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Legal or unenforceable? Violations of trade regulations and the case of the Philippine Sailfin Lizard *Hydrosaurus pustulatus* (Reptilia: Squamata: Agamidae)

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Abstract: The Philippine Sailfin Lizard (Agamidae: *Hydrosaurus pustulatus*) is a nationally protected Philippine endemic species. It is threatened by habitat destruction, pollution and overexploitation for the domestic pet trade, yet less is known about the international component of the trade. Here we investigate the international trade in *Hydrosaurus* spp. (*H. weberi*, *H. amboinensis*, and *H. pustulatus*) with an emphasis on *H. pustulatus*. We analysed international seizures combined with international online sales and trade data for the United States of America (USA). The export of *H. pustulatus* from the Philippines has been prohibited since 1991, except under special circumstances, yet they continue to be traded internationally, and we found evidence for trade in Asia, Europe, and North America. Most of these animals, however, were declared to be captive-bred. While imports to and exports from the US consisted mostly of other species of *Hydrosaurus*, *H. pustulatus* was by far the most coveted species online, with prices significantly higher for *H. pustulatus* than any of the other species. While not many seizures have occurred outside the Philippines, even wild-caught individuals were found to be 'legally' imported to the USA – in apparent violation of the Lacey Act. We recommend H. pustulatus to be listed in CITES Appendix III, in order for countries other than the USA to have a legal basis to seize wild-caught animals trafficked from the Philippines and to monitor trade in captive-bred specimens. Further, we suggest the use of automated cross-referencing between imported species and the national protection status of the species' native range states to ensure that legislation violations are detected at the point of import.

Keywords: CITES, conservation, Lacey Act, LEMIS, reptiles, wildlife trade.

Abbreviations: CITES—The Convention on International Trade in Endangered Species of Wild Fauna and Flora | DAO—Department of Environment and Natural Resources Administrative Order | DENR—Department of Environment and Natural Resources | LEMIS—Law Enforcement Management Information System | USA—United States of America | USD—US Dollars | Wildlife Act—Wildlife Resources Conservation and Protection Act of 2001 (Republic Act No. 9147).

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INTRODUCTION

Unsustainable wildlife trade, both illegal and legal, threatens an increasing number of species globally (Rosser & Mainka 2002; Marshall et al. 2020). To ensure that international trade in wildlife does not threaten their survival, the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) entered into force in 1975. Currently, more than 38,000 taxa that are threatened by international trade are listed in one of the three Appendices of CITES, which regulate the trade in these species to varying levels; however, many species that are traded internationally are not included in the CITES Appendices, often because international trade data and/or other assessments are lacking for these species (Purcell et al. 2014; Vincent et al. 2014; Janssen & Shepherd 2018; Janssen & Leupen 2019; Jensen et al. 2019). The pet trade in particular has increased substantially in recent years and reptiles are among the most heavily exploited taxa for this purpose (Herrel & van der Meijden 2014; Auliya et al. 2016; Jensen et al. 2019; Marshall et al. 2020). While not the largest in terms of volume, more species are traded for the international trade for pets than for any other purpose (Janssen: in press). Yet, as of November 2019, only ~954 reptile species are listed in the Appendices of CITES (https://cites.org/eng/disc/species.php) – approximately 8% of all currently recognised reptile species (Uetz et al. 2020).

Non-CITES species can usually be traded without international restrictions that would ensure the sustainability of the species' exploitation, and only few national legislations protect non-native, non-CITES species in trade (Vinke & Vinke 2015; Janssen & Leupen 2019; Jensen et al. 2019). This is especially relevant when it comes to nationally protected species that are found in international trade. Many of these, such as the Borneo Earless Monitor *Lanthanotus borneensis* prior to its Appendix II listing in 2017 (Janssen & Krishnasamy 2018), are illegally extracted from the wild in their range states and exported to international destinations, where a lack of or inadequate legislation impedes efforts to counter this trade (Altherr 2014; Auliya et al. 2016; Altherr & Lameter 2020). Once these animals have entered a consumer country, they often continue to be traded 'legally' (Vinke & Vinke 2015; Heinrich et al. 2021).

Hydrosaurus spp. represent the largest members of the Agamidae family and can grow over a meter in length (Denzer et al. 2020). These oviparous, omnivorous, semi-aquatic lizards are restricted to riparian vegetation in coastal regions of different islands in Indonesia, New Guinea, and the Philippines (Ledesma et al. 2009; Denzer et al. 2020). *Hydrosaurus* spp. are known to be threatened by habitat loss and pollution, local subsistence hunting, as well as overexploitation for the pet trade, for which the hatchlings and subadults are especially targeted (Ledesma et al. 2009; Siler et al. 2014; Department of Environment and Natural Resources 2020). One nationally protected species negatively affected by trade is the endemic Philippine Sailfin Lizard *Hydrosaurus pustulatus* (Image 1). While *H. pustulatus* is classified as 'Vulnerable' on the IUCN Red List of Threatened Species (Ledesma et al. 2009), the remaining *Hydrosaurus* species have not been assessed to date.

It has been suggested that there are two species occurring in the Philippines, *H. pustulatus* in the north and *H. amboinensis* in the south, but that their exact distribution is unclear due to identification issues (Ledesma et al. 2009); however, there is a general uncertainty regarding *Hydrosaurus* taxonomy and species distribution, with more recent studies suggesting that only *H. pustulatus* occurs in the Philippines (Siler et al. 2014; Denzer et al. 2020). Further, Siler et al. (2014) suggested that there are four species of *Hydrosaurus* based on genetical analyses, but noted that further research is required. Denzer et al. (2020) conclude that there are currently five species within the genus *Hydrosaurus*, mainly based on morphological features. Due to the unresolved nature of the genus taxonomy, there is a high likelihood of mislabelling during trade, deliberately or otherwise. Siler et al. (2014) also describe at least six genetically distinct clades of *H. pustulatus* restricted to different Philippine islands and note that the sailfin lizards found in the illegal domestic trade (at least in Manila) originate from a single clade of *H. pustulatus* sourced from the Bicol Faunal Region, particularly the island of Luzon.

