Closing the border on Australia's domestic elephant ivory trade

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Damien Huffer led data collection and manuscript writing

Freyja Watters contributed to writing, editing, and led statistical analysis and data vizualisation.

Thomas Swearingen contributed to method development and the building of a project specific webscraper for Invaluable.com

Kellie Toole contributed to article writing and editing and advised on legal aspects.

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ABSTRACT

Australia's domestic market for elephant (Elephantidae ssp.) ivory remains active online, despite long-standing international controls and pledges to close domestic trade. We conducted snapshot monitoring of surface-web vendors (online auction houses and webstores with 'buy-it-now' payment options) and a survey of Facebook Marketplace posts made between January and June 2025, sampled every two weeks. We recorded 1,698 ivory listings from 70 Australia-based surface-web vendors with AUD $653,101 in auction sales, AUD $573,997 in webstore asking prices, and unsold auction lots carrying dealer estimates between AUD $127,400 and $189,765. Indications of compliance with international law were sparse (one stated an ivory policy; four mentioned the Convention on International Trade in Endangered Species of Wild Fauna and Flora). Listing-level transparency was low, <1% listings provided documentation; 26% stated provenance, 9% provenience, and 62% an approximate age. Most listings were auctions (1,303 out of 1,698; 77%) and sell-through was high: 87% of auction lots sold. Sold versus passed lots did not differ significantly in provenance, provenience, or age disclosure. The market was dominated by small carved objects, *netsuke* (23.5%) and figurine/carvings (21.4%), with jewellery (12.1%), miniatures/relief art (10.0%) and tableware/utensils (7.5%) following. Price-calibration analyses (sold auctions) showed realised prices averaged c. 11.7% below dealers' estimate midpoints. A total of 92 listings were recovered from Facebook Marketplace during five sampling sessions between March and May 2025. Collectively, a sizable, unregulated online market exists, moving a wide variety of primarily worked ivory items, including categories of item considered (and marketed) as cultural heritage for specific cultures, and items of potential historic significance. This points to an immediate need for mandatory documentation at point of listing and harmonised state-level regulation; although a

comprehensive market closure would be highly preferred, and in-line with many other international jurisdictions.¶

Keywords: Australia; CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora); domestic wildlife trade; elephant ivory; e-commerce; social media.

INTRODUCTION ¶

Ivory (from Elephantidae spp.; hereafter "ivory") remains a highly demanded wildlife product. It accounts for approximately 15% of the observed global illicit wildlife trade, and sustains both large-scale trafficking and persistent antique and cultural-heritage curio markets (UNODC, 2024). Illicit wildlife trade is often framed as poaching and trade, driven by profit and facilitated by poverty (e.g., Evangelista et al., 2025; Geldenhuys, 2025; Stiles et al., 2016; Wyatt, 2022). However, demand is also shaped by sanctioned and unsanctioned cultural uses, and decorative-art markets that may contribute to contemporary threats to biodiversity (Chardonnet et al., 2002; Williams et al., 2025).

Ivory in these markets spans a wide range of unworked (e.g., partial/whole tusks) and worked forms (e.g., carvings such as figurines and Japanese *netsuke*, jewellery, decorative inlay, miniature portraits painted on ivory, and other decorative and utilitarian items). This diversity makes it difficult to distinguish lawful antiques from recently poached or misrepresented material because listings, particularly in online markets, often rely on seller descriptions and photos. Documentation is inconsistently provided and difficult to verify. Ivory may be deliberately disguised or mislabelled as other materials, and even post-seizure assessments are constrained by limited expertise in ageing and forensic dating (Indraswari et al., 2020; Kufnerová et al., 2025; Quarta et al., 2019; Venturini & Roberts, 2020). Very few systematic reviews of online ivory markets exist, even for established platforms such as eBay (Hernandez-Castro & Roberts, 2015; Waller, 2023; Yeo et al., 2017), yet public and industry awareness of the ramifications of the continued ivory trade is growing (Kovesi & Johnson, 2020).

The international trade in ivory is regulated under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Commercial international trade between CITES Parties (184 nations, including Australia, and the European Union (EU)) in

ivory is widely prohibited. *Elephas maximus* (Asian elephant) has been listed in Appendix I since 1975, and *Loxodonta spp.* (African elephants) were uplisted from Appendix II (listed in 1976) to Appendix I in 1989, in a pivotal measure to address rampant poaching driven by escalating global demand for ivory commodities (Stiles, 2004). While subsequent decisions downlisted the national African elephant populations of Botswana, Namibia and Zimbabwe (1997) and South Africa (2000) to Appendix II, binding annotations effectively treat their ivory as Appendix I, and CITES Parties have authorised two tightly controlled, one-off sales of government stockpiles: c. 50 tonnes in 1999 (to Japan), and c. 102 tonnes in 2008 (to China and Japan) (Stiles, 2009; UNEP-WCMC, 2025). ¶

Limited exceptions exist for pre-Convention worked ivory, that is, items acquired prior to the first listing of the species in CITES, which may be traded internationally with a CITES pre-Convention certificate (subject to stricter national measures). However, there is no universal method to verify age and provenance, leaving trade vulnerable to fraud. INTERPOL estimates customs seizures capture, at most, c. 10% of the illegal ivory trade globally (TRAFFIC, 2020).

Domestic legal frameworks vary widely, because CITES governs cross-border international trade, not internal commerce. Consequently, domestic ivory markets are widely recognised as sustaining demand and creating laundering opportunities, especially where laws and enforcement differ across jurisdictions (Chakanyuka, 2021; Milliken & Sangalakula, 2009). ¶

In response, CITES Parties have pursued an agenda to close domestic ivory markets. At the 2016 CITES Conference of the Parties (CoP17) the Parties amended Resolution Conf. 10.10 (Rev. CoP17) to recommend urgent closing any domestic market that contributes to poaching or illegal trade, allowing only narrow, demonstrably safe exemptions. Since CoP17, Parties have implemented follow-up reporting and review processes for legal markets, and several major consumer hubs have enacted national reforms (CITES, 2025). The United States of

America (USA) banned intrastate commerce (2016); and full bans were enacted in mainland China (2017); Hong Kong and Singapore (both 2021) and the United Kingdom (UK) (2022). The EU tightened restrictions in 2021, allowing only limited exceptions (e.g., pre-1947 worked antiques). Other major markets have tightened controls without outright bans (e.g., Japan and Thailand) (CITES, 2025). As a result, domestic ivory market status varies widely globally. Australia is one of the few high-income jurisdictions where a comprehensive legislative closure has not been achieved, and domestic trade remains open and weakly regulated. ¶

In Australia, importation of ivory is permitted only for verifiably pre-CITES Convention items. Under the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) s 303CD, if an unlawful/unauthorised shipment of ivory product is seized, the importer faces up to AUD $310,000 in fines and/or 10 years' imprisonment. These legal requirements, however, largely stop at the national border: domestic sales fall under state and territory jurisdiction; (e.g., Linacre, 2021) and, in the absence of specific legislation, domestic sellers are not required to demonstrate lawful import, ownership history, item age or species identification at point of sale. We examined the scale and characteristics of the contemporary online ivory market in Australia and assessed the extent to which sellers provide information consistent with lawful acquisition.

Over the past fifteen years, ivory commerce has increasingly shifted into digital spaces (UNODC, 2024), expanding cross-border reach while complicating detection, jurisdiction and the application of local enforcement mandates (ECO-SOLVE, 2025; Guan & Xu, 2015; Indraswari et al., 2020). Many platforms prohibit advertising wildlife products, and in some cases ivory specifically, in their terms of service (e.g. Meta, *Yahoo! Japan*). However, enforcement is uneven and trade can shift across platforms, including to dealer websites, auction houses, or closed social networks (Environmental Investigation Agency, 2025;

Nishino & Kitade, 2020). More broadly, e-commerce and social media have made all forms of licit or illicit collecting and commerce easier (Lidington, 2002; López et al., 2025; Schmid, 2004), broadening the pool of buyers, and enabling trade through public listings and semi-private communities. These platforms can both facilitate illegal wildlife commerce and make detection more challenging (UNODC, 2024). End-to-end encryption and cross-platform advertising (Matyska, 2025) further reduce visibility, limiting what platform moderators and government regulators can observe without targeted monitoring and investigation, and meaning that in many cases, even up-to-date legislation relies on -community self-policing.

Australia's position in the global ivory trade landscape has been recognised since the mid-late 2010s, when media investigations and academic and non-government organisation (NGO) research began to document Australia's significance in the trade (e.g., Cox, 2018; McPherson, 2018; Nicholson, 2015). Public debate about continued legal dealings in ivory and rhinoceros horn was often framed in ethical terms and discussed in tandem (e.g., Davies, 2014; Fritz, 2018). An investigation by the International Fund for Animal Welfare (IFAW) of online listings from prominent Australian and New Zealand auction houses (October 2014-June 2015) recorded 1,318 listings comprising *c.* 2,772 items, with a total cumulative value of AUD $635,204 (AUD $820,398 in 2025 dollars) (IFAW, 2016). ¶

This evidence contributed to public concern regarding the volume and diversity of ivory items being sold domestically, exemplified by events such as the "Melbourne Crush" during which over 100kg of rhinoceros horn and ivory items was publicly destroyed in Bourke St. Mall on United Nation's World Wildlife Day, 2018 (King, 2018; Unwalla, 2018).

In 2018, a federal parliamentary inquiry into the trade in ivory and rhinoceros horn found that Australia lacked a comprehensive domestic regulatory framework, and recommended a national ban with limited exemptions (e.g., 10% *de minimis* and musical instruments <20% both pre-1975) be implemented cooperatively by the Commonwealth, states and territories

via the Council of Australian Governments (now the Environment Ministers Meeting) (Commonwealth of Australia, 2018). The Committee reached this view because, while the Commonwealth regulates imports and exports under the EPBC Act, domestic sales are governed by state and territory laws that vary across jurisdictions. The Australian Constitution confers limited power on the Commonwealth to impose uniform intrastate commercial rules without state cooperation. The inquiry recognised that section 51(i), which empowers the Commonwealth to regulate 'trade and commerce' 'among the states', could potentially be used to prohibit domestic trade. It considered this a worthwhile option because if states, concurrently, exercised their own powers to regulate the trade, there would be a complex and conflicting regime like one that has proved difficult to administer in the USA. Under growing public pressure, the Environment Minister for the Liberal-National Party coalition Government announced at the CITES CoP18 in August 2019, that Australia had "formally announced [its] intention to close the domestic trade of ivory and rhino horn" (Keck & Gralki, 2019). Other government representatives also acknowledged Australia was a 'back door' to get ivory and rhinoceros horn into the high-end legal art market (Keck & Gralki, 2019). This assessment was supported by investigations revealing that recently poached ivory was often disguised as vintage (Bee-Elle, 2019). Antiques dealers, meanwhile, expressed concerns that a ban would devalue stock or push trade underground (Coote, 2019). However, in May 2024, the successor Australian Labor Party Government tabled its response to the inquiry, stating that, across all recommendations, "given the passage of time since this report was tabled, a substantive Government response is no longer appropriate" and outlining no alternative measures (Australian Government, 2024). Media investigations kept, at least, some attention on the matter. They highlighted that Australian e-commerce platforms, like Gumtree, continued to host listings, where recently poached, vintage, or even fake ("substitute" species) items were difficult to distinguish, and that progress toward a ban had

stalled, partly due to limited understanding by state representatives of the scale of trade (Dahlstrom, 2021). NGOs have continued to call for a domestic ban and comprehensive cross-jurisdictional legislation (e.g., Human Society International Australia, 2024; IFAW, 2024).

