  doi:10.1017/S037689291800005X

Using online media-sourced seizure data to assess the illegal wildlife trade in Siamese rosewood

PENTHAI SIRIWAT* AND VINCENT NIJMAN
Oxford Wildlife Trade Research Group, Department of Social Sciences, Oxford Brookes University, Oxford, OX0 1BP, UK
Date submitted: 30 November 2016; Date accepted: 13 January 2018

SUMMARY

The illegal wildlife trade is covert by nature, and thus is often challenging to study. Seizure data is traditionally the most common means to gain insight into the trade for many species. Online media-sourced seizure records were applied to study the illegal trade of Siamese rosewood (*Dalbergia cochinchinensis*), one of 33 timber species of *hongmu* (rosewood), which is logged to produce luxury products predominantly for Chinese markets. Despite recent international pressure to strengthen the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) regulations, illegal trade of Siamese rosewood is prevalent in its range states. This paper will explore seizure reports in Thai online media and analyse spatial, temporal and other factors that potentially explain the trade. Between January 2014 and April 2016, 835 independent seizures were reported in 37 of 76 provinces in Thailand. Seizures occurred mostly in the north-eastern and eastern provinces with higher numbers of seizures closer to the border. The number of seizure reports decreased over time, and the average number of logs seized per seizure was consistent over the 28-month study period. Inadequate domestic legislation is a key factor facilitating the trade. Improvements are needed to the legislation and enforcement ahead of implementing other regional timber-specific initiatives and regulations. In this specific context, CITES also appears to be unacknowledged and ineffective in hampering the Siamese rosewood trade. Importantly, we find that using media-sourced seizure data is highly apt in Thailand's context, considering Thailand's sensitive political state and the prevalence of trade in other non CITES-listed rosewood species. The approach demonstrated here is applicable to many other wildlife species.

*Correspondence: Penthai Siriwat email: siriwat.penthai@gmail.com
Supplementary material can be found online at https://doi.org/10.1017/S037689291800005X

Keywords: hongmu, rosewood trade, *Dalbergia*, illegal timber trade, Thailand, China

INTRODUCTION

The illegal trade in wildlife resources is one of the key threats to global biodiversity loss (Butchart *et al.* 2010). Trade occurs from local to global scales, most of which is unregulated, unsustainable and has detrimental effects on ecosystems (Duckworth *et al.* 2012). Due to its clandestine nature, there are several methodological difficulties in accurately monitoring the illegal wildlife trade, and the majority of previous work has been biased towards fauna over flora species (see Keane *et al.* 2008; Nijman 2010; Phelps & Webb 2015).

Although data on the illegal wildlife trade are inherently incomplete (Rosen & Smith 2010), seizure records such as in the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) trade database are a main source of information on the trade of several wildlife and plant species (Ferriss 2014; D'Cruze & Macdonald 2016; UNODC 2016). Data can also be acquired through national governments, regional enforcement offices, non-governmental organizations (NGOs; e.g. World Wide Fund for Nature (WWF), Environmental Investigation Agency (EIA) and TRAFFIC; Gomez *et al.* 2016) or specific database systems for high-profile species (Rosen & Smith 2010; Underwood *et al.* 2013; Challender *et al.* 2015). Using the CITES seizure data by itself can be relatively limiting, for reasons such as the periodic time lag between trade occurring and trade reporting (UNODC 2016), dependency on reporting rates for each country (Pistoni & Toledo, 2010; Milliken *et al.* 2012) and inaccuracy or absence of information on domestic trade (Blundel & Mascia 2005; Giles *et al.* 2006; Phelps *et al.* 2010), as well as the overlooking of trade in non-CITES species (Bruckner 2001; Schlaepfer *et al.* 2005; Rhyne *et al.* 2012). Alternative monitoring methods are therefore increasingly utilized to fill data gaps (Phelps & Webb 2015). One such example is the use of publicly available news articles to monitor the trade of pangolins (Nijman 2015; Cheng *et al.* 2017).

Among plant species, timber is one of the most traded items (Brack 2003), with illicit timber logging accounting for a substantial volume of activity (Sundström 2016). Several initiatives have been launched to promote the sustainable trade of various species (Li & Chen 2015). This includes

domestic and regional legislative bans on illegal timber (Brack 2010), forest certification systems to track the legality of forest products along the supply chain (Lawson & Macfaul 2010), legality verification (Li & Chen 2015) and global initiatives such as the Forest Law Enforcement Governance and Trade (FLEGT) action plan implemented to curb illegally sourced timber in markets by improving existing legislation in source countries whilst pushing consumer countries to heavily scrutinize imports (Cashore & Stone 2012). Furthermore, CITES, which is often seen to focus on animal species, has recently turned its attention to regulation of the commercial trade in many high-value endangered hardwood species (Schloenhardt 2008; Phelps & Webb 2015).

A group of timber species currently under significant threat from unregulated trading is rosewood. A specific group of rosewood species are further classified as *hongmu*, which consists of 33 species in five key genera consisting of *Dalbergia*, *Pterocarpus*, *Diospyros*, *Millitia* and *Cassia*, distributed across Africa, Latin America and Asia (Treanor 2015). *Hongmu* possess a characteristic heartwood, with unique deep-red colouring, aromatic scent and distinctive durability (EIA 2014). Several *hongmu* species have previously been logged to produce high-value decorative timbers (e.g. musical instruments; Innes 2010), but in the past decade have become popular in China among rapidly growing, wealthy, middle-class elites (Schuurman & Lowry 2009; Treanor 2015; CITES 2016a). This has led to highly unregulated trade and the commercial extinction of several species, including fragrant rosewood or *huang hua li* (*Dalbergia odorifera*) in China (EIA 2016) and Madagascar rosewood (*Dalbergia baronii*) (Schuurman & Lowry 2009; Innes 2010).

