UNCOVERING THE TRADE OF WILD-COLLECTED ORNAMANTAL PLANTS IN THAILAND, INCLUDING IMPORTS FROM MYANMAR AND LAO PDR

JACOB PHELPS

B.S (Hons.) Michigan State University

M.Phil. University of Cambridge

THESIS SUBMITTED
FOR THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF BIOLOGICAL SCIENCES
NATIONAL UNIVERSITY OF SINGAPORE

2013

Declaration

I hereby declare that the thesis is my original work and it has been written by me in its entirety. I have duly acknowledged all the sources of information which have been used in the thesis.

This thesis has also not been submitted for any degree in any university previously.

Jacob Phelps
08 July, 2013

Summary

Wild-collected botanical resources are widely traded across Southeast Asia. There is growing concern over the conservation of commercially-traded ornamental plants—notably the family Orchidaceae, trade in which is regulated under the Convention on International Trade of Endangered Species of Fauna and Flora (CITES). However, there is virtually no baseline data on their regional trade dynamics or conservation. Between May 2011 and June 2012, we interviewed plant harvesters, traders and middlemen (N=158), made market observations and conducted botanical surveys of Thailand's four largest plant markets, at Jatujak Market (Bangkok), Chedi Sam Ong and Dan Singkorn Markets (Thailand-Myanmar border) and Mukdahan Market (Thailand-Lao PDR border). The multidisciplinary study provides initial baseline data on the ornamental plant trade, and leverages the case to explore broader themes, including wildlife farming, CITES implementation, and conservation rule-breaking.

Surveys uncovered a previously undocumented regional trade dominated by Orchidaceae (87.5% of documented trade), including more than 82,000 orchid specimens of 347 species in 93 genera. Although highly conservative estimates, observed volume and richness were orders of magnitude greater than CITES-reported trade records for the region since 2004, highlighting clear potential for improved monitoring. Moreover, many encountered species were listed as threatened in Thailand (57 species), although conservation assessments are lacking for most species and countries in the region (>75% species unassessed). Yet, approximately 60% of observed trade was dominated by only 4 genera (*Dendrobium, Rhynchostylis, Aeries* and *Paphiopedilum*), highlighting limitations of heavy regulation, as well as scope for more nuanced trade monitoring and regulation, and potentially *in situ* resource management for targeted species, beginning with those identified in this study.

Value Chain Analysis highlighted that most plants originated from neighbouring Myanmar and Lao PDR, traded via complex routes and networks often involving multiple steps, challenging enforcement and conservation efforts. However, mapping and nuanced study of trade dynamics uncovered prospective interventions, including through geographic targeting, trade bottlenecks, and gaps in existing enforcement efforts. Characterization of trade participants further revealed potential for integrating various human dimensions into trade regulation. For example, the relatively short tenure of most traders (~5 years), clear economic motivations for engaging in plant trade over other employment, and reported existence of alternative livelihoods suggest that the social costs of increased enforcement may be acceptable. Yet, trade is heavily gendered, and there is a clear need to account for how increased enforcement or alternative livelihoods would particularly affect women.

In these ways, the thesis reflects back on how to improve wildlife trade management, and proposes a range of strategies through which to strengthen CITES implementation, related to systematic data collection, responsive monitoring, rigorous data analysis, and peer review. Improved implementation also requires an imporoved understanding of how traders circumvent conservation laws. Direct study of *de facto* practices at the plant markets revealed that rule-breaking can be both heterogeneous and locally institutionalized, suggesting that improved resource management requires more than simple enforcement, but efforts to align state and social forms of authority, and increased checks-and-balanced through a more functional multi-level governance.

Howver, prospective interventions extend beyond regulation and enforcement, and we also evaluated the potential for wildlife farming to yield conservation outcomes, as explored through trade of the ornamental orchid, *Rhynchostylis gigantea*. Morphometric measurements of wild (N=401) and cultivated (N=469) plants, and trader (N=13) and consumer interviews (N=23) highlighted a range of explanations for why such supply-side interventions may lack effectiveness. Notably, consumer and trader preferences for wild-collected products, barriers to farming, low enforcement and few financial incentives to participate in cultivation, highlight the need for additional interventions across the market chain.

This thesis represents among the most in-depth, multifaceted studies on wildlife trade. It not only characterizes a largely unrecognized facet of the illegal wildlife trade in Southeast Asia, but leverages the case to explore trade dynamics of relevance to other taxa and the broader region.

Acknowledgements

My appreciation to the dozens of plant harvesters and traders who participated in the study—allowed us to handle their plants, patiently answered our questions, and shared details about their lives and experiences.

With my most sincere appreciation to Hannah Watson for her help with fieldwork, sense of adventure, unfailing support and love.

Thank you to my Supervisor, Dr. Edward L. Webb, for his insight and comments, encouragement, friendship and hospitality.

Thank you to my excellent and patient field assistants and translators, Buraskorn Torut, Dr. Htee Heh and Sirinath Matra.

Thank you my parents, Sybil and Bill Phelps, for their tremendous support and for fueling my interest in nature. Thank you also the rest of the Phelps and Watson families (Myra, Jacky, Cass) for their encouragement and tolerating forest walks and botanic garden visits.

Thank you to:

Dr. Patana Thavipoke for sharing his extensive knowledge about Thai orchids and regional trade, and for his kind friendship.

Dr. Somran Suddee of his team at the Bangkok Forest Herbarium for their assistance with taxonomic verifications and CITES paperwork.

Dr. Dan Arbuthnot Friess for keeping me well hydrated throughout this process.

Dr. Roman Carrasco, Alison Wee, Sheila Poo, Grace Blackham for their friendship and kind technical help.

Rachel Webb and the rest of the Applied Plant Ecology Lab family for their support.

Dr. Thiraphong Bualar for his frequent help and long friendship.

Professor Kasin Suvatabhandhu Herbarium for hosting me and sharing their resources.

My Committee Members, Dr. David Bickford, Dr. Carl Grundy-Warr and the late Dr. Navjot S. Sodhi for their input and patience reviewing this thesis.

Dr. Arun Agrawal, Dr. Carl Olson, Dr. Ganesh Shivakoti and Dr. Kyoko Kusakabe for their comments and suggestions.

The National Research Council of Thailand for their support and for ensuring that this research could go ahead.

The community of Southeast Asian orchid experts and taxonomists for their advice and help with identifications, including: Dr. Hubert Kurtzweil, Dr. Jaap Vermeulen, Jim Cootes, Peter O'Byrne, Dr. Santi Watthana, Dr. Piyakaset Suksathan, Dr. Bill Thompson, Matti Nissalo.

To Reena Devi, Priscilla Li and the Graduate Committee for their support.

To Kevin Glass and Mamie Heard for setting me on the right track.

This research was funded by The National University of Singapore Research Scholarship and President's Graduate Scholarship, The Rufford Small Grants for Nature Conservation, and the Harry S. Truman Scholarship.

In fond memory of John M. Hall III

Table of Contents

List of Figures

List of Tables

List of Maps

List of Photographs

Glossary of key terms, abbreviations and organisations

ANOM = Analysis of Means; ANOM is used to compare means and variances across multiple groups and can be used to test whether any of the means in the group are stastitically different from the overall mean.

CITES = The Convention on International Trade in Endangered Species of Wild Fauna and Flora Species; Established in 1973, CITES is an international multilateral agreement to ensure that international trade of wild flora and fauna does not threaten species survival. It now has 179 signatories, and regulates trade of more than 35,000 species.

CITES Appendices = CITES-listed species are categorized into three Appendices based on the degree of protection they require.

CITES Appendix I = Appendix I species are listed by agreement of Parties to the Convention, and includes species considered threatened with extinction. Commercial trade of Appendix I species is banned and other types of trade are permitted only in exceptional circumstances, such as scientific research.

CITES Appendix II = Appendix II species are listed by agreement of Parties to the Convention, and their trade is controlled in order to avoid trade that could endanger species survival. In some cases (e.g., Orchidaceae), Appendix II also includes species that resemble threatened or endangered species (see "look-alike" species).

CITES Appendix III = Appendix III includes species listed by a least one Party nation, which has asked other Parties for assistance in controlling trade. Species can be listed unilaterally.

CITES Secretariat = The CITES Convention Secretariat is administered by the United Nations Environmental Programme in Geneva, Switzerland, and is responsible for a wide range of administrative roles important to implementation of the Convention, including arranging meetings, providing technical assistance to Parties, collecting annual reports, and making recommendations regarding Convention implementation.

CITES Management Authority = One or more CITES Management Authorities are designated by each Party to the Convention, and are responsible for administering domestic licensing systems for CITES-listed wildlife.

CITES Res Conf 8.3 [Rev CoP13] = CITES Resolution adopted at the 13th meeting of the Conference of Parties in 2004, which recognizes "that implementation of CITES-listing decisions should take into account potential impacts on the livelihoods of the poor".

CITES Scientific Authority = Scientific Authorities are designated by each Party to the Convention and are responsible for advising national Management Authority(ies) on the effects of trade on the status of target species, including regarding Non-Detriment Findings.

de jure and *de facto* practices = Often contrasted, *de jure* refers to practices according to a law, while *de facto* practices are not necessarily legally sanctioned, or may even contravene an existing law.

EOO = Extent of Occurrence; EOO is a principle criteria used in the IUCN Red List Categories and Criteria in order to classify species based on their risk of extinction. EOO refers to the area contained iwthin the shortest continuous imaginary boundary that could be drawn to encompass all the known, inferred or protected sites of present occurrence of a taxon.

GLMM = General Linear Mixed Model

GMS = Greater Mekong Subregion

IUCN Red List = International Union for Conservation of Nature and Natural Resources Red List of Threatened Species; A collaboration between the IUCN Species Programme and the Special Survival Commission, the Red List establishes criteria and supports efforts to assess the conservation status of species, subspecies, varieties, and selected subpopulations on a global scale in order to highlight taxa threatened with extinction.

Kew World Checklist of Orchidaceae = Part of the World Checklist of Selected Plant Families managed by Kew Royal Botanic Gardens, the Checklist of Orchidacea is an international collaborative programme that provides the latest information on the accepted scientific names and synonyms for Orchidaceae.

"Look-alike" species = Refers to species that resemble other species. Regardless of their individual conservation designations, these species sometimes face precautionary CITES trade restrictions in order to avoid confusion and laundering.

NDF = Non-Detriment Finding; In order to obtain CITES import or export permits for listed species, NDFs are required. NDF involves a Party's Scientific Authority advising that thrade will not be determinetal to the survival of that species. NDFs can consider factors such as population status, trade patterns and distribution, and can call on outside expertise.

NTFP = Non-Timber Forest Product; NTFPs is a wide-reaching, often debated term that refers to wild-collected forest resources, excluding timber, but often including other forest products such as honey (see Belcher 2003). Here it is considered to include wild-collected ornamental plants.

Parties/Parties to the Convention = Refers to nations signatory to the CITES Convention.

Profitability analysis = Refers to part of the economic analysis that considers returns on investment.

TRAFFIC = TRAFFIC, the Wildlife Monitoring Network; Established in 1976, TRAFFIC is an international organization created thorugh a partnership between WWF and IUCN, which works closely with the CITES Secretariat to ensure that trade in wild plants and animals is not a threat to the conservation of nature. It has a strong focus on trade in East and Southeast Asia.

UNEP-WCMC = United Nations Environmental Programme–World Conservation Monitoring Centre; UNEP-WCMC is a collaboration between the intergovernmental organization UNEP, and the UK charity WCMC. UNEP-WCMC is the UNEP's specialist on biodiversity assessment, and is responsible for collating, verifying and synthesizing information on biodiversity and ecosystems to inform policy, including CITES trade data submitted by the Management Authorities globally.

VCA = Value Chain Analysis; VCA is a methodological tool that considers, maps and describes the range of activities and actors involved from production through to the final purchase of a product.

WWF = World Wide Fund (USA) or World Wide Fund for Nature (elsewhere); WWF is a leading non-governmental conservation organization that runs various programmed across the Greater Mekong region, including Thailand. It is involved in conservation practice, restoration and research.

Chapter 1:
Introduction to ornamental plant trade in Southeast Asia

1.1 Wildlife trade threat to biodiversity

Wildlife trade[1] refers a wide range of plant and animal species, their parts and derivatives that are harvested for a wide variety of medicinal, culinary, aromatic, cosmetic, ornamental, construction and cultural uses (among others). While sustainable trade has been achieved in some contexts, overharvest is common—particularly in the context of commercial trade (Dulvy et al. 2003; Milner-Gulland & Bennett 2003; Schreckenberg et al. 2006; Warkentin et al. 2009).

Commercial trade is a prominent threat to the conservation of many plant and animal species, and can have profound effects—extirpations and extinctions, changes in community composition and loss of genetic diversity (Ng and Tan 1997; Bennett et al. 2002; Dulvy et al. 2003; Milner-Gulland & Bennett 2003; Sodhi et al. 2004; Sutherland et al. 2009; Warkentin et al. 2009; Keping Ma et al. 2010; Sharrock 2011). These changes can have cascading ecological effects, economic impacts (Gavin et al. 2009; Peres 2010), and compromise protected areas (e.g., Johnson et al. 2003; Sylvester and Avalos 2009). Moreover, wildlife trade is a common vector for infectious diseases (Daszak et al. 2000; Smith et al. 2009), and invasive species (Vitousek et al. 1996) that also affect agriculture, livestock and public health.