Here, we analyse Australia's domestic online ivory market in the first half of 2025, assessing: a) the scale of the detectable trade under our methodology, and b) the extent to which sellers provide information consistent with legal acquisition. We focussed, primarily, on surface web e-commerce (i.e., online webstores, auction houses, and e-commerce platforms), and also present a preliminary two-month sample of Facebook Marketplace advertisements (mid-March to mid-May 2025). We ask:

1. To the extent observable, what is the size and scope of Australia's online domestic ivory market in 2025?
2. What is the diversity of worked and unworked items within this market?
3. To what extent is Australia's domestic ivory market shifting onto public social media platforms (e.g., Facebook Marketplace)?

We then discuss the implications of these findings and make recommendations to help Australian marketplaces and authorities close key loopholes that currently allow domestic ivory trade to continue largely unimpeded. ¶

METHODS¶

Surface web data collection and collation

We conducted two data collections: (1) a preliminary manual survey and (2) a larger, semi-automated collection from Australian auction houses.

Collection 1: Search Engine Collection

We conducted snapshot (short-term) monitoring of surface web online stores, live auctioneers and Facebook Marketplace from January 1st through June 30th, 2025. Webstores and auction house websites were identified following methodology described in Stringham et al. (2021), using search permutations of "[keyword] Australia", "[keyword] for sale OR purchase Australia", "buy [keyword] Australia". Each keyword was queried in three search engines, with language set to English and location to Australia. Search terms were ivory; carved ivory; ivory jewellery; vintage ivory; ivory inro; elephant ivory; netsuke; ivory figurines; genuine ivory; ivory okimono; ivory figurines; and pre-ban ivory. The first 50 URLs per search were tabulated in Microsoft Excel and visually screened for relevant listings and duplicates.

Collection 2: Australian Auction House Collection

Auction house listings were retrospectively collected in July 2025, via a centralized online auction platform, using a two-stage semi-automated workflow. In stage 1, we searched the keywords "ivory" and "netsuke" on the centralized platform website using a web browser, filtering to auctions occurring in Australia with closing date between 1 January and 30 June, 2025. The results page was saved as an HTML file and parsed for basic listing information (title, close date, and URL) yielding 2,434 listings. In stage 2, we filtered the 2,434 listings by excluding 274 listings that contained at least one of the exclusion keywords in the title (Table 1), 2,160 auction listings.

Table 1: Keywords excluded from the filtered auction listing searches, and the rationale for their exclusion, i.e.: (i) Synthetic material; (ii) Non-target species/items; (iii) Unrelated items.

Synthetic material	*Non-target species/items*		*Unrelated items*		
Faux ivory	Mammoth	Whale	Blouse	Jacket	Shorts
Ivorine	Narwhal	Whaletooth	Carpet	Pants	Skirt
Ivory white	Scrimshaw	Spermwhale	Coat	Rug	Suit
	Tagua nut		Dress	Shirt	Sweater

A custom webscraper was developed to collect the large volume of relevant information from the listings as they were too numerous to capture manually. The webscraper visited each listing to extract item and price data, producing a dataset of 2,160 listings with detailed information on the listing title, URL, final sale price (if any), auction house address, and item category.

Combined Collections

Listings from Collection 1 and 2 were screened manually to remove any irrelevant listings (e.g., boxwood *netsuke*). All listings within the target date range were retained unless the search algorithm had clearly returned items referring to ivory as a colour (e.g., tiles, wedding dresses). Where the listing text or images suggested Elephantidae ssp (e.g., patina, stated age, weight, or item type) but the material was unidentified, or labelled as mammoth ivory, photographs were manually examined for Schreger lines characteristic of Elephantidae *spp.* tusks (e.g., Baker et al., 2020; Espinoza & Mann, 1993). Due to inconsistent photo quality, items without clearly visible Schreger lines were retained if the listing itself presented them as ivory to potential buyers. Listings were excluded if both estimated and realised prices were unavailable, either because price data was omitted for sold items or restricted behind a paywall. The final dataset comprised 1,698 valid listings.

Requesting Additional Information from Dealers

Because most listings provided minimal documentation, we emailed a standardised inquiry template (posing as a prospective customer) to 18 auction houses and 44 webstore vendors with active listings in early July 2025, with a follow-up on July 13th 2025, to non-respondents. If no reply was received by July 27th 2025, the inquiry was considered to be "ignored". This process was conducted under the University of Adelaide's (Adelaide

University since January 1st 2026) Human Research Ethics Committee (HREC) approvals H-2020-184 and H-2020-256. Each inquiry linked to a listing, and asked (paraphrased):

1. What paperwork is provided with this piece to prove its age?
2. What paperwork is provided to verify when it entered Australia?
3. Does it include a certificate of authenticity, or similar? ¶

Investigation of Facebook Marketplace Sales

We conducted snapshot samples of Facebook Marketplace as an indicator of ivory sales activity on a public, widely used social media platform that can be searched by postcode/proximity with or without a personal account. We searched for the 11 keywords listed above, setting location to each Australian capital city (50km radius; occasionally returning listings beyond that range). Five searches were conducted at ~ two-week intervals on March 20th-21st, April 4th, April 18th-19th, May 6th, and May 16th, 2025. Multi-day sessions occurred when searches began in the evening and concluded the next morning. Each session lasted 2-4 hours. Relevant listings were screen-captured using Windows 11's Snipping Tool and saved as PNG files; duplicates were removed by manual visual screening. Data were tabulated by item category, general location/state, and listed price. Analyses were conducted in R (v4.5.1) (R Core Team, 2025); packages are listed in Table S13. ¶

Vendor documentation by sale status

We analysed listing-level binary outcomes by sale status for auctioned items (sold/passed) and webstore items (buy it now) regarding whether a listing: (i) stated provenance; (ii) stated provenience; (iii) specified an approximate age; or (iv) included documentation. Our estimand was the population-average effect of sale status on the

probability of each outcome. We fitted generalised estimating equations (GEE) with a logit link, exchangeable working correlation, and vendor clustering.

We screened for separation, cross-tabulating outcomes by sale status. Only (iv) "documentation included" showed complete/quasi-separation and was reported descriptively (counts/percent; three listings included documentation). No overdispersion was observed (Pearson $\varphi \approx 0.66–1.00$ across modelled outcomes), and GEE's robust confidence intervals (CIs) mitigate mild variance misspecification. An omnibus proportions test across sale-status levels supported modelling for approximate age and provenance (non-significant for documentation; borderline for provenience). Full diagnostics are provided in Table S2.¶

Auction sell-through (auction data only)

We estimated overall sell-through (sold = 1 vs passed = 0), using an intercept-only logistic regression pooling all item categories. We accounted for multiple listings per seller using Huber–White (sandwich) standard errors clustered by vendor (33 vendors; median 12 listings/vendor, IQR 4–46; range 1–211). Twelve vendors sold 100% of their listings (complete separation). Although such separation can inflate uncertainty, it does not bias the mean in an intercept-only model.

A standard generalised linear model (GLM) revealed no overdispersion (Pearson $\varphi = 1.00$, df = 1299). A GEE with exchangeable working correlation did not converge ($\hat{\alpha} \approx 0.028$), so we report the simpler clustered-SE GLM. The estimated sell-through rate was $\hat{p} = 0.866$ (95% CI 0.844–0.886). Comparison with naïve GLM (95% CI: 0.847–0.884) and exact binomial (95% CI: 0.846–0.884) showed near-identical results. We repeated this intercept-only analysis by item category using vendor-clustered standard errors to estimate category-specific $\hat{p}$ and 95% CIs. Full diagnostics, alternative CI's, cluster structure, and vendor-level separation are summarised in Tables S2–4.

Auction estimate vs realised calibration (auction data only)

For sold auction listings, we compared realised prices to the dealer's pre-sale estimates. Each listings estimate range (min/max) was parsed, and the midpoint used as the pre-sale benchmark. Realised prices and benchmarks were log-transformed to stabilise variance and interpret coefficients as proportional differences. To assess how closely results tracked the benchmark (calibration), we fitted a generalised least squares model using restricted maximum likelihood (GLS with REML), allowing variance increase with price (a power function of log(midpoint)), consistent with pre-analysis residual checks (Fig. S1). The offset model log(realised/midpoint) ~ 1 estimates overall bias, while log(realised) ~ log(midpoint) estimates scale calibration (slope = 1 indicates perfect scaling; <1 suggests higher-priced lots underperform relative to expectations). We compared a linear mean model to a natural spline (df = 3) using an Akaike information criterion (AIC). As a robustness check for outliers, a Huber M-estimator was applied to log(realised/midpoint). Residual and Q–Q diagnostics are reported in Table S5. ¶

Due to heteroskedasticity and deviation from normality, we constructed prediction bands via quantile regression of log(realised) on log(midpoint) at $\tau = 0.10$, 0.50, and 0.90 (plus $\tau = 0.05$ and 0.95 for wider bands). Bands were exponentiated to yield q10–q90 and q05–q95 intervals, which captured 80.3% 90.0% of sales, respectively (Fig. S1). Rule-of-thumb multipliers by benchmark decile are in Table S6. For item category comparisons, we used a mixed-effects model with a random intercept for category and vendor (partial pooling). A random-slope alternative (category-specific slopes), did not improve model fit. Under the selected model, the population slope was 0.907 (SE 0.016; p = <0.001) with category and vendor level intercept SDs of 0.065 and 0.23 (log scale), indicating modest between category

and moderate vendor level d heterogeneity. Model comparisons and pooled-band coverage are reported in Tables S7-8.¶

RESULTS

E-commerce Platforms

Between January and June 2025, we recorded 1,698 ivory product listings from 70 Australia-based surface-web vendors (webstores and auction houses). Vendors operated in 7 of 8 states/territories (none in the Northern Territory (NT)) with activity highly concentrated in New South Wales (NSW: 906 listings; 28 vendors), Victoria (VIC: 639; 23), and Queensland (QLD: 107; 7), which together accounted for 97% of all listings (Fig. 1). Market concentration, measured by the Herfindahl–Hirschman Index (HHI; 0–1, higher = more concentrated), was 0.12 in NSW, 0.15 in VIC, and 0.29 in QLD (Table S9)

