

Using customs data to understand overlooked trade in non-CITES birds between Africa and Asia

Abstract

The international trade in live birds poses risks to animals, people, and biodiversity. To effectively mitigate these risks, decision-makers require information on the volume, dynamics, and direction of trade. Despite Africa once being the largest exporter of birds, very little data exist on recent trade in live birds not listed on the appendices of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Here, we use UN Comtrade data to explore trade in non-CITES birds from African countries to key Asian hubs for wildlife trade, Hong Kong and Singapore, between 2006-2020. We supplemented these data with species-specific data obtained from the Hong Kong government in the period 2015-2020 to further understand the species taxonomic composition of recent imports. Over a million non-CITES birds were imported to Hong Kong and Singapore between 2006-2020. Africa accounted for an increasing proportion of these imports and from 2010 was the source of 80.2% of imports. West African countries and particularly Mali have played an increasingly important role in recent years. Import data from the Hong Kong government indicates that canaries (*Crithagra* spp.) dominated these imports, including species that have been heavily traded for decades and are experiencing declines in the wild. We identify opportunities to improve the usefulness of Comtrade data for monitoring international wildlife trade, particularly involving species otherwise difficult to monitor, and for improving trade policy.

23 **Introduction**

24 The legal international trade of live animals for exotic pets is vast and varied, involving millions
25 of animals annually (Harfoot et al., 2018). Therein, birds are one of the most frequently traded
26 and diverse taxonomic groups (Bush et al., 2014). At least a third of the world's bird species
27 (33.9%) are known to be involved in the pet trade worldwide (Butchart, 2008), and a greater
28 proportion of traded birds are sourced from the wild compared with other taxa such as
29 mammals or reptiles (Bush et al., 2014). Although this trade (including legal, illegal, captive-
30 bred, and wild-sourced) can be a source of income and cultural activity in many countries, it
31 also poses multiple risks to biodiversity, animal and human health, and animal welfare.

32 Overexploitation in trade is one of the biggest threats to bird conservation (Birdlife
33 International, 2022), causing the decline of wild populations of heavily traded species in Africa
34 (Khelifa et al., 2017; Martin, 2018a), Southeast Asia (Harris et al., 2017) and South America
35 (Alves et al., 2013). High mortality rates mean that more birds must be supplied to meet the
36 same demand (Leader-Williams & Tibanyenda, 1996). Biodiversity in importing countries is
37 threatened by species introduced via trade (Lockwood et al., 2019) and human, livestock, and
38 wildlife health are at risk from zoonotic diseases transmitted by birds, including highly
39 pathogenic Avian Influenza (H5N1) (Karesh et al., 2007), Newcastle's disease (Karesh et al.,
40 2007), Psittaciform Beak and Feather Disease (Fogell et al., 2018). Achieving and maintaining
41 sustainable and safe trade is challenging in the absence of adequate monitoring of trade and its
42 impacts on wild populations; clear policies and processes; and resources for regulation (Gilardi,
43 2006). It is therefore essential to have a robust understanding of the volume, composition, and
44 dynamics of recent trade in order to develop appropriate policy responses and interventions to
45 mitigate risks.

46 The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
47 is the principle multilateral framework through which international trade in wildlife is
48 regulated. Parties to the Convention are required to monitor trade in species listed under the

49 appendices of CITES and these data are publicly accessible. However, the majority of traded
50 species are not listed on the appendices (hereafter referred to as “non-CITES species”). Among
51 birds, only 5.9% of species (n=647) are listed on the appendices and the percentage varies
52 between groups (1.4% of Passeriformes, 99% of Psittaciformes). Bird trade outside of the CITES
53 regulatory framework has hereto been investigated and evaluated using market and social
54 media surveys (e.g., Harris et al. 2015; Chiok & Chng, 2021; Davies et al, 2022). However, these
55 methods may underestimate the volume of international trade leading to a situation where
56 species’ conservation listings and trade regulations do not accurately reflect the situation on the
57 ground (Janssen & Shepherd, 2018).

58 Historically, African countries have played a major role in the international bird trade, with
59 Guinea, Mali and Senegal collectively accounting for 70% of all bird exports reported to CITES
60 between 1995 and 2005 (Reino et al., 2017) and Tanzania reporting exports of over 500,000
61 birds from CITES species from 1983 to 1990 (Leader-Williams & Tibanyenda, 1996). In 2005
62 the EU, which had been the leading importer of birds from Africa, ended legal imports of wild
63 birds which majorly reduced the overall volume of global trade in these species (Reino et al.,
64 2017). In 2007, 116 African bird species, which made up much of the trade prior to 2005, were
65 removed from CITES Appendix III (Notification to the Parties. No. 2007/007) and, as a result,
66 these species have not been consistently monitored by CITES Parties since. CITES Parties
67 recently initiated a process to examine trade in Passeriformes due to concerns about the
68 volumes of trade and noted that the songbird trade from Africa is currently the most poorly
69 understood (CoP18 Doc. 79).