Siamese rosewood (*Dalbergia cochinchinensis*) is one of the high-grade rosewoods found in Cambodia, Lao PDR, Thailand and Vietnam (Winfield *et al.* 2016). The region of Southeast Asia serves as one of the hotspots for rosewood, particularly for *Dalbergia* and *Pterocarpus* species (Treanor 2015). Between 2000 and 2013, the Mekong region (Cambodia, Laos PDR, Myanmar, Vietnam and Thailand) exported over US$2.4 billion of rosewood to China, accounting for 70% of Chinese markets (EIA 2014). As a highly collectible and increasingly rare commodity, the market value of Siamese rosewood in 2012 was US$15 000 m^{-3}, 15-times higher than in 2005 (Wenbin & Xiufang 2013; EFI 2014). Domestically, Siamese rosewood has been legally protected in all its range states since 2008 (EIA 2014). Internationally, CITES included Siamese rosewood as an Appendix II species in 2013 (CITES 2016a) and in 2016 listed all *Dalbergia* species on Appendix II (CITES 2016b).

Despite increased efforts in regulation and enforcement, the illegal logging of Siamese rosewood remains rampant (EIA 2014; Singh 2014). The demand for such a high-value commodity has led to increased militarization within forests, resulting in fatal clashes between enforcement officers and armed loggers backed by organized syndicates and enforcement officers in Laos (Dwyer *et al.* 2016), Thailand (EIA 2014) and Cambodia (*Phnom Penh Post* 2017). This trade persists partly due to governmental commodification and lax import laws in China (Treanor 2015), but also due to corruption among governments, traders and local communities in source countries and the exploitation of legal loopholes in domestic and regional policies within the Asia-Pacific region (Schloenhardt 2008; Singh 2014; Sundström 2016). Most of the previous reports have highlighted the general global trade trends (e.g. UNODC 2016; Winfield *et al.* 2016), with a specific focus on the corrupt networks operating within the region (e.g. EIA 2014, 2016).

There are many factors that drive the illegal wildlife trade, including poverty, resource management, legislation, market demand and awareness (TRAFFIC 2008). Economic indicators such as gross domestic product and gross provincial product (GPP) are proxies that reflect the economic status of a population (Douglas & Alie, 2014). Although there are detailed complexities to the definition of poverty (Duffy *et al.* 2015), there is a strong relationship between poverty and illicit activity such as illegal wildlife hunting (Mackenzie *et al.* 2011). It is also crucial to evaluate the resource management or availability (TRAFFIC 2008) – in this case of source countries – of the remaining distribution of Siamese rosewood trees. As there are no updated official records on the remaining populations of rosewood (Schloenhardt 2008), forest cover per province is the only available proxy for remaining stocks (Patel 2007).

Here, we investigate the trade of Siamese rosewood in Thailand by using seizure records reported in public media from January 2014 to April 2016. We attempt to explain the patterns of the trade (Table 1). First, we test for spatial and temporal patterns associated with the trade, then we consider economic and ecological factors to explain patterns of trade. We discuss the effectiveness of domestic and international regulations currently implemented for the protection of rosewood species and we evaluate the use of media-sourced seizure data to study the illegal trade.

METHODS

Data collection

Public online news reports on Siamese rosewood seizures from January 2014 to April 2016 were searched in April to May 2016 in Thai language using the tags 'rosewood' (Thai: ไม้พะยูง, rosewood; ค้าไม้พะยูง, rosewood trade; จับไม้พะยูง rosewood arrests) News agencies included *Manager* (manager.co.th), *Thairath* (thairath.co.th), *Daily News* (dailynews.co.th), *MCOT* (tnamcot.com) and *Banmuang* (banmuang.co.th).

The five news agencies selected were the most popular daily online news sites in Thailand (4International Media & Newspapers 2016). The selection sufficiently covered the media coverage of Siamese rosewood seizures as represented in Thai online media; this is confirmed as the number of reports did not increase with the addition of more news sites. Details were collected for each article, where possible, on date, location (district and province), number and/or volume

https://doi.org/10.1017/S037689291800005X

Table 1 Hypotheses and respective proxies used to quantify and explain the trade of Siamese rosewood trade in Thailand. CITES = Convention on International Trade in Endangered Species of Wild Fauna and Flora.

Variable	*Hypothesized relationship*	*Proxy*	*References*
Spatial	Negative – as Siamese rosewood products are intended for international markets, it is expected that seizures will increase with distance from the border	Distance to closest land border from district within each province with the highest seizure rates	EIA 2014, 2016
Temporal	Positive – it is expected that the demand for Siamese rosewood is still high over time, given stocks are still available Negative – as CITES regulations were implemented in 2013, there could be a decrease in seizures	Number of seizures per trimester (4 months) with a time frame of 28 months (January 2014–April 2016)	EIA 2014; Schloenhardt 2008
Population	Positive – places with higher populations have more chances to have higher rates of wildlife crime	Provincial population	–
Economy	Negative – high economic reward for wildlife crime and illegal logging is expected to be more prevalent in poorer provinces	Gross provincial product	TRAFFIC 2008; Douglas & Alie, 2014; Winfield *et al.* 2016
Environment	Positive – illegal logging is expected to occur more in provinces with more forest resources (where Siamese rosewood stocks are available)	Provincial forest cover (national parks and forest areas)	Patel 2007; Schloenhardt 2008

seized, intended destinations and respective government agencies conducting the arrest. Other details were also included, such as if suspects were apprehended, nationality of suspects, if cash was also found in-hand or if other prohibited timber was also found in the same seizure. Each report was classified according to type as 'storage' (timber stored or hidden in private properties, facilities or warehouses), 'en route' (timber seized during transport), 'protected areas' (cases seized within or bordering government-protected areas) or 'on-the-spot logging' (reports of rosewood trees being cut down in non-protected areas).