The Philippines has strong wildlife legislation in place, which pertaining to terrestrial wildlife, mainly consists of the Wildlife Resources Conservation and Protection Act of 2001 (Republic Act No. 9147, hereafter also referred to as the 'Wildlife Act') and its implementing Rules and Regulations. Pursuant to Section 5 and 22 of the Wildlife Act, the preliminary 'List of Threatened Wildlife' was established in 2004 by the Department of Environment and Natural Resources (DENR) Administrative Order (DAO) No. 2004-15, which was last updated in 2019 by DAO No. 2019-09. Since 2004, *H. pustulatus* is classified as 'Other Threatened Species' and it is illegal to collect or trade the species (including exportation), except

Image 1. The Philippine Sailfin Lizard *Hydrosaurus pustulatus*.

under special circumstances (such as an exemption for captive-bred animals) which need to be accompanied by a permit issued by DENR. Before 2004, *H. pustulatus* was classified as a 'Rare' species from 1991 according to DAO 91-48, equally prohibiting its collection and trade (including export) unless permitted by DENR, as is the case today. Since 1991 there have only been three legal exports of *H. pustulatus* from the Philippines, all of which were captive-bred animals, and no facilities currently have a permit to export *H. pustulatus* for commercial purposes in the Philippines (DENR Biodiversity Management Bureau, in litt., April 2021).

The Philippine Sailfin Lizard is known to be exploited for the domestic trade (Sy 2018; Sy 2021), yet less is known about its availability on the international market. They have been observed in low quantities, e.g., in mainland China (Yunrui et al. 2020) and Taiwan (Shiau et al. 2006), and anecdotal evidence suggests that they were more common in the United States of America (USA) and Europe in the 1970s and 80s, until the Philippines restricted the species' export in 1991. Grey literature documenting the husbandry and captive breeding of this species dates back to the 1970s (e.g., Gonzales 1974) with scattered reports on husbandry and breeding results over time (Krasula 1988; Gábriš 2003; Wirth & Riedel 2011; Fischer 2020a,b). Yet, despite a history of being kept and bred in captivity, its large size and resulting husbandry requirements, in combination with export restrictions, have likely contributed to them not being widely available on the international market to date.

Due to the relatively small captive population and thus limited available offspring, *H. pustulatus* is potentially at risk of unsustainable harvesting if emergent demand exceeds the availability of animals. Moreover, the unresolved taxonomy presents an opportunity for laundering, as *H. pustulatus* may be labelled as other *Hydrosaurus* species that are similar in appearance yet have fewer trade regulations. Here we investigate and characterise the scale of the international trade in *H. pustulatus* and other *Hydrosaurus* species, with specific focus on illegal trade in wild-caught specimens and the conservation implications.

METHODS

Seizure data were requested from the Philippines Department of Environment and Natural Resources; however, no response was received. We thus collated seizure data on sailfin lizards (*Hydrosaurus* spp.) from open-source media reports, such as the Robin des Bois On the Trail bulletins (https://robindesbois.org; containing seizure incidents available from 2013–2020), ad hoc online searches, and grey literature (e.g., Sy 2021). For two incidents where no quantity was

recorded, we assumed the incidents had to involve at least one animal, noting that the true number of animals involved may have been higher.

Data for the USA from 2000–2018 were obtained from the Law Enforcement Management Information System (LEMIS) database through a Freedom of Information Request. LEMIS *Hydrosaurus* trade data consisted almost exclusively of live animals. As we were mostly interested in the pet trade, we excluded the 49 'scientific or museum specimens' from seven trade records, as well as the 525 mollusc or turtle shell products from one trade record (which we also assumed must have been misclassified by the Fish and Wildlife Service).

We collated online trade data from English language and Japanese websites. Japanese websites were chosen because of anecdotal reports, it being known as a popular destination for exotic pets (Vall-Llosera & Su 2018; Wakao et al. 2018; McMillan et al. 2020), as well as Japan being reported as a destination in the previously recorded seizure incidents. Following the framework of Stringham et al. (2020) we obtained human research ethics committee approval from the University of Adelaide (Australia) to use automated data mining and searched a total of eight international English language and eight Japanese websites, using the keywords 'sailfin' and '*Hydrosaurus*', as well as 'ホカケトカゲ' in October 2020. For ethical reasons we keep the identities of the websites anonymous (see also Stringham et al. 2020), however, they are international classifieds that receive a high frequency of daily trade. We manually checked each entry to confirm the animals in the listings were in fact referring to sailfin lizards of the genus *Hydrosaurus*, as 'sailfin' also led to results for other species (e.g., chameleons, geckos, Australian water dragons). During the data curation process we recorded characteristics from the listing text description, including but not limited to: i) the species (*H. pustulatus, H. amboinensis*, or *H. weberi*); ii) price; iii) source (captive-bred or wild-caught); and iv) life stage (juvenile, subadult, or adult).

