* Even the most exhaustive negative lists could not accommodate perennial shifts in exotic animal keeping trends, which may present new threats. The procedural obligations for governments to follow the science means that retaining the negative list model for pet trading and keeping is untenable both in terms of management and cost burdens. The sheer scale and diversity of animals currently traded as exotic pets under negative list systems represent a considerable enforcement burden. Under negative list systems, problems relating to animal welfare, species conservation and environmental protection, public health and safety, and invasive alien species continue to burgeon. Administrative complexity and difficulty for enforcers. Array of legislation and enforcement protocols requiring a high level of expertise. Wide diversity of permitted species with largely unreliable husbandry guidance or species that may be unable to thrive in captivity. Authorities forced to be reactive as new species come into trade or problems are identified. Burden of proof is on individual scientists, humane and other groups, societies, or governments. *Positive lists* Positive lists can be easily and economically maintained in the light of new evidence. Concise positive lists can act as a useful mechanism to control online trade, as has been demonstrated in Belgium where members of the

		public promptly alert authorities to online advertisements for prohibited species. A positive list also removes “hiding places” for illegal trade—for example, at ports of entry where, currently, representational problems occur when species are misdescribed or paperwork is forged. A clear list of permitted species removes the need for enforcement officers to check the legality of species against numerous statutes. Implementing and operating positive lists offers significant cost-savings and is an efficient use of limited resources directed at tackling illegal trade. Positive lists do not include species unless rigorous scientific assessment has shown them to be suitable to be traded and kept as pets. This ensures that animals, consumers, and the wider environment are protected. Evidence-based species risk assessments offer consumer protection, animal health and welfare, and environmental safeguards. Administrative simplicity and ease for enforcers. Greater clarity for public regarding which species can be legally kept assists compliance. Reliable, and improving, husbandry guidance for established pet species Authorities able to take proactive measures. Species added to positive lists only after thorough risk assessments have been undertaken. Burden of proof for adding species is on the prospective exploiter.
Bang & Courchamp (2021)	Discusses “whitelisting” and “blacklisting” pertaining to invasive species.	“Whitelisting” is more stringent and hence more effective in controlling potential invasions, it is also more logical as assessments would need to be done only for species in industry.
Hughes (2021)	Notes that the COVID-19 pandemic has led to renewed calls for a reverse listing approach within CITES where species would need to be listed to enable international trade.	Justified by noting that a proactive rather than a reactive approach would serve species better by not waiting until they were already endangered to institute management and monitoring
(*3*)	Proposes that domestic wildlife laws, CITES, and other relevant international agreements apply a positive list approach whereby for a species to be listed as saleable the trader must first demonstrate that trade is not detrimental to its conservation.	Monitoring species can be challenging and population size, status, and numbers in trade are often unknown. Because of costs or perhaps inertia or disinterest, the required data tend to be gathered and collated only for charismatic species. Monitoring is often imprecise and there is often limited power to detect change.

		If the burden of proof lies primarily on conservationists to demonstrate that trade is negatively affecting a given species before it is afforded the legal protection required to prevent its extinction, and given the general inadequacy of monitoring, drastic overexploitation may occur long before any checks can be effective. Starting from a presumption of wildlife protection, the onus might more appropriately be put on would-be commoditisers to provide the first evidence of the trade's sustainability, humaneness, and safety, not vice versa.
Nature Needs More (2021)	The regulatory regime shifts from blacklisting to whitelisting (also called "positive lists" or "reverse listing"). Under a reverse listing model: The burden of proof that trade is compatible with ecologically sustainable use (e.g., using the Addis Ababa principles) would be on those wishing to trade. Without providing proof of both sustainability and compliance upfront, the trade will not be approved and cannot happen. This model incorporates demand-side considerations, effects on the illegal trade, effects on enforcement and other criteria already used within CITES rather than simply focusing on supply-side factors. The CITES authorities would set the standards, but businesses would be required to pay for the necessary research, which is the same in other industries using a white-listing approach (e.g., pharmaceuticals). Industry would cover the cost of regulation through businesses submitting applications for trade for which they would pay a fee. In addition to the application fees businesses would have to pay ongoing, annual listing fees based on the value of the trade in species. These fees would cover costs of processing applications, monitoring, and enforcement.	CITES does not currently apply the Precautionary Principle. It assumes that exploitation of wild flora and fauna for consumption and trade does not pose a significant risk to humans that would warrant making "no trade" the default position for any species. Blacklisting means that the default social norm is to "extract biomass" so this model cannot and will not work Under the blacklisting model, the burden of proof lies with those who oppose trade, which in most instances is NGOs, philanthropists, and sometimes governments. Business can lobby governments without contributing financially to regulation. The current blacklisting system in CITES means that the burden of proof when confiscating items lies with customs, not the exporter. If, for example, the exporter claims on their paperwork that the lizards being shipped are not CITES listed, it would be up to customs to prove that they are and require an export permit. CITES suffers from several regulatory failures (e.g., inadequate funding). Under the whitelisting model and compliance model outlined sanctions would be more targeted than under the current system (e.g., focused on companies rather than countries).