Within Southeast Asia, wildlife trade represents a leading threat to biodiversity

[1] While in some contexts the term "wildlife" is understood to refer only to fauna or specifically to game, "wildlife" and "wildlife trade" are referred to here as including all harvested plants and animals, their parts and derivatives, including for subsistence and commercial use, both small and large-scale. This generally follows the broad definition adopted by CITES, which refers to wild flora and fauna (1973).

conservation (Nash 1997; Noreen and Claridge 2001; Sodhi et al. 2004, 2008; McNeely et al. 2009; CBD 2009). The region includes the world's 'hottest hotspots' for species diversity and endemism (Myers et al. 2000), but is subject to significant wildlife trade (WB 2005; Sodhi et al. 2008; Rosen and Smith 2010; Nijman 2010). There is diverse evidence of trade in threatened animal species across the region, including of bears (Shepherd and Nijman 2007), turtles (Nijman and Shepherd 2007; Shepherd and Nijman 2008), big cats (Shepherd and Nijman 2008b; Oswell 2010), seahorses (Giles et al. 2006); various reptiles (Nijman and Shepherd 2010, 2011) and bushmeat (Van Song 2008). There is also evidence that the region is important to the broader regional and international transit of wildlife (Nijman and Shepherd 2010b, 2011; Nowell 2012).

1.2 Trade in botanical resources

Botanical resources[2] are an especially diverse and important wildlife category. They include a wide range of taxa, and both timber and non-timber forest products (NTFPs) such as including fuelwood, food products, commercial resins, and ornamental species (Cotton 1996; Marshall et al. 2006). In addition, Schippman et al. (2002) estimate that ~50,000 species are medicinally exploited, and that ~2,500 species are globally traded for medicinal and aromatic properties.

Roughly 0.955-1.455 billion people directly depend on forest resources for their livelihoods (Scherr et al. 2003). Many of these communities, particularly poor households, are directly dependent on them for household provisions (Neuman and

[2] Plant-based resources have been broken up into a number of different categories associated with different disciplines and agendas (e.g., rural development, conservation, ethnobotany; see Belcher 2003). These typologies are not employed here, and I refer more generally to "botanical resources" or Non-timber Forest Products (NTFPs).

Hirsch 2000). However, forest resources can also provide safety nets during periods of hardship, livelihood diversification, and a broad range of income generation opportunities (Wollenberg and Ingles 1998; Neuman and Hirsch 2000; Shackleton and Shackelton 2004). These include benefits can also extend to employees of downstream forest-based enterprises (Scherr et al. 2003) and a chain of downstream botanical traders (Stoian 2005; Jensen 2009).

There is growing concern over the impacts of large-scale commercial trade on botanical diversity (e.g., Jenkins and Oldfield 1992; Galetti and Fernandez 1998; Schippman et a. 2002; UNEP-WMCM 2007; CBD 2009). However, given the diversity of species and harvest regimes, the sustainability of wildlife harvest can vary significantly (Peres 2010). Vulnerability of botanical resources to overharvesting has been largely be conceptualized in terms of four factors: 1) species rarity, as shaped by geographic range, habitat specificity and the size of local populations (Rabinowitz 1981; Schippman et al. 2002); 2) harvest intensity and scale of trade, including whether harvest is for subsistence purposes or commercial, and whether use is for local, domestic, regional or international markets (e.g., Belcher et al. 2005); 3) what part of the plant is harvested (e.g., leaf, root, whole-plant) and how this impacts individual survival, and 4) and the life form and history of the species (e.g., annual, perennial, tree) (Schippman et al. 2002).

Evidence broadly suggests that increased harvest collection pressures is generally associated with decreased wild resource bases (e.g., Galetti and Fernandez 1998; Belcher et al. 2005). Furthermore, anecdotal evidence from across the Southeast Asia suggests that wild harvest is negatively impacting the populations of a number of plant species, including medicinal species and ornamental plant groups such as Cycadaceae, Nepenthaceae and Orchidaceae (Cribb 1987; Foppes et al. 1996; Cribb et al. 2003; Schuiteman et al. 2008; Ashwell and Walston 2008; Lamxay 2008; WWF 2009). The Convention on Biological Diversity's Global Strategy for Conservation of Plants specifically aims to ensure "No species of wild flora (is) endangered by international trade" (CBD 2010)

1.3 Trade in Southeast Asian Orchidaceae

Southeast Asia is a center of global orchid diversity (Koopowitz et al. 2003; Table 1.1). The orchid flora of Thailand has been comparatively well studied (Seidenfaden 1975-1988), although remains incomplete (e.g., Pedersen and Ormerod 2009; Vermeulen and Phelps, in prep.). Orchid flora of the broader Southeast Asian region remains largely unexplored and are expected to grow (Schuiteman and Vogel 2000; Lwin 2005; Schuiteman et al. 2008; Schuiteman et al. 2008b; Hinsley 2011; Kurtzweil 2011; H. Kurtzweil, Singapore Botanic Gardens, pers. comm.).

Table 1.1. Approximate number of orchid genera and species in countries targeted in this study: Thailand, Myanmar and Lao PDR

Country	Genera	species	Reference
Thailand	~162	~1200	(Schuiteman and Vogel 2004; Govearts 2012)
Myanmar	<150	~800	(H. Kurtzweil, Singapore Botanic Gardens 2013, pers. comm.)
Lao PDR	108	485	(Schuiteman et al. 2008)

There is a long history of commercial wild-collected orchid trade in Southeast Asia, notably of ornamental orchids for international export to Europe and the United States (Cribb et al. 2003; Koopowitz et al. 2003). However, those exports have decreased from the historical highs when hundreds of thousands of wild plants were commercially exported to collectors overseas (Koopowitz et al. 2003). While, in the case of Thailand, a lucrative commercial floriculture industry has emerged in its place

(Cheamuangphan et al. 2013), the international trade of wild-collected ornamental plants continues across the region (Kew 1999; WB 2005; UNEP-WCMC 2007; others). Despite improving CITES implementation in the region, the First Asian Plant Conservation Report acknowledged insufficient progress in reducing illegal trade of protected plant species (Keping Ma et al. 2010). A 2007 review of trade data reported under the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) between 1995-2005, identified international commercial trade in 259 newly-described orchid species, including from Indonesia, Malaysia, Thailand and Philippines (UNEP-WCMC 2007). Although the vast majority of CITES-documented trade is reported artificially propagated (UNEP-WCMC 2007; CITES 2013), there is also broad, if scattered, evidence that wild specimens are in trade, including newly discovered Southeast Asian species (Vermeulen and Lam 2011; see also Chapter 3). For example, since the 1980's, Thailand's Plant Authority for Thailand has reportedly[3] documented approximately 500 wild-collected orchid species in regional and domestic trade (M. Jaichagun, CITES Thailand Management and Scientific Authority for Plants, pers. comm.). A 1996 market assessment on a Thai-Lao PDR border market documented high trade volumes of ornamental plants, including 56 orchid species in 20 genera and 35 other ornamental species (Foppes 1996), and a recent market visit documented wild orchid trade surrounding Cambodia's Cardamom Mountains (Hinsley 2011). Botanical field surveys across Southeast Asia have also encountered commercial trade in wild orchids, including in the limestone karsts of Sarawak (Rusea et al. 2009), Lao PDR (Schuiteman et al. 2008; Lamxay 2008) and Vietnam (Averyanov et al. 2003; Averyanov 2011). Previous studies have also recorded commercial trade of other Southeast Aasian

[3] Data not publicly available.

ornamental plants, including in the families Polypodiaceae, Huperziaceae, Cycadaceae, Nepenthaceae and Gesneriaceae (e.g., Foppes 1996; Simpson 1995; Bhima 2003; WWF 2004; Lwin 2005; Jenning and Rhor 2011). There is also some evidence to suggest growing regional demand for wild medicinal and ornamental plants, including protected orchid species harvested in Lao PDR, Myanmar, Vietnam, Malaysia, and Cambodia for consumers in Thailand and China, and for re-export to botanical collectors and medicinal shops in Japan, USA, Europe, Taiwan and Korea (Kong et al. 2003; Cribb et al. 2003; WB 2005; Laxmay 2008).

Most of these trade phenomena, however, have been been formally monitoried or researched, although there is mounting conservation concern. Field reports from Lao PDR document that thousands of tons of medicinal orchids have been traded with China and Thailand, and botanists at the National University of Lao PDR report a decrease in wild orchid populations, including within protected areas (Lamxay 2008). There are also several historical cases of local and regional orchid extinctions as a result of over-collection for the ornamental trade, notably in charismatic genera such as *Paphiopedilum* (Cribb 1987; Cribb et al. 2003; Averyanov 2011), including recent cases where newly-described species are targeted for incentive harvest and trade (Vermeulen and Lamb 2011; Averyanov et al. 2011). There is extensive anecdotal evidence, from both ecologists and wild palnt collectors, of local orchid extirpations across mainland Southeast Asia as a result of over-harvest (Foppes et al. 1996; Cribb et al. 2003; Laxmay 2008; Rusea et al. 2009; E. Vernon, Pak Sae Orchid Project; P. Bonnet, ORCHIS Project Lao PDR; P. Wijitchot, Thailand orchid expert; P. Suksathan, Queen Sirikit Botanic Garden, S. Lwin, Myanmar Floriculture Association 2009, pers. comm.).

1.4 Interventions to reduce impacts of trade

Conservation interventions to mitigate against unsustainable wildlife trade broadly correspond to four categories: 1) resource monitoring, restrictions and management to promote sustainable use; 2) restrictions and bans to eliminate pressures of unsustainable harvest and trade; 3) wildlife farming/cultivation to reduce demand for wild specimens , and 4) conservation education to reduce demand (Brooks et al. 2004; Jepson & Ladle 2005; Phelps et al. 2010; Dutton et al. 2011; Phelps et al. In press).

Supply and demand-side conservation approaches, such as wildlife farming and consumer education have the potential to reduce or satisfy consumer demand (e.g., Jepson & Ladle 2005; Bulte & Damania 2005; detailed in Chapter 6), while creating sustainable livelihoods alternatives for former resource extractors (Larsen & Olsen 2007; Lubbe & Verpoorte 2011; see Chapter 5). However, the potential for wildlife farming and consumer education to yield conservation outcomes have not been adequately evaluated, or very widely implemented (see Schippmann et al. 2002; Brooks et al. 2010).

Policies to ban and restrict harvest and trade are much more common approaches to NTFP governance (Laird et al. 2009). Related policies in most tropical developing countries are heavily informed by their CITES commitments to the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES). Established in 1973, CITES is a multilateral agreement with 175 national signatories to regulate trade of nearly 34,000 species whose conservation has been deemed as under threat from international trade. It remains the most important initiative to monitor and regulate international trade of threatened plants and animals (Sand 1997;

CITES 2013), and all of the countries in mainland Southeast Asia are signatories that have committed to monitoring and regulating international wildlife trade.

Orchidaceae is of particular interest because all orchids are CITES-listed, such that trade in all ~25,000 species is regulated (CITES 2010). In fact, orchids comprise more than 70% of all CITES-listed species. This broad regulation is largely the result of a precautionary approach because Orchidaceae includes many “look alike” species that, while not necessarily threatened by international trade, resemble threatened species (see Clemente-Munoz 2009). Such taxonomic uncertainty is particularly a concern in the context of untrained customs agents inspecting sterile specimens (e.g., McGough et al. 2004).

Species become CITES-listed through the agreement of the Conference of Parties, which lists species in one of the three CITES Appendices (Table 1.2). Appendix I represents an almost complete international trade ban, and applies to a limited number of species. Notably, these include all species in the pan-Asian genus *Paphiopedilum.* Appendix II, which applies to the remainder of the family Orchidaceae, allows for international trade only with permits and if the export is not detrimental to the survival of the species.

However, efforts to regulate unsustainable wildlife trade in Southeast Asia remain grossly inadequate (Sodhi et al. 2004, 2010; McNeely et al. 2009; Keping Ma 2010; Phelps et al. 2010), and there is great concern over the efficacy of restrictions and bans to actually reducing trade (e.g., Nijman and Shepherd 2007; Gavin et al. 2009). There is broadening recognition that efforts to address wildlife trade will require more nuanced responses, especially given the diversity of exploited species and harvest regimes (Laird et al. 2009). It will also require improved understanding of how the illegal trade works (WB 2005); how specific species are affected by trade (Smith et al. 2010); how trade contributes to rural livelihoods (Belcher et al. 2005; Dickson 2008), and how related conservation interventions can be designed to increase efficacy (e.g., Bulte & Damania 2005; Phelps et al. 2010; Briceno-Linares et al. 2011).