If the species was not specifically mentioned in the listing text, we classified it as *Hydrosaurus* spp. Due to the uncertain and changing taxonomy of the genus *Hydrosaurus*, it is possible that the advertised *H. amboinensis* and *H. weberi* may be individuals that are now recognised as *H. celebensis* or *H. microlophus,* therefore we regard the observed *H. amboinensis* and *H. weberi* as sensu lato. The price per animal was recorded as described in the listing text and later transformed to 'price per animal' in American Dollars (USD). If the total price was given for all advertised animals in the listing, price was converted to price per individual. If the price was given in a currency other than USD, the price per animal was converted to USD in December 2020 (www.xe.com). We also recorded whether the animal for sale was a hybrid or morph (i.e., colour variety), all of which were later classified as '*Hydrosaurus* spp.' and assumed to be captive-bred, even if the source was not stated specifically in the listing text. 'CB' was assumed to mean captive-bred. 'Captive born' or 'Farm bred' animals were also classified as captive-bred. Animals were only classified as 'wild-caught' if this was specifically stated in the listing text. If not otherwise stated whether the animals were wild-caught or captive-bred, all other listings were classified as 'unknown' regarding the source of the animals. The life stage of the animals was recorded as reported in the listing text, being either 'juvenile', 'subadult', or 'adult'. 'Babies' were classified as juveniles. In n= 32 listings the size of the animals was reported in conjunction with the life stage and following the data distribution of these listings we later added the life stage according to the size of the animal, for instances where only the size, but not the life stage, was reported in the listing text (n= 34). For this we assumed that the total length of the animals was reported in all instances and if animals were below 45cm they were classified as juveniles, between 46 and 85 cm as subadults, and above 85cm as adults. The quantity of the animals per listings were recorded from the listing text description. If not stated otherwise, each listing was assumed to include at least one animal. If not stated otherwise and the listing text indicated that 'sailfins' (i.e., more than one animal) were involved, we assigned two animals to the listing, noting that the true number of available animals per listing may have been higher. If a 'clutch' of animals was advertised we assumed that seven animals would be involved (Meiri et al. 2020).

Median prices and data distribution were displayed using the 'ggplot2' package (Wickham 2016). Generalised linear models (GLMs) were used to test for effects of species, source and life stage on market price. Advertisements of people looking to buy animals were excluded from the price analysis. Candidate models were selected based on the lowest Akaike's Information Criterion ($\Delta AIC > 5$). New explanatory variables, including interactive effects, were added to models in a stepwise fashion if the inclusion of such variables sufficiently reduced the AIC. We conducted pairwise comparisons between variable levels with the 'emmeans' package (Lenth et al. 2020). Wald χ^2 tests for independence were used to test for differences in the quantity of traded animals per species recorded in the LEMIS data, as well as

between the quantity of advertised animals per species in online listings. We used contingency-type frequency tests to assess the independence of categorical variables, using the mosaic function of the '*vcd*' package (Meyer et al. 2017). All data were curated and analysed in the R software environment for statistical computing, version 4.0.1 (R Core Team 2020).

RESULTS

Seizure data

We found 15 seizure incidents involving at least 233 sailfin lizards since 2010 from four countries (Table 1). In five incidents, involving 120 animals, the species was confirmed as *H. pustulatus*. In another nine incidents, involving at least 109 animals, the seizures occurred in the Philippines and the species was very likely also *H. pustulatus*, although this was not specifically mentioned. Only three of the seizures occurred in countries outside the Philippines, namely Indonesia, India, and Hong Kong (Table 1). Reported destinations included Japan, Taiwan, and Sweden.

LEMIS data

From 2000 to 2018 there were 421 trade records involving 12,479 live sailfin lizards. The majority of these consisted of animals of the species *H. weberi* (Figure 1). During this timeframe, there were only four imports into the USA involving 117 live *H. pustulatus*, and 15 exports involving 70 *H. pustulatus*, which was thereby the least traded of the three recorded species (Figure 1).

Hydrosaurus weberi was more likely to be declared wild-caught and less likely to be captive-bred; whereas *H. amboinensis* and *H. pustulatus* were more likely to be captive-bred and, in the case of *H. amboinensis*, less likely to be wild-caught (n= 421, χ^2= 62.54, degrees of freedom df= 3, p <0.001; Figure 2). There were only seven shipments (one import, seven exports) involving a total of 123 wild-caught Philippine Sailfin Lizards. Only two of these shipments (involving five animals) originated in the Philippines, while the remaining five supposedly originated in Taiwan (one incident, 76 animals) and Indonesia (four incidents, 42 animals).

Online trade data

We recorded a total of 369 listings involving at least 811 animals of the genus *Hydrosaurus* on six of the eight English and two of the eight Japanese language websites. *Hydrosaurus pustulatus* was by far the most popular species online with 141 listings involving at least 418 animals. It was followed by unidentified *Hydrosaurus spp*. (106 listings/187 animals), *H. weberi* (75/138), and *H. amboinensis* (47/68). Of all listings, 281 (76%) were advertising sailfin lizards for sale, while the remaining 88 listings concerned people looking to

Table 1. International seizures of sailfin lizards from January 2010 – February 2021.

Seizure date	Species	Seizure location	Origin country	Transit country	Destination country	Quantity seized[1]
18.ii.2021	*Hydrosaurus* spp.	Philippines			Taiwan	15
05.vi.2020	*H. pustulatus*	Philippines	Philippines			18
04.vi.2020	*H. pustulatus*	Indonesia	Philippines			85
10.x.2019	*Hydrosaurus* spp.	India		Malaysia		4
iii.2018	*Hydrosaurus* spp.	Philippines			Japan	-
26.x.2017	*Hydrosaurus* spp.	Philippines			Sweden	10
28.i.2016	*H. pustulatus*	Philippines			Japan	8
05.vi.2014	*H. pustulatus*	Philippines				4
viii.2013	*Hydrosaurus* spp.	Philippines				-
08.ii.2012	*H. pustulatus*	Hong Kong	Philippines			5
16.vii.2011	*Hydrosaurus* spp.	Philippines				3
02.vii.2011	*Hydrosaurus* spp.	Philippines				4
22.vi.2011	*Hydrosaurus* spp.	Philippines				1
19.vi.2010	*Hydrosaurus* spp.	Philippines				37
15.iii.2010	*Hydrosaurus* spp.	Philippines				37

[1] Where the exact quantity was not provided, we assumed the incident involved at least one animal, noting that the true number of animals may have been higher.