70 The United Nations International Trade Statistics Database (UN Comtrade) aggregates data on
71 commodities traded between UN member parties and has been used to examine trade in
72 wildlife including seafood and live animals for the pet trade (Gephart & Pace et al., 2018;
73 Andersson et al. 2021). The system captures trade in all species, including those outside of the
74 CITES regulatory framework, providing an opportunity to gather data on volumes and

75 directions of trade for non-CITES species including birds. The database and collection protocol
76 are designed for taxation purposes and therefore have several limitations for understanding
77 important information relevant to the management of wildlife trade for other purposes (Chan et
78 al., 2015; Andersson et al., 2021). These include most data being reported at higher taxonomic
79 levels (i.e., order or higher) in most cases and no indication of source (e.g., captive-bred or wild).
80 However, combined with ancillary information, including internal government data and
81 knowledge of avicultural and bird trapping practices in exporting countries, further inferences
82 of trade patterns can be made.

83 The Hong Kong Special Administrative Region of the People's Republic of China (hereafter
84 referred to as Hong Kong) and Singapore serve as major nodes in international wildlife trade
85 networks for a number of historical, geographical, and logistical reasons. Trade links established
86 during the colonial era enabled these cities to function as entry points to Asia (specifically China,
87 in the case of Hong Kong) and to play a central role in international trade for wildlife and
88 wildlife products (Webster, 1975; Eaton et al., 2017, ADMCF, 2018; Andersson et al., 2021). Both
89 currently act as significant trade points in the international live bird trade (Poole & Shepherd,
90 2017; Inglis et al., 2022) and both were in the top ten importing countries (excluding European
91 countries) between 1995-2011 (Reino et al., 2017); Singapore was the third largest importer
92 after European countries and the US in 1988 (Leader-Williams & Tibanyenda, 1996). Singapore
93 has active bird-keeping and bird-singing traditions (Nash, 1993; Eaton et al., 2017), while Hong
94 Kong has historically imported large volumes of bird for religious or 'mercy' release (Chan,
95 2006).

96 Here we use the UN Comtrade Database to describe the volume, dynamics, and direction of
97 trade in overlooked avian species from Africa to key trade centres in Southeast Asia between
98 2006-2020. We supplement these data with more granular species-specific import data on
99 species from African countries to Hong Kong acquired from the Hong Kong Agriculture,
100 Fisheries and Conservation Department (AFCD) to identify which species are predominant in

101 trade and consider the implications for initiatives to mitigate trade-related harms. We further
102 compare data availability between exporting and importing countries to explore the challenges
103 and opportunities of using UN Comtrade data for understanding trade in non-CITES species.

104 **1. Materials and Methods**

105 1.1. Comtrade Data Collection and Filtering

106 Annually, UN member parties report commodity trade to the World Customs Organization,
107 using 5,300 globally agreed six-digit Harmonised System (HS) codes to classify different
108 commodities in trade. These data are aggregated in the UN Comtrade database which is publicly
109 available online at UN Comtrade (Comtrade.un.org). We downloaded 427 trade entries (total
110 reported imports from a given trade partnership in a given year) from the UN Comtrade
111 database using the HS Code 10639 (live birds excluding birds of prey, Psittaciformes, ostriches,
112 emus and live poultry) for the period 2002-2020, specifying the trade flow as 'Import' and the
113 reporter as either 'China, Hong Kong SAR' or 'Singapore'.

114 We excluded 38 entries where the partner was 'World', representing the aggregated imports of
115 all trade partners in that year, to avoid replication. In the remaining 389 entries, quantity data
116 was listed in 96.1% of entries (n = 374), trade value in 100% and net weight in 43.7% (n = 170).
117 We used quantity, listed as 'number of individuals' which we interpreted to indicate the number
118 of individual birds, as our primary metric. It was a more direct measure of trade volume than
119 trade value, given the diversity of species and associated value in the bird trade, and has more
120 conservation relevance. Inconsistencies in reporting due to varying interpretations of "quantity"
121 may exist, such as reporting the number of shipment boxes or permits issued. Furthermore, it is
122 unclear whether quantity includes animals that have died in transit. Therefore, our estimates
123 may underestimate the true volume of exported African birds. We removed entries with no
124 quantity unit or value (n = 15).