Each news article normally corroborates the news source, often the arresting government, which increases the validity to the news article. The respective news sites were reviewed twice to ensure all cases were included. Each report was treated as an independent case and extensively cross-checked for repetition and factual accuracy. In the case of duplications, the report with the most details was selected (cf. Nijman 2015).

Statistical analyses

Each seizure (regardless of number of logs seized) was treated as one unit of analysis. Where available, we also analysed the number of logs seized. In Thai language, 'ton' (ท่อน) refers to log-shaped items, often referring to raw logs, debarked logs or even sawn logs of all sizes (branches, whole trunks and parts of trunks). Most records were of the number of 'logs' rather than volume of timber seized.

Data collected were separated into 4-month periods in order to analyse temporal trends and broken down to the provincial level for spatial analysis. To predict the provincial variation of the total number of logs and the number of seizures, we used the shortest overland distance to a land border, using the district with the largest number of seizures as the centre point, provincial human population size as of 2012 (NESBD 2014), GPP per capita for 2014 (in Thai baht) (NESBD 2014) and forest area (in km^2) for each province (DNP 2014).

All data were log-transformed prior to analysis. Statistical analysis was conducted using R version 3.2.1 (R Core Team 2016), using the simple linear (lm) model in R, accepting significance as $p < 0.05$ in a two-tailed test.

Monetary values were invariably reported in Thai baht; these were converted to US$ (US$1 = 35.7 baht, June 2016; in the 2.5-year period, the range was 31.8–36.4 baht).

RESULTS

General trade patterns

From January 2014 to April 2016, a total of 929 seizures were recorded from 37 of 76 Thai provinces, of which 835 were unique individual seizures (see Supplementary Table S1, available online). Approximately 94% (788/835) of these referred exclusively to Siamese rosewood, whereas the remainder also involved other prohibited woods such as Burmese rosewood (*Dalbergia oliveri*), Burmese padauk (*Pterocarpus macrocarpus*) and teak (*Tectona grandis*).

Seizures ranged from single logs through to over 10 000 logs seized from a private property in Amnatcharoen province in January 2015. A total of 88% (735/835) of seizures contained information on the quantities of Siamese rosewood seized, totalling 80 433 logs, suggesting that the total amount of seized goods might be close to 100 000 logs. Most seizures were reported in terms of 'logs' (394 referred specifically to 'logs'; 264 reported a mix of transformed logs); there were 85 seizures

https://doi.org/10.1017/S037689291800005X

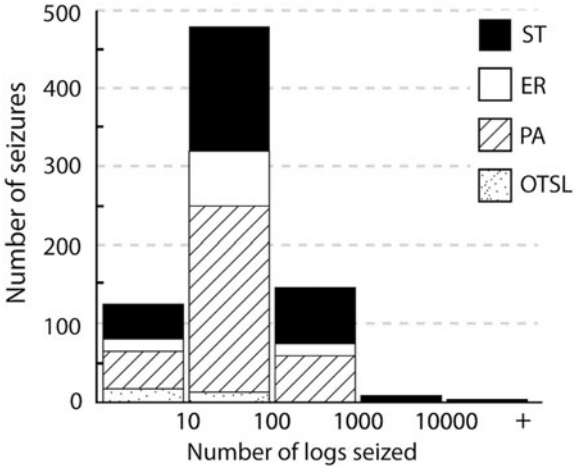

Figure 1 Plot of seizure frequency against number of logs per seizure in the following categories: 'on-the-spot logging' (OTSL; rosewood trees cut down in non-protected areas); 'protected areas' (PA; cases seized within or bordering government-protected areas); 'en route' (ER; timber seized during transport); and 'storage' (ST; timber stored or hidden in private properties, facilities or warehouses).

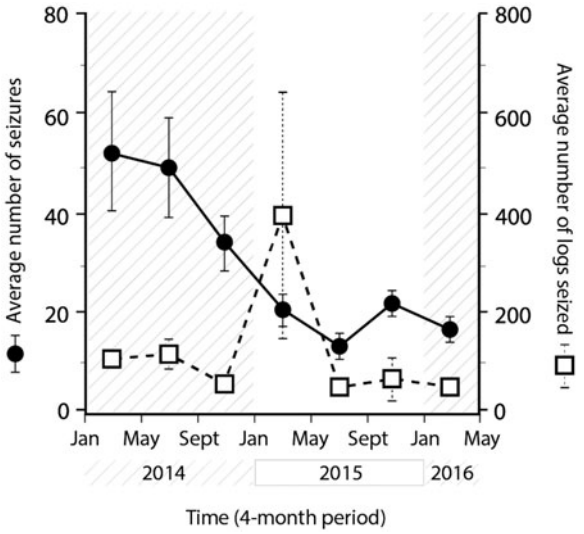

Figure 2 Plot of mean number of seizures (circles) and mean number of logs seized (squares) per 4 months from January 2014 to April 2016.

of sheets or sawn timber boards and 47 did not report details related to the form of the timber.