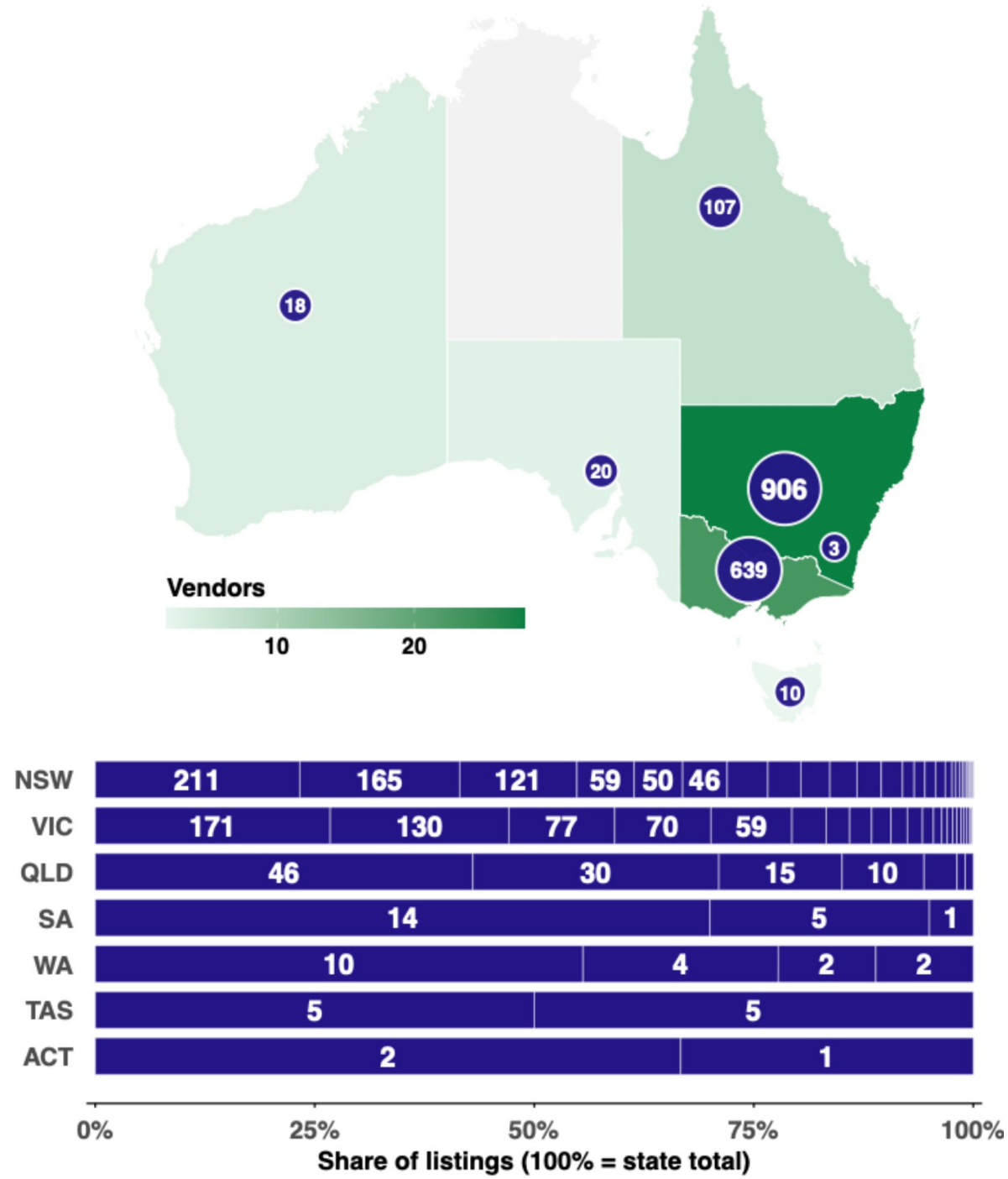


Figure 1. Geographic distribution of surface-web ivory listings and vendors in Australia, Jan–Jul 2025. States/territories are shaded green by the number of distinct active vendors. Overlaid circles are sized by the total number of listings in each state/territory. The bar chart shows vendor share of state listings: each horizontal bar represents a state (100% total), with

vendor segments ordered left-to-right from largest to smallest; white numbers show raw listing counts for segments ≥5%. States/territories are ordered top-to-bottom by total listings.

Among the 70 vendors, shipping was widely advertised (Fig. 2). For domestic shipping, 64.3% offered it directly, 25.7% via third parties and 10% gave no information. For international shipping, 38.6% offered it directly, 28.6% via third parties, 11.4% did not ship internationally, and 21.4% provided no information. Only one vendor stated an ivory policy (limiting trade to de minimis items), and just four mentioned CITES. None provided substantive guidance beyond advising buyers to familiarise themselves with relevant requirements. At the listing level, only 3 of 1698 listings (<1%) included documentation; 445 (26%) stated provenance; 158 (9%) stated provenience; and 1052 (62%) gave an approximate age. Documentation and item-detail disclosures varied across vendors (Fig. 2).

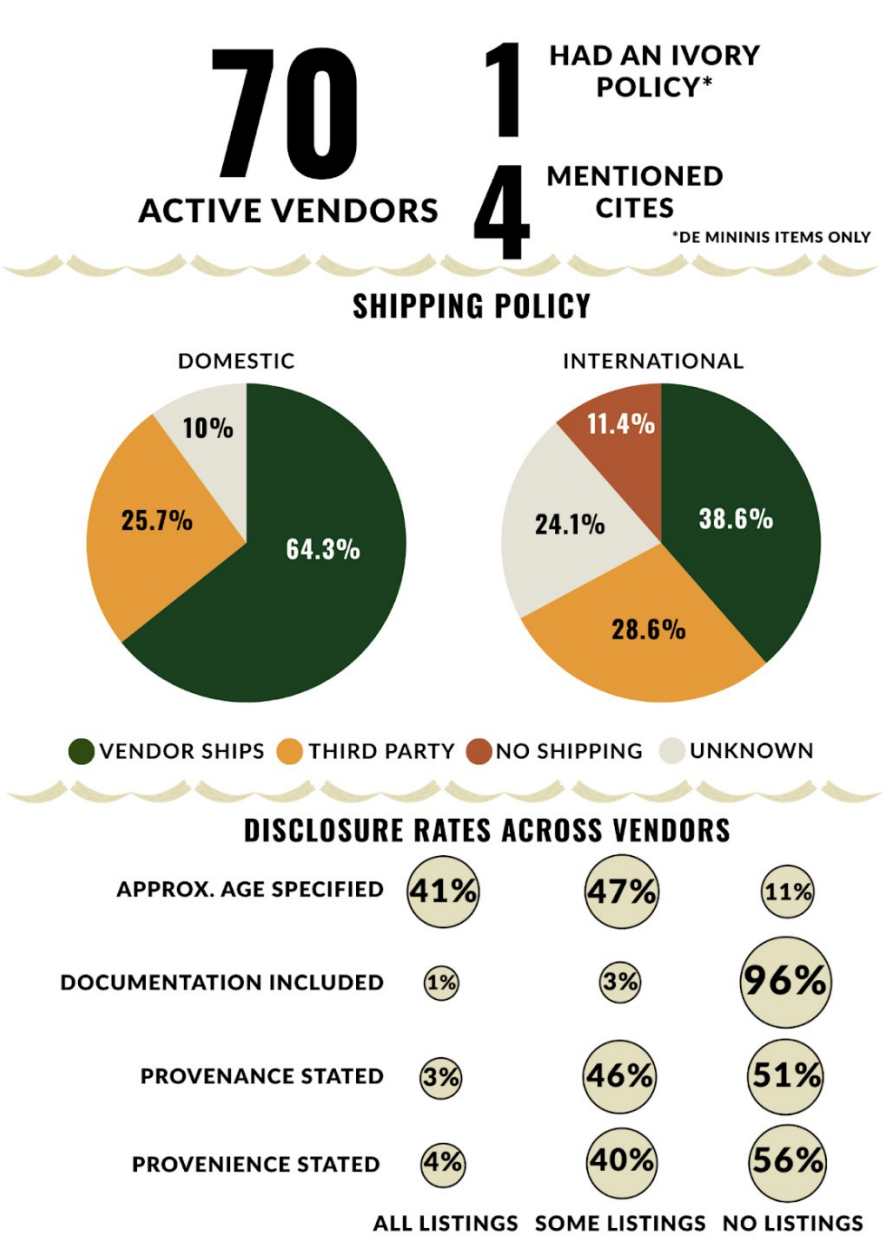


Figure 2. Shipping and Documentation Practices Among Australian Surface-Web Ivory Vendors, Jan–Jul 2025.

Of the 1,698 listings, 395 (23%) were fixed-price "buy-it-now" webstore items and 1,303 (77%) were timed auction lots (three auction lots with missing sold prices were excluded from price-based analyses) (Fig. 3). Auction sold lots realised a total of A$653,101, while buy-it-now listings totalled A$573,997 in asking prices. Auction lots that did not sell had estimated dealer value ranges of A$127,400 (minimum), A$158,882 (median), and

A$189,765 (maximum). Nearly all listings featured worked ivory; only one was an unworked tusk. The market was dominated by small carved objects: netsuke (n = 399; 23.5%) and figurines/carvings (n = 364; 21.4%), together comprised 45% of items. Jewellery (n = 205; 12.1%), miniatures & relief art (n = 170; 10.0%) and tableware & utensils (n = 128; 7.5%) brought the top five categories to ~75%, of all listings (Fig. 3).

Auctions lots were significantly more likely to result in a sale: 1,126 of 1,300 (86.6%) sold. An intercept-only logistic model with vendor-clustered Huber–White standard errors estimated $\hat{p} = 0.87$ (95% CI 0.84–0.89), suggesting high sell-through across vendors. This pattern held across item categories: all with ≥2 vendors having statistically significant sell-through rates above 50% (lowest CI lower bound 0.629), with the lowest category-specific estimate at $\hat{p} = 0.80$. Full category results are reported in (Table S10). All 12 categories showed realised prices significantly below the dealer midpoint (Fig. 4b). See Fig. 4a and 4c for summaries of the frequency of prices falling below, within, or above each lot's dealer range.

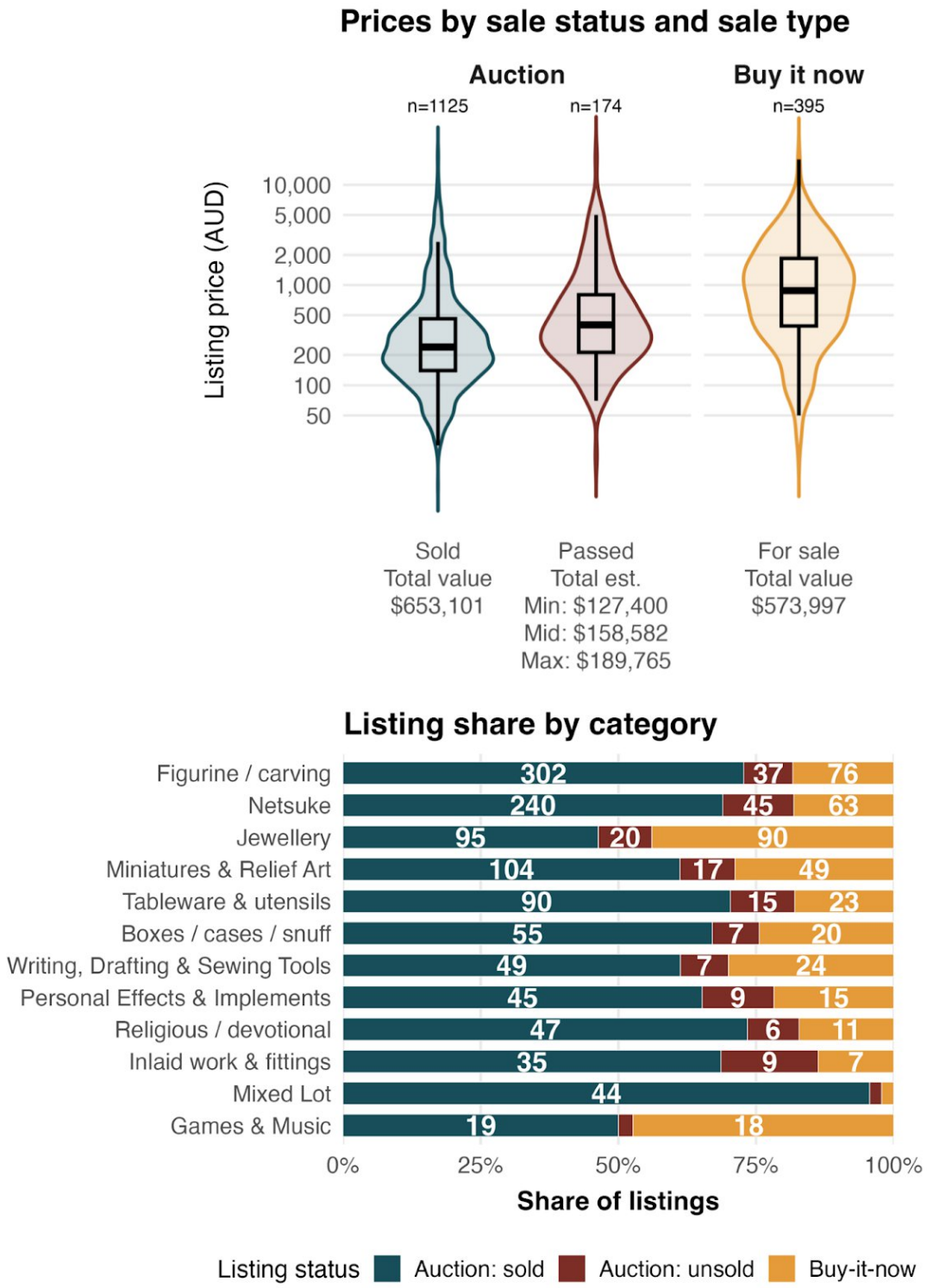


Figure 3. Prices and composition of Australian ivory listings. Auction (sold/unsold) vs Buy-it-now (available): price distributions and category share of listings; Jan–June 2025.