125 Reviewing the data revealed a large volume of imports into Hong Kong from China, with 14 796
126 692 birds imported from 2002-2017 with a reported trade value of US\$ 28 755 518. This
127 accounted for 85.7% of the overall quantity in 16 entries. High imports from China to Hong
128 Kong have been recorded historically (Melville, 1982), with an estimated minimum of 1 000 000
129 birds imported from China in 1979, including 'food' birds that may not be classified as poultry
130 (e.g., doves, pheasants, francolins). The volume of this trade obscured patterns of trade from
131 other countries so we excluded entries with the partner 'China' (n = 16). Finally, we identified
132 anomalously high imports in 2003 (n = 816 879) and 2004 (325 360), largely involving imports
133 into Singapore from Indonesia and Malaysia. These large values were mainly attributed to 36
134 entries where quantity had been estimated in the Comtrade data processing and validation
135 process (Flag = 6). This estimation is based on the provided trade value and the Standard Unit
136 Value by product category (CEPII, 2010), which is unlikely to accurately reflect the actual value
137 and quantity of birds in trade. The limited confidence of this data prevented us from being able
138 to confidently compare trade before and after the EU trade ban in 2005 and as such, we chose to
139 only analyse data from 2006-2020, with a final total of 268 entries. To compare reporting by
140 importing and exporting countries, we identified the African countries that were trade partners
141 with Singapore or Hong Kong based on import data. For these countries, we downloaded
142 Comtrade data from 2006-2020, specifying the HS commodity code as 10639 (Live Birds,
143 excluding birds of prey, Psittaciformes, ostriches and emus), the trade flow as 'Export' and the
144 partner as either 'China, Hong Kong SAR' or 'Singapore'.

145 We used HS Code '10639' as a best approximation of trade in non-CITES species. The HS code
146 10639 subsumes over 9000 bird species, of which only 60 (0.6%) represent CITES species
147 native to African countries, such as turacos and cranes. CITES data indicates that only nine of
148 these 60 species (not removed in 2007) were imported to Hong Kong and Singapore from
149 African countries in the period 2006-2020, totalling 1194 individual birds (Reino, 2017;
150 supplementary data). We considered this in the interpretation of our results. We also assumed
151 that the vast majority of bird in our sample were wild-sourced. Comtrade codes do not

152 distinguish between farmed and wild organisms and so it is not possible to determine source
153 with certainty. However, besides South Africa, most African countries do not have well-
154 developed avicultural industries capable of producing large quantities of birds, which would
155 likely be uneconomical given access to wild birds and have a long history of exporting wild birds
156 (CITES Trade Database, 2022).

157 1.2. Species-specific data collection

158 To gain insight into the composition of species, we examined import data provided by the
159 Agriculture, Fisheries and Conservation Department (AFCD) of the Government of Hong Kong
160 for the years 2015-2020, specifying imports of African bird species, excluding parrots and birds
161 of prey. This data included the total number of individuals of each species imported in each year
162 and the exporting countries, though the number of individuals was not disaggregated by
163 country. In two years, African species were imported from Malaysia. This data has been
164 included because there is a strong chance that these shipments are re-exports from African
165 countries; Malaysia is a major exporter of live birds (Nijman, 2010) and has no large breeding
166 facilities to the authors' knowledge. Species quantities are presented as a range between the
167 quantity from only African countries and the quantity from all countries including Malaysia
168 where relevant. Singapore collects similar species-specific data regarding non-CITES species
169 based on permits issued. We contacted Singapore customs requesting this data but were not
170 successful in obtaining it.

171 1.3. Conservation Implications

172 To explore the conservation and population status of traded species and the potential risks of
173 trade, we downloaded data on the International Union for Conservation of Nature (IUCN) Red
174 List of Threatened Species and estimated population trend from BirdLife Datazone
175 (<http://datazone.birdlife.org/species/search>) and used the Songbirds in Trade Database
176 (SiTDB) (Juergens et al., 2021), which summarises data from market and social media surveys;

177 peer-reviewed and avicultural literature; and published and unpublished expert notes, to
178 identify species that are traded in quantities which could plausibly affect ‘the sustainability of
179 the species or particular populations’. This category of ‘plausible’ is assigned in the SiTDB when
180 estimated domestic and international trade is high or extreme relative to population size.

181 **2. Results**

182 2.1. Comtrade Import Data

183 Between 2006 and 2020, Hong Kong and Singapore reported that 1,085,326 individual birds
184 were imported from all trade partners. Overall trade fluctuated over this period but declined to
185 its lowest levels in 2018 (n = 30,430) and 2020 (n = 33,030). Singapore was the largest
186 importer, importing 831,765 individual birds, accounting for 76.6% of reported birds 2006-
187 2020 (Table 1).

188 Africa was the largest source of birds imported into both Hong Kong and Singapore, accounting
189 for 65.3% of the total reported quantity (n = 708,861). The prominence of Africa as a source
190 increased over the period and from 2010 onwards Africa accounted for 80.2% of imports
191 (Figure 1). Singapore imported 492 507 birds from 11 named African countries, primarily from
192 Mali, Guinea and the United Republic of Tanzania which accounted for 71.1% of African bird
193 imports to Singapore, with an additional 22 750 bird imported from unnamed African countries
194 (4.4%) (Figure 2). Hong Kong imported 193 604 birds from eight named African countries,
195 primarily Mali and Mozambique which accounted for 74% of African bird imports to Hong Kong
196 (Figure 2). Based on import data, Singapore was a larger trade partner than Hong Kong for all
197 African trade partners.