The average was 110 logs per seizure. The most frequent types of cases were seizures caught or en route (345/835), where seizures averaged 64 logs per seizure (Fig. 1). Logs found in storage seizures were larger, averaging 208 logs per seizure, and facilities used in storage-based seizures (278/835) ranged from individual private housing, cargo containers in shipping ports, abandoned warehouses, schools, temples and forest boundaries. Seventeen seizures from large-scale facilities and shipping port raids did not report exact volumes or numbers of logs seized. Seizures conducted within government areas, such as protected areas or wildlife sanctuaries (130/835), averaged 48 logs per seizure, with the highest rate of suspects caught, averaging three to four suspects per seizure. There was a significant decrease in the number of seizures over time (linear regression: $F_{1,5} = 18.32$, $p < 0.05$), but there was no statistical difference in the number of logs seized per seizure over time (linear regression: $F_{1,5} = 0.08$, $p = 0.79$) (Fig. 2).

In 45% (377/835) of seizures, suspects were apprehended at the scene. Where information was provided (301 seizures and 873 suspects), >81% of the suspects were Thai, and 85% (198/229) of Thai suspects originated or lived in the 20 provinces in the north-eastern region, where most of the seizures were made. Other suspects were found to be from bordering nations (145 from Cambodia, 16 from Laos and 2 from China). Vehicles were modified to maximize carry load, and in some cases front and/or back vehicles were present to scout for roadside checkpoints for the central vehicle and/or to serve as escape vehicles. Suspects were also found to carry cash-in-hand upon arrest. From the 109 reports that stated exact cash rewards, the amount of financial payment promised to the suspects averaged US$336 (range US$28–2801).

Legal protection of Siamese rosewood

Of the 835 reports, the Royal Thai Police were involved in 69% of all cases (579/835). Officers from the Department of National Parks, Wildlife and Plant conservation or the Royal Forestry Department were also present to verify the timber in 41% of cases (344/835). Thailand's military sector was involved in 45% of cases, with the navy patrolling heavily along the Mekong River. Other agencies involved included Thai Customs, the Immigration Bureau and the Department of Special Investigations. Most seizure reports refer to the legal penalties involving the possession of prohibited timbers in relation to the protection articles within the Thai constitution; however, in 929 reports, there was no mention of CITES regulations and/or penalties.

Spatial patterns of the Siamese rosewood trade

The rosewood trade in Thailand was concentrated in the north-eastern and eastern provinces, especially in provinces bordering Cambodia and Laos (Fig. 3). Provinces with the highest numbers of seizures reported are Ubonratchathani (201), Sisaket (96) and Mookdaharn (78). The Mekong River was used as the main crossing point for transport across the border, using motorized boats moored along the riverbanks. Many news articles indicated that the logs seized were being directed to China as a consumer country.

The numbers of seizures per province showed significant negative relationships with the distance to the nearest land border (linear regression: $F_{1,35} = 14.67$, $p < 0.0005$) and with the GPP per capita (linear regression: $F_{1,35} = 7.17$,

https://doi.org/10.1017/S037689291800005X

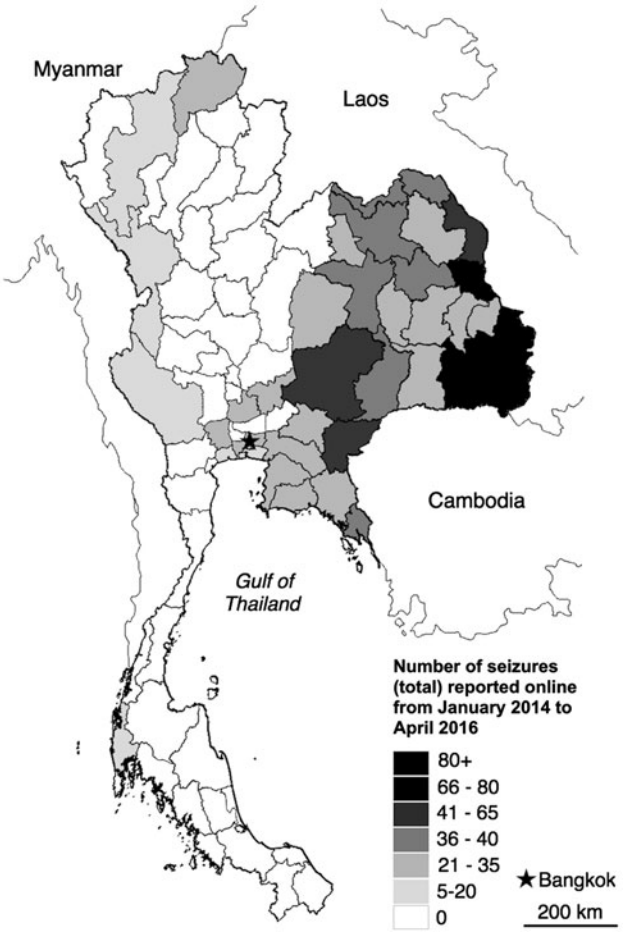

Figure 3 Distribution of rosewood seizures by province in Thailand from January 2014 to April 2016.

$p < 0.05$). Population size and forest cover showed no significant relationships with seizure rates (linear regression: $F_{1,29} = 0.27$, $p = 0.61$; $F_{1,27} = 0.11$, $p = 0.45$, respectively).

DISCUSSION

Using online-sourced seizure data, we show that the Siamese rosewood trade network is dispersed throughout Thailand, with a concentration in the eastern and north-eastern regions. Overall, Thailand acts as a source and transport country. Seizure activity was greater along the border with Cambodia and Laos, indicating intention to move the logs over the border for international trade, as per NGO reports that highlighted the pathway to China (EIA 2014, 2016; Treanor 2015). The Mekong River bordering Thailand, Laos and Cambodia is porous and encourages open movement as a convenient escape route (cf. Phelps *et al.* 2010). Industrial shipping ports are also increasingly used (e.g. Lamchabang port in Chonburi province), as cargo containers hold large volumes of logs that are often misdeclared as other products. The various modes of transport emphasize the large-scale domestic and regional networks operating for this trade.