Table 1.2. Orchid species on CITES Appendices I and II

Appendix	Species	CITES regulations [a]
CITES App. I [b]	*Aerangis ellisii* *Dendrobium cruentum* [*] *Laelia jongheana* *Laelia lobata* *Peristeria elata* *Renanthera imschootiana* [*] *Paphiopedilum* spp. [*] *Phragmipedium* spp.	• An import permit issued by the MA of the State of import is required. This may be issued only if the specimen will not be used for primarily commercial purposes and if the import is for purposes that are not detrimental to the survival of the species. In the case of a live animal or plant, the SA must be satisfied that the proposed recipient is suitably equipped to house and care for it. • An export permit or re-export certificate issued by the MA of the State of export or re-export is also required. • An export permit may be issued only if the specimen was legally obtained; the trade will not be detrimental to the survival of the species; and an import permit has already been issued. • A re-export certificate may be issued only if the specimen was imported in accordance with the provisions of the Convention and, in the case of a live animal or plant, if an import permit has been issued. • In the case of a live animal or plant, it must be prepared and shipped to minimize any risk of injury, damage to health or cruel treatment.
CITES App. II [b]	All other species in the family Orchidaceae [b]	• An export permit or re-export certificate issued by the MA of the State of export or re-export is required. • Export permit may be issued only if the specimen was legally obtained and if the export is not detrimental to the survival of the species. • A re-export certificate may be issued only if the specimen was imported in accordance with the Convention. • In the case of a live animal or plant, it must be prepared and shipped to minimize any risk of injury, damage to health or cruel treatment. • No import permit is needed unless required by national law.

[a] Summary of CITES regulations from Clemente-Munoz (2009)
[b] Some exceptions for hybrids and specimen for scientific research
[*] Found in Southeast Asia

1.5 Overwhelming gaps in wildlife trade data

Yet, there are overwhelming gaps in our understanding of most species threatened by trade. This notably relates to a lack of information on basic ecology, distribution and responses to harvest (Smith et al. 2010). However, there are equally gaps in our understanding of the policy, markets, trade dynamics and local and international stakeholders involved in trade (Wollenberg and Ingles 1998; Monteiro et al. 2009; Nijman 2010).

There is a particular regional lack of data on trade within Southeast Asia, despite its role as a global center of wildlife trade (Schaedla 2007; Nijman 2010). There is, for example, no regular or systematic monitoring of market-based wildlife trade in the region. Existing efforts are principally driven by non-governmental organisations (notably TRAFFIC). Constrained by human and financial resources, these have often relied on government-reported statistics, or provide snap shots of trade dynamics based on occasional surveys. Moreover, focus has often been on wildlife trade to industrialised countries (e.g., Europe, Japan, US), and relatively few studies have considered local and regional demands, particularly for botanical resources (Nash 1997; Olsen and Helles 1997; de Albuquerque et al. 2007; Bussman et al. 2007; Shackleton et al. 2007; Monteiro et al. 2009), or the roles of regional-level periurban and urban wildlife traders (Stoian 2005).

Botanical trade represents a particular data gap. Conservation efforts and public attention have focused primarily on charismatic megafauna (Nash 1997; Small 2011; Nijman et al. 2012), and research on botanical trade has fallen far behind consumer demand (Schippmann et al. 2006). Existing botanical trade studies in Southeast Asia have focused on selected high-value species, notably timber, resinous trees, bamboo and rattan (de Beer and McDermott 1996; e.g., Belcher 1998; Peters et al. 2007;). Medicinal plants in the region have received only limited attention (e.g., Jensen and Meilby 2008; Ashwell and Walston 2008), and wild-collected ornamental plants have been almost completely overlooked (e.g., Kuster and Belcher 2004; although see Simpson 1995; Bhima 2003; Jenning sand Rohr 2011).

Although a comparatively well researched plant group, there is similarly a lack of data on the commercial trade of wild Orchidaceae. Little is know about which species are commercially traded, their taxonomy, origins, distribution, ecology, harvest regimes, trade volumes or commercial destinations, which hinders threat assessments and sustainable harvest recommendations (CITES 2008). While anecdotal reports are compelling, there is a pressing need for evidence-based conservation policy (Cribb et al. 2003; CITES 2008; CBD 2009; IUCN 2012). To date, orchid conservation efforts have been largely driven by “emotive concern” (Pupulin 2004), while data gaps can lead to erroneous assumptions about NTFPs and their harvest (Olsen and Helles 1997; Belcher 2003).

1.6 Study motivation and research approach

This study is motivated by the particular importance of better understanding wildlife trade within Southeast Asia, and by the particular lack of previous research on regional botanical trade. It focuses on ornamental plants, principally orchids, as a group of plants that are heavily protected but are common in trade. This study provides a baseline of data on the trade of these ornamental plants within Thailand, including botanical imports from Lao PDR and Myanmar.

The research takes a heavily heuristic approach, due to the almost total lack of previous research on this topic, and the need for baseline data to inform conservation interventions. Given the complexity of wild resource use, this baseline is built by drawing on multiple disciplines, methods and sites (cf. Wollenberg and Ingles 1998). Where possible, it provides quantitative data, but views a critical qualitative perspective as equally important to informing policy (Hammersley 2008). It draws heavily from research situated in borderlands and marketplaces, as unique sites for research that serve as geographic funnels for trade where "unauthorized flows maybe also much more visible…than in other classic sites of observation" (Abraham and Van Schendel 2005; see also Newmann 2006). It draws data from borderland market-based research in order to understand activities along the rest of the value chain. To this end, it is heavily informed by Value Chain Analysis (VCA) for considering wildlife products from production to consumption (cf. te Velde et al. 2006; see also Chapter 4).

The study further takes an applied ethnobotanical approach (c.f. Cotton 1996), valuing botanical resources both for their intrinsic conservation value *and* for their contributions to the livelihoods of plant harvesters and traders. This is in keeping the with recent CITES amendment calling for Parties to consider the impacts of conservation on livelihoods (Res. Conf. 8.3 [Rev. CoP13]), and with a broadening recognition that environmental regulations must also account for human dimensions of conservation (e.g., Ros-Tonen and Kusters 2011). As such, the study takes a legalistic approach to wildlife trade that problematises resource use in violation of declared conservation policies. However, it is also concerned with local livelihoods, practices and rule systems (cf. Abrahams 2006). This often raises binary distinctions between state and socially-sanctioned activities that are necessary to the analysis of environmental regulation. However, the study also recognises 'illegality' as contested and politicized (cf. McElwee 2004; Singh et al. 2008), and is conscious of the "possible intellectual and political pitfalls of 'talking like a state' that is, of adopting the categories or characterizations of the illicit deployed by policing and regulatory agencies for thinking well about such flows" (Gootenberg 2009). This was indicative of an ongoing reflexivity that characterized the research, including an awareness of how relationships, prior knowledge and personal biases can affect research outcomes (see Section 2.8; Finlay 2002).

Finally, while the research is geographically and taxonomically targeted and makes specific policy recommendations for botanical conservation, it also seeks to leverage this case study to draw broader observations about wildlife trade in the region, including related to trade regulation, multilateral environmental agreements, wildlife framing/cultivation and rule-breaking.

1.7 Research objectives

This monograph is comprised of six data chapters. The three initial chapters provide baseline data to answer: What ornamental plant species are commercially traded?; How are they being traded? (trade networks), and Who is involved in the trade? These descriptive chapters principally serve to identify points of entry for future conservation interventions.

The example of ornamental plants trade is further leveraged to explore three themes in wildlife trade regulation: What are the factors that determine whether wildlife farming/cultivation interventions reduce pressures on wild populations?; How can the CITES multilateral agreement be strengthened successfully regulate wildlife trade?, and How can direct study of local rule-breaking inform our understanding of how top-down environmental regulations are implemented?

Chapter 2: Provides an overview of the research methodology, notably site selection, interviews, botanical market surveys. The chapter includes a description of the four target market study sites.

Chapter 3: Identifies the diversity of ornamental plants traded at four major botanical markets in Thailand, including along its border with Lao PDR and Myanmar, to identify species of particular concern.

Chapter 4: Describes regional trade dynamics across Thailand, Lao PDR and Myanmar, focused on identifying points of entry for conservation and enforcement.

Chapter 5: Characterizes trade participants and their motivations, to inform prospective interventions.

Chapter 6: Evaluates the conditions under which wildlife farming/cultivation could reduce demand for wild-collected wildlife. It presents a checklist of conditions, which are specifically applied to the trade of the ornamental orchid species, *Rhynchostylis gigantea*, at Bangkok's Jatujak Market.

Chapter 7: Evaluates the capacity of the CITES as an international environmental agreement to regulate wildlife trade. It specifically contrasts observations of wild orchid trade with official statistics. Based on a broad review and lessons from this study, it also considers interventions for improving CITES.

Chapter 8: Assesses the relationships between national and international restrictions on wildlife trade, and local rule-breaking practices that allow for continued trade. It specifically considers *de facto* rule systems at six plant markets and contrasts these with declared policies in order to better understand rule-breaking behaviours.

Chapter 9: Concludes with a discussion of the main findings, and reflects on the process of conducing research on illegal wildlife trade and associated methods.

Chapter 2: Methods

2.1 Introduction

This section provides an overview of the research sites and employed methods, principally the market botanical surveys and face-to-face interviews that inform all of the following chapters. However, given the diversity of methods employed, more specific methodological notes are given within the chapters to which they are most relevant.

"The illegal nature of the activities pose unique methodological challenges….The conservation literature leaves little doubt that illegal resource use is a major problem. An equally common claim, however, is that sufficient data on illegal resource use do not exist and that collection of this information is too difficult" (Gavin et al. 2009). Although challenging, there are a actually diversity of methods available for studying illegal resource use and trade (e.g., Wollenberg and Ingles 1998; Gram 2001; te Velde et al. 2006; Keane et al. 2008; Moyle 2010; Nijman 2010). Gavin et al. (2009) specifically identify eight principal methods: law-enforcement records, indirect observation, self-reporting, direct observation, direct questioning, randomized response technique, forensics, and modeling. This study draws on several of these strategies, notably CITES trade records for the region, indirect observation of trade via surveys of the markets, direct observation of trade behaviours, and direct questioning of traders and collectors.

As in most ethnobotanical studies, the methods are heavily qualitative. However, ethnobotany is a rapidly evolving field, with the recent adoption of greater quantitative methods and techniques from other disciplines (Monteiro et al. 2009). These shifts are reflected in this study, which combines quantitative and qualitative methods, including of diversity indices developed for ecology, ranking activities and economic data.

2.2 Market site selection

Direct study of rule-breaking behaviour presents significant logistical challenges (Kean et al. 2008; van Lampe 2012). Conservation rule-breaking is often discrete—prevalent in the periphery (e.g., Ali and Nyborg 2010), hidden through elaborate criminal enterprises (Bennett 2011; e.g., Wyatt 2009), and/or secluded as back-room government deals (e.g., Singh et al. 2006). However, the open nature of wildlife trade at public markets provides insights that are often secretive and closed to researchers in more secretive black market trade. Moreover, the geographic focus on borderland markets is particularly conducive to trader research, as borders can serve as funnels and often represent "3rd spaces" at which "unauthorized flows maybe also much more visible… than in other classic sites of observation" (Abrahams and van Schendel 2005 see Newmann 2003). As such, research at public markets can provide valuable entry-points and insights into broader trade patterns, networks and up and downstream participants (cf. Shepherd 2006; Shepherd and Nijman 2006; Allebone-Webb et al. 2011).

We first identified plant markets across Thailand, with the assistance of traders in Bangkok's Jatujak Market. We visited markets across the country and used a chain-referral approach through which traders are one market provided referrals to other markets, the largest of which were selected (Fig. 2.1).

Map 2.1. Location of study sites. Sites of target markets where market surveys and interviews were conducted, and sites where supplementary interviews were conducted.

Research specifically targeted the four largest public markets for botanical surveys and interviews (Fig. 2.1): Jatujak (Bangkok, Thailand), the Mukdahan Indochine Market (Thailand-Lao PDR border), Chedi Sam Ong and Dan Singkorn Market (Thailand-Myanmar border). We also conducted supplementary interviews at three smaller markets: Sanam Luang II (Bangkok, Thailand), Tha Uthen (Thailand-Lao PDR border) and Mae Sot (Thailand-Myanmar border).

Photo 2.1. Stall specialized in selling wild-collected ornamental orchids at Jatujak Market, Thailand (February 2012).

Although all within Thailand (or immediately on the Thailand border), the four target markets provided a diversity of contexts to allow for comparative study. This dynamic allows us to deal with a single resource (ornamental plants), within the same country and subject to the same state regulations, in order to compare across sites The non-random selection of markets is common in wild-product trade studies (e.g., Newton et al. 2008; Shepherd and Nijman 2007), and is justified for several reasons.