Within auctions, sold vs passed lots did not differ significantly in provenance (OR = 1.17, 95% CI: 0.80–1.73, $p = 0.42$), provenience (OR = 1.52, CI: 0.99–2.33, $p = 0.058$), or approximate age (OR = 0.90, CI: 0.67–1.22, $p = 0.50$). Documentation was too rare to analyse (3/1,125 sold; 0/174 passed). Compared to auction-sold lots, buy-it-now listings were more likely to state approximate age (85% vs 55%; OR = 3.88, CI: 2.55–5.93, $p < 0.001$), while provenance and provenience did not differ significantly (OR = 0.50, CI: 0.25–1.01, $p = 0.053$; OR = 1.46, CI: 0.85–2.53, $p = 0.17$). See Table S11 for prevalence and Table S12 for GEE results. On average, realised prices were 11.7% below the dealer midpoint (GLS offset on log scale). Scale calibration deviated from one-to-one: the GLS slope was 0.91 (95% CI: 0.88–0.93), indicating higher-priced items sold relatively lower than lower-priced items. ¶

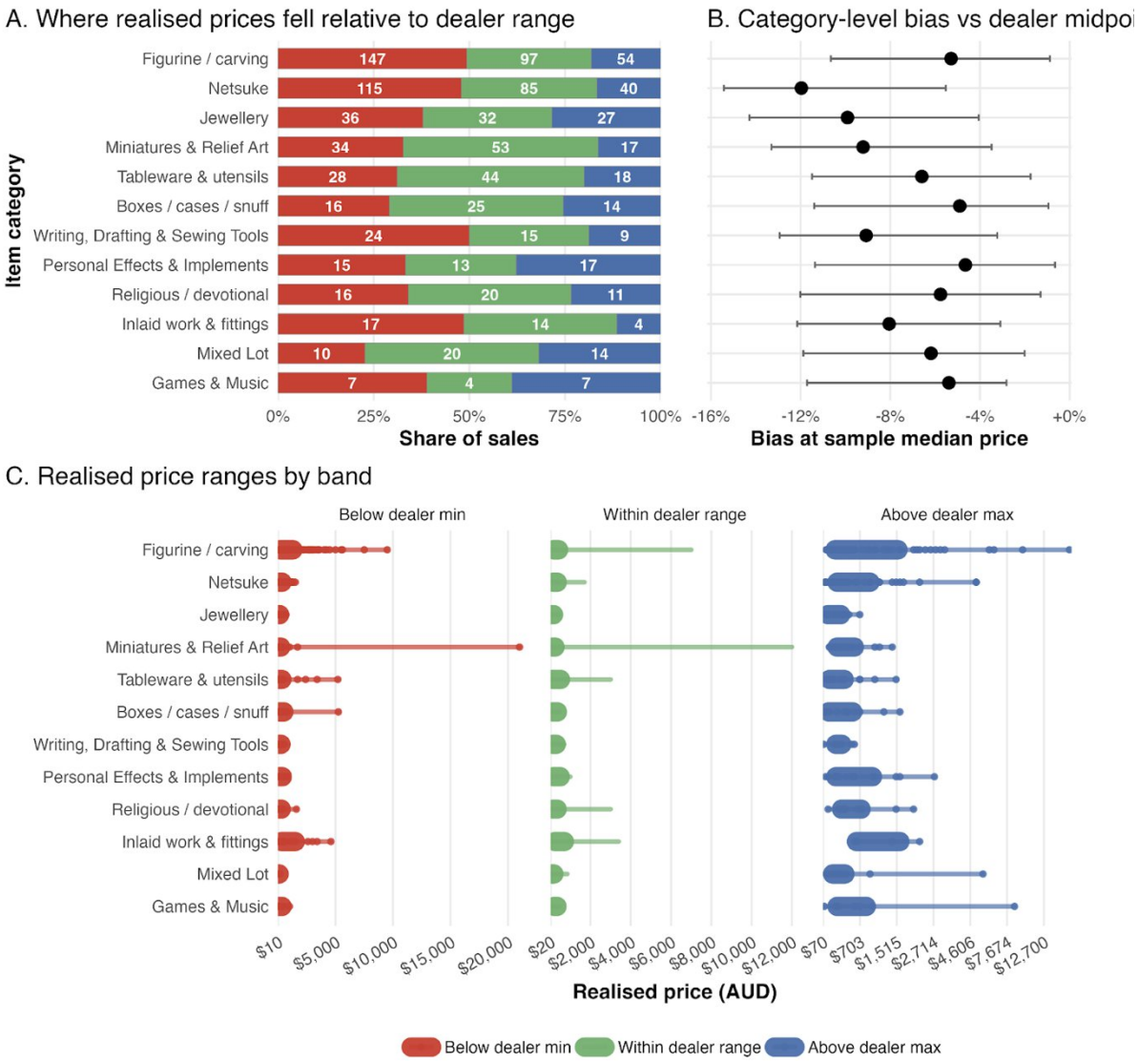


Figure 4. Where realised (sold) auction prices for Australian online ivory item auctions (Jan–Jul 2025) sat relative to dealers' quoted price range estimates, and how category sold prices deviated from the dealer midpoint A) Share of sold lots falling below (red), within (green) or above (blue) the dealer estimated price range; numbers in bars are lot/listing counts. B) Category-level bias from the dealer estimated price range midpoint at the sample median price (percent with 95% CIs); categories are significant when the 95% CI does not cross 0. Values < 0 indicate sales below the midpoint. C) Realised price distributions by band (AUD; pooled across all dealers). Thick segments show the IQR and thin whiskers the min–max for each category. Bands are defined per listing using that dealer's quoted

min–max, so absolute dollar values can overlap across bands (e.g., a "below" sale from a high-priced dealer may exceed a "within" sale from a lower-priced dealer).

Dealer Inquiries

Of the 21 auction houses contacted, 13 responded within two weeks, while 30 of the 44 online store proprietors replied (Appendix 1). None of the responses clearly stated that documentation was included with the offered item or provided citable proof upfront. Many emphasised their experiential expertise or reputation, often assuring that they themselves purchased from reputable dealers. Several respondents indicated that a receipt with details as to age estimate or material composition could be provided.

Zero auction house listings and four webstore listings cited that their membership within the Australian Antique & Art Dealers Association Limited (AAADA) was sufficient to reassure buyers that what they offered for sale was both authentic and legal. One vendor specifically referenced "lines of retzius" (Schreger lines), thus implying the item was authentic ivory and thus able to confer higher status upon the buyer or wearer (e.g., Szczygielska, 2023). Importantly, one Melbourne auction house mentioned its listed item was consigned by an owner who acquired it in Hong Kong "a few years ago" but had lost the paperwork prior to consignment.

Facebook Marketplace

Between mid-March and mid-May 2025, our sampling of Facebook Marketplace recovered 99 unique listings depicting real or purportedly real ivory. Every jurisdiction except the NT was represented. An unexpectedly high number of listings from Tasmania came from a single Launceston-based vendor who listed 24 lots of mostly carved figurines and *netsuke* on April 18th 2025. During all other sampling periods, numbers of listings from

Tasmanian vendors were very low. In total, across all sampling periods, listings from NSW based vendors accounted for 25% of the total (n=25). Listings from Queensland, Victoria and Western Australia comprised between 10% and 13% of total listings. In contrast, the much smaller number of listings posted from the Australian Capital Territory and South Australia (SA) each represented unique items from individual sellers. Specific elephant species were not identified in any listing; a pattern consistent with the e-commerce and auction house data. Overall, the combined total value across all sample periods was AUD $32,971. Only two listings were excluded: 1. A piano with alleged ivory keys (no stated price); 2. A composite "pirate ship" made of numerous pieces of ivory, listed for $123,456 (most likely a place-holder price). All of the categories seen in the e-commerce and buy it now listings were represented in our Facebook Marketplace sample, except religious/devotional and raw material (i.e., unworked tusks or tusk fragments). However, 62% (n=62) of listings comprised figurines/carvings, netsuke and jewellery. Three examples of composite listings bundled worked ivory items with unrelated goods (e.g., coral jewellery, plastic toys). Other unique listings include a Chinese stringed instrument with ivory inlay, a smoking pipe, a cameo miniature portrait and a dresser with an ivory handle.

DISCUSSION

The widespread lack of documentation confirms that Australia's domestic ivory market operates in a regulatory 'grey zone'. In the absence of enforceable laws requiring vendors to prove an item's composition, origin, or legality, ambiguity becomes the standard practice rather than the exception. This situation creates ideal conditions for laundering recently carved and illegally imported ivory as legal antiques, a pattern well-documented in illicit wildlife markets globally (e.g., Sharma et al., 2025). Instead of providing documentation, many vendors rely on their personal reputation, expertise, or trade association

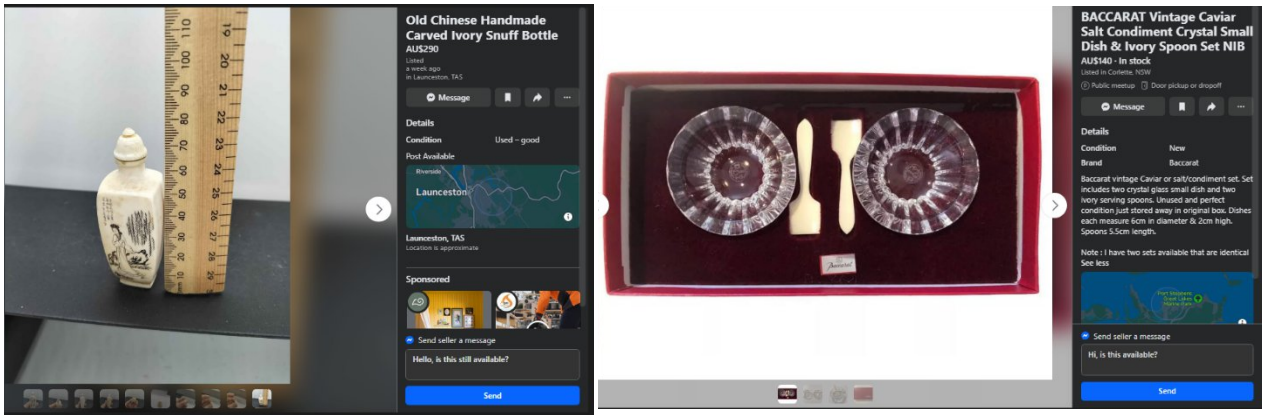
memberships to reassure buyers, but ostensible "good faith" does not necessarily demonstrate legal compliance. Without regulatory oversight, Australia's domestic market remains vulnerable to misuse.

This lack of transparency is not new. A 2014–2015 IFAW investigation of Australian and New Zealand auction houses documented substantial ivory sales and found that provenance information was rarely included (only 8% of listings) and often absent altogether (~42% gave no reference to provenance or age) (IFAW, 2016). The persistence of these documentation gaps in our study, a decade later, suggests limited regulatory progress and strengthens the case for decisive reform.