One of the drivers of the trade could be money, as provinces with lower incomes (GPP) had higher seizures rates. The high financial reward for storing or transporting timber, in combination with unreliable income from traditional sources such as agriculture or farming (Reuters 2016), may incentivize people to get involved in illicit activity. The relationship between poverty and illicit activity such as wildlife hunting has been highlighted in previous literature (Mackenzie *et al.* 2011). Other factors in the present analysis did not show significant statistical correlation, but this could largely be due to misrepresentation. Although many cases of illegal rosewood logging occur within protected areas (Patel 2008; Schloenhardt 2008), it is not limited to just national parks; Siamese rosewood is also found to be targeted towards public spaces and private properties. The use of percentage forest area as an environmental proxy is therefore not directly representative; however, there is no recent census of the remaining population of Siamese rosewood (EIA 2014). This highlights the data gap that is required in order to effectively evaluate and manage this species.

The findings here represent a fraction of the trade. As one of the main agencies involved, the Department of National Parks, Wildlife and Plant Conservation has revealed that Siamese rosewood is still significantly seized in high volumes (DNP 2016). Political instability, poor governance and ill-conceived environmental policies are key drivers of corruption and exploitation of natural resources in developing nations (Innes 2010; Douglas & Alie 2014), and Thailand's political status has been relatively unstable since the military coup in 2014 (Freedom House 2016).

Utility of seizure data

Seizure reports are a viable source of data used to illustrate the presence and patterns of the Siamese rosewood trade in Thailand, as reported in previous studies of the illegal wildlife trade (Underwood *et al.* 2013; Nijman 2015; D'Cruze & Macdonald 2016; Gomez *et al.* 2016; UNODC 2016; Cheng *et al.* 2017). Although news articles are dependent on reporting rates in the same way as official seizure data are (Rosen & Smith 2010), the different numbers of news outlets increases the chances of reporting. When multiple reporting agencies are used to gauge seizure data, this makes it possible to capture the magnitude of the trade; however, double and triple reporting inevitably becomes an issue. By including just the two largest online news agencies (out of the five) in our study, we retrieved 81.4% of all seizure reports; adding the third largest led to an increase of 8.1%, a fourth 7.6%, whereas adding the fifth agency only added 2.9%. This shows that including more agencies only leads to marginal increases in the number of new seizure reports.

Given cautious and systematic data collection, online media can be a highly useful sources of alternative seizure data, as there are degrees of flexibility in conducting research

https://doi.org/10.1017/S037689291800005X

in different languages with minor geographic limitations (Nijman 2015). It is also a novel proxy that reflects real-time trends, independent of governments or monitoring agencies. This thereby addresses issues of the periodical delays in information being released by monitoring agencies such as CITES or UN Comtrade databases (Phelps *et al.* 2010). In Thailand, timber crime is not viewed as negatively as other illegal wildlife crime; therefore, authorities are more encouraged to report seizures.

The CITES trade database does not include the trade of other non-CITES listed species (Bruckner 2001; Schlaepfer *et al.* 2005; Rhyne *et al.* 2012), the poaching of species (UNODC 2016) or trade in domestic markets (Pistoni & Toledo 2010). Third-party monitoring sources can therefore be used to cross-check official government reports (Coston 1998; Blundell & Mascia 2005), and also to complement official trade statistics by providing valuable insight into the specific nuances of the trade and to reduce gaps in understanding. For example, in the CITES trade database, records on Siamese rosewood are relatively limited, only showing decreased export volume over time from key exporters such as Laos, Cambodia and Vietnam, and only one single report of confiscated Siamese rosewood from Germany to China (P. Siriwat & V. Nijman, unpublished data 2017). Therefore, these independent records of illegal trade activity, as used in this study, can be proactively used to monitor conservation efforts, help inform and reveal current gaps and ambiguities in the legal systems and lead to positive policy reforms extending beyond just monitoring and enforcement, which importantly corroborate and reflect current trade situations (Phelps *et al.* 2014; Phelps & Webb 2015).

Rosewood legislation

Inadequate domestic and regional legislation is a fundamental issue that needs to be addressed, and suggestions to review legislation for the live reptile and amphibian trade (Nijman & Shepherd 2011) and the orchid trade (Phelps 2013) in Thailand have previously been highlighted. In this rosewood-specific case, English translated names of species used by the Thai government are inconsistent with the international literature (Department of Agriculture 2016; see Supplementary Table S2). Unclear taxonomic nomenclature can lead to inaccurate reporting of legal and illegal trade or even delayed prosecution, and thus it is important to update legislation in order to minimize trans-border inconsistencies and enable law enforcement agencies to be in agreement (Zhou *et al.* 2016).

Similarly, inconsistencies in export quotas within the Mekong region open channels for corruption and for illegally sourced rosewood to cross borders and become legal for export (Innes 2010; EIA 2014). The Mekong River has been previously highlighted as a channel to move wildlife products such as wild orchids (Phelps *et al.* 2010) and other wildlife products (Shepherd *et al.* 2007). Higher export quotas and allowances in neighbouring countries like Laos and Cambodia inevitably drive the movement of logs across the border (Treanor 2015). Furthermore, despite the clear intention of crossing international borders, we found a lack of acknowledgement of CITES penalties in all 929 news reports. This suggests that crimes related to the Siamese rosewood trade may not be considered an international issue and may represent the state's indifference towards this convention (Nijman & Shepherd 2011).