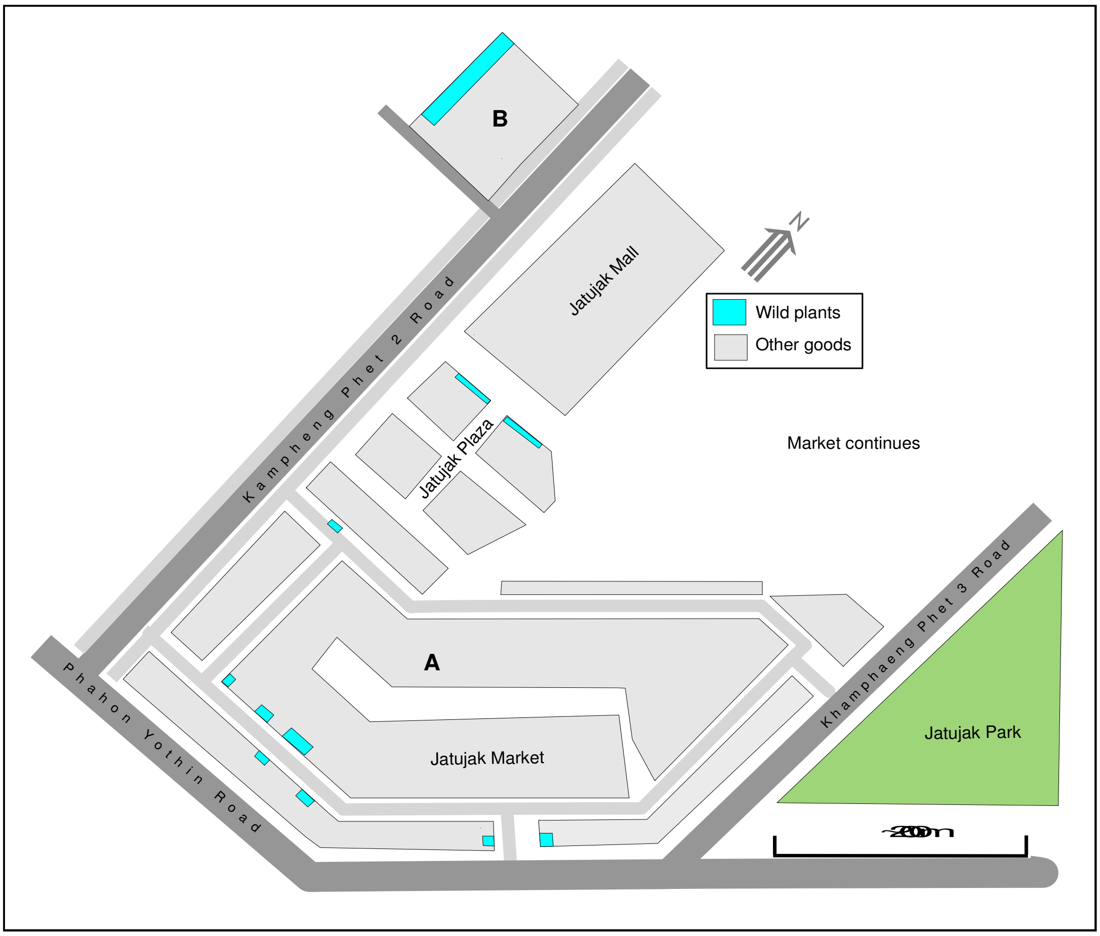
None of the parameters of interest are normally distributed, including trade volumes, species distribution or diversity (Koopowitz et al. 2003), limiting the potential for stratified or random sampling. Additionally, previous ethnobotanical studies have demonstrated that species richness is heavily skewed towards larger and more central markets (Cunningham 2001), such as Jatujak and the largest border markets.

2.3 Site descriptions

We briefly describe the four target sites and three supplementary market sites. The four main target markets were also sketched (September, 2012) in order to facilitate surveys and descriptions of local practices (see Cunningham 2002), using Ortelius 1.1.3 (Mapdiva 2010). Trade dynamics were mapped using Ortelius, based on layers from diva-gis.com, protected area maps from the World Database on Protected Areas (IUCN-WCMC 2010).

2.3.1 Bangkok: Jatujak Market

Jatujak (also Chatuchak, The Bangkok Weekend Market, J.J.) is a large, government-managed market in northern Bangkok that hosts thousands of traders that sell a wide range of goods;—including a number of illegal wildlife products (e.g., Nijman and Shepherd 2007; Todd 2011; Nijman and Shepherd 2011b). On Wednesdays, and to a lesser extent on Thursdays, Jatujak hosts hundreds of live plant traders, most selling cultivated plants for the horticultural market. Depending on the season, between 14-27 stalls specialize in wild-collected ornamental plants, principally orchids and ferns. The plants are sold in the open, in two sections of the market: wild plant stalls are interspersed with the commercial plant traders in the main market and sell from temporary stalls. A subset of larger traders have permanent stalls around a secluded parking lot near the market (Map 2.2).



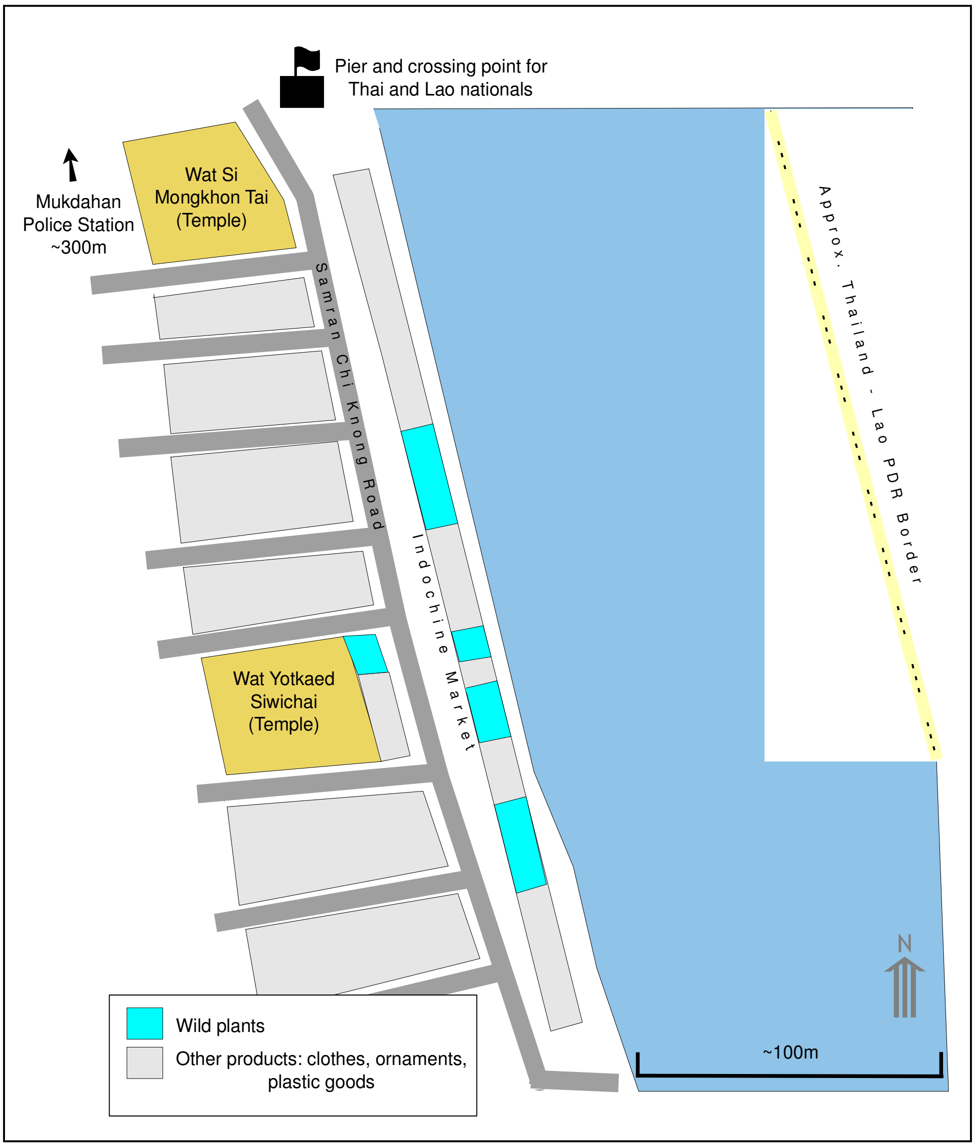
Map 2.2. Simplified map of Jatujak Market, northern Bangkok. Shows approximate location of wild plant stalls and the two sections of the market: A) Wednesday/Thursday plant market, and B) separate market for large-volume sales.

2.3.2 Bangkok: Sanam Luang II Market

Much like Jatujak, Sanam Luang II Market hosts traders in a large, covered marketplace on the western outskirts of Bangkok. Established in 2000, the market is best known for its plants, outdoor decorations, antiques, and pets. It is open daily and includes approximately 5 traders that sell a mix of cultivated and wild-collected plants, mostly orchids, from permanent stalls.

2.3.3 Thailand-Lao PDR Border: Mukdahan Market

Between 10 and 27 Thai wild plant traders set up informal, temporary stalls on a boardwalk along the Mekong River in Mukdahan City, Northeastern Thailand (Map 2.3). They form part of the larger Indochine Market, popular with Thai tourists and renowned for products from Lao PDR, Vietnam and China. While some traders are there daily, most operate Friday-Sunday. All the market traders are from Thailand, although almost all of the plants are from Lao PDR.



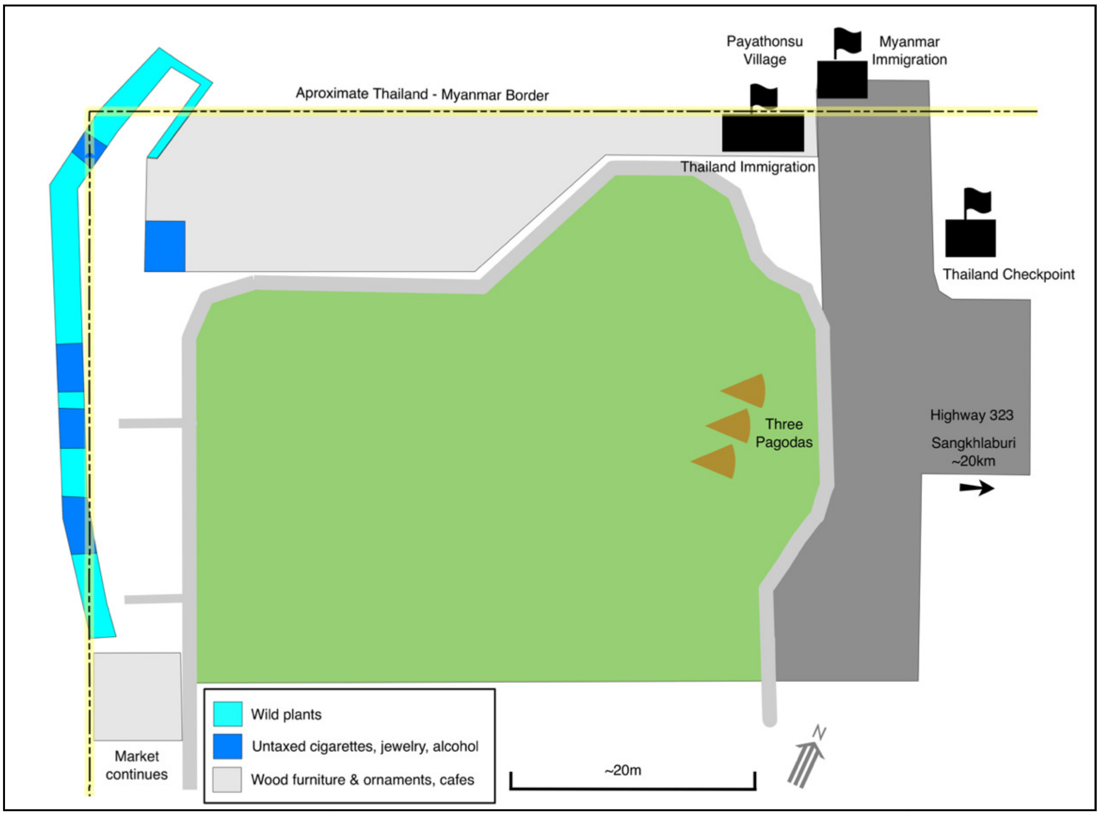
Map 2.3. Simplified map of Mukdahan Market, Thailand-Lao PDR border.

2.3.4 Thailand-Lao PDR Border: Tha Uthen Market

Tha Uthen is a small town in Thailand's Northeastern Nakhon Phanom Province. Each Thursday, approximately 5 wild plant traders from Lao PDR cross the Mekong River from Hinboun Village into Tha Uthen for the "Lao Market", which caters to Thai residents from the region. Traders sell principally fruits, vegetables and inexpensive goods from Vietnam and China, and pay an immigration office in Lao PDR for a border-crossing permit and travel by small boat to Thailand, where they set up an informal, temporary market.