Building on this background, our results show that Australia's domestic market remains not only opaque, but also highly active and lucrative. We recorded nearly AUD $1.2 million in listings across surface web platforms, with a high (87%) sell-through rate in timed auctions. The range and number of listings, especially for cultural heritage or antique items like *netsuke*, figurines/carvings and jewellery, suggest a robust collector market. However, in the absence of proper documentation and regulatory oversight, the trade in small collectibles provide a readily accessible pathway for laundering illicit ivory.

This is a well-documented issue in domestic markets globally. In the EU, a 2018 study found that 74% of ivory items advertised as legal antiques (pre-1947) were actually confirmed by radiocarbon testing to be post-1947. One in five pieces originated from elephants that were alive in the 1990s-2000s, including some killed as recently as the 2010s, which was well after global bans were imposed (AVAAZ et al., 2018). Similarly, before its 2022 ban, Hong Kong's domestic ivory market was widely seen as a laundering hub for poached ivory. Undercover investigations revealed that vendors routinely restocked using illegal ivory, exploiting a system that lacked any reliable means to match tusks or carvings with verified

443 documents (Knights et al., 2015). These examples highlight a common problem; a lack of
444 enforceable standards for seller disclosure enables illicit ivory to enter legal channels.
445 Australia faces a similar risk. Under current law, ivory vendors are not required to verify an
446 item's age or origin, nor provide CITES permits or age-testing results (Commonwealth of
447 Australia, 2018). We did not assess physical retail, which previous research shows remains a
448 significant part of domestic ivory trade (e.g., Patman 2017). Less than 1% of online listings in
449 our study mentioned any supporting paperwork. This isn't simply an illustration of seller
450 negligence, but rather reflects a system based on self-reporting rather than independent
451 verification. This creates a regulatory blind spot where there is no means to separate legal
452 from illegal ivory. The limited visibility of many transactions further compounds the issue.
453 On social media, encrypted messaging and semi-private and invitation-only groups represent
454 additional blind spots. What emerges is evidence of a modest but active market where ivory
455 circulates through several underregulated domestic channels. Unless loopholes are closed
456 through tighter regulation or a national ban, the trade in illicit ivory will remain difficult to
457 detect, disrupt, or prosecute.
458 Sampling Facebook Marketplace over a two-month period confirmed that ivory, both worked
459 and unworked, actively circulates on social media. Between March and May 2025, we
460 recorded 92 unique listings depicting real or purportedly real ivory cumulatively valued at
461 just under AUD $33,000. These included high-value items, such as carved figurines and
462 alleged carved tusk segments, with many listings originating from repeat vendors. Figures 5
463 shows two example listings captured April 4th, 2025.



a) b)

Figure 5. Two example Facebook Marketplace posts captured April 4th, 2025: a) An old ivory 'Chinese' snuff bottle; b) A crystal caviar set with ivory spoons Post captured via search terms mentioned above with a 50km radius set on Hobart, TAS (left) and Sydney, NSW (right).

These findings highlight an ongoing policy-practice gap on Meta platforms. Despite Meta's terms of service (Meta, 2025) prohibiting trade in endangered species and items made from them, and its role as a founding member of the Coalition to End Wildlife Trafficking Online, which reported blocking 24.1 million prohibited listings or sellers between March 2018 and September 2024 (Pimont et al., 2024), ivory items remain accessible. Independent analysis suggests the rate of post-removal across platforms is declining (McIntosh, 2025), and earlier NGO research found that a wide range of wildlife products and live animals was still readily available on Facebook in 2020, especially via non-English language pages and groups (Paul et al. 2020).

Recent attempts to improve monitoring of these nebulous markets include applied machine learning and computer vision (e.g., Sharma et al., 2025). Use of such methods for any question or topic involving sensitive data must be ethically weighed, and the results must always be "ground truthed" by human researchers (e.g., Huffer et al., 2019). Other research continues to demonstrate that social media continues to facilitate ivory markets, even in the

face of increased government and civilian scrutiny and calls for regulation (e.g., DPA International, 2025; Indraswari et al., 2020). Ultimately, with the 'shackles of the saleroom' (Fay, 2011; Lidington, 2002) removed, the sale of wildlife products continues to thrive on these platforms (e.g., Raine et al., 2025; Si et al., 2025).¶

Lessons from other countries

Efforts to restrict or ban domestic ivory markets abroad provide useful lessons in what does and does not work. For example, Japan is currently reviewing its Law/Act for Conservation of Endangered Species of Wild Fauna and Flora (LCES/ACES), first passed in 1992 (Environmental Investigation Agency, 2025; Japanese Wildlife Conservation Society, 2025). Current public outreach campaigns seek to fully close Japan's domestic market by 2027, but it is unclear whether Japan's current government has appropriately legislated. In addition to proposed amendments to LCES/ACES legislation, a widely circulated petition and testimony from CITES Japan Youth representative, Kanaka Tanako, have attempted to demonstrate to the Diet (national legislature of Japan) that owning ivory is increasingly unpopular. However, to the best of our knowledge, Japan remains an important hold out in global efforts to pass and enforce domestic bans in all major markets.

However, international pressure from the African Elephant Coalition (32 elephant range states) and the U.S. House of Representatives has strengthened global abolition efforts (Environmental Investigation Agency, 2025).

Chen et al. (2023) examined the effect and limitations of China's ivory ban five years on, finding loopholes remain around importation, auctions, and ban exemptions, and weak sentencing has resulted in simultaneous rises in real or purportedly real mammoth ivory. In contrast, in 2021, Singapore implemented a nationwide ban on the sale of ivory (Endangered Species (Import and Export) Act, 2006), which led to an immediate 76% drop in total ivory

listings, outperforming the post-ban declines observed in China (Yeo et al., 2024). Much of this success came from a two-year lead-up period, during which authorities and NGOs (like the World Wide Fund for Nature (WWF)-Singapore) engaged in public consultation and collaborated closely with e-commerce platforms (Yeo et al., 2024). ¶

After the ban took effect, authorities continued to work with online marketplaces to remove flagged listings, and provided keyword lists to support large language models (LLM)-assisted illegal post removal.

Thailand permits ivory sales only from registered, domesticated, Asian elephants, and its experience suggests that regulating physical markets is only part of the solution. Targeted regulation and enforcement reduced open, in-person trade, but appears to have displaced illicit activity into alternative, less regulated spaces, such as social media groups. In a three-month monitoring-period, over 800 elephant-related online –advertisements were detected, most for raw ivory, often disguised using emojis or coded language to evade detection (ECO-SOLVE, 2025).

The EU's restrictions, updated in December 2021, are another case in point. These rules significantly restricted cross-border trade in ivory between member states, banning most commercial transactions except for pre-1975 musical instruments and pre-1947 antiques; both of which must be accompanied by a certificate from a national government Management Authority (European Commission, 2021). However, a 2024 snapshot study revealed persistent weaknesses. Across seven EU states, fewer than 10% of worked and 3.1% of raw ivory or suspected ivory listings included verifiable proof of legality, such as certificates or registration numbers (Pimont et al., 2024). A key reason for this enforcement gap is that much of the EU framework consists of non-binding rules reliant on national-level implementation. As a result, domestic markets, particularly on local-language e-commerce

platforms, remain inconsistently regulated and poorly policed. This kind of regulatory fragmentation offers an important lesson for Australia.

The key takeaway for Australia is that effective market closure will require legislative reform, proactive collaboration with e-commerce platforms and antique trade associations, a clear, phased transition period, and enforcement tools targeted to online marketplaces. If Australia moves to restrict or ban domestic ivory trade, those measures need to be applied uniformly across all states and territories. Without a coordinated approach, there is a high risk of creating a patchwork of inconsistent laws, where ivory banned in one state or territory could still be sold in another. This kind of inconsistency makes enforcement more difficult. As the EU experience shows, strong rules on paper require binding national coordination and consistent local enforcement to be effective. To counter these risks, governments must develop stronger partnerships with online e-commerce platforms. As monitoring tools improve, keyword filters and LLMs are becoming increasingly effective for detecting illicit wildlife trade online, particularly when complemented by public education efforts such as the WWF's pop-up warnings on Facebook when users search using wildlife trade terms (ECO-SOLVE, 2025; WWF, 2020; Xu et al., 2019). ¶

To cite another example, Thailand now hosts a national data hub within the Global Monitoring System (GMS), operated by the Global Initiative Against Transnational Organized Crime, in collaboration with CITES. This platform tracks the illegal wildlife trade, including the ivory trade, across social media and e-commerce platforms. ¶

For Australia, investing in similar partnerships and digital infrastructure will be key to preventing trade from simply shifting into less visible, harder-to-police spaces. ¶

The 2018 parliamentary recommendations still offer the most effective path to close or regulate the domestic ivory market; that is, by national agreement. This 'cooperative federalism' (French, 2003) could be achieved through either (i) referral of powers from each

state and territory so the Commonwealth can enact one national law applying across the referring jurisdictions, or (ii) complementary state and territory legislation, where each parliament passes uniform provisions through its own parliament.

(i) Referral of powers

Under section 51(xxxvii) of the Australian Constitution, by agreement between the Federal Parliament and any state parliament(s), state law-making powers can be 'referred' to the Commonwealth. Territories can refer power, although it is rarely necessary given the Federal Parliament is authorised to make laws for the territories under s 122. This process of referral has occurred multiple times over Australia's history on matters as diverse as war, family law, industrial relations and terrorism (Parliamentary Education Office, n.d.).

(ii) Complementary state/territory legislation

Alternatively, the states and territories could pass uniform legislation that complements relevant Commonwealth statutes. There are no legal impediments to this process and progress toward harmonisation of laws across Australian jurisdictions has been achieved in a broad range of areas including evidence, occupational health and welfare, regulation of the legal profession, road rules and defamation (Australasian Parliamentary Counsel's Committee, 2025). However, uniformity is, politically, difficult to achieve and maintain over time.

The parliamentary inquiry did not express a preference for one option over the over, and we are similarly agnostic as to which pathway is taken to a coherent, cross-border regulatory framework. However, we note that, over the long term, a referral might offer more stability than individual state and territory-based legislation that could be revisited, revised or repealed by multiple governments or parliaments at any time.

To begin to reduce Australia's market in advance of new legislation banning the trade, we strongly recommend:

1. State and territory law enforcement should more closely monitor auction houses and online vendors in their jurisdiction. Our sample from just the first half of 2025 revealed open commerce in a wide range of purported or stated ivory items listed with little or no documentation publicly viewable to accompany them.

2. The Commonwealth government should devise new standards for qualified legal import, in consultation with subject-matter experts.

3. For any newly imported ivory, dealer organisations should more strictly require proof of legal origin and age at point of sale plus a documented chain of custody (receipts, provenance).

4. Any ivory sold with false paperwork could see the resultant profits seized under the Proceeds of Crime Act 2002 (Cth) (Department of Home Affairs, 2025).

5. An educational outreach campaign targeting both dealers and buyers regarding what constitutes sufficient provenance, provenience and documentation could be developed to help clarify that inherited heirloom items don't need to be disposed of but cannot be sold for profit.

CONCLUSION

Our online market analysis revealed a sizeable, active online market concentrated in Australia's three most populous states, with very few instances of publicly provided provenance documentation, high auction sell-through and growing spillover onto social media platforms. The most vexing obstacle to reform is a lack of political will at the state and Commonwealth level since 2018.