At the 17th meeting of the Conference of the Parties to CITES (CoP17) in Johannesburg in September 2016, CITES, as the key regulating body of wildlife trade (Amilien 1996; Challender *et al.* 2015), approved several listings for the protection of rosewood (CITES 2016a, 2016b). While acknowledging the progress made, protection conventions need to be more effective in reflecting markets in an updated and realistic manner (Challender *et al.* 2015). Siamese rosewood stocks will inevitably be entirely depleted, thus proactive listings need to be proposed, especially for clear cases like Burmese paduak (*P. macrocarpus*), an unlisted, but commercially recognized *hongmu* species. Gaps in protection such as these shifts the burden onto unprotected species, effectively undermining controls implemented to protect all rosewood species. Furthermore, the question arises as to whether or not CITES is adequate to regulate trade in certain flora species (Brack 2003; Innes 2010; Phelps & Webb 2015). High-value timber species simply do not grow fast enough to compensate high logging rates and commercial trading volumes (Winfield *et al.* 2016). These problems are not new and have been highlighted in the regulations of Brazilian rosewood (*Dalbergia nigra*; Ferriss 2014) and broad-leaf mahogany (*Swietenia macrophylla*; Innes 2010).

Timber-specific trade regulations

Beyond CITES, there are several timber-specific trade initiatives directed at reducing the incentives for illegal logging and timber trade (Brown *et al.* 2008). Timber certification is one of the mechanisms aimed to promote sustainability (Cashore & Stone 2012), regulating the trade of rosewood species such as the north Indian rosewood (*Dalbergia sissoo*; Winfield *et al.* 2016). Beyond that, legality verification is another tool that combines elements of timber certification with principles of good forest governance (FLEGT) (Brown *et al.* 2008) to give decision-making and regulating powers to sovereign governments (Cashore & Stone 2012). Therefore, it shifts focus onto technical and innovative solutions to remove the supply of illegally sourced wood from global forest products and to achieve traceability of timber sources (Li & Chen 2015). As a result, this approach is growing in popularity, with positive reviews in implementation projects in China (Li & Chen 2015) and Indonesia (Maryudi 2015).

These policies provide some basic building blocks to help countries reach a level of legality assurance so as to effectively reduce the illegal timber trade (Cashore & Stone 2012). Of course, each policy has varying levels of

https://doi.org/10.1017/S037689291800005X

acceptance and objection (Brown *et al.* 2008); however, the effectiveness of each mechanism will depend largely on the political commitment of actors, interpretation of the scope and robustness of domestic law and enforcement (Cashore & Stone 2012; Li & Chen 2015). It is especially important to choose and enforce action plans that specifically address trade patterns in respective regions or locales (Phelps 2013). Moreover, timber trade, like all wildlife trade, requires centralized monitoring mechanisms that respond quickly to changes in supply, demand and pricing (Challender *et al.* 2015). Without the framework to estimate the magnitude of illegal logging and trade, it will be a challenge to effectively evaluate any of the proposed initiatives (Pepke *et al.* 2015). While it is positive to commit to larger conservation projects, it is imperative for governments to first re-evaluate priorities and focus on strengthening the backbone of domestic legislation and enforcement before extending beyond borders.

ACKNOWLEDGEMENTS

We thank A.W. Jones, E. Webb and one anonymous reviewer for their constructive comments and suggestions for improvement.

FINANCIAL SUPPORT

This research did not receive any specific grant from funding agencies in the public, commercial or not-for-profit sectors.

CONFLICT OF INTEREST

None.

ETHICAL STANDARDS

None.

Supplementary material

To view supplementary material for this article, please visit https://doi.org/10.1017/S037689291800005X

References

4International Media & Newspapers (2016) Top newspapers in Thailand by web ranking [www document]. URL http://www.4imn.com/th/

Amilien, C. (1996) Conflicting international policies in tropical timber trade. *Environmental Conservation* **23**: 29–33.

Blundell, A.G. & Mascia, M.B. (2005) Discrepancies in reported levels of international wildlife trade. *Conservation Biology* **19**: 2020–2025.

Brack, D. (2003) Illegal logging and the illegal trade in forest and timber products. *International Forestry Review* **5**: 195–198.

Brack, D. (2010) *Controlling Illegal Logging: Consumer-Country Measures*. London, UK: Chatham House.

Brown, D., Schreckenberg, K., Bird, N., Cerutti, P., Del Gatto, F., Diaw, C., Fomété, T., *et al.* (2008) *Legal Timber: Verification and Governance in the Forest Sector*. London, UK: Russell Press.

Bruckner, A.W. (2001) Tackling the trade in ornamental coral reef organisms. *Aquarium Sciences and Conservation* **3**: 79.

Butchart, S.H.M., Walpole, M., Collen, B., van Strien, A., Scharlemann, J.P.W., Almond, R.E.A., Baillie, J.E.M., *et al.* (2010) Global biodiversity: Indicators of recent declines. *Science* **328**: 1164–1168.

Cashore, B. & Stone, M.W. (2012) Can legality verification rescue global forest governance? Analyzing the potential of public and private policy intersection to ameliorate forest challenges in Southeast Asia. *Forest Policy and Economics* **18**: 13–22.

Challender, D.W.S., Harrop, S.R. & MacMillan, D.C. (2015) Understanding markets to conserve trade-threatened species in CITES. *Biological Conservation* **187**: 249–259.

Cheng, W., Xing, S. & Bonebrake, T.C. (2017) Recent pangolin seizures in China reveal priority areas for intervention. *Conservation Letters* **10**: 757–764.

CITES (2016a) *Consideration of Proposals for Amendment of Appendices I and II, CoP17 Prop. 53*. Johannesburg, South Africa: Convention on International Trade in Endangered Species.