2.3.5 Thailand-Myanmar Border: Chedi Sam Ong Market

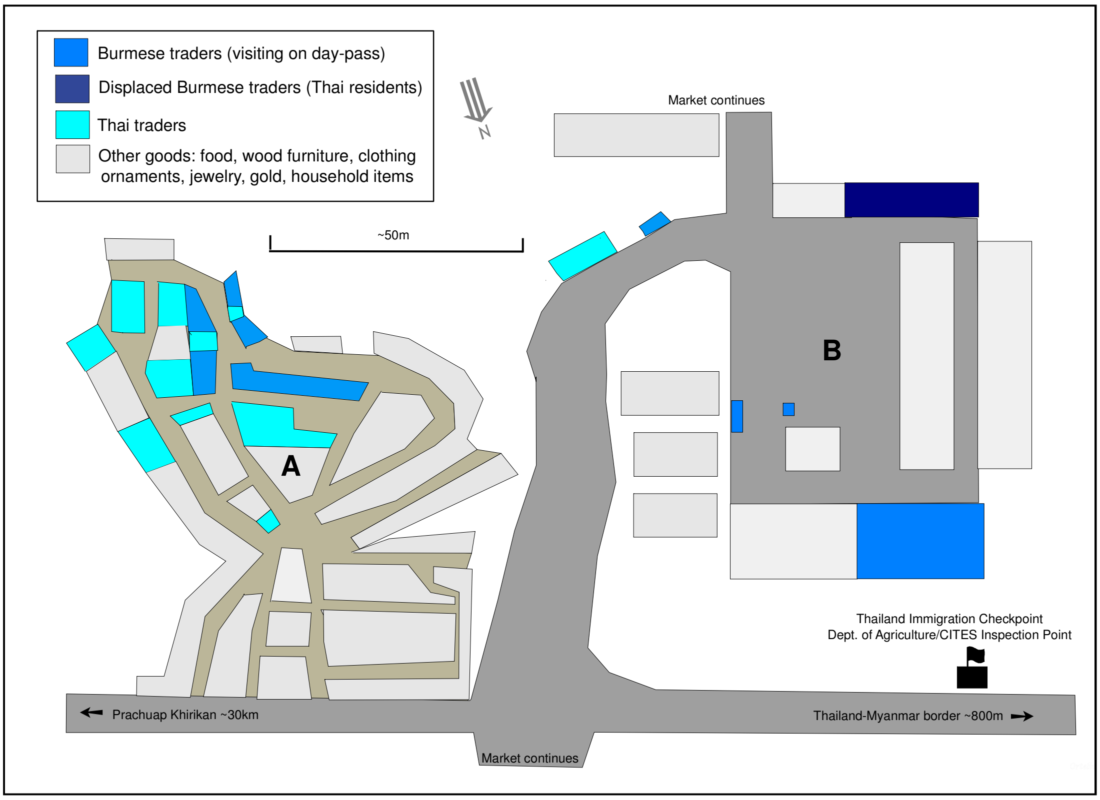
Chedi Sam Ong Market (also Three Pagodas Pass) is situated on the Thailand-Myanmar border, about 20km from Sangkhlaburi in Central west Thailand. The border is not an official crossing between the two countries, but receives hundreds of Burmese workers who enter from the adjacent town of Payathonsu on day passes to work in Thai factories. The border also hosts a market of Burmese goods that caters to Thai tourists. Approximately 12 Burmese market traders specialize in wild plants, which they purchase from middlemen and collectors in Myanmar, and sell every day from permanent stalls (Map 2.4). The market is on officially on Thai territory, and is immediately next to immigration and police checkpoints. However, stalls that sell wild plants, untaxed jewelry, cigarettes and alcohol from Myanmar are located on the borderline, rather than within the main market.



Map 2.4 Simplified map of Chedi Sam Ong Market, Thailand-Myanmar border.

2.3.6 Thailand-Myanmar Border: Dan Singkorn Market

Dan Singkorn, located on the southern Thai-Myanmar border near the city of Prachuap Khirikhan and adjacent the Burmese village of Moda. It is a site of considerable development interest, as local authorities and businesses respond to prospects for greater trade with Myanmar (Anantarangsi 2011). However, it is not a regular immigration point, with Burmese allowed to cross only for local day-trade and Thai citizens allowed to cross over only during major religious holidays (Anantarangsi 2011). The market is open every day, but most plant trade is conducted Friday-Sunday. Up to almost 70 wild plant traders sell at two, linked markets at Dan Singkorn—an informal market of wood stalls and temporary structures held on private property, and a new (opened late 2011) government-managed market of large covered cement pads (Map 2.5). The market hosts three categories of traders: traders from Thailand, traders from Myanmar that visit the market on single day immigration passes, and displaced Burmese traders who reside within a restricted part of Prachuap Khirikan. The market is a recognized center of trade for wild plants, Burmese wood products, and everyday goods (Anantarangsi 2011). Plant traders principally sell wild orchids from Myanmar, although several of the Thai traders also sell plants from other parts of Thailand and Lao PDR.



Map 2.5. Simplified map of Dan Singkorn Market, southern Thailand-Myanmar border. A. the private market areas, B. the new government-managed market.

2.3.7 Thailand-Myanmar Border: Mae Sot Market

Mae Sot Market is located at the foot of the Thailand-Myanmar Friendship Bridge in Tak Province, Thailand. It is a major border-crossing between Thailand and the Burmese town of Myanwaddy, and is the site of a bulk of the two countries' cross-border trade (Anantarangasi 2011). Trade includes a large-volume trade of wild plants that are sent directly to Bangkok and to Thai middlemen, which is largely unseen.

There are also six small plant stalls, including three run by Burmese traders and three by Thai traders. The Burmese stalls are located immediately on the Thai-Myanmar border, while the two stalls run by Thai traders are within the main market.

2.4 Ethics and Consent

Research was conducted with formal sanction from the National Research Council of Thailand (2010/074) and was subject to their internal scientific and ethics reviews. The project was also evaluated and compliant with the National University of Singapore Institutional Review Board ethics guidelines (NUS-1259).

Prospective participants for interviews and market stall surveys were provided with a Participant Information Sheet (Appendix 1) that described the principle research objectives and respondent rights to refuse to participate, in part or in full. Where needed, participants had these objectives orally explained. Oral consent was obtained from all participants, and trade and interview data were anonymised. Nevertheless, locations were disclosed, the research documents rule-breaking that could be used to inform enforcement efforts, and parts of the study will be used to produce a public brief to inform conservation policy. This represents a profound ethical research quandary, as there was a responsibility not only to respondents, but to report illegal activities where they were encountered. Moreover there is no legal privilege extended to researchers.

Yet this case also represent an exception within illegal wildlife trade research because it involves a unique methodological approach among wildlife trade studies, where generally monitoring is hidden, with researchers posing as prospective buyers, and studies are led by conservation organisations with clear objectives and different ethical guidelines (cf. extensive work by Shepherd and Nijman). A deceptive approach to wildlife trade research may, in fact, be more appropriate for gathering certain types of data, and would avoid some of the ethical dilemmas faced in this study. Moreover, deception may be the only strategy possible in many cases. However, this approach but also severely limits the nature and depth of questions that can be asked.

2.5 Botanical Surveys

Botanical surveys were conducted at the four target markets in order to construct species lists, establish relative abundances, document countries and regions of origin, and record sale prices. The three target border markets were subject to quarterly surveys. Jatujak, due to its size, diversity and accessibility was subject to monthly surveys, as well as rapid checks every 2 weeks to search for additional blooming specimens to add to the species list. The bi-weekly surveys were abbreviated because of the need to reduce respondent fatigue. However, heavy flooding in the last quarter of 2011 eliminated one of the quarterly surveys at the border markets and the November monthly survey at Jatujak.

Surveys only targeted stalls selling wild plants. Wild and farmed orchids can be easily distinguished based on their physical condition, using guidelines from Kew Botanic Gardens and the CITES Secretariat for customs agents (McGough et al. 2004; GreenCustoms ND; Fig. 2.1).

Figure 2.1. Comparison of wild (left) and farmed (right) plants of *Rhynchostylis gigantea* in the marketplace. Plant on left exhibits common signs of wild-harvest: a) physical leaf damage, b) cracked leaf midrib and cells due to dehydration, c) burrowing insect damage, d) damaged, irregular root system with dead roots and tree bark still attached.

Surveys were conducted on the main market day, which had been determined during reconnaissance visits. They started when traders arrived at the market to set up, and each survey began at a random stall in the marketplace and included all stalls in each market. Surveys were time-constrained in so much as they sought to cover stalls as quickly as possible before the plants were sold, and had to be complete before market end. With the exception of Dan Singkorn, all surveys were conducted within 1 day.

Importantly, this survey method only captured a fraction of trade volume because of plants sales throughout the day that were not detected prior to survey. Moreover, we observed that some bulk sales, sold by the kilo in large boxes, were made by some traders and operated outside of the formal marketplace. In addition, while we targeted surveys on the largest market days, many stalls were open on multiple days of the week. Also, while new plant stock usually arrived in preparation for the largest market day, some traders were also seen to receive new stock on other days.

2.5.1 Levels of taxonomic identification

There are significant challenges associated with species identification in the marketplace, especially of sterile specimens for Orchidaceae where taxonomy is largely based on floral characteristics. The vast majority of plants encountered were sterile (84.1%) (Table 2.1). The challenge is particularly great for large and fairly vegetatively indistinct genera such as *Coelogyne* and the Subtribe *Bulbophyllinae*. As such, surveys were conducted over a one-year period in order to capture seasonal fluctuations and maximum diversity (cf. Gram 2001), and to account for phonological differences across orchid genera (e.g., *Bulbophyllum* vs. *Dendrobium*). In fact, the observed variation in species richness throughout the year (see Chapter 3) was likely heavily influenced by detection associated with peaks in blooming, rather than a sampling bias.

Taxonomic challenges were compounded by limitations on collecting herbarium or live vouchers due to the legality and ethics of purchasing wild-collected protected species, as well as the high costs of purchasing and growing plants until they bloom (discussed in de Albuquerque et al. 2007). Aside from limited flower spirit vouchers, photographs were the most appropriate means of vouchering (cf. Cotton 1996).

Table. 2.1. Percent blooming specimens encountered during surveys and number of pickled specimens and photographic vouchers collected at each market

Market	Blooming (%)	Pickled specimens	Photo vouchers
Jatujak	22.6	116	1293
Mukdahan	8.2	16	178
Chedi Sam Ong	8.4	33	195
Dan Singkorn	11.0	49	607
Total	15.9	214	2341

While previous studies have claimed near 100% species-level identification during market surveys (Foppes et al. 1996; WWF 2009), even among experts it is exceedingly difficult to accurately identify a majority orchid species from sterile plants (see Flores-Palacios and Valencia-Diaz 2007). As such, market surveys relied on a hierarchical approach to identification (Fig. 2.2).

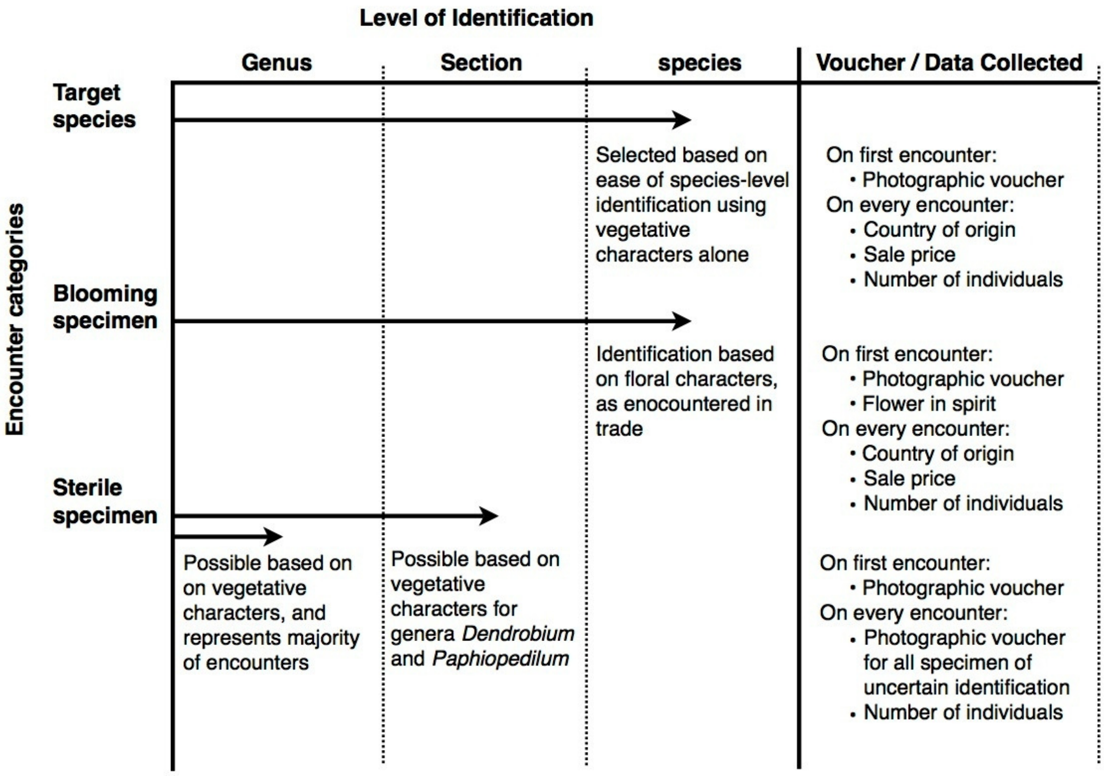


Figure 2.2. Identification hierarchy. Target, blooming and sterile species of orchid enabled different levels of identification.

Three major categories of plant specimen were identified:

1. Markets were dominated by sterile specimen, for which accurate identification was generally limited to the genus-level. In the cases of the orchid genera *Dendrobium* and *Paphiopedilum* identifications were consistently made to the level of Subgenus or Section based on vegetative characters. On the first encounter with a new genus, photographic vouchers were collected. On successive encounters, vouchers were only collected if there was any uncertainty over its identification. *Paphiopedilum* specimen were photographed at every encounter because they are listed on CITES Appendix I and merited particular

documentation. Number of individuals was documented at each encounter.