What is apparent is that much more needs to be done to regulate the trade and educate both buyers and sellers. If the Commonwealth government is willing to revisit the possibility of a domestic trade ban on ivory products, it would be prudent to look to other market

608 countries and jurisdictions, such as the UK, (Creagh 2025), which are strengthening and
609 broadening ivory import/export bans. ¶
610
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628 **REFERENCES**
629 Australasian Parliamentary Counsel's Committee. (2025). *National Uniform Legislation |*
630 *Australasian Parliamentary Counsel's Committee*. Australasian Parliamentary
631 Counsel's Committee. https://pcc.gov.au/uniform_legislation_official_versions.html

Australian Government. (2024). *Australian Government response to the Joint Law Enforcement Committee report: Trade in elephant ivory and rhino horn [May 2024]. Document 6155*. https://www.aph.gov.au/Parliamentary_Business/Tabled_Documents/6155

AVAAZ, University of Oxford, & Elephant Action League. (2018). *Europe's Deadly Ivory Trade. Radiocarbon testing illegal ivory in Europe's domestic antique trade*. AVAAZ. https://s3.amazonaws.com/avaazimages.avaaz.org/AVAAZ_EUROPES_DEADLY_IVORY_TRADE.pdf

Baker, B., Jacobs, R., Mann, M., Espinoza, E., & Grein, G. (2020). *CITES Identification Guide for Ivory and Ivory Substitutes* (C. Allan, Ed.; 4th ed.). World Wildlife Fund Inc. https://files.worldwildlife.org/wwfcmsprod/files/Publication/file/6smyb8xhvw_R8_IvoryGuide_07162020_high_res.pdf

Bee-Elle. (2019, September 7). "The elephant's entire face is missing": Can Australia do more to stop the ivory trade? *ABC News*. https://www.abc.net.au/news/2019-09-08/saving-elephants-needs-more-than-ivory-trade-ban/11466442

Chakanyuka, T. L. (2021). The Conservation of African Elephants under the CITES International Ivory Trade Ban. *Kathmandu School of Law Review*, 71–83. https://doi.org/10.46985/kslr.v7i2.1210

Chardonnet, Ph., Des Clers, B., Fisher, J. R., Gerhold, R., Jori, F., & Lamarque, F. (2002). The value of wildlife. *Revue Scientifique et Technique de l'OIE*, *21*(1), 15–51. https://doi.org/10.20506/rst.21.1.1323

Chen, Y., Wang, Y., & Mumby, H. S. (2023). Five years of the ivory ban in China: Developments, limitations, and potential for improvement. *Biological Conservation*, *284*, 110177. https://doi.org/10.1016/j.biocon.2023.110177

CITES. (2025). *CoP20 Doc. 76.2: Implementing Aspects Of Resolution Conf. 10.10 (Rev. CoP19) On The Closure Of Domestic Ivory Markets*. https://cites.org/sites/default/files/documents/COP/20/agenda/E-CoP20-076-02.pdf

Commonwealth of Australia. (2018). *Inquiry into the Trade in elephant ivory and rhinoceros horn*. Parliamentary Joint Committee on Law Enforcement.

Coote, G. (2019, August 22). *Horns of a dilemma: Antique dealers fret over ivory ban*. ABC Listen. https://www.abc.net.au/listen/programs/am/horns-of-a-dilemma:-antique-dealers-fret-over-ivory-ban/11440218

Cox, L. (2018). *Bipartisan inquiry recommends Australia ban domestic ivory trade*. The Guardian. https://www.theguardian.com/environment/2018/sep/19/bipartisan-inquiry-recommends-australia-ban-domestic-ivory-trade

Dahlstrom, M. (2021, August 12). *"Shocking": Elephant ivory being sold on Gumtree despite ban announcement*. Yahoo News. https://au.news.yahoo.com/shocking-online-sales-of-elephant-ivory-flourish-despite-ban-announcement-033725035.html

Davies, A. (2014, March 31). *Rhino horns sold for $92,500 in Sydney*. The Sydney Morning Herald. https://www.smh.com.au/environment/conservation/rhino-horns-sold-for-92500-in-sydney-20140331-35t0p.html

Department of Home Affairs. (2025). *Proceeds of Crime Act 2002.* Department of Home Affairs Website. https://www.homeaffairs.gov.au/about-us/our-portfolios/criminal-justice/proceeds-of-crime-act

DPA International. (2025, May 27). *Indonesian police uncover online ivory trade via TikTok and Facebook*. Yahoo News. https://www.yahoo.com/news/indonesian-police-uncover-online-ivory-083924459.html

ECO-SOLVE. (2025). *Monitoring The Online Illegal Wildlife Trade With Insightss Into Ivory And Plants January 2025* (Global Trends Report). https://globalinitiative.net/wp-

content/uploads/2025/01/Monitoring-illegal-wildlife-trade-Ivory-and-plants-GI-TOC-January-2025.pdf

Endangered Species (Import and Export) Act (2006). https://sso.agc.gov.sg/Act/ESIEA2006

Environmental Investigation Agency. (2025, August 12). Japan's Big Opportunity to Shut Down Its Ivory Market. *EIA*. https://eia.org/blog/japans-big-opportunity-to-shut-down-its-ivory-market/

Espinoza, E. O., & Mann, M.-J. (1993). The History and Significance of the Schreger Pattern in Proboscidean Ivory Characterization. *Journal of the American Institute for Conservation*, *32*(3), 241–248.

European Commission. (2021). Commission Notice Revised GUIDANCE DOCUMENT EU regime governing trade in ivory 2021/C 528/03. *Official Journal of the European Union*, 19–35.

Evangelista, P. H., Young, N. E., Schulte, D. K., Tricorache, P. D., Luizza, M. W., Durant, S. M., Jones, K. W., Mitchell, N., Maule, T., Ali, A. H., Tesfai, R. T., & Engelstad, P. S. (2025). Mapping illegal trade routes of live cheetahs from the Horn of Africa to the Arabian Peninsula. *Conservation Biology*, *39*(3). https://doi.org/10.1111/cobi.14412

Fay, E. (2011). Virtual Artifacts: eBay, Antiquities, and Authenticity. *Journal of Contemporary Criminal Justice*, *27*(4), 449–464. https://doi.org/10.1177/1043986211418887

French, R. (2003) The Referral of State Powers, *31*(1) *University of Western Australia Law Review. https://classic.austlii.edu.au/au/journals/UWALawRw/2003/2.html*

Fritz, R. (2018, October 1). Filmmakers backing call to ban sale of ivory and rhino horn in Australia – The Advocate. *The Advocate*. https://theadvocate.org.au/news/filmmakers-backing-call-to-ban-sale-of-ivory-rhino-horn-in-australia/

Geldenhuys, K. (2025). Abalone under siege. *Servamus Community-Based Safety and Security Magazine*, *118*(3), 20–25. https://doi.org/10.10520/ejc-servamus%255C_v118%255C_n3%255C_a6

Guan, J., & Xu, L. (2015). *Deadly Messaging: Ivory Trade in China's Social Media*. TRAFFIC. https://www.traffic.org/site/assets/files/10442/deadly-messaging.pdf

Hernandez-Castro, J., & Roberts, D. L. (2015). Automatic detection of potentially illegal online sales of elephant ivory via data mining. *PeerJ Computer Science*, *1*, e10. https://doi.org/10.7717/peerj-cs.10

Huffer, D., Wood, C., & Graham, S. (2019). What the Machine Saw: Some questions on the ethics of computer vision and machine learning to investigate human remains trafficking. *Internet Archaeology*, *52*. https://doi.org/10.11141/ia.52.5

Human Society International Australia. (2024, August 12). *Time for all Australian governments to shut down our legal ivory trade*. https://newshub.medianet.com.au/2024/08/time-for-all-australian-governments-to-shut-down-our-legal-ivory-trade/61445/

IFAW. (2016). *Under the hammer. Are Auction Houses in Australia and New Zealand Contributing to the Demise of Elephants and Rhinos?* (pp. 1–42). International Fund for Animal Welfare.

IFAW. (2024). *It's time to end Australia's ivory trade. Take action today.* IFAW - International Fund for Animal Welfare. http://action.ifaw.org/page/155692/action/1?locale=en-AU

Indraswari, K., Leupen, B. T. C., Nguyen, M. D. T., & Phassaraudomsak, M. (2020). *Trading Faces: A Snapshot of the Online Ivory Trade in Indonesia, Thailand and Viet Nam in 2016 with an Update in 2019*. TRAFFIC. https://www.traffic.org/site/assets/files/12981/three-country-ivory-report.pdf

730 Japanese Wildlife Conservation Society. (2025). Japan is home to the world's largest legal
731 domestic market for ivory. *Japan Wildlife Conservation Society (JWCS)*.
732 https://www.jwcs.org/en/now/913/
733 Keck, M., & Gralki, P. (2019). *Australia Will Ban Domestic Trade of Ivory and Rhino Horns*
734 *in Massive Win for Biodiversity*. Global Citizen.
735 https://www.globalcitizen.org/en/content/australia-ban-domestic-trade-ivory-and-
736 horn/
737 King, T. (2018, March 3). Ivory crush sees 100kg of horn items destroyed on World Wildlife
738 Day in Melbourne. *ABC News*. https://www.abc.net.au/news/2018-03-04/ivory-crush-
739 sees-100kg-of-horn-items-destroyed/9506994
740 Knights, P., Hofford, A., Andersson, A., & Cheng, D. (2015). *The Illusion of Control: Hong*
741 *Kong's 'Legal' Ivory Trade.* WildAid. https://wildaid.org/wp-
742 content/uploads/2017/09/The-Illusion-of-Control-Full-Report-10.23.15-2_0.pdf
743 Kovesi, C., & Johnson, L. (2020). Mammoth Tusk Beads and Vintage Elephant Skin Bags:
744 Wildlife, Conservation, and Rethinking Ethical Fashion. *Fashion Theory*, *24*(7),
745 983–1011. https://doi.org/10.1080/1362704x.2019.1646559
746 Kufnerová, J., Frouzová, J., Světlík, I., Weissová, K., & Pachnerová Brabcová, K. (2025).
747 Expert opinion versus radiocarbon dating in the ivory trade. *Global Ecology and*
748 *Conservation*, *61*, e03659. https://doi.org/10.1016/j.gecco.2025.e03659
749 Lidington, H. (2002). The role of the internet in removing the 'shackles of the saleroom':
750 Anytime, anyplace, anything, anywhere. *Public Archaeology*, *2*(2), 67–84.
751 https://doi.org/10.1179/pua.2002.2.2.67
752 Linacre, A. (2021). Wildlife crime in Australia. *Emerging Topics in Life Sciences*, *5*(3),
753 487–494. https://doi.org/10.1042/etls20200288

López, F. G., Rebollo, M. E., Santillán, M. Á., Berkunsky, I., Cooper, N. W., Tella, J. L., & Grande, J. M. (2025). The illegal trade of wild birds in a social network: A call for action from Argentina. *Ornithological Applications*, *127*(2). https://doi.org/10.1093/ornithapp/duaf012

Matyska, P. (2025, September 29). *How Illegal Wildlife Trafficking Evades Online Platforms*. Resolver. https://www.resolver.com/blog/illegal-wildlife-trafficking-platforms/

McIntosh, T. (2025, January 24). Social Media Companies Removing Fewer Posts by Traffickers in Illegal Wildlife · Eye on Global Transparency. *Eye on Global Transparency*. https://eyeonglobaltransparency.net/2025/01/24/social-media-companies-removing-fewer-posts-by-traffickers-in-illegal-wildlife/

McPherson, E. (2018). *Ivory ban: No decision yet over Australia*. 9News. https://www.9news.com.au/national/elephant-ivory-and-rhino-horn-tusks-still-for-sale-in-australia-considers-ban/1a4b5069-ffc7-4ae1-b69b-04dbe9e16742

Meta. (2025). *Restricted Goods and Services | Transparency Centre*. Meta. https://transparency.meta.com/policies/community-standards/restricted-goods-services/

Milliken, T., & Sangalakula, L. (2009). *The Elephant Trade Information System (ETIS) and the illicit trade in ivory* (pp. 1–40). TRAFFIC East/Southern Africa.