CITES (2016b) *Consideration of Proposals for Amendment of Appendices I and II, CoP17 Prop. 55*. Johannesburg, South Africa: Convention on International Trade in Endangered Species.

Coston, J.M. (1998) A model and typology of government–NGO relationships. *Nonprofit and Voluntary Sector Quarterly* **27**: 358–382.

D'Cruze, N. & Macdonald, D.W. (2016) A review of global trends in CITES live wildlife confiscations. *Nature Conservation* **15**: 47–63.

Department of Agriculture (2016) การตรวจพิสูจนเนื้อไมพะยูง *[Rosewood Identification Handbook]*. Bangkok, Thailand: Department of Agriculture; Department of National Parks, Wildlife and Plant Conservation; Royal Forestry Department..

DNP (2014) ตาราง *1:* พื้นที่ป่าไม้แยกจังหวัด ปีพ.ศ. *2555-2556 [Table 1: Forest Areas by Province 2012–13]*. Bangkok, Thailand: Department of National Parks, Wildlife and Plant Conservation.

DNP (2016) สรุปรายงานการกระทำผิดกฎหมายเกี่ยวกับการป่าไม้ ของหน่วยงานในสังกัดกรมอุทยานแห่งชาติ สัตว์ป่าและพันธุ์พืช [*Annual forest crimes statistics from the Department of National Parks, Wildlife and Plant Conservation*]. Bangkok, Thailand: Department of National Parks, Wildlife and Plant Conservation.

Douglas, L.R. & Alie, K. (2014) High-value natural resources: Linking wildlife conservation to international conflict, insecurity, and development concerns. *Biological Conservation* **171**: 270–277.

Duckworth, J.W., Batter, G., Belant, J.L., Bennett, E.J., Brunner, J., Burton, J., Challender, D.W.S., *et al.* (2012) Why Southeast Asia should be the world's priority for averting imminent species extinctions, and a call to join a developing cross-institutional programme to tackle this urgent issue. *Sapiens* **5**: 77–95.

Duffy, R., St John, F.A.V, Büscher, B. & Brockington, D. (2015) Toward a new understanding of the links between poverty and illegal wildlife hunting. *Conservation Biology* **30**: 14–22.

Dwyer, M.B., Ingalls, M.L. & Baird, I.G. (2016) The security exception: Development and militarization in Laos' protected areas. *Geoforum* **69**: 207–217.

EIA (2014) *Routes of Extinction: The Corruption and Violence Destroying Siamese Rosewood in the Mekong*. London, UK: Environmental Investigation Agency.

EIA (2016) *The Hongmu Challenge: A Briefing for the 66th Meeting of the CITES Standing Committee*. London, UK: Environmental Investigation Agency.

EFI (2014) *China's Hongmu Furniture Industry and Timber Trade Linkages with Myanmar/Burma. Paper prepared for the International Workshop on Promoting Legal and Sustainable Trade and Investment of Forest Products (March 25–27)*. Shanghai, China: European Forest Institute.

Ferriss, S. (2014) *An Analysis of Trade in Five CITES-listed Taxa*. London UK: Chatham House/TRAFFIC.

Freedom House (2016) Freedom in the World 2016. Washington, DC, USA [www document]: URL https://freedomhouse.org/report/freedom-world/2016/thailand

Gomez, L., Leupen, B.T.C., Theng, M., Fernandez, K. & Savage, M. (2016) *Illegal Otter Trade – An Analysis of Seizures in Selected Asian Countries*. Selangor, Malaysia: TRAFFIC.

Giles, B.G., Ky, T.S., Hoang, D.H. & Vincent, A.C.J. (2006) The catch and trade of seahorses in Vietnam. *Biodiversity and Conservation* **15**: 2497–2513.

Innes, J. (2010) Madagascar rosewood, illegal logging and the tropical timber trade. *Madagascar Conservation & Development* **5**: 5–10.

Keane, A., Jones, J.P.G., Edwards-Jones, G. & Milner-Gulland, E.J. (2008) The sleeping policemen: understanding issues of enforcement and compliance in conservation. *Animal Conservation* **11**: 75–82.

Lawson, S. & MacFaul, L. (2010) *Illegal Logging and Related Trade, Indicators of the Global Response*. London, UK: Chatham House.

Li, J.Q. & Chen, S.Z. (2015) Empirical analysis on the practical feasibility of timber legality verification work in China. *Open Journal of Political Science* **5**: 167–179.

Mackenzie, C., Chapman, C.A. & Sengupta, R. (2011) Spatial patterns of illegal resource extraction in Kibale National Park, Uganda. *Environmental Conservation* **39**: 38–50.

Maryudi, A. (2015) Choosing timber legality verification as a policy instrument to combat illegal logging in Indonesia. *Forest Policy and Economics* **68**: 99–104.

Milliken, T., Burn, R.W., Underwood, F.M. & Sangalakula, L. (2012) *The Elephant Trade Information System (ETIS) and the Illicit Trade in Ivory: A Report to the 16th Meeting of the Conference of the Parties to CITES*. Cambridge, UK: TRAFFIC East/Southern Africa.

NESBD (2014) *Thailand GPP Per Province 1995–2014*. Bangkok, Thailand: National Economic and Social Development Board.

Nijman, V. (2010) An overview of the international wildlife trade from Southeast Asia. *Biodiversity and Conservation* **19**: 1101–1114.

Nijman, V. (2015) Pangolin seizure data reported in Indonesian media. *Traffic Bulletin* **27**: 44–46.