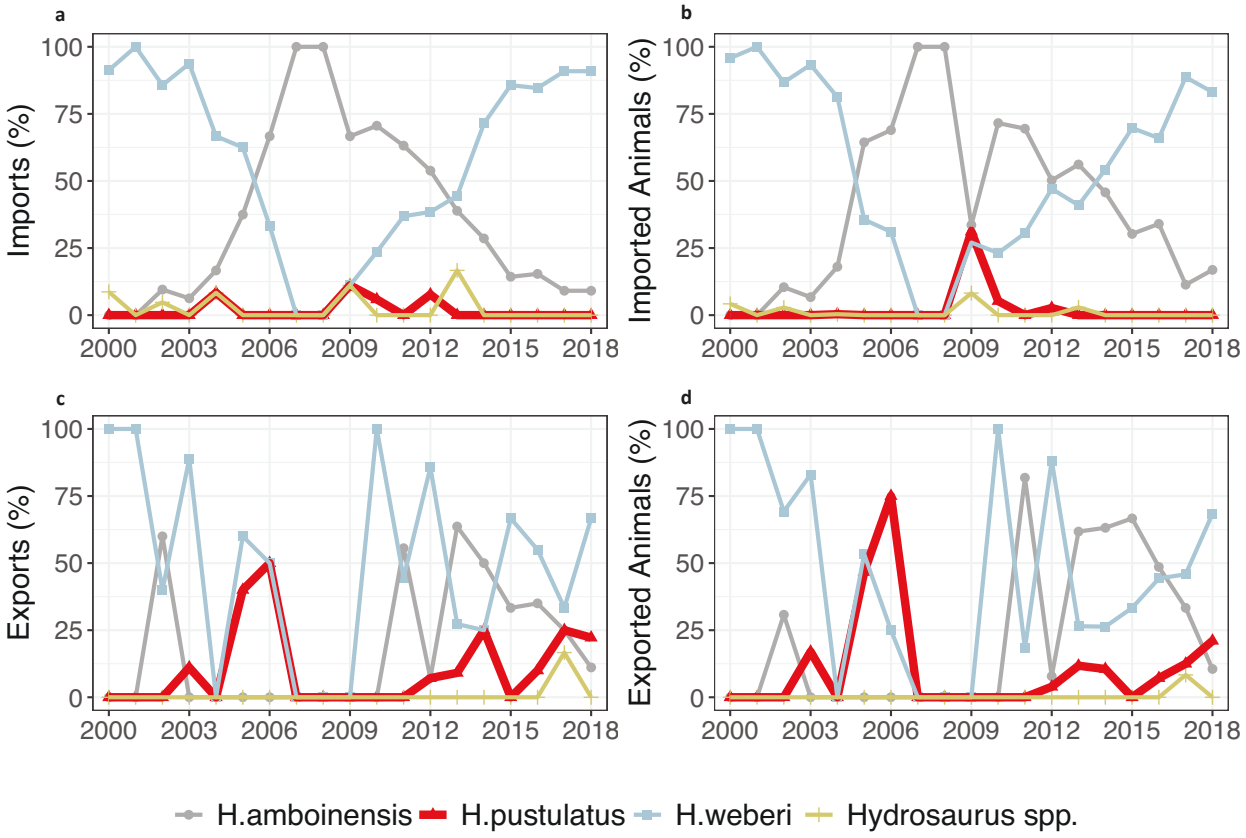

Figure 1. Imports to (a and b) and Exports from (c and d) the United States of America involving live sailfin lizards (*Hydrosaurus* spp.). Displayed are the proportions of trade records and traded animals for each species (if known).

buy sailfin lizards. Of the listings where people were searching for sailfin lizards, 49 (56%) were looking for *H. pustulatus* specifically. Most listings were recorded from people in the USA with 295 listings (80%), followed by listings from Japan (18 listings), the United Kingdom (UK; four), Portugal (three), Ukraine (two), Spain (one), and Canada (one). The country of the trader could not be identified in 45 listings.

Our selected candidate GLM included the effects of price, life stage and source, as well as interactions between levels of all three variables. The price per animal for *H. pustulatus* was significantly higher compared to *H. amboinensis* for captive juveniles (305.38 ± 106.1; p= 0.0209), yet lower for adults (-1169.37 ± 139.5; p <0.0001). *Hydrosaurus pustulatus* were significantly higher in price than *H. weberi* regardless of life stage (see Supplementary Data 1 for pairwise comparisons). The median price per animal for *H. pustulatus* (700 USD) was significantly higher compared to *H. amboinensis* (Estimate= -275.52, SE= 70.22, p < 0.001), *H. weberi* (Estimate= -527.85, SE= 61.59, p <0.001), or unidentified *Hydrosaurus spp*. (Estimate= -347.48, SE= 57.5, p <0.001; Figure 3). Overall, prices were lowest for *H. weberi* (median= 140 USD), but *H. amboinensis* (median= 183 USD) had a few notable outliers, including the maximum price of any recorded listing of 2,500 USD for a single captive-bred adult animal (Figure 3). Adult *H. pustulatus* were significantly less valuable than juveniles (-708.18 ± 266; p= 0.0458) if they were wild-caught and were significantly more valuable than juveniles (309.24 ± 107.3; p= 0.0205) and sub-adults (459.4 ± 124.2; p= 0.0012) if they were captive-bred (Figure 4).

Hydrosaurus weberi and *H. amboinensis* were more likely to be of wild-caught origin in online trade, and, in the case of *H. amboinensis*, less likely to be captive-bred (n= 369, χ^2= 45.1, df= 6, p <0.001; Figure 5). The opposite was true for *H. pustulatus* in trade, which were more likely to be captive-bred, and less likely to be of either wild or unknown origin (Figure 5).