2. Blooming specimen were identified to the species-level. On the first encounter with a new species, a photographic voucher and a flower for pickling in spirits were collected. On each encounter, reported country of origin, price data and number of individuals were documented.
3. Surveys further focused on a subset of target orchid species (Appendix 2). Given the significant taxonomic challenges associated with Orchidaceae, target species were selected based on ease of identification by vegetative characters alone, and their presence in trade at multiple markets. The reliability of identification of these species based on vegetative characters was confirmed with externs, but these characteristics of the target species are documented in Appendix 2. There were 27 target species: *Arundina graminifolia, Ascocentrum curvifolium, A. garayi, A. ampullaceum, Cleisostoma arietinum, Bulbophyllum blepharistes, Dendrobium bellatulum, D. chrysotoxum, D. falconerii, D. findlayanum, D. jenkinsii, D. lindleyi, D. pachyphyllum, D. parishii, D. pulchellum, D. secundum, D. senile, D. sulcatum, Doritis pulcherrima, Gramatophyllum speciosum, Ludisia discolor, Rhynchostylis gigantea, R. retusae, Phalaenopsis cornucervi, Pholidota articulata, Hygrochilus parishii, Habernaria carnea.* Not all of these species, however, were ultimately encountered in large volumes or frequently. Photographic vouchers were collected on first encounter. On every successive encounter reported country of origin, sale price and number of individuals were recorded.

All wild plants encountered were first identified in the field. All photographic vouchers were subsequently reviewed 1-2 more times to confirm identification, which was listed as either "certain" or "uncertain". The majority of orchid specimens were identified with confidence (79.4%). Identifications were conducted using a library put together specifically for this study, comparable to the best herbariums in the region. Latest nomenclature was used according to the Kew Checklist (Govearts 2012). Notes on the study's taxonomic approach are in Appendix 3.

Spirit samples collected for blooming specimens were pickled in 70% ethanol 30% water, with no fixative or glycerol, due to lack of availability. They were studied using a dissecting microscope at the Professor Kasin Suvatabhandhu Herbarium at Chulalongkorn University, Bangkok, and were deposited at the Bangkok Forest Herbarium.

The use of molecular techniques has considerable potential for improving and facilitating species-level plant identifications (Hollingsworth et al. 2009), including within the context of horticultural trade (e.g., Pryer et al. 2010) and specifically for Orchidaceae (e.g., Zhang et al. 2007; Gigot et al. 2007). The matK gene region has been proposed as possible candidate for a reliable, universal genetic marker for plants, including for DNA barcoding of Orchidaceae (Hollingworth et al. 2009; Gigot et al. 2007), although at the time of study commencement this was not very advanced. A small test was done on the viability of using matK for identification within the CITES Appendix I genus *Paphiopedilum* with a small number of samples from Singapore, but resolution was inadequate, distinguishing only among sub-genera, which can also be done based on morphological characteristics. Moreover, genetic tools were ultimately infeasible in the context of this study due to the high costs of processing samples, and the burdens of developing an adequate baseline genetic library for such a large taxonomic group. Its use in the region for the genus *Dendrobium*, for example, would have required a baseline library of >100 species, many of which are not even available through botanic gardens in Singapore or Thailand.

2.5.2 Plant origin and price

For blooming specimen and target species, market-based traders were asked to report on country or region of origin, if known. Traders tended to use the same procurement lines over time and so generally knew the country of origin of their plants.

Traders were also asked the sale price per plant or kilo (as per the identification hierarchy, Fig. 2.2). The researchers were already known at each of the markets, and it was clear that we were not purchasing plants, and were familiar with approximate price ranges. As such trader-reported prices were, with few exceptions, representative of actual sale prices. Pricee were regularly checked against prices during observed transactions with real customers and, in some cases, with the prices written on the trader signs. Rare outliers prompted further questioning of the traders, and were usually corrected. If prices remained outside the likely scope without explanation (e.g., a higher price for a special variety), they were excluded from the dataset. At the start of research, a Thai research assistant informally conducted several spot-checks on plant prices at Jatujak and Dan Singkorn Markets to confirm that reported prices were consistent with what had been reported during the surveys, and there were no reported inconsistencies, so continued cross-checking was not pursued as a likely source of bias. However, we were not able to capture price changes that occurred as a result of bargaining. Moreover, prices were not always provided in standard per plant units, and traders often reported price ranges for a given species, based on size of the individual (not necessarily weight) or price per kilo.

2.5.3 Plant units

It was important to define individual plant units in order to record number of individuals and to report plant price. Unlike other taxa such as animals and trees where individual specimens are clearly distinct, this is less clear for plant rametes, where reproduction can be sexual or by rhizomes, corms or tubers. Observed count and price per individual was based on the number of plant bundles (potentially including multiple individuals or cuttings of different individuals) plus the number of individuals (potentially divisions of larger plants), both recorded as single counts. This follows the CITES approach, and is conservative relative to traditional customs recording, but not necessarily representative of the number of genetically distinct individuals.

2.5.4 Taxonomic verifications and identification accuracy

A subset of plant vouchers were sent to Dr. Somran Sundee and his colleagues at the Bangkok Royal Forest Herbarium to provided external taxonomic verifications. External verifications were very time-consuming, and there were limited taxonomists in Thailand that were capable and willing to provide this cross-checking service, which constrained the number of verifications conducted.

Of the 5,841 records made during market surveys, 5192 records were of Orchidaceae, for which 2,341 had a photographic voucher. The vast majority of these records could be identified with confidence (Table 2.2). Almost all of the records for which identification was uncertain were accompanied by a photographic voucher.

Table 2.2. Identification confidence and photographic vouchers of orchids encountered.

	Identification confidence		
Photo voucher	Certain	Uncertain	Total
No	2843	8	2851
Yes	1967	374	2341
Total	4810	382	

A total of 596 records of certain and uncertain identification confidence were randomly selected and sent for external verification (a greater number [~25% sample] were originally selected, but additional taxonomists were unable to complete verifications by the deadline). These represented 11.5% of total orchid records documented (Table 2.3). Records were sent to the external reviewers unlabeled, and experts were asked to use the Kew Checklist as their reference and to make a "best guess" identification based on the vouchers available (mostly photographic vouchers, some pickled specimens). Records of sterile specimen were identified to genus-level, with the exception of *Paphiopedilum* and *Dendrobium* specimens, which they identified to Section. Records of blooming specimens were identified to species or species complex. External verifications were re-reviewed to check congruence (accuracy assessment), but also to identify any contentious disagreements.

There was high congruence between identifications made during market surveys and the external verifications: 94.6% agreement for 'certain' genus-level identifications and 83.3% agreement for 'certain' species-level identifications (Table 2.4). There was also very high congruence between Section-level identifications for the genera *Dendrobium* (89.9%) and *Paphiopedilum* (90.0%) (Table 2.5).

Table 2.3. Records sent for external verification. Number of records of 'certain' and 'uncertain' identification confidence that were sent for verification.

Identification Confidence	Number of external verifications	Percent of records	Percent of records with photo vouchers
'Certain' identification	335	7.0	17.0
'Uncertain' identification	234	46.0	61.3
Total	596	11.5	25.5

Table 2.4. Identification accuracy based on external verifications. Congruence of genus and species-level identifications with the external verifications

	Number of external verifications	Agreement	Disagreement	Suspected incorrect [a]	ID provided where previously unknown	Unidentified
Records of 'certain' identification confidence						
Genus-level	335	317 (94.6)	8 (2.4)	8 (2.4)	0	0
Species-level	138	115 (83.3)	14 (10.1)	10 (7.2)	0	0
Records of 'uncertain' identification confidence						
Genus-level	234	148 (63.2)	33 (14.1)	3 (1.3)	46 (19.6)	6 (2.6)
Species-level	58	27 (46.6)	14 (24.1)	11 (19.0)	7 (12.1)	13 (22.4)

[a] During re-review of verifications to identify any mistakes or known incorrect identifications, and disagreements due to identifications within a narrow species complex.

Table 2.5. Identification accuracy for *Dendrobium* and *Paphiopedilum*. Congruence of Section-level identifications for the two genera with external verifications

	Agreement	Disagreement
Dendrobium records (=129)		
Genus-level	126 (97.7)	3 (2.3)
Section-level	116 (89.9)	4 (3.1)
Paphiopedilum records (N=40)		
Genus-level	40 (100)	0
Section-level	36 (90.0)	2 (5.0)

Agreement for the 'uncertain' identifications was predictably much lower: 63.2% agreement at the genus-level and 46.6% at the species-level. However, these records of uncertain identification confidence represented only 7.9% of total orchid records. Moreover, review of the external verifications identified that a number of cases (19% of uncertain records) were due to disagreements at the species-complex level as well as several clear mistakes by the external reviewers (Table 2.4).

2.6 Interviews

We created separate survey instruments for market-based plant traders and plant harvesters (Appendix 4). These were trialed and refined based on responses from plant traders at a non-target market in Bangkok and with traders of other goods (N=5). Interview questions were translated into Thai and Burmese by research assistants.

We interviewed wild plant harvesters, middlemen and traders in Thailand, Lao PDR and Myanmar during 2011 and 2012 (N=153). Focus was on the four target markets, where we interviewed the primary owner of every stall in the marketplace (N=108), excluding children, a small number of refusals, and some occasional traders at Jatujak that were present during monthly botanical surveys but were absent during the interview period (Table 2.6). Nevertheless, interviews at the target markets approached saturation sampling. Market traders were asked to participate emi-structured interviews (Appendix 4) at the target markets lasted approximately 40-60 minutes, while interviews with harvesters (Appendix 4) and middlemen were generally more abbreviated and/or informal.

In addition, we also conducted supplementary, mostly informal interviews with all willing traders at That Uthen, Sanam Luang II and Mae Sot Markets (N=13) (Table

2.6). We further conducted opportunistic, mostly informal interviews with middlemen and harvesters from central Lao PDR around Savannakhet Province (N=12) and with harvesters in Southern Myanmar around the vicinity of Dan Singkorn, Chedi Sam Ong and Mae Sot Markets (N=20). These interviews with harvesters and middlemen were considerably more difficult to conduct than the interviews with market traders, as they were geographically scattered, tended to travel frequently, and many were located in parts that were inaccessible—in Myanmar due to the political situation and in Lao PDR due to the rainy season. Moreover, not all traders and middlemen were willing to provide upstream links, which was a particular barrier in Lao PDR.

Interviews were conducted in Thai, Lao, Burmese or Karen language, with the help of local assistants, all of whom were fluent in English and held graduate-level degrees. To reduce the potential for "lost in translation" the primary researcher was directly involved in all Thai language interviews. Research objectives and question meanings were also carefully reviewed with each assistant prior to beginning research.

Interviews were, where possible, conducted privately in order to avoid the participation of others. However, especially where several individuals shared a single stall, in some cases multiple people helped to answer questions during the interview. Interviews included both questionnaire-like questions, ranking exercises, and semi-directive, conversational questions used to establish motivations and personal experiences (Huntington 2000). Interviews addressed a broad range of issues, including demographic data, species selection, trade patterns, livelihood alternatives and economic dependence on trade, and regulations that govern resource trade.

Table 2.6. Interview respondent details. Records of harvesters, middlemen and traders at seven sites (based around four target markets) where full and informal interviews were conducted [a]

Market Site	Number of visits	Number of market traders/stalls [b]		Number of respondents	Respondent details	Refusals
		Min.	Max.			
Jatujak Market, Bangkok, TH	60+	14/19	31/27 (43 unique stalls total over 1 year)	16	16 market traders from Thailand (including 1 key informant)	7
Sanam Luang II Market, Bangkok, TH	4	5/4	7/5	4	4 market traders from Thailand (informal)	1
Mukdahan Market, Mukdahan Prov., TH / Savannakhet Prov., Lao PDR	10	23/22	40/33	34	26 market traders from Thailand (including 1 key informant) 1 former market trader key informant (informal) 3 middlemen from Lao PDR 2 middlemen from Lao PDR (informal) 2 harvesters from Lao PDR	1
Tha Uthen Market, Nakhon Phanom Prov., TH / Hinboun Village, Hinboun Prov., Lao PDR	4	3/3	5/5	5	2 market traders from Lao PDR 1 local Lao Forest Dept. official in adjacent Hinboun Province, Lao PDR (informal) 2 collectors from Lao PDR (informal)	0
Chedi Sam Ong Market, Kanchanaburi Prov. TH / Payathonsu Town, Kayin State, MM	10	11/11	15/14	22	12 market traders from Myanmar (including 2 key informants) 9 collectors from Myanmar 1 middleman from Myanmar (informal)	0
Dan Singkorn Market, Prachuap Khirikhan Prov., TH / Moda Villa, Tanintharyi Division, MM	13	54/50	69/67	63	16 market traders from Thailand (including 1 key informant) 9 displaced Burmese traders living in Thailand 31 market traders from Myanmar (including 1 key informant) 6 collectors from Myanmar 1 middleman from Myanmar (informal)	2
Mae Sot Market, Tak Prov., TH / Myawaddy Town, Kayin State, MM	3	3/3	6/6	9	3 market traders from Myanmar 1 market trader from Thailand (informal) 5 collectors from Myanmar	2

[a] Represent full interviews unless indicated
[b] Minimum and maximum number of traders and stalls encountered during 2011-2012 market surveys. Number of traders include working children, who were not interviewed.