	Processing of applications would be centralised through the creation of a CITES Listing Authority, which would set the rules for listing applications and evaluate the proposals based on those rules. To make sure that applications and fee paying are equitable, businesses will be forced to submit joint applications (similar to what is implemented in the European Chemicals Agency REACH framework). This would ensure exporters and importers work together. To support compliance two new centralised authorities would be created: a CITES Compliance Authority (CCA) and a CITES Monitoring and Enforcement Authority (CMEA). A new Appendix I is also proposed, which would include species that should not be exploited commercially either domestically or through any form of trade. Appendix II would implement the whitelisting model.	
Warwick & Steedman (2021)	Discusses negative lists and their prominent role in regulating both wild pet and domesticated animal trading and keeping, before focusing on positive lists as an alternative management policy. Includes discussing key available methodologies for the development of positive lists, discussing potentially important principles and scenarios for positive list design, and outlining a novel methodological option for developing positive lists. Proposes that the tool presented provides an objective method for developing positive lists for pet trading and keeping.	Compelling rationales, as well as an important scientific evidence-base, strongly indicate replacement of historically common negative list approaches with positive list systems to better regulate the sale and keeping of both wild pet and domesticated pet animals.
Eurogroup for Animals & Animal Advocacy and Protection (2023)	Discusses the establishment of an EU-wide positive list with which to regulate trade in animals as pets.	Positive lists show significant advantages over negative lists, being simpler and more effective, precautionary rather than reactive in nature, and future proof.

Options include through the use of an EU Directive or Regulation.

If via a Regulation then member states could maintain their own positive list laws because they may have stricter rules in place.

An independent legal opinion concluded that feasible objectives of an EU positive list include (1) protect animal welfare and public morals - many animal species have highly complex physiological and behavioural needs which are extremely difficult, if not impossible, to accommodate in a home environment. When kept in captivity as companion animals, they suffer from serious health and welfare problems and many die prematurely; (2) improve the conditions for the establishment and functioning of the internal market for companion animals. The patched existence of non-harmonised positive lists, negative lists and lack of regulation of tradable species at national level affects trading conditions within the EU and creates obstacles to cross-border trade of companion animals between member states.

An EU positive list would likely have a mechanism to add or remove species from the list – however, this alteration would occur infrequently and, on an EU-wide level.

Keepers of animals, would, under certain conditions, be able to trade and keep unlisted animals. A form of “grandfather clause” would be important to ensure those people already keeping species of animal not on the list, and who could prove that they had gained ownership (traded) the animal before the application of the EU positive list legislation, would not be prohibited from holding on to the animals until the end of their natural life.

A 2008 European Court of Justice (ECJ) and an independent legal opinion show that a positive list is a legally valid means to restrict the intra-EU trade and imports of wild animals kept as pets.

An EU positive list approach is likely to have significant added value in reducing invasive alien species pathways into Europe and may help to strengthen existing invasive alien species regulation by removing or significantly reducing the threat posed by the pet trade.

An EU positive list could enhance the effectiveness of digital safety regulations by making it more practical for Very Large Online Platforms (VLOPs) to fulfil the requirements (e.g., strengthen checks to ensure that seller information is reliable and accurate).

An EU positive list would narrow the number of animals legally traded as companion animals, which would enhance and facilitate the enforcement of legal provisions of the Animal Health law, Transport Regulation and Official Controls Regulation.

Non-CITES-listed animals are so varied in terms of species, and vast in number of individuals that identification and registration is simply impractical, where a reduced number of species traded under an EU positive list would be far more feasible to monitor.

A positive list of companion animals that are allowed to be traded and/or kept in the whole EU would be coherent with Article 114 of the Treaty on the Functioning of European Union (TFEU) specifically the functioning of the internal market.