198 The biggest exporters of wild birds were Mali, Guinea, Mozambique, and the United Republic of
199 Tanzania, together accounting for 86.3% of imports from African countries (n = 611 785)
200 (Appendix S1). Mali was the largest trade partner over the entire study period, accounting for
201 28.2% of all imports from African countries. Mali did not report any exports prior to 2012 and

202 accounted for 45.9% of all imports after 2011. The profile of major exporters changed over time,
203 with Tanzania and Guinea being the most prominent exporters prior to 2010, while Mali and
204 Mozambique became more prominent after 2011 (Figure 2).

205 2.2. Comparisons of importer-reported and exporter-reported data

206 There was a difference in the availability of trade entries from importing (n = 79) and exporting
207 countries (n = 32) (Appendix S1). For the two biggest trading partners, Mali and Guinea, no
208 export data were available. Records with quantity were found for twelve entries, six from
209 Mozambique and six from South Africa, which reported total exports of 31 784 individual birds
210 between 2006 and 2020. This represents a fraction of the 170 772 birds reported imported by
211 Singapore and Hong Kong from Mozambique and South Africa.

212 2.3. Hong Kong species-specific import data

213 In the period 2015-2020, Hong Kong AFCD data indicated that between 132,905-147,908 birds
214 representing 34 African species were imported from five African countries (Mali, Mozambique,
215 Senegal, Tanzania and Guinea) and Malaysia, all of which were songbirds (Passeriformes)
216 (Appendix S2). There were 26 species imported only from African countries; two species
217 (*Estrilda astrild* and *Vidua camerunensis*) imported only from Malaysia; and six species imported
218 from both African countries and Malaysia. Two species dominated imports from 2015-2020:
219 Yellow-fronted canary (*Crithagra mozambica*; 66,583-66,883 individuals) and the white-
220 rumped seedeater (*C. leuopygia*; 45,990-57,590 individuals) that together accounted for 84% of
221 recorded imports from Africa in the period 2015-2020. More broadly, the top six species all
222 came from the genus *Crithagra* (canaries) and accounted for 95.1% of all birds imported from
223 Africa in this period. All species were categorised as Least Concern by the IUCN Red List but
224 wild populations are considered to be declining in four species (*Crithagra mozambica*, *Crithagra*
225 *citrinipectus*, *Cinnyricinclus leucogaster*, *Anthobaphes violacea*) and unknown in one species
226 (*Lamprotornis iris*). The Songbirds in Trade Database estimates that trade is a plausible threat to
227 wild populations of six species imported to Hong Kong (Appendix S2).

228 3. Discussion

229 Although African countries have long been major exporters of live birds, little is currently
230 known about bird trade in non-CITES species from this region. Our analysis of legal trade in
231 birds reported in the UN Comtrade database indicates that Africa has been the primary source
232 of non-CITES live birds to key global trade hubs in Asia since 2010, suggesting that Africa
233 remains an important source of wild birds international trade. The volume of trade and existing
234 literature on some of the species involved raises concerns about the sustainability of trade, the
235 overexploitation of wild populations and biosecurity risks to people and animals. Imports
236 primarily came from a small number of countries in West and East Africa, but the countries
237 involved shifted during the study period and also differed from the period prior to 2006
238 indicating dynamic trade patterns potentially responding to changes in availability, demand,
239 transport infrastructure and regulation.

240 3.1. Trade Volume and Dynamics

241 The volume and associated risks of trade in non-CITES species can often be overlooked in
242 analysis and discussion of international wildlife trade (Janssen & Shepherd, 2018) impeding the
243 effective management of trade in wildlife. A comparison of Comtrade data with concurrent
244 CITES data suggests that analyses of international live bird trade based on CITES data alone (e.g.
245 Reino *et al.*, 2017) may severely underestimate the true volume. Comtrade data indicates
246 Singapore and Hong Kong imported over one million birds (excluding parrots, birds of prey,
247 ostriches and emus) in a 15-year period (2006-2020) from countries globally, of which CITES
248 data suggests less than 1% (n = 1,194) may have been from CITES species. This volume, is more
249 than three times greater than estimated imports of CITES species to Singapore in a concurrent
250 ten-year period (2005-2014) from countries globally, based on CITES importer-reported data
251 (n=225,561) (Poole & Shepherd, 2017). Even this is likely an underestimate of the true volume
252 of trade due to limitations in reporting of Comtrade data (see 2.1).

253 The high volume of imported birds reflects a broader trend of Asia acting as a major source of
254 demand in the exotic live bird trade (Bush et al., 2014; Chan et al, 2021). For example, imports
255 of CITES-listed bird species into Bangladesh and Pakistan have increased dramatically in the last
256 decade (Poonia et al., 2022) and permits issued for non-CITES birds to be imported into
257 Bangladesh indicate high import volumes of a diverse array of exotic species, with permits
258 issued for 167 186 birds from 269 species between October 2020 and September 2021 (World
259 Parrot Trust 2022). Growth in demand for live birds in Asia could have a significant impact on
260 wild bird populations and could increase the risk of disease transmission and poor welfare
261 without corresponding growth in management and enforcement capacity. A complete
262 understanding of shifting patterns of trade post-2006 would require data on bird imports
263 beyond CITES species from all importing countries from sources including customs and
264 environment government departments.