Sensitive questions were last during the interview. It has been argued that this type of open, qualitative method represents best practice for research in similar, sensitive contexts (Burns and Miggelbrink 2011). Where strong relationships were established, respondents were selected as key informants for longer, more qualitative interviews We also opportunistically and informally spoke with a number of customers, other traders and officials in marketplaces. Where appropriate, responses were sorted into categories and coded for analysis.

With the exception of a small number of interviews with consumers at Jatujak (N=23; method described in Chapter 6), we did not focus on plant consumers[4], although consumer preferences, motivations, education and responses to regulation are important dimensions of the wildlife trade (e.g., Gault et al. 2008; see Chapter 6).

Efforts to engage local government institutions and agents, including proposals for formal collaborations, were not productive. Interview were attempt with local forestry and wildlife agencies in three regions and with representatives from CITES, but these provided few insights regarding *de facto* practices, and officials either passed responsibility onto other offices, reiterated points uncovered during the literature review, or delayed/avoided participation all together. There was evidence to suggest that some government officials were displeased with the nature of the research, and avoiding conflict with government institutions in the host country was a priority. There are several possible explanations for this non-engagement, notably concern that research would highlight institutional failings. In addition, previous evaluations of wildlife management authorities within Thailand have highlighted

[4] Consumer preferences for orchids are the the current focus of Ph.D. research by Amy Hinsley, Unviersity of Kent.

jurisdictional overlaps and lack of clarity over institutional roles (Thitiprasert et al. 2007; DNP 2011a), which might explain why some agencies attributed responsibilities to other agencies. Nevertheless, government institutions and agents represent key stakeholders in this research, and many of the associated policy recommendations would require their cooperation (See Chapter 6).

2.7 Participant Observation

Participant observation featured heavily in the research, some of which was targeted, but much of which occurred informally during the field reconnaissance and market surveys, and included time spent helping traders to clean their plants and stalls, orgainising plants into genus/species groups, drawing and identifying plants, playing games, showing photographs, eating and drinking. This borrowed heavily from anthropological research methods, within which such ‘hanging out’ often features prominently, as it allows researchers not only opportunities to observe behaviour, but also to integrate, establish rapport and learn about how and then to ask questions appropriately (Bernard 2002; see Section 2.8 for discussion of researcher positionality).

Market sites were visited between 4 and 60+ times (target markets at least 10 times; Table 2.6). The extensive time spent in the markets confirmed that, while illegal activity is “usually unrecorded, it is often observable” (Robbins 2000). We encountered numerous interactions between traders and government agents, including market raids, border-crossings, payments, arrests, casual inspections and purchases. We also observed interactions between traders, harvesters and middlemen as well as plant shipments and transactions with customers. The observations were particularly important to identifying trade networks, documenting local trade rules and understanding enforcement patters, and also shaped the interview instruments. Hanging out was also critical to gaining the respondent confidence necessary to conduct interviews.

This type of close-quarters participant observation, however, is an exception within wildlife trade research, and might not be possible where traders are more wary and enforcement is greater. In fact, the general lack of enforcement against wild plant traders is a likely reason why it was possible to observe and engage with the trade so directly.

2.8 Bias and Reflexivity

There are clear challenges associated with these methods, including related to researcher safety, data comparability (von Lampe 2012; Wyatt 2009), unquantifiable biases and margins or error (Keane et al. 2008; Gavin et al. 2009; St. John et al. 2011). There are also strong reasons to suspect respondent answers to sensitive questions about illegal wildlife trade, (Bush 2002; Keane et al. 2008; St. John et al. 2011). This could include systemic biases caused by social desirability (Fisher 1993), especially because of the conservation focus and the non-deceptive approach in which traders knew the purpose of the research.

However, similar to Robbins et al. (2009), many wildlife traders actually view their actions as legitimate and uncontroversial, and so are willing to openly discuss them. Moreover, we relied heavily on a relationship-based approach to interviews at the target markets, an approach that can increase respondent candor (Sylvester and

Avalos 2009; Burns and Miggelbrink 2011). The multiple market visits made during reconnaissance and botanical surveys allowed us to establish relationships with prospective respondents prior to the interviews. These relationships are a particularly significant in the context of market-based ethnobotanical studies because research is contingent on stakeholder buy-in and cooperation, not only in answering questions, but handling plant material (see de Albuquerque et al. 2007). Respondents also knew that we had observed many of their transactions with customers and governments agents, such that there was “little to hide”. We additionally provided assurances of anonymity and clear explanations of the main research objectives, which can also enhance respondent candor (Singer et al. 1995; Sylvester and Avalos 2009). In this context, neither indirect questioning (Fisher 1993) nor games-based approaches (e.g., randomized response or nominative techniques, St John et al. 2011) were considered necessary or efficient, due to relatively high rates of respondent openness and small populations.

However, researcher interpretation was critical to exploring results of the semi-structured interviews (discussed in Bush 2002), and required integrating interviews with market survey, contextualised based on extensive market observations. And, while we collected quantitative data on topics such as household incomes, the core of the interviews dealt with relatively broad themes and patters, including trade patterns, plant origins and local market rules. In this context, even relatively small samples (as few as 6 interviews) are adequate to identifying recurring themes, and our interview samples at each site were generally beyond that required for non-probabilistic analyses (Guest et al. 2006).

Nevertheless, triangulation techniques to compare and interpret multiple data sources and methods can improve accuracy and increase validity (Hammersley 2008; Gavin et al. 2009), and were employed where possible. Notably, data was cross-checked during successive interviews. For example, we cross-checked market-specific rules about trade with different respondents in the same marketplace until we were able to compile a clear picture of the overall situation. As we had spent considerable amounts of time at the target markets, we were also able to ask participants questions specifically in reference to events we had observed (e.g., market visits by forestry officials) (see Cunningham 2002). Key informant interviews also allowed us to cross-check sensitive information, and to reformulate questions based on locally sensitive issues (e.g., cross-border trade at Mukdahan). To some degree, cross-checking was also possible between market survey data and interview data, notably related to plant origins. Data from one-time interviews were compared with data from market surveys that were collected gradually over time. Cross-checking was also used to determine plant prices: through observed sale prices, trader-reported prices, comparisons among traders, and informal price spot-checks by local assistants. Overall, we had a relatively high degree of confidence in quality of trader-reported data. For example, traders at Mukdahan explicitly indicated an awareness that it was illegal to trade plants collected within Thailand, but many also candidly stated that they traded plants collected in Thailand. Traders at multiple sites stated that they had been told not to trade plants in the genus *Paphiopedilum*, and yet many candidly provided information on trade of this genus. Cumulative experience at the market suggests that, while there were some themes about which traders did not provide full or entirely accurate information (e.g., plant origins from Lao PDR), there were few incidences to suggest that traders sought to mislead our research.

Given the central importance of respondent relationships to the researchers and the role of researcher interpretation, reflexivity—in which researchers engage in explicit self-aware analysis of their role—was also an important methodological dimension (see Finlay 2002), as our engagement was neither static nor simply as neutral investigators and researcher positionality influenced research in diverse ways (Harré and Van Langenhove 1999). Our relationships with market traders were also as friends, tourists and language-learners, as well as prospective threats (associated with enforcement), and nuisances. Moreover, relationships varied across sites and with different respondents, and proved dynamic—most traders became increasingly comfortable over time. Yet, we also faced cases of respondent refusals, which had to be adaptively managed to avoid conflicts and rumours. We also faced some cases of respondent saturation, and had to respond by altering research schedules and, at one point, reducing visits to Jatujak Market. The continued evaluation and management of relationships was central to the research.

Reflexivity further involved considering how the underlying environmental agenda and pre-determined ideas about resource governance may have influenced research design, respondent answers, and data analysis. This was particularly important because of the non-deceptive nature of the research, in which respondents knew about our overall conservation objectives, and because of the research focus on sensitive themes such as such as corruption, illegality, rule-breaking and illegal trade. As such, there was ample potential for constructing "others" through research (cf. Harding 1991)-–in this case potentially relying on caricatures of inept Third World government agents, poor resource users and environmental criminals. Similarly, reflection was necessary to order to avoid imposing outside notions of good governance (e.g., of labeling corruption, Gupta 1995; labeling of illegality, Gootenberg 2009) and of appropriate conservation science (e.g., regarding wildlife management, Singh 2008). Revisiting topics through successive interviews and recurrent discussions with key informants were important to ensuring our understanding and interpretation of local rules and dynamics were accurate.

The case called for both open-minded approach to research and a continual process of reflexive evaluation. That process, however, is challenging, ambiguous and fundamentally subjective. Yet, however, it is critical to avoiding bias and providing a transparent, critical and honest assessment.

Chapter 3:
A blooming trade in ornamental plants

3.1 Introduction

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) has blanket trade restrictions on the family Orchidaceae, which includes ~2,000 orchid species in continental Southeast Asia. On paper, the family represents among the best protected wildlife taxa. However, there is virtually no baseline data on the trade of wild ornamental plants in Southeast Asia, aside from grossly inaccurate government trade data (see Chapter 7) and assorted anecdotal reports (e.g., Cribb 1987; Foppes et al. 1996; Cribb et al. 2003; Schuiteman et al. 2008; Ashwell and Walston 2008; Lamxay 2008; WWF 2009). There is a clear need for broader, more systematic study to determine what species are being targeted trade to inform science-based policy.

We conducted botanical surveys at four large botanical markets in Thailand to 1) compile species lists of plants in trade; 2) determine which taxa are most heavily targeted by trade, 3) compile lists of price ranges for each orchid genus and species at each market, and 4) conduct a preliminary threat analysis. The data reveal a commercial trade in wild-collected orchids that has been neglected by conservation efforts in Southeast Asia. Paradoxically, the data suggest that while there is little enforcement of conservation rules to protect wild ornamental plants, existing CITES restrictions on wild orchid trade represent a case of over-regulation. We provide a first set of baseline data on the ornamental plant trade in the region, to: explore the shortcomings of existing regulations; consider the viability of sustainable wild harvest, and demonstrate the need for improved monitoring of botanical resources.

3.2 Methods

Over the course of one year (2011-2012), we conduced botanical surveys of all stalls selling live, wild-collected plants at four large plant markets in Thailand: Jatujak Market in Central Bangkok, Chedi Sam Ong and Dan Singkorn Markets on the Myanmar border, and Mukdahan Market on the border with Lao PDR. Border markets were surveyed quarterly and Jatujak Market was surveyed every two weeks (with several exceptions, see Chapter 2). Surveys involved genus or sub-genus level identification for all sterile specimens. For blooming specimens and a subset of target species we pursued species-level identification, and collected trader-reported country of origin and sale price. Survey data was supplemented by interviews with traders at the four target markets (N=108) and opportunistic interviews with harvesters at three sites in Southern Myanmar (N=20), to document turnover rates, targeted species, harvest practices and changes in resource abundance. Chapter 2 details the market survey and interview methods.

The total annual trade volume estimate for Jatujak was calculated based on observed monthly trade volumes. We applied reported high and low seasons turnover rates to determine annual trade volumes per trader. For traders that were not interviewed, we applied a conservative turnover rate of once per month.

Species composition across the four sites was compared using Sorensen and Morisita-Horn similarity indices calculated with *EstimateS* version 9 (Colwell 2013).

Genus and species price ranges were based on trader-reported prices per-piece, which were more commonly reported than per-kilo prices (see Chapter 2 for methods). We compared mean prices of species and genera encountered at Jatujak Market using JMP Ver. 7 (2007), restricted to prices of flowering specimen, as this reliably yielded species-level identification and avoided any blooming/non-blooming effect on price.

We conducted a coarse threat analysis for the species encountered in trade that considered available data on: species rarity, scale of trade, what part of the plant was harvested, and species life history (based on criteria in Rabinowitz 1981; Schippman et al. 2002), and reflected the criteria for the IUCN Red List (A-E) (IUCN 2012). We used "The Preliminary Check-list of Threatened Plants in Thailand" (Pooma et al. 2005), and the "Thailand Red Data: Plants" checklist of threatened plant species based on IUCN Red List Criteria from 1994 and 2001 (Santisuk et al. 2006) to identify species of particular concern. Neither checklist used updated IUCN criteria or justifications for individual species listing were not provided. Nevertheless, Brito et al. (2009) demonstrated significant concurrence between national-level threatened species lists and IUCN Red Lists, suggesting that lists prepared for Thailand are likely to overlap with more rigorous evaluations.

We used World Conservation Monitoring Center (WCMC) species evaluations, the Kew World Checklist of Orchidaceae (Govaerts 2012), lists of threatened plants for Thailand (Pooma et al. 2005; Santisuk et al. 2006), and diverse taxonomic references to establish Extent of Occurrence (EOO) and gather information on conservation status or rarity (e.g., Seidenfaden 1985; Schuiteman et al. 2008; Kurtzweil 2012). Given the lack of detailed distributional information for most species, we informally ranked EOO according to the categories: "Widespread", "Regional", "Narrow" or

"Endemic" to identify species for which geographic restrictions might indicate vulnerability to over-harvest.