Harmonisation and simplification of the rules on the legal trade in pets through an EU positive list would likely make monitoring of legal business owners and operators more manageable, and facilitate the systematic collection of data on the legal trade in different member states, through possible identification and registration of the animals allowed as companion animals.

A harmonised positive list would raise pan-EU public awareness, of benefit to law enforcement officials.

By prohibiting the trade of animal species as pets other than those on the list, the measure would determine uniformity of trade conditions, and therefore of conditions of cross-border trade, for companion animals in the EU, while aiming to improve animal welfare. In this context, the measure would contribute to protecting public health and safety, preventing the global decline of wild species and protecting native plants and animals in the EU against invasive alien species.

	The report also discusses potential methods for developing a positive list for the EU regarding the trade in animals as pets.	A negative list will always lag behind, while a positive list system is future proof, able to cope with varying trends in trade, or even a new species entering the pet market from other areas of the globe – it would be automatically prohibited in the EU. Numerous knowledge gaps demonstrate that the complexity of the current rules create difficulties in monitoring and regulating the trade that would be simplified through harmonisation. Finally, the pet trade inflicts severe negative impacts on the welfare of wild animals inappropriately kept as pets and raises serious public health and safety concerns. The Treaty on the Functioning of European Union (Article 114) requires EU institutions to provide for high-levels of human health and environmental protection. A positive list gives greater legal certainty as to which animals may be traded as well as being easier to update. Hybridization, including with domestic animals, is also a potential problem for animal welfare. Negative lists are less suitable because the instrument is reactive to this practice – there is a continuous need to add names of new hybrids.
Xiao *et al.* (2024)	Discusses the pros and cons of a black-listing and white-listing approach and the potential of using an approach that combines elements of both in China.	A white-list in China for species in commercial captive breeding and trade would simplify market supervision and law enforcement because species not in the white-list would be easily detected in markets. Similarly, shifting the burden the of proof that a species is listed [on a white-list] from law enforcement officers and market supervisors to wildlife traders/importers would simplify law enforcement tasks. Newly described species would be automatically protected by law. Xiao *et al.* conclude by arguing that elements of both white-listing and black-listing of species in China would be desirable. `

Table S2. Countries using or considering reverse listing to regulate wildlife trade.

Country	Details	Source
Belgium	Legal provision for a positive list of species and a positive list in place for animals as pets	(*4*)
China	Uses a combination of “black-“ and “white-listing” of species to regulate the trade in wildlife	Xiao *et al.* 2024
Cyprus	Legal provision for a positive list of species and a positive list in place for animals as pets	(*4*)
France	Legal provision for a positive list of species but in the process of formulating the list. Applies to animals traded as pets	(*4*)
Italy	Legal provision for a positive list of species and a positive list in place for animals as pets	(*4*)
Lithuania	Legal provision for a positive list of species but in the process of formulating the list. Applies to animals traded as pets	(*4*)
Luxembourg	Legal provision for a positive list of species and a positive list in place for animals as pets	(*4*)
Malta	Legal provision for a positive list of species and a positive list in place for animals as pets	(*4*)
Netherlands	Legal provision for a positive list of species but in the process of formulating the list. Applies to animals traded as pets	(*4*)
EU	The European Union (EU) is evaluating the reverse listing to manage the trade in pets	(*4*)
Slovenia	Legal provision for a positive list of species but in the process of formulating the list. Applies to animals traded as pets	(*4*)

Supplementary Material 2 – Evaluation

Amendments to CITES if the Parties were to adopt reverse listing.

If the Parties to CITES decided to formally adopt reverse listing within the Convention – rather than on an individual country basis only – this would necessitate revising the text of the Convention. The Convention text comprises 25 Articles prescribing how the treaty functions, including how trade is to be regulated (Articles III-V), measures to be taken by the Parties (Article VIII), and the functions of the Secretariat (Article XII). Article XVII includes provisions for amending the Convention. The Parties would need to call an extraordinary Conference of the Parties (CoP) meeting at which to discuss proposed amendments to the Convention. This would require one-third of the Parties (62/185) to call such a meeting. Proposed amendments for discussion would need to be submitted by one or more Parties and would require a two-thirds majority vote of Parties present and voting to be adopted. Amendments adopted would enter into force for Parties that have accepted them 60 days after two-thirds of the Parties (123/185) have accepted the amendments (Article XVII). Were amendments to the Convention text adopted to integrate a reverse listing approach in CITES, this would likely produce a “split-CITES” where some Parties have adopted reverse listing and others have not. This would result in markedly different laws among Parties likely complicating the legal status and trade of CITES-listed species.

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