Nicholson, L. (2015, April 8). *Ivory smuggling ring probe after elephant tusk find at Perth Airport*. WAtoday. https://www.watoday.com.au/national/western-australia/ivory-smuggling-ring-probe-after-elephant-tusk-find-at-perth-airport-20150408-1mgrh2.html

Nishino, R., & Kitade, T. (2020). *Teetering on the brink: Japan's online ivory trade*. https://www.traffic.org/site/assets/files/13414/teetering-on-the-brink_en.pdf

Parliamentary Education Office. (n.d.). *Chapter I, Part V: Powers of the Parliament—The Australian Constitution*. The Australian Constitution. Retrieved January 9, 2026, from https://ausconstitution.peo.gov.au/chapter-i_part-v_powers-of-the-parliament.html#note-15

Paul, K.A., Miles, K, Huffer, D. (2020). *Two clicks away: Wildlife sales on Facebook.* Alliance to Counter Crime Online. https://countering-crime.squarespace.com/wildlife-sales-on-facebook

Patman, D. (2017). *Australia…No domestic trade!* For the love of Wildlife. https://fortheloveofwildlife.org.au/illegal-ivory-sale-going-call/

Pimont, E., Lawley, D., Di Silvestre, I., Crnojevic, M., Kless, R., Zwiers, S., & Hachemin, L. (2024). *The elephant in the net: Research snapshot of the online ivory trade after the adoption of the new EU rules*. International Fund for Animal Welfare. https://www.ifaw.org/au/resources/elephant-in-the-net

Quarta, G., D'Elia, M., Braione, E., & Calcagnile, L. (2019). Radiocarbon dating of ivory: Potentialities and limitations in forensics. *Forensic Science International*, *299*, 114–118. https://doi.org/10.1016/j.forsciint.2019.03.042

R Core Team. (2025). *A language and environment for statistical computing.* (Version 4.5.0) [Computer software]. R Foundation for Statistical Computing. https://cran.r-project.org

Raine, A. F., Gregg, J., Scott, L., Hirschfeld, A., Ramadan-Jaradi, G., & Bamberghi, F. (2025). Digital trophies: Using social media to assess wildlife crime in Lebanon. *Oryx*, *59*(2), 201–209. https://doi.org/10.1017/S0030605324000814

Schmid, D. (2004). Murderabilia: Consuming Fame. *M/C Journal*, *7*(5). https://doi.org/10.5204/mcj.2430

Sharma, K., Barbosa, J. S., Roberts, S., Gondhali, U., Petrossian, G., Jacquet, J., Freire, J., & Chakraborty, S. (2025). Descriptive Analysis of Online Wildlife Products Using Vision Language Models. *Proceedings of the ACM SIGCAS/SIGCHI Conference on Computing and Sustainable Societies*, 461–472. https://doi.org/10.1145/3715335.3735484

Si, H., Hausmann, A., & Li, Z. (2025). The exotic pet craze on Chinese social media: Trends, community dynamics, and conservation implications. *Biological Conservation*, *311*, 111420. https://doi.org/10.1016/j.biocon.2025.111420

Stiles, D. (2004). The ivory trade and elephant conservation. *Environmental Conservation*, *31*(4), 309–321. https://doi.org/10.1017/S0376892904001614

Stiles, D. (2009). CITES–approved ivory sales and elephant poaching. *Pachyderm*, *45*, 150–153. https://doi.org/10.69649/pachyderm.v45i.187

Stiles, D., Redmond, I., Cress, D., Nelleman, C., & Formo, R. K. (2016). Stolen Apes: The Illicit Trade in Chimpanzees, Gorillas, Bonobos, and Orangutans. In N. Haenn, R. R. Wilk, & A. Harnish (Eds.), *The Environment in Anthropology (Second Edition)* (2nd ed., pp. 359–361). NYU Press; JSTOR. http://www.jstor.org/stable/j.ctt180410k.43

Szczygielska, M. (2023). Reading Teeth. *Historical Studies in the Natural Sciences*, *53*(3), 308–331. https://doi.org/10.1525/hsns.2023.53.3.308

TRAFFIC. (2020). *Elephant Trade Information System (ETIS) Report: Overview of seizure data and progress on requests from the 69th and 70th meetings of the Standing Committee (SC69 and SC70)*. CITES. https://cites.org/sites/default/files/MIKE/ETIS/E-CITES%20Secretariat_TRAFFIC_ETIS%20report_Sept2020_final_MESubgroup.pdf

UNEP-WCMC. (2025). *The Checklist of CITES Species Website* [Dataset]. http://checklist.cites.org.

827 UNODC. (2024). *World Wildlife Crime Report 2024: Trafficking in Protected Species*.
828 United Nations Publications.
829 file:///Users/freyjawatters/Downloads/Wildlife2024_Final.pdf
830 Unwalla, N. C. & S. (2018, March 3). *Ivory trinkets crushed en masse in Bourke Street Mall*.
831 The Sydney Morning Herald. https://www.smh.com.au/national/ivory-trinkets-
832 crushed-en-masse-in-bourke-street-mall-20180303-p4z2oz.html
833 Venturini, S., & Roberts, D. L. (2020). Disguising Elephant Ivory as Other Materials in the
834 Online Trade. *Tropical Conservation Science*, *13*.
835 https://doi.org/10.1177/1940082920974604
836 Waller, S.-M. (2023). *The availability of online elephant ivory* [Master of Science by
837 Research (MScRes) thesis]. University of Kent.
838 Williams, V. L., Drouilly, M., Coals, P. G. R., & Whittington-Jones, G. M. (2025). Pan-
839 African review of cultural uses of carnivores. *PLOS ONE*, *20*(3), e0315903.
840 https://doi.org/10.1371/journal.pone.0315903
841 WWF. (2020). *New Facebook alert informs users about wildlife trafficking*. World Wildlife
842 Fund. https://www.worldwildlife.org/stories/new-facebook-alert-informs-users-about-
843 wildlife-trafficking
844 Wyatt, T. (2022). *Wildlife Trafficking: A Deconstruction of the Crime, Victims and*
845 *Offenders*. Springer International Publishing. https://doi.org/10.1007/978-3-030-
846 83753-2
847 Xu, Q., Li, J., Cai, M., & Mackey, T. K. (2019). Use of Machine Learning to Detect Wildlife
848 Product Promotion and Sales on Twitter. *Frontiers in Big Data*, *2*, 28.
849 https://doi.org/10.3389/fdata.2019.00028
850 Yeo, H. H. T., Ng, S. J. W., Lee, J. S. R., Soh, M. C. K., Wong, A. M. S., Loo, A. H. B., &
851 Er, K. B. H. (2024). A systematic survey of the online trade in elephant ivory in

Singapore before and after a domestic trade ban. *Oryx*, *58*(1), 48–55. https://doi.org/10.1017/S0030605323000728

Yeo, L. M., McCrea, R. S., & Roberts, D. L. (2017). A novel application of mark-recapture to examine behaviour associated with the online trade in elephant ivory. *PeerJ*, *5*, e3048. https://doi.org/10.7717/peerj.3048

Supplementary Methods

Table S1. Diagnostics summary (pooled, per outcome)

Outcome	**Separation flag**	**Pearson φ (dispersion)**	**Omnibus p (prop.test across statuses)**
Stated provenance	No	1	3.44×10^{-16}
Stated provenience	No	1	0.0556
Approximate age specified	No	1	2.17×10^{-25}
Documentation included	**Yes**	0.66	0.466

Table S2. By-category auction sell-through: method comparison (clustered GLM, naïve GLM, exact binomial) with estimated $\hat{p}$, 95% CIs, and two-sided tests vs 0.5.

Category	**Method**	**Sell-through (95% CI)**	**p (vs 0.50)**
Miniatures & Relief Art	GLM (naïve SE)	86% (79–91%)	<0.001
Miniatures & Relief Art	GLM (vendor-clustered SE)	86% (78–91%)	<0.001
Miniatures & Relief Art	Exact binomial	86% (78–92%)	<0.001
Inlaid work & fittings	GLM (naïve SE)	80% (65–89%)	<0.001
Inlaid work & fittings	GLM (vendor-clustered SE)	80% (63–90%)	0.001
Inlaid work & fittings	Exact binomial	80% (65–90%)	<0.001
Figurine / carving	GLM (naïve SE)	91% (85–92%)	<0.001

Figurine / carving	GLM (vendor-clustered SE)	91% (85–92%)	<0.001
Figurine / carving	Exact binomial	91% (85–92%)	<0.001
Games & Music	GLM (naïve SE)	95% (72–99%)	0.004
Games & Music	GLM (vendor-clustered SE)	95% (71–99%)	0.005
Games & Music	Exact binomial	95% (75–100%)	<0.001
Religious / devotional	GLM (naïve SE)	89% (77–95%)	<0.001
Religious / devotional	GLM (vendor-clustered SE)	89% (74–96%)	<0.001
Religious / devotional	Exact binomial	89% (77–96%)	<0.001
Jewellery	GLM (naïve SE)	83% (75–88%)	<0.001
Jewellery	GLM (vendor-clustered SE)	83% (69–91%)	<0.001
Jewellery	Exact binomial	83% (74–89%)	<0.001
Mixed Lot	GLM (naïve SE)	98% (86–100%)	<0.001
Mixed Lot	GLM (vendor-clustered SE)	98% (86–100%)	<0.001
Mixed Lot	Exact binomial	98% (88–100%)	<0.001
Writing, Drafting & Sewing Tools	GLM (naïve SE)	88% (76–94%)	<0.001
Writing, Drafting & Sewing Tools	GLM (vendor-clustered SE)	88% (79–93%)	<0.001
Writing, Drafting & Sewing Tools	Exact binomial	88% (76–95%)	<0.001
Tableware & utensils	GLM (naïve SE)	86% (78–91%)	<0.001
Tableware & utensils	GLM (vendor-clustered SE)	86% (80–90%)	<0.001
Tableware & utensils	Exact binomial	86% (78–92%)	<0.001
Netsuke	GLM (naïve SE)	84% (80–88%)	<0.001
Netsuke	GLM (vendor-clustered SE)	84% (79–88%)	<0.001
Netsuke	Exact binomial	84% (79–88%)	<0.001
Boxes / cases / snuff	GLM (naïve SE)	89% (78–95%)	<0.001
Boxes / cases / snuff	GLM (vendor-clustered SE)	89% (78–95%)	<0.001

Boxes / cases / snuff	Exact binomial	89% (78–95%)	<0.001
Raw ivory	GLM (naïve SE)	100% (0–100%)	1
Raw ivory	Exact binomial	100% (3–100%)	1
Personal Effects & Implements	GLM (naïve SE)	83% (71–91%)	<0.001
Personal Effects & Implements	GLM (vendor-clustered SE)	83% (74–90%)	<0.001
Personal Effects & Implements	Exact binomial	83% (71–92%)	<0.001

Table S3. Cluster structure by category: number of vendors and listings per vendor (median, interquartile range, min–max).

Item category	Vendors (n)	Median listings/vendor	Q1 (25th pct.)	Q3 (75th pct.)	Min	Max
Boxes / cases / snuff	16	2	1	5.25	1	15
Figurine / carving	24	6.5	3	12	1	76
Games & Music	11	2	1	2	1	4
Inlaid work & fittings	15	1	1	3	1	12
Jewellery	17	5	2	6	1	34
Miniatures & Relief Art	18	4	2	8.25	1	27
Mixed Lot	16	2	1	5	1	8
Netsuke	15	8	5.5	28.5	1	60
Personal Effects & Implements	16	2	1	5.5	1	10
Raw ivory	1	1	1	1	1	1
Religious / devotional	15	2	1	4.5	1	11
Tableware & utensils	20	3	1.75	7.25	1	19
Writing, Drafting & Sewing Tools	17	2	1	3	1	16

Table S4. Vendor-level separation by category: counts of vendors with all sold, all passed/not sold, and mixed outcomes.