Of all listings, 13% noted difficulties in keeping sailfins and reported either physical injuries of the animals, such as nose rubbing, missing or damaged tails and digits, or behavioural problems, such as skittishness, aggressiveness and/or fear towards the owner or

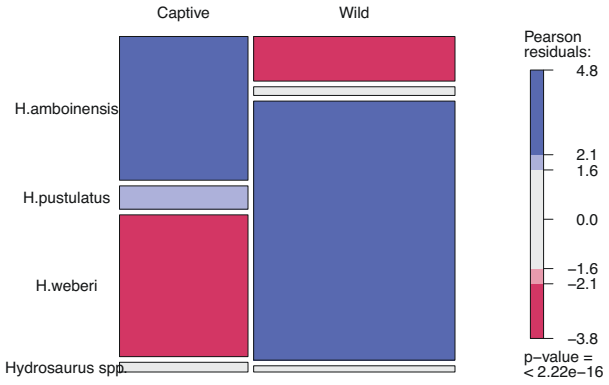

Figure 2. Mosaic plot of the deviation in conditional independence between source (wild or captive) and species, based on the number of shipments of live imported and exported sailfin lizards reported in LEMIS data from 2000 – 2018. The size of each cell is proportional to the observed cell frequency for each trait. Following Zeileis et al. (2007), the residual-based shading reflects the cell contribution to the χ2 statistic: Higher Pearson residuals indicate the observed frequency is significantly greater than expected under independence.

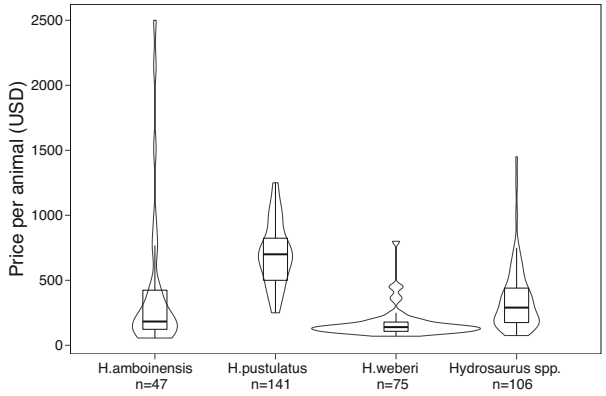

Figure 3. Median price per animal per species of sailfin lizards (*Hydrosaurus* spp.) recorded in online advertisements on two Japanese and six English language websites. Shown is the data distribution as well as the median price and interquartile range.

conspecifics, head bumping and/or deliberate running into cage walls (noting that most advertisements did not include detailed descriptions of the animals or reasons for selling). Private owners also reported an inability to provide enough space, time, and/or appropriate conditions for the animals as a reason for selling the sailfins, while breeders often remarked on the special requirements that sailfins need. For the 13% of listings that did mention difficulties in keeping sailfins, most of these were in regard to unidentified *Hydrosaurus* spp. (23 listings / 22% of all unidentified *Hydrosaurus* spp. listings), and relatively equally distributed between *H. pustulatus* (14 listings/10% of all *H. pustulatus* listings), *H. weberi* (8/11%), and *H. amboinensis* (4/9%). The proportion involving wild-caught animals (23% of all listings involving wild-caught animals were noted having difficulties in keeping the animals), however, was greater than for captive-bred animals (11%) or animals of unknown origin (14%).

DISCUSSION

Our results demonstrate that sailfin lizards of the genus *Hydrosaurus* are coveted pets on the international market, and *H. pustulatus* in particular appears to be the most popular of the *Hydrosaurus* species, as shown with the online trade data. It is possible, however, that idiosyncrasies exist between *Hydrosaurus* trade dynamics of online versus 'brick and mortar' pet shops (e.g., Siriwat & Nijman 2020). The USA featured most prominently in the international sailfin trade, and while this could be due to our sampling method of collating online trade data predominantly from English language websites, European countries were comparatively less represented despite English-language websites being commonly used to trade reptiles. Seizure data revealed, however, that Sweden was one of the intended destinations for a shipment of live *H. pustulatus*. Japan, a known destination country for a variety of exotic pet species (Vall-Llosera & Su 2018; Wakao et al. 2018; McMillan et al. 2020), was another destination in seizure incidents, as well as Taiwan. Given that seizure data is subject to biases due to imperfect detection (Symes et al. 2018), illegal trade is likely occurring at greater rates and across a greater diversity of European and Asian countries than is currently recorded. In terms of the online advertisements, it should be noted that more data may have been acquired using search terms from a greater diversity of languages (see also Stringham et al. 2020).

LEMIS data revealed that the majority of imports to and exports from the USA consisted of animals of the species *H. weberi* and *H. amboinensis* in the last ~20 years (noting that due to the uncertain taxonomy, species misidentifications are a genuine possibility and individuals that were recorded as these species are also likely to include the currently recognised species *H. microlophus* and *H. celebensis* (Denzer et al. 2020)). In the same timeframe, only four imports involving 117 live animals and 15 exports involving 70 live animals of *H. pustulatus* were recorded. Yet, *H. pustulatus* is the most traded species in online marketplaces, 80% of which were recorded on the American market, indicating that either the traded animals are bred in captivity in