265 Comtrade data indicate a drop in imports in 2020 that may reflect the impact of the Covid 19
266 pandemic and increased restrictions on international travel (Wildlife Justice Commission,
267 2021). However, the data also suggest that imports had already been low since 2018. Possible
268 explanations include export restrictions, with Tanzania implementing a national ban on wildlife
269 exports in 2016; import restrictions, with Singapore prohibiting imports of ornamental birds
270 from countries with recent Avian Influenza outbreaks (Animal and Veterinary Services, 2021);
271 or declines in wild populations in areas of heavy trapping. It is uncertain whether the decline
272 will persist or whether trade might rebound. For example, the status of the national export ban
273 in Tanzania is currently in question, as it was declared that the ban would be lifted only for this
274 announcement to be reversed a day later (Pole, 2022). The significance of this decline should
275 also be treated cautiously, given the short and recent duration and high variability in the data.

276 3.2. Species Composition

277 Bird imports into Hong Kong, based on AFCDD data, were dominated by songbirds
278 (*Passeriformes*), particularly the yellow-fronted canary (*Crithagra mozambica*) and the white-

279 rumped seedeater (*C. leucopygia*). This is largely consistent with historical data on the African
280 bird trade (Ruelle & Bruggers, 1983; Leader-Williams & Tibanyenda, 1996), historical CITES
281 data (Reino et al., 2017; supplementary data) and online monitoring (Davies et al., 2022). While
282 many imported species are considered Least Concern on the IUCN Red List of Threatened
283 species, there is little recent available field data on population distribution or observed
284 population change in source countries on which to determine the sustainability of trade. Among
285 the most commonly imported species, two species (*Crithagra mozambica* and *Crithagra*
286 *citrinipectus*) are in decline as a direct result of trapping for trade and for two species
287 (*Crithagra mozambica* and *Crithagra atrogularis*), trade is identified as a 'plausible' threat in the
288 SiTDB (Juergens et al., 2021), with the most popular species, the yellow-fronted canary, fitting
289 both categories. There are numerous examples of once common and widespread songbird
290 species experiencing severe population declines and range retraction as a result of
291 overexploitation, suggesting the conservation community should not be complacent about this
292 trade (e.g., Khelifa et al., 2017; Leupen et al., 2020). Current data on the population status of
293 popular African songbirds as well as other bird groups, particularly from major exporting
294 countries, is urgently needed to assess the sustainability and impacts of this ongoing trade.

295 In addition, it is possible that some species were misdeclared either accidentally or intentionally
296 in order to covertly import other non-CITES or CITES species (e.g. Martin et al., 2019).
297 Consequently, some popular species may be overrepresented, while others may be
298 underrepresented or absent. This has been observed in import data for other countries such as
299 Bangladesh where there has been a sharp rise in the volume of legal bird imports (Poonia *et al.*
300 2022, World Parrot Trust 2022). Inspections are made challenging by the arrival of large
301 shipments and lack of capacity (Inglis et al., 2022). Without adequate customs inspections, legal
302 trade can provide cover for illegal and unregulated trade in threatened species.

303 3.3. Importers and Exporters

304 Prior to 2006, Mali and Guinea were leading exporters of African birds and along with Senegal,
305 exported more birds from CITES species than any other countries (Reino et al., 2017). Our
306 analysis of the Comtrade data indicates that these countries continue to be prominent exporters
307 of birds. As the largest source of birds from Africa, the role of Mali in the bird trade particularly
308 warrants investigation. It is unclear whether the rise in prominence in the last decade is due to
309 policy decisions, reporting error or other unknown factors. Mali has been implicated in the
310 possible misuse of export permits to export threatened parrots not found in the country
311 (Martin, 2018b; CITES, 2019) and has acted as a transit destination for exports of CITES-listed
312 parrots from South Africa (CITES Trade Database, 2022). It is unclear whether similar trade
313 relationships and permitting issues also exist in non-CITES species. Surprisingly, Senegal was a
314 comparatively smaller export partner to both importers despite being one of the largest
315 historical exporters (Ruelle & Bruggers, 1983; Leader-Williams & Tibanyenda, 1996) although it
316 is associated with the import of *C. leucopygius* and *C. mozambicus* in AFCD data. It is possible
317 that exports from Senegal may have been overlooked by our study if they have established trade
318 partnerships with countries other than Singapore and Hong Kong. Recent surveys of birds
319 offered for sale on social media surveys suggests a diverse range of bird species are still
320 exported from Senegal (Davies et al., 2022). There is no recent data on the current state of bird
321 trapping for international trade in Mali, Guinea, or Senegal, making it difficult to determine
322 whether the industries remain diminished following the removal of their primary markets in
323 the EU or whether they are recovering with connections to new trading partners. East African
324 countries, Tanzania and Mozambique were both prominent trade partners. This was surprising
325 as recent literature has emphasised the role of West African countries in the African live bird
326 trade (Reino et al., 2017; Davies et al., 2022). Little literature has considered the recent role of
327 East African countries, despite Tanzania being one of the biggest exporters of birds in 1988
328 (Leader-Williams & Tibanyenda, 1996) and the scale and scope of this trade demands further
329 investigation.