Nijman, V. & Shepherd, C.R. (2011) The role of Thailand in the international trade in CITES-listed live reptiles and amphibians. *PLoS ONE* **6**: e17825.

Patel, E.R. (2007) Logging of rare rosewood and palisandre (*Dalbergia* spp.) within Marojejy National Park, Madagascar. *Madagascar Conservation and Development* **2**: 11–17.

Pepke, E., Bowyer, K., Bratkovich, S., Fernholz, K,. Frank, M., Groot, H. & Howe, J. (2015) *Impacts of Policies to Eliminate Illegal Timber Trade*. Minneapolis, MN, USA: Dovetail Partners, Inc.

Pistoni, J & Toledo, L.F. (2010) Amphibian illegal trade in Brazil: What do we know? *South American Journal of Herpetology* **5**: 51–56.

Phelps, J. (2013) Uncovering the Trade of Wild-Collected Ornamental Plants in Thailand, Including Imports From Myanmar and Lao PDR. PhD Thesis, National Unviersity of Singapore, Singapore.

Phelps, J., Shepherd, C.R., Reeve, R., Niissalo, M.A. & Webb, E.L. (2014) No easy alternatives to conservation enforcement: Response to Challender and Macmillan. *Conservation Letters* **7**: 495–496.

Phelps, J. & Webb, E.L. (2015) 'Invisible' wildlife trades: Southeast Asia's undocumented illegal trade in wild ornamental plants. *Biological Conservation* **186**: 296–305.

Phelps, J., Webb, E.L., Bickford, D.P., Nijman, V. & Sodhi, N.S. (2010) Boosting CITES. *Science* **330**: 1752–1753.

Phnom Penh Post (2017) Cambodians shot by Thai soldiers over alleged logging – *Phnom Penh Post*, 27 June 2017 [www document]. URL www.phnompenhpost.com/national/cambodians-shot-thai-soldiers-over-alleged-logging

R Core Team (2016) *R: A Language and Environment for Statistical Computing*. Vienna, Austria: The R Foundation for Statistical Computing.

Reuters (2016) As Asia's rice crop shrivels, food security fears resurface. Thomson Reuters Foundation News [www document]. URL www.reuters.com/article/us-asia-rice/as-asias-rice-crop-shrivels-food-security-fears-resurface-idUSKCN0XS1NG

Rhyne, A.L., Tlusty, M.F., Schofield, P.J., Kaufman, L., Morris Jr, J.A. & Bruckner, A.W. (2012) Revealing the appetite of the marine aquarium fish trade: The volume and biodiversity of fish imported into the United States. *PLoS ONE* **7**: e35808.

Rosen, G.E. & Smith, K.F. (2010) Summarizing the evidence on the international trade in illegal wildlife. *EcoHealth* **7**: 24–32.

Schloenhardt, A. (2008) *The Illegal Trade in Timber and Timber Products in the Asia-Pacific Region*. Canberra, Australia: AIC.

Schuurman, D. & Lowry, P. (2009) The Madagascar rosewood massacre. *Madagascar Conservation & Development* **4**: 98–103.

Schlaepfer, M.A., Hoover, C., Dodd Jr, K. (2005) Challenges in evaluating the impact of the trade in amphibians and reptiles on wild populations. *BioScience* **55**: 256–264.

Shepherd, C.R., Compton, J. & Warne, S. (2007) *Transport Infrastructure and Wildlife Trade Conduits in the GMS: Regulating Illegal and Unsustainable Wildlife Trade. Biodiversity Conservation Corridors Initiative; International Symposium Proceedings 27–28 April 2006*. Bangkok, Thailand: Asia Development Bank.

Singh, S. (2014) Borderland practices and narratives: Illegal cross-border logging in northeastern Cambodia. *Ethnography* **15**: 135–159.

Sundström, A. (2016) *Understanding Illegality and Corruption In Forest Management: A Literature Review*. Gothenburg, Sweden: The Quality of Government Institute.

TRAFFIC (2008) *What's Driving the Wildlife Trade? A Review of Expert Opinion on Economic and Social Drivers of the Wildlife Trade and Trade Control Efforts in Cambodia, Indonesia, Lao PDR and Vietnam. East Asia and Pacific Region Sustainable Development Discussion Papers*. Washington, DC, USA: World Bank.

Treanor, N.B. (2015) *China's Hongmu Consumption Boom: Analysis of the Chinese Rosewood Trade and Links to Illegal Activity in Tropical Forested Countries*. Washington, DC, USA: Forest Trends.

https://doi.org/10.1017/S037689291800005X

Underwood, F.M., Burn, R.W. & Milliken, T. (2013) Dissecting the illegal ivory trade: An analysis of ivory seizures data. *PLoS ONE* **8**: e76539.

UNODC (2016) *World Wildlife Crime Report*. Vienna, Austria: United Nations Office on Drugs and Crime.

Wenbin, H. & Xiufang, S. (2013) *Tropical Hardwood Flows in China: Case Studies of Rosewood and Okoumé*. Washington, DC, USA: Forest Trends, World Agroforestry Centre, CIFOR.

Winfield, K., Scott, M. & Grayson, C. (2016) Global status of *Dalbergia* and *Pterocarpus* rosewood producing species in trade [www document]. URL www.global-eye.co/ge/wp-content/uploads/2016/09/CoP17-Inf-Doc-XXX-English-Exec-Summ-Global-Overview.pdf

Zhou, Z.-M., Newman, C., Buesching, C.D., Meng, X., Macdonald, D.W. & Zhou, Y. (2016) Revised taxonomic binomials jeopardize protective wildlife legislation. *Conservation Letters* **9**: 313–315.

https://doi.org/10.1017/S037689291800005X