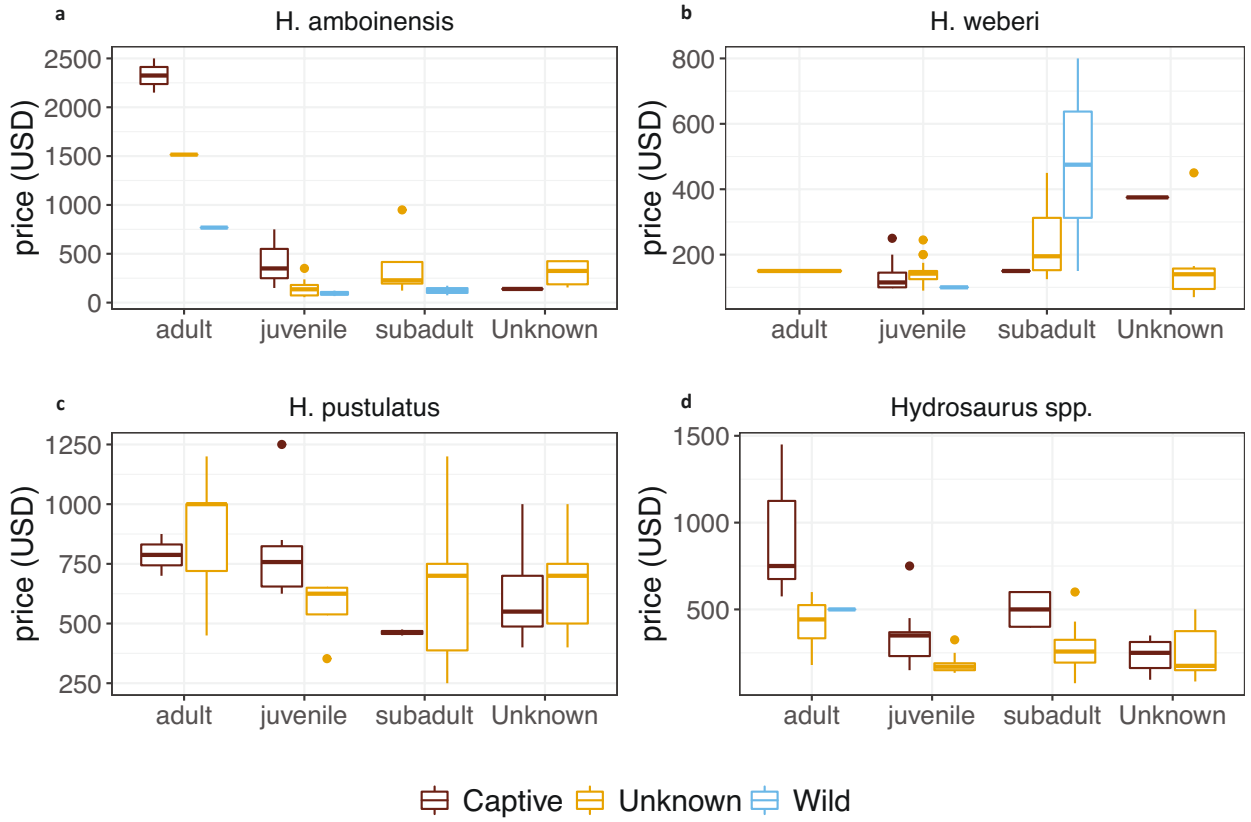

Figure 4. Median price per animal per species of sailfin lizard (*Hydrosaurus* spp., *H. amboinensis*, *H. pustulatus*, *H. weberi*), their life stage (adult, juvenile, subadult, unknown) and source (captive, unknown, wild) recorded in online advertisements on two Japanese and six English language websites. Note the different y-scales in each plot.

the USA predominantly from stock imported prior to 1991, captive-bred elsewhere and imported to the USA predominantly after 2018, or that there continues to be an influx of illegal *H. pustulatus* into the USA. If *H. pustulatus* trade is being supplied, or partly supplied, by the illegal trade, wild-caught individuals are likely to be falsely declared as captive-bred. Alternatively, individuals bred in other nations may be imported without declaration, however this is less likely, as there are no national or international regulations that prevent legal captive-bred importations.

No online advertisements detected in our study mention *H. pustulatus* to be of wild-caught origin and *H. pustulatus* is significantly more likely to be captive-bred, even compared to unknown origins. Whether this is due to people being aware of the illegality of their (wild-caught) pets, and fraudulently declaring them as captive-bred, or because export restrictions from the Philippines resulted in a captive population primarily consisting of captive-bred animals, is unclear. We recognise that there are genuine captive breeding efforts from specialised enthusiasts, however, grown *H. pustulatus* are large

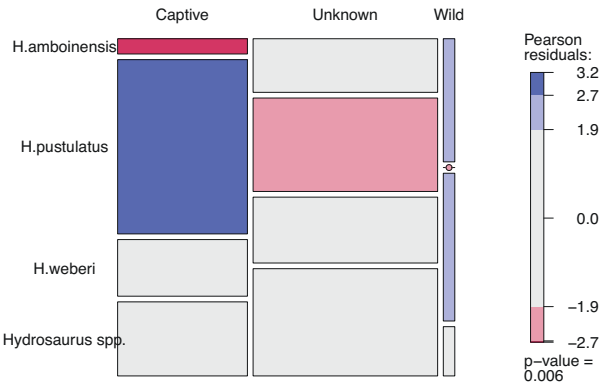

Figure 5. Mosaic plot of the deviation in conditional independence between source (wild, unknown, or captive) and species of sailfin lizard (*Hydrosaurus* spp., *H. amboinensis*, *H. pustulatus*, *H. weberi*) listed in online advertisements on eight international websites. The size of each cell is proportional to the observed cell frequency for each trait. Following Zeileis et al. (2007), the residual-based shading reflects the cell contribution to the χ2 statistic. Higher Pearson residuals indicate the observed frequency is significantly greater than expected under independence.

animals and can provide challenges to keep and breed in captivity when considering husbandry requirements. Further, with continuing demand and the comparatively high prices that can be obtained for *H. pustulatus*, the possibility remains that wild-caught animals are illegally imported to the USA and elsewhere. As confirmed by the Philippine's Biodiversity Management Bureau, there have only been three legal exports of captive-bred animals since 1991, and at the moment, no facilities in the Philippines have a permit to export *H. pustulatus* for commercial purposes.