330 Both Hong Kong and Singapore act as major wildlife trade gateways. Singapore re-exports
331 wildlife products to many countries including Taiwan, Japan and the Netherlands (Shepherd et
332 al., 2012; Su et al., 2014) and based on a paucity of data on exports or re-exports, corroborated
333 by observations by local researchers and the intended destination of seized shipments wildlife
334 appears to be illegally exported from Hong Kong destined for China (ADMCF, 2018; Inglis et al.,
335 2022). The absence of non-CITES listed African birds in Singapore markets (Eaton et al, 2017;
336 Chiok & Chng, 2021) and Hong Kong markets in contrast to Taiwan bird markets (Su et al.,
337 2014) suggests that either there is very large-scale misdeclaration of species identity or that the
338 majority of birds imported are not remaining in domestic markets but being re-exported. As
339 major trade transit points for large numbers of wild birds, it is vital that both Hong Kong and
340 Singapore implement adequate disease screening policies. Multiple strains of Avian Influenza
341 have been identified numerous sub-Saharan countries, including in species trapped for
342 international live bird trade (Kalonda et al., 2020). Singapore's restrictions on imports of birds
343 from countries experiencing outbreaks of Avian Influenza (Animal and Veterinary Services,
344 2021) may help prevent the spread of H5N1 and other pathogens and provide a model for other
345 countries. Broadening restrictions on imports of live birds to include other exporting countries
346 unable to demonstrate adequate surveillance for pathogens of human and animal health
347 concern and robust quarantine procedures would also be prudent for mitigating biosecurity
348 risks.

349 3.4. Opportunities and Challenges of UN Comtrade Data

350 Customs and import data offer an alternative source of data that can contextualise and highlight
351 limitations in other research methods such as social media and market surveys. The strong live-
352 bird trade connection between African countries and Hong Kong and Singapore was not
353 apparent based on CITES data and social media studies (Reino et al., 2017; Davies et al., 2022),
354 likely due to the way data in those studies was collected. Social media studies may only capture

355 certain country connections depending on the individuals sampled and certain platforms may
356 be used preferentially by different countries.

357 Furthermore, some market surveys have presumed that species including the yellow-fronted
358 canary are entirely captive-bred (Eaton et al., 2017; Chiok & Chng, 2021), which data on the
359 source country of imports bring into question. It appears unlikely that Tanzania and
360 Mozambique are producing large volumes of this species in captivity given the lack of
361 avicultural capacity in country, likely price differentials between production in captivity and
362 capture from the wild, and regulatory structures which allow for the capture and export of these
363 species. Given the above and the overlap in trade between captive-bred and wild-sourced birds,
364 the proportion of wild-sourced canaries in trade may be underestimated by market surveys.

365 Comtrade data has major limitations, most notably the lack of species specificity. This study
366 demonstrates how these limitations can be partially mitigated with the support of
367 supplementary data. Data from the Hong Kong AFCD offer insights into the diversity and
368 prominence of non-CITES listed species in trade. This data may not always be available and
369 equivalent data was not accessible from Singapore. Furthermore, misdeclaration either by
370 accident or intentionally in order to traffic other species may mean that some species are
371 disproportionately represented or omitted. However, cross-referencing data against other
372 relevant sources such as the CITES trade database, market surveys and social media data can
373 establish greater confidence and highlight discrepancies. Changes could be made to increase the
374 taxonomic specificity of standard Comtrade data by distilling existing HS codes and establishing
375 genus-specific codes, particularly for broad categories including rare species such as 'other
376 birds' (Chan et al., 2015; Andersson et al., 2021), as has been done with HS code 030191 ('Other
377 live fish').

378 Another major limitation of the Comtrade data is a lack of reporting consistency between
379 importing and exporting countries. A comparison of available Comtrade data from Hong Kong
380 and Singapore with exporting African countries revealed a wide disparity in the number of

381 entries and reported volume for all partners. This means that the volume of trade cannot be
382 verified with the exporter and there is no available data on the relative size of Hong Kong and
383 Singapore as trading partners for African countries. This information is particularly important
384 for understanding the broader picture of trade in non-CITES listed species and for evaluating
385 the impact of recent versus historical trade. The complete absence of data from the two largest
386 exporters, Mali and Guinea, is particularly concerning. Similar discrepancies have been
387 observed in other areas of wildlife trade, including sea cucumbers and fish maws (Constant et
388 al., 2020; Louw & Búrgener, 2020). The reasons for omission are unclear, although explanations
389 include ineffective reporting, low customs capacity, or incorrect use of HS codes either
390 accidentally or intentionally to avoid taxes and tariffs. More information is needed to
391 understand the key limiting factors contributing to underreporting and resources should be
392 invested into building reporting capacity if Comtrade data is to be used to accurately investigate
393 international wildlife trade (Constant et al., 2020; Louw & Búrgener, 2020).