Item category	Vendors: all sold	Vendors: all not sold	Vendors: mixed
Boxes / cases / snuff	9	1	6
Figurine / carving	13	2	9
Games & Music	10	0	1
Inlaid work & fittings	9	2	4
Jewellery	7	2	8
Miniatures & Relief Art	10	0	8
Mixed Lot	15	0	1

Netsuke	7	0	8
Personal Effects & Implements	9	2	5
Raw ivory	1	0	0
Religious / devotional	12	0	3
Tableware & utensils	10	0	10
Writing, Drafting & Sewing Tools	12	1	4

Table S5. Calibration model specification & key diagnostics

Model	**Mean structure**	**Variance structure**	**Bias %**	**Slope [95% CI]**	**AIC (Δ vs linear)**	**δ (varPower)**	**σlog**	**n**	**Spline df**
GLS (linear, REML)	log y ~ log x	varPower{log x}	–11.7	0.907 [0.880–0.934]	1795.8 (0)	–0.648	1.636	1119	—
GLS (spline, REML)	log y ~ ns(log x, 3)	varPower{log x}	—	—	1796.8 (+1.0)	–0.655	1.655	1119	3
Huber (offset)	log(y/x) ~ 1	robust	–14.2	—	—	—	—	1119	—

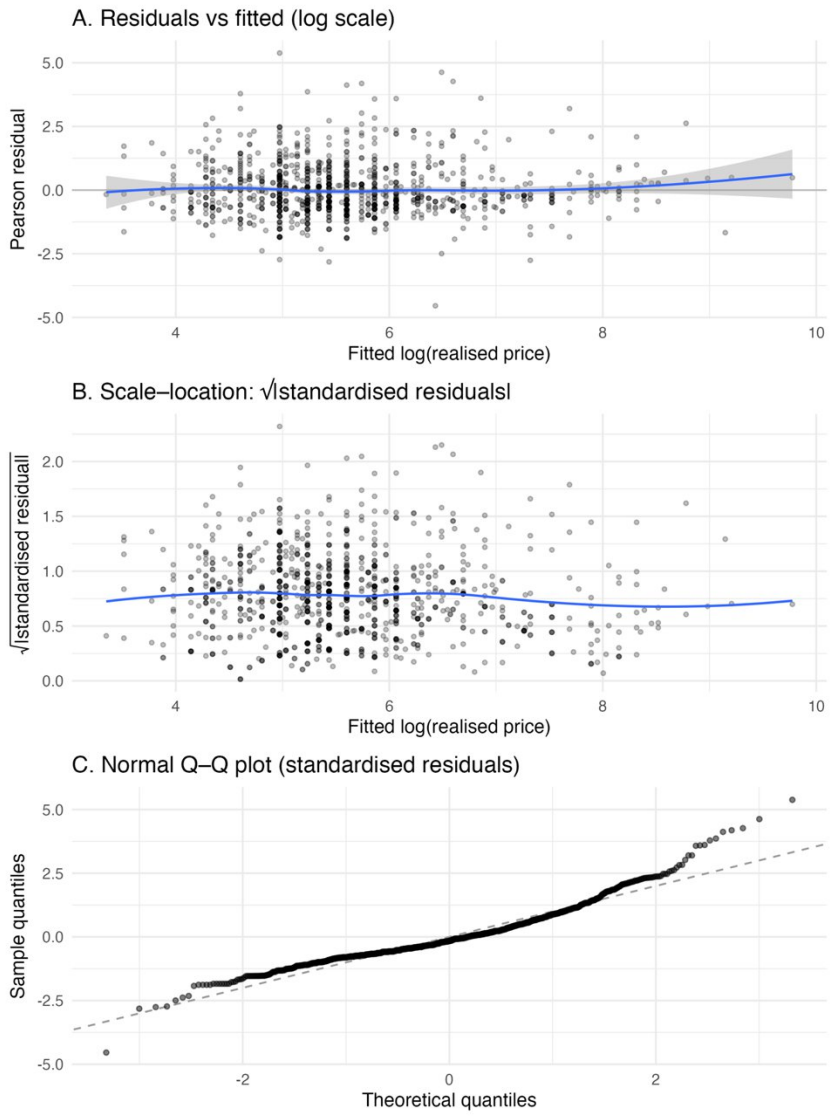

Fig. S1. Diagnostics for the GLS calibration model (REML, varPower on log(midpoint)). (A) Pearson residuals vs fitted (log scale) show increasing spread with price (heteroskedasticity). (B) Scale–location plot (√|standardised residuals| vs fitted) shows the same monotone increase in dispersion. (C) Normal Q–Q plot shows tail departures. Together, these motivate the varPower variance function and the use of quantile regression for uncertainty bands

Table S6. Converting dealer midpoints to expected realised prices by benchmark price decile. Multiply the dealer-estimate midpoint by the "Median (× mid)" to obtain a typical realised price; the central 80% band is given by the P10–P90 multipliers

Decile (by est. midpoint)	**Benchmark midpoint (AUD)**	**Median × mid**	**P10 × mid**	**P90 × mid**
q10%	90	0.94×	0.52×	2.27×
q20%	150	0.89×	0.53×	2.05×
q30%	160	0.89×	0.53×	2.02×
q40%	200	0.87×	0.53×	1.93×
q50%	250	0.85×	0.53×	1.84×
q60%	300	0.83×	0.53×	1.77×
q70%	400	0.81×	0.53×	1.67×
q80%	600	0.78×	0.54×	1.53×
q90%	1,250	0.73×	0.54×	1.31×

Table S7. Mixed-effects model comparison for category effects (REML). Response: log(realised price). Fixed effect: log(midpoint). *Random-effects SDs and residual SD on log scale. ΔAIC is relative to the best (lowest AIC). "Singular" indicates a boundary fit (per lme4::isSingular). Best model in blue.

Model	Random effects (lme4 syntax)	AIC	Singular	SD (cat intercept)	SD (cat slope)	SD (vendor intercept)	Residual SD (log)	n (obs.)	n (categories)	n (vendors)	ΔAIC
Random intercept + vendor	(1 | category) + (1 | vendor)	1770.5	FALSE	0.065	*NA*	0.23	*NA*	1119	12	32	0
Random intercept	(1 | category)	1820.7	FALSE	0.045	*NA*	*NA*	*NA*	1119	12	32	50.2
Random slope	(log_est | category)	1824.6	TRUE	0	0.008	*NA*	*NA*	1119	12	32	54.2

Table S8. Coverage of pooled 80% prediction band (by category). Definition: Coverage = share of sales with realised price falling between the pooled q10–q90 quantile-regression band for log(realised) ~ log(midpoint). Target ≈80%. Only categories with n ≥ 10 are shown

Category	**n (sold)**	**Coverage (q10–q90)**
Figurine / carving	298	78.90%
Netsuke	240	81.20%
Miniatures & Relief Art	104	82.70%
Jewellery	95	76.80%
Tableware & utensils	90	84.40%
Boxes / cases / snuff	55	83.60%
Writing, Drafting & Sewing Tools	48	85.40%
Religious / devotional	47	85.10%
Personal Effects & Implements	45	73.30%
Mixed Lot	44	77.30%
Inlaid work & fittings	35	77.10%
Games & Music	18	66.70%

Table S9. State-level surface-web ivory listings, vendors, and market concentration (Herfindahl–Hirschman Index (HHI), 0–1, higher = more concentrated), Australia, Jan–Jul 2025.

State	**No. listings**	**No. vendors**	**Listings by top vendor**	**Top-vendor share (%)**	**HHI**
NSW	906	28	211	0.2	0.1
VIC	639	23	171	0.3	0.2
QLD	107	7	46	0.4	0.3
SA	20	3	14	0.7	0.6
WA	18	4	10	0.6	0.4
TAS	10	2	5	0.5	0.5
ACT	3	2	2	0.7	0.6

Table S10. Auction sell-through by item category (sold vs passed/not sold). Estimates are from intercept-only logistic models with vendor-clustered Huber–White standard errors; cells show $\hat{p}$ and 95% CIs. "Vendor-clustered SEs" indicates clustered inference; categories with only one vendor/listing are shown descriptively.

Item category	Listings (n)	Sold / Not sold	$\hat{p}$ (%)	95% CI (%)	Inference
Boxes/cases/snuff	62	55 / 7	88.7	78.2–94.5	Vendor-clustered SEs
Figurine/carving	339	302 / 37	89.1	84.9–92.2	Vendor-clustered SEs
Games & Music	20	19 / 1	95	70.7–99.3	Vendor-clustered SEs
Inlaid work & fittings	44	35 / 9	79.5	62.9–89.9	Vendor-clustered SEs
Jewellery	115	95 / 20	82.6	69.3–90.9	Vendor-clustered SEs
Miniatures & Relief Art	121	104 / 17	86	77.8–91.4	Vendor-clustered SEs
Mixed Lot	45	44 / 1	97.8	86.4–99.7	Vendor-clustered SEs
Netsuke / Okimono	285	240 / 45	84.2	79.1–88.3	Vendor-clustered SEs
Personal Effects & Implements	54	45 / 9	83.3	73.8–89.9	Vendor-clustered SEs
Religious/devotional	53	47 / 6	88.7	74.1–95.6	Vendor-clustered SEs
Tableware & utensils	105	90 / 15	85.7	80.1–90.0	Vendor-clustered SEs
Writing, Drafting & Sewing Tools	56	49 / 7	87.5	78.6–93.0	Vendor-clustered SEs

Table S11. Listing-level prevalence by sale status (pooled across categories)

Outcome	**Sold (n=1125)**	**Passed/not sold (n=174)**	**Webstore (buy it now, n=397)**	**All (N=1696)**
Stated provenance	335 (30%)	67 (39%)	42 (11%)	444 (26%)
Stated provenience	91 (8%)	22 (13%)	44 (11%)	157 (9%)
Approximate age specified	620 (55%)	94 (54%)	336 (85%)	1050 (62%)
Documentation included	3 (<1%)	0 (0%)	0 (0%)	3 (<1%)

Table S12. GEE odds ratios vs sold (population-average; vendor-clustered robust CIs)

Outcome	**Contrast**	**OR**	**95% CI**	**p-value**
Stated provenance	passed vs sold	1.17	0.80–1.73	0.42
Buy it now vs sold	0.5	0.25–1.01	0.053	
Stated provenience	passed vs sold	1.52	0.99–2.33	0.058
Buy it now vs sold	1.46	0.85–2.53	0.17	
Approximate age specified	passed vs sold	0.9	0.67–1.22	0.5
Buy it now vs sold	3.88	2.55–5.93	<0.001	
Documentation included	Passed vs sold	—	—	—
Buy it now vs sold	—	—	—	

Table S13. R (v. 4.5.1) statistical packages and citations

Package	**Citation**	
dplyr	Wickham et al. 2022	
tidyr	Wickham et al. 2025a	
stringr	Wickham 2025	
readxl	Wickham and Bryan 2025	
readr	Wickham et al. 2025b	
tibble	Müller and Wickham 2025	
ggplot2	Wickham 2016	
scales	Wickham et al. 2025c	
nlme	Pinheiro et al. 2025	
lme4	Bates et al. 2015	
lmerTest	Kuznetzova et al. 2017	
MASS	Venables and Ripley 2002	
quantreg	Koenker 2025	
geepack	Halekoh et al. 2006	
sandwich	Zeileis et al. 2020	
lmtest	Zeileis and Hothorn 2002	
broom	Robinson et al. 2025	
broom.mixed	Bolker and Robinson 2025	
splines	Wang and Yan 2021	
patchwork	Pederson 2025	
ggh4x	van den Brand 2025	