It is clear that *H. pustulatus* is being traded internationally, and given the high prices that can be attained with these animals and the associated high commercial incentive to obtain and trade this species, this would suggest that illegal trade is likely to occur. There do not appear, however, to be many seizures of *H. pustulatus*, which could be due to the fact that internationally, very few countries have a legal framework to intercept nationally protected animals that were illegally sourced from their origin country (Altherr 2014; Vinke & Vinke 2015). Therefore, in the case of *H. pustulatus*, a lack of international seizures does not necessarily mean that there is no illegal trade, but rather that there is no legal basis to confiscate the species once it has been smuggled out of its origin country (see also Vinke & Vinke 2015). This is often the case for nationally protected species that are illegal to be exported, and exceptions usually involve CITES-listed species, countries with legislation similar to the Lacey Act in the USA, or additional protections such as the regulation of certain non-CITES species in the European Union (Council Regulation (EC) No 338/97). *Hydrosaurus pustulatus* is threatened domestically and largely unprotected internationally; therefore, to address these issues, we recommend that *H. pustulatus* be listed in CITES Appendix III by the Government of the Philippines.

The genus *Hydrosaurus* was once proposed to be listed in CITES Appendix I at the first Conference of the Parties in 1976 (Proposal 470); however, the proposal was rejected and no *Hydrosaurus* species was ever listed in any of the CITES Appendices. *Hydrosaurus pustulatus* is a nationally protected threatened species that is evidently found in international trade, thereby fulfilling the most important criteria for a CITES Appendix III listing (Res. Conf. 9.25 (Rev. CoP18)). A listing of this species in Appendix III may therefore assist in protecting wild populations in the Philippines. For the right candidate species, an Appendix III listing can have multiple benefits, including an ability to monitor legal international trade (which in the case of *H. pustulatus* should essentially only occur in captive-bred animals if they are traded commercially) and a legal basis internationally to confiscate illegal specimens that are detected in trade. Moreover, Appendix III listings have the potential to curtail trade without rapidly increasing the perceived value of a traded species, as is known to occasionally happen with Appendix I listings (e.g., Janssen & Krishnasamy 2018).

The merits of a species- versus genus-level listing should be considered carefully. Due to the unresolved taxonomy and similar looking species with lower levels of protection, there is strong potential that a species-level Appendix III listing may stimulate laundering via deliberate mislabelling. A genus-level Appendix III listing would reduce the likelihood of laundering, yet the impacts on trade of potentially less threatened sailfin species should be weighed against the need to protect *H. pustulatus*. Given the changing taxonomy of the genus, the newly recognised *Hydrosaurus* species may need to be re-assessed in terms of their conservation status, as they may be more threatened than previously assumed.

Beyond CITES, individual nations benefit from legislation that prevents the import of non-native wildlife if they were illegally exported or harvested in their native range states. A well-known example of this is the Lacey Act; under the Lacey Act, the import, export, sale, acquisition, or purchase of wildlife taken, possessed, transported, or sold in violation of any USA or foreign law is prohibited. Our study, however, shows 123 wild-caught *H. pustulatus* that were approved for import or export at some point into the USA despite being in violation of the Lacey Act. Only two of these shipments (one in 2013 and one in 2017 involving a total of five animals) originated in the Philippines, while the remaining five shipments supposedly originated in Taiwan (one incident, 76 animals in 2009) and Indonesia (four incidents, 42 animals between 2003 and 2006). All shipments except the one from Taiwan were exports from the USA, however, it remains uncertain how they were supposed to be legally imported to the USA beforehand. The only possibility is that these animals were imported prior to the export restrictions from the Philippines in 1991, however, this seems unlikely. Further, the Philippine Sailfin Lizard does not occur in Indonesia nor Taiwan and all of these shipments should have been seized; however, the only shipment of live *Hydrosaurus* spp. that was ever refused in the USA concerned a single shipment of two *H. amboinensis* that originated in Indonesia and were about to be exported to Canada. It is noteworthy that both Indonesia and Taiwan were also found to be involved in illegal trade

of *H. pustulatus*, as evidenced with the international seizure data.

The approved importation of illegally acquired wildlife, even in countries that do have a legal framework to prevent such incidents, is not restricted to Philippine Sailfin Lizards. Other studies have found similar inconsistencies and violations of the Lacey Act (Altherr 2014; Auliya et al. 2016; Janssen & Leupen 2019; Janssen & Gomez 2021). Clearly, further measures need to be taken to ensure that this valuable legislation is used effectively. We therefore propose the establishment of a database where law enforcement officials and other interested parties can check whether a non-CITES species is protected in its origin country/countries, and whether wild-caught individuals are allowed to be exported. This database could be automatically cross referenced against shipment information, including species, location of import and captive/wild status, in order to rapidly detect violations of the Lacey Act or other relevant legislation elsewhere. While resources are inevitably required to establish such a database, the long-term benefits to enforcement efficacy are likely to be substantial. In the first instance, this database could include only nationally protected, endemic, non-CITES species, and subject to funding and resources, could be expanded to include other nationally protected native non-CITES species at a later stage, as well as further information on life history traits, and the ability to breed the species in captivity. Such a database could also be of value for the pet-keeping community to help in the decision process of whether to purchase an animal. Overall, these recommendations have the potential to curtail the trade in wild-caught *H. pustulatus*, as well as other threatened nationally protected species with international trade demand.

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Supplementary Data 1. Pairwise comparisons of the GLM output of the market price for all combinations of sailfin lizard species (*H. amboinensis*, *H. pustulatus*, *H. weberi*, *Hydrosaurus* spp.), source (captive-bred, wild-caught, unknown), and life stage (juvenile, subadult, adult, unknown).