394 **4. Conclusion**

395 Our study provides insights into trade in wild non-CITES birds between Africa and two key
396 Asian trade hubs over a 15-year period following major regulatory changes that removed major
397 markets. Despite the inherent limitations of Comtrade customs data, we have demonstrated
398 how considering patterns of legal live bird trade in the context of other data can provide
399 important insights into global wildlife trade hubs, revealing significant volumes of trade in
400 overlooked species between unexpected trade partners. We urge decision-makers in relevant
401 countries to develop effective evidence-based policies for the trade in live wild-sourced birds
402 and interventions to mitigate risks linked to this practice. Exporting and importing countries
403 should urgently implement robust monitoring programmes of wild populations of exploited
404 species and consider carefully whether the economic benefits of this trade and the challenges
405 and burdens of ensuring regulatory compliance outweigh the risks.

406

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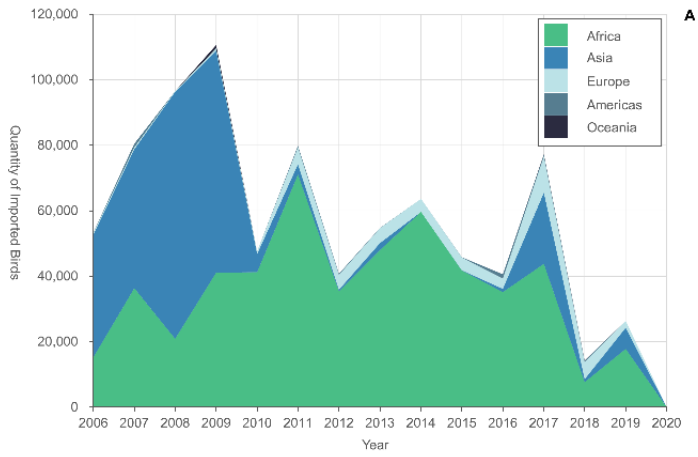
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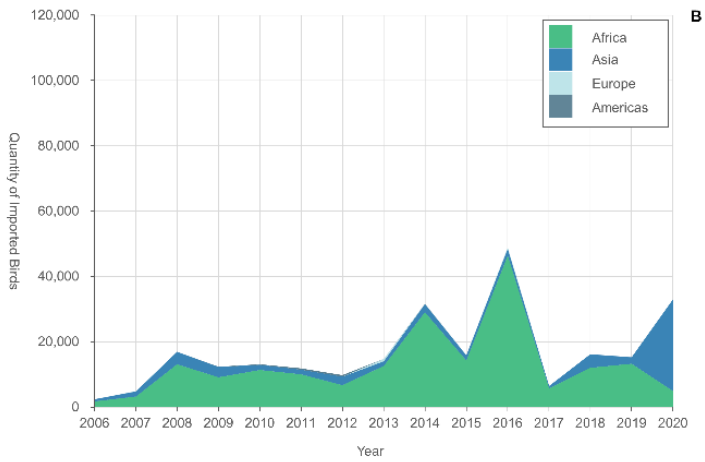
544 **Table 1.** The total number of import records and quantity of birds imported to Hong Kong and
 545 Singapore by world region in the period 2006-2020 (from HS Codes).

Reporting Country	No. Entries	Quantity					Total
		Africa	Asia	Europe	Americas	Oceania	
Hong Kong	80	193,604	57,380	1,358	1,219	-	253,561
Singapore	188	515,257	264,303	46,543	4,406	1,256	831,765
Total	268	708,861	321,683	47,901	5,625	1,256	1,085,326