Species = *H. amboinensis*, Source = Captive				
Contrast	**Estimate**	**SE**	**Z ratio**	**P value**
adult - juvenile	1783.99	132.9	13.428	<.0001
adult - subadult	1702.06	176.1	9.665	<.0001
adult - Unknown	1843.17	148.9	12.377	<.0001
juvenile - subadult	-81.93	135.8	-0.603	0.931
juvenile - Unknown	59.18	108.5	0.546	0.9477
subadult - Unknown	141.11	148.2	0.952	0.7765
Species = *H. pustulatus*, Source = Captive				
Contrast	**Estimate**	**SE**	**Z ratio**	**P value**
adult - juvenile	309.24	107.3	2.883	0.0205
adult - subadult	459.4	124.2	3.698	0.0012
adult - Unknown	455.25	107.1	4.25	0.0001
juvenile - subadult	150.16	105	1.43	0.4804
juvenile - Unknown	146.01	79.3	1.841	0.2542
subadult - Unknown	-4.15	105.4	-0.039	1
Species = *H. weberi*, Source = Captive				
Contrast	**Estimate**	**SE**	**Z ratio**	**P value**
adult - juvenile	223.56	213.6	1.047	0.7219
adult - subadult	169.9	226.7	0.75	0.8769
adult - Unknown	298.17	220.2	1.354	0.5285
juvenile - subadult	-53.67	110.5	-0.486	0.9623
juvenile - Unknown	74.61	100.2	0.745	0.8789
subadult - Unknown	128.27	129	0.994	0.7527
Species = *Hydrosaurus* spp., Source = Captive				
Contrast	**Estimate**	**SE**	**Z ratio**	**P value**
adult - juvenile	518.8	77.4	6.706	<.0001
adult - subadult	444.56	99.8	4.453	<.0001
adult - Unknown	599.18	85.9	6.979	<.0001
juvenile - subadult	-74.24	87.7	-0.847	0.832
juvenile - Unknown	80.37	71.8	1.12	0.6772
subadult - Unknown	154.62	95	1.627	0.3631
Species = *H. amboinensis*, Source = Unknown				
Contrast	**Estimate**	**SE**	**Z ratio**	**P value**
adult - juvenile	1587.73	137.6	11.54	<.0001
adult - subadult	1417.57	159.7	8.875	<.0001
adult - Unknown	1485.9	147.1	10.103	<.0001
juvenile - subadult	-170.16	100.7	-1.69	0.3287
juvenile - Unknown	-101.83	87.6	-1.162	0.6507
subadult - Unknown	68.33	113	0.605	0.9307
Species = *H. pustulatus*, Source = Unknown				
Contrast	**Estimate**	**SE**	**Z ratio**	**P value**
adult - juvenile	112.99	90.9	1.243	0.5996
adult - subadult	174.92	79.9	2.189	0.1261
adult - Unknown	97.98	88.2	1.11	0.6832
juvenile - subadult	61.93	89.2	0.694	0.8993
juvenile - Unknown	-15.01	89.7	-0.167	0.9983
subadult - Unknown	-76.94	86.7	-0.888	0.8113

Species = *H. weberi*, Source = Unknown				
Contrast	**Estimate**	**SE**	**Z ratio**	**P value**
adult - juvenile	27.31	189.9	0.144	0.9989
adult - subadult	-114.59	197.6	-0.58	0.9381
adult - Unknown	-59.1	196.5	-0.301	0.9906
juvenile - subadult	-141.89	78.3	-1.812	0.2675
juvenile - Unknown	-86.4	76.9	-1.123	0.6751
subadult - Unknown	55.49	95.2	0.583	0.9372
Species = *Hydrosaurus* spp., Source = Unknown				
Contrast	**Estimate**	**SE**	**Z ratio**	**P value**
adult - juvenile	322.55	92.5	3.487	0.0027
adult - subadult	160.08	98.6	1.624	0.3648
adult - Unknown	241.91	89.5	2.703	0.0347
juvenile - subadult	-162.47	78.6	-2.067	0.1639
juvenile - Unknown	-80.64	67.3	-1.198	0.6281
subadult - Unknown	81.84	74.2	1.103	0.6878
Species = *H. amboinensis*, Source = Wild				
Contrast	**Estimate**	**SE**	**Z ratio**	**P value**
adult - juvenile	766.57	218.9	3.502	0.0026
adult - subadult	550.43	218.9	2.514	0.0577
adult - Unknown	NA	NA	NA	NA
juvenile - subadult	-216.13	143.9	-1.502	0.436
juvenile - Unknown	NA	NA	NA	NA
subadult - Unknown	NA	NA	NA	NA
Species = *H. pustulatus*, Source = Wild				
Contrast	**Estimate**	**SE**	**Z ratio**	**P value**
adult - juvenile	-708.18	266	-2.663	0.0388
adult - subadult	-692.22	272.6	-2.539	0.0541
adult - Unknown	NA	NA	NA	NA
juvenile - subadult	15.96	169.7	0.094	0.9997
juvenile - Unknown	NA	NA	NA	NA
subadult - Unknown	NA	NA	NA	NA
Species = *H. weberi*, Source = Wild				
Contrast	**Estimate**	**SE**	**Z ratio**	**P value**
adult - juvenile	-793.86	318.2	-2.494	0.0607
adult - subadult	-981.73	325.2	-3.019	0.0135
adult - Unknown	NA	NA	NA	NA
juvenile - subadult	-187.87	143.9	-1.306	0.5591
juvenile - Unknown	NA	NA	NA	NA
subadult - Unknown	NA	NA	NA	NA
Species = *Hydrosaurus* spp., Source = Wild				
Contrast	**Estimate**	**SE**	**Z ratio**	**P value**
adult - juvenile	-498.62	260	-1.918	0.2205
adult - subadult	-707.06	271.7	-2.602	0.0458
adult - Unknown	NA	NA	NA	NA
juvenile - subadult	-208.44	164.1	-1.27	0.5818
juvenile - Unknown	NA	NA	NA	NA
subadult - Unknown	NA	NA	NA	NA

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