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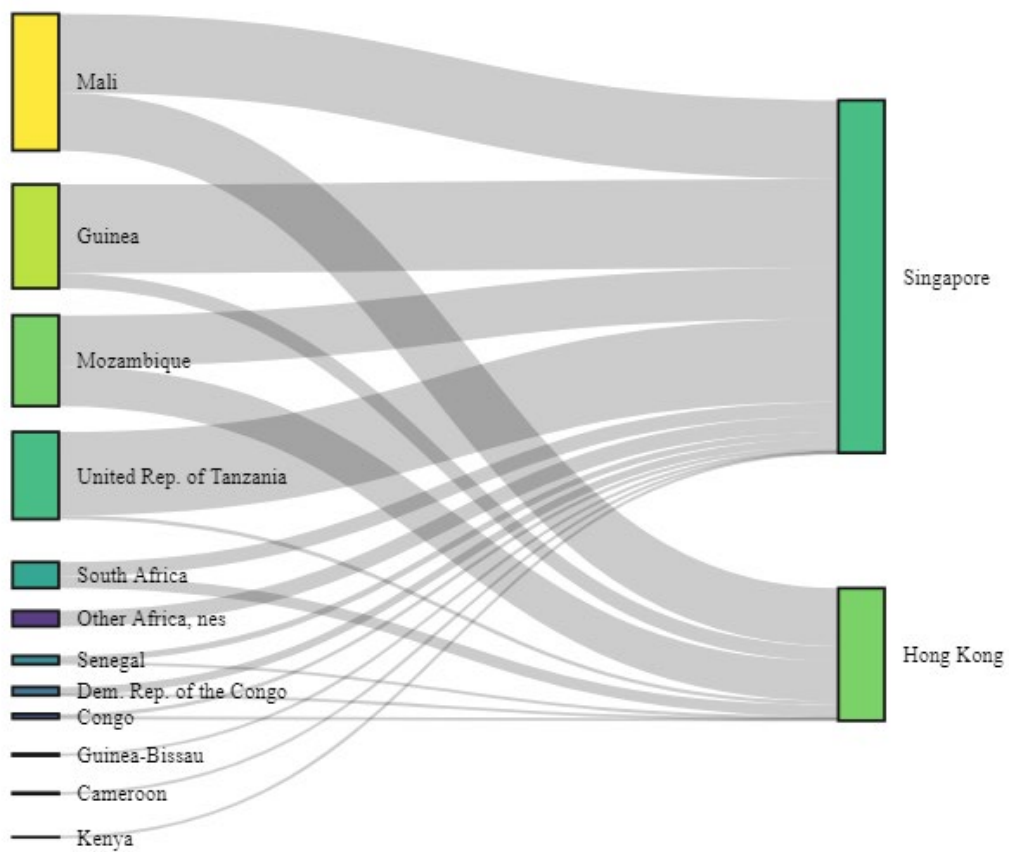


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549 **Figure 1.** Quantity of birds imported into (A) Singapore and (B) Hong Kong between 2006-2020
 550 by world region.

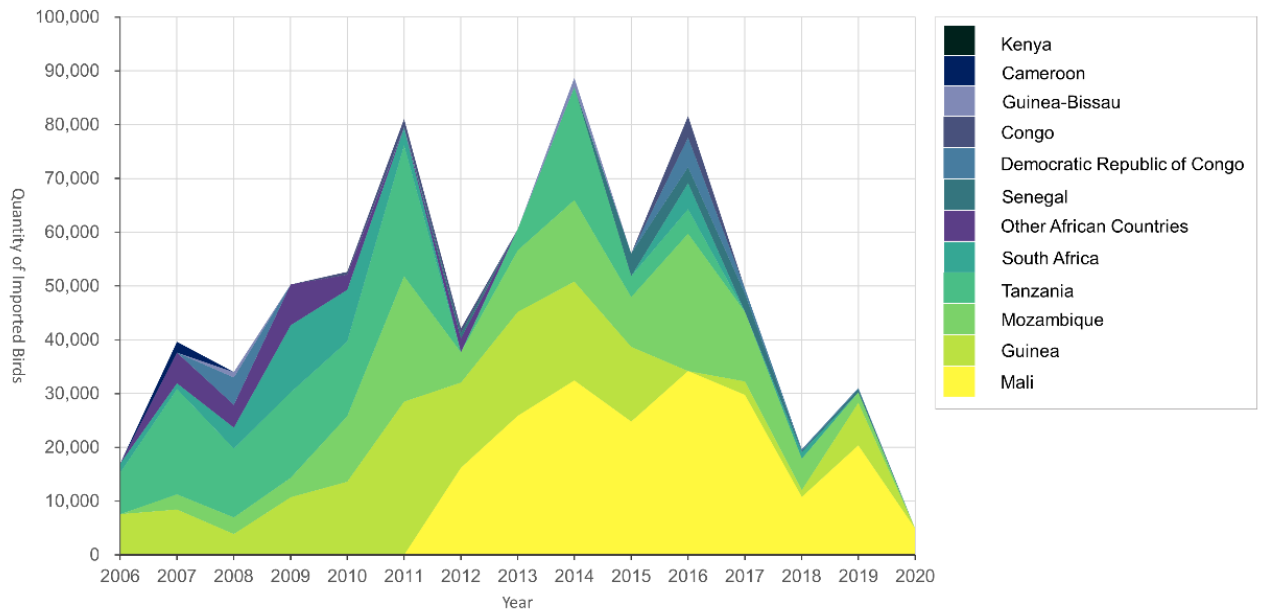


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552 **Figure 2.** Trade flows from African exporting countries to Singapore and Hong Kong between
 553 2006-2020 based on import records. The height of the bars indicates the quantity of birds
 554 reported as imported.

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556



557

558 **Figure 3.** Quantity of birds imported into Hong Kong and Singapore from African countries
559 2006-2020. Layers ordered by total quantity with the countries with the greatest total import
560 quantity at the bottom.