Conservation status and EOO were integrated with market surveys data. Where species were encountered in trade (>10 individuals) overlapped with records that indicated the species was threatened, rare or a narrow endemic, we considered these as potentially threatened by regional trade. Considering the lack of ecological and trade data, the analysis was supplemented by anecdotal reports from interviews with harvesters in Southern Myanmar.

3.3 Results

3.3.1 Orchidaceae dominates ornamental plant trade

Trade in live, wild-collected plants at the four markets was almost exclusively of ornamental plants, overwhelming in the family Orchidaceae (Fig. 3.1; 87.2% overall). Of the ~89,000 plants encountered during surveys of the four target markets, >82,000 individuals were from the family Orchidaceae. This represented a small fraction of total orchid sales; we conservatively calculated, for example, that >130,000 wild orchid plants are traded at Jatujak Market annually.

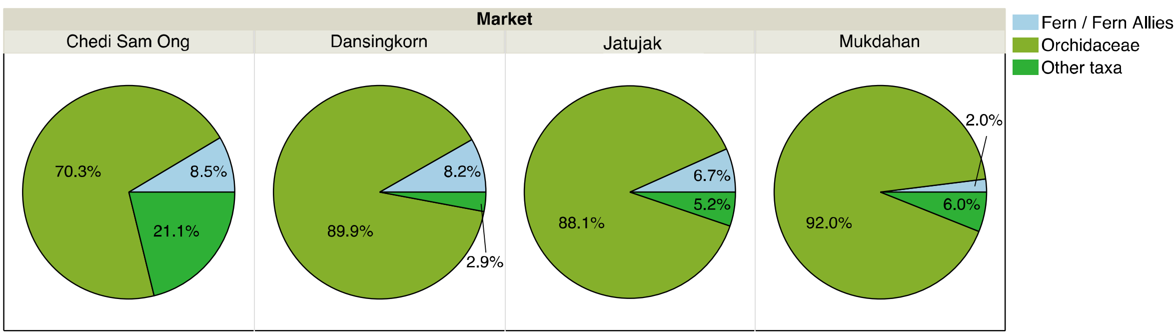


Figure 3.1. Relative abundance of Orchidaceae, fern and fern allies, and other taxa of ornamental plants observed in trade at four markets in Thailand.

Photo 3.1. Wild collected non-orchid ornamental taxa in trade.
a. *Cycas* sp.; b. *Platycerium* sp.; c. *Dischidia* sp.; d. *Curcuma* sp.; e. *Tacca* sp.; f. *Crinum* sp.; g. *Huperzia* sp.; h. *Gesneria* sp.

An eclectic mix of other ornamental taxa were also traded (>25 families and >32 genera) in comparatively smaller volumes, including the genera *Tacca, Huperzia, Platycerium, Cycas, Hoya, Amorphophallus, Impatiens, Curcuma, Nepenthes*, and *Hynophytum/Myrmecodia* (Photo 3.1). Appendix 4 includes a checklist of wild-collected, ornamental plant species found in trade, including a species list for each of the four target markets, including observed trade volumes and relative abundance. Appendix 6 lists the spirit vouchers deposited in the Bangkok Forest Herbarium.

3.3.2 Orchid trade species list

Botanical surveys of the four markets revealed 347 orchid species in 93 genera in trade (Table 3.1). Based on trader-reported country origins (see Chapter 4), this represented approximately 13% of Thailand's known orchid flora (Kew 2013), 22% of Lao PDR's known orchid flora (see Schuiteman et al. 2008), and 15% of Myanmar's known orchid flora (see Grovaerts 2013).

Table 3.1. Number of orchid genera and species identified at four target plant markets

	Jatujak	Mukdahan	Chedi Sam Ong	Dan Singkorn	Total
Number of Genera	90	49	46	71	93
Number of species	290	53	51	117	347

Market surveys also uncovered at least one new species in the genus *Bulbophyllum*, a suspected new species in the genus *Thrixsperumum*, several suspected new species records for Myanmar and Lao PDR found at border markets within Thailand, and one instance of synonimisation (Table 3.2).

Table 3.2. New species descriptions, records and synonimisations as a result of plant market surveys

Col. Record [a]	Species	Comment
J.Phelps 8078	*Bulbophyllum* sp. nova.	New species: collected in Jatujak Market, reportedly collected in Thailand. Under description by J.J. Vermeulen
J.Phelps 7209	*Thrixspermum* sp.	Suspected new species, under investigation
J.Phelps 3045	*Habenaria hossuesii*	New record Myanmar: Recorded only from Thailand, but specimen collected from trader on Myanmar border at Chedi Sam Ong, collected in Myanmar.
J.Phelps 3622	*Pelatantheria woonchengii*	New species record for Myanmar: Recorded only from Thailand, but specimen collected (and observed on several occasions) at Dan Singkorn among plants collected in Myanmar.
J.Phelps 6809	*Bulbophyllum* sp.	Specimen results in the synonimisation of *Bulbophyllum dhaninivatii* and *B. tripaleum*, according to J.J. Vermeulen. Specimen collected at Jatujak Market.
J.Phelps 5569	*Bulbophyllum muscarirubrum*	New species record for Lao PDR: Recorded only from Thailand, but specimen collected at Jatujak Market and reportedly from Lao PDR.
J.Phelps 5299	*Bulbophyllum sukhakulii*	New species record for Myanmar: Recorded only from Thailand (Kanchanaburi), but specimen collected at Dan Singkorn from Burmese trader that reported harvest in Myanmar.
J.Phelps 531	*Cleisostoma kerrii*	New species record for Myanmar: recorded only from Thailand (Yala), but specimen collected from trader at Dan Singkorn, collected in Myanmar

[a] Specimen deposited in Bangkok Forest Herbarium

New species were added to the Jatujak Market species list very consistently throughout the year; even following 12 months of surveys at Jatujak, species accumulation remained almost exponential (Fig. 3.2). As expected, Jatujak also hosted a far greater number of species than the three border markets, even after the first sampling period. Species accumulated at a faster rate than at the other markets (Fig. 3.2). In contrast, the species accumulation curves began to asymptote for the border markets after only 2 surveys, particularly at Chedi Sam Ong and Mukdahan, which had the lowest overall species richness. Accumulation curves at the genus level, however, began to asymptote much more quickly, even at Jatujak (e.g., Fig. 3.3). This was especially true for the genera most abundant in trade (see Fig. 3.5).

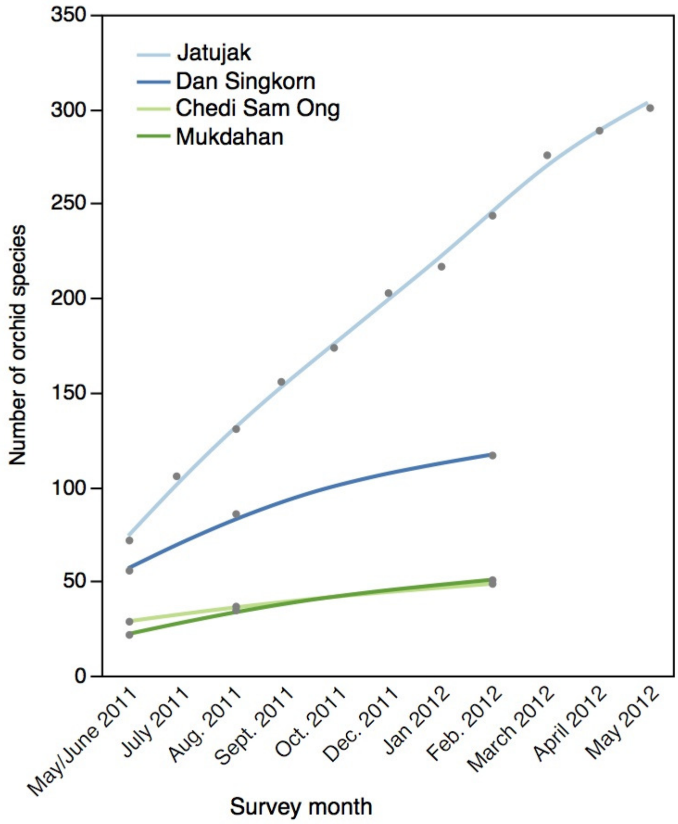


Figure 3.2. Orchid species accumulation over successive surveys of four botanical markets. Circles indicate survey months.

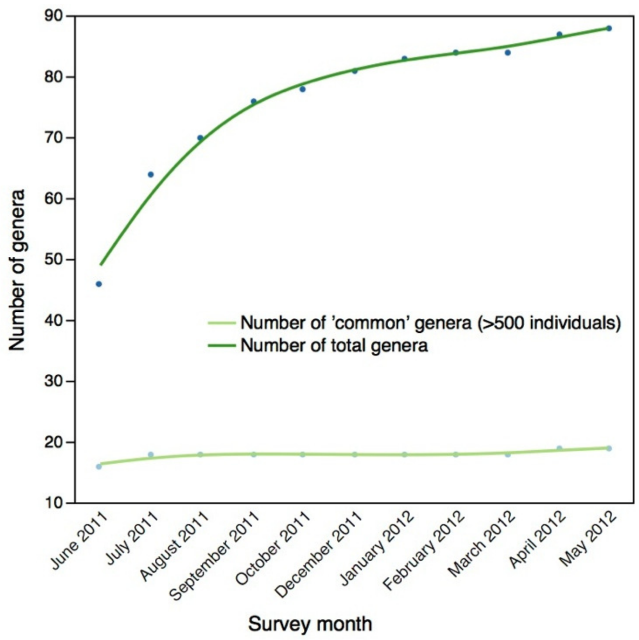


Figure 3.3. Orchid genus accumulation curve over successive surveys of Jatujak Market, showing total number of genera and the 19 genera that were most abundant in trade (>500 individuals observed at Jatujak).

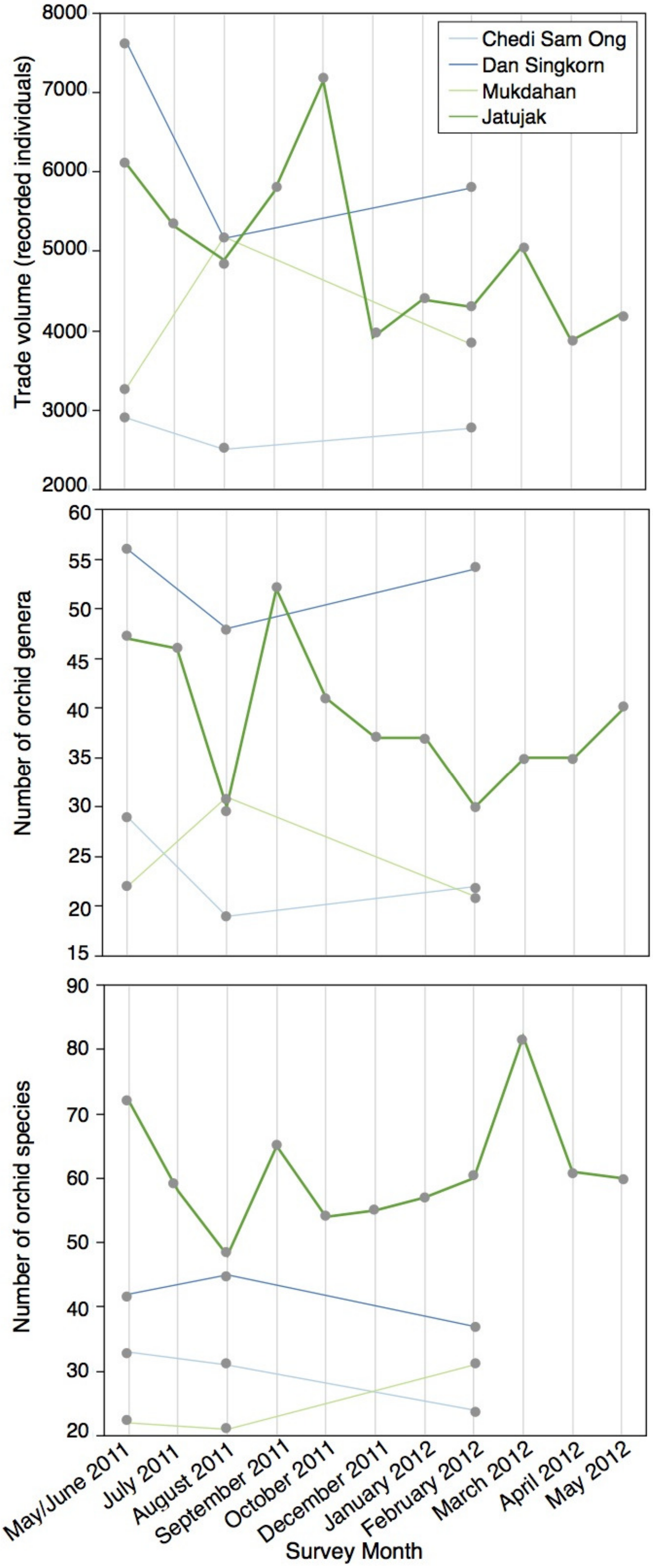


Figure 3.4. Number of orchid genera and species and trade volume at each market by month. Circles indicate survey months: Jatujak surveys were conducted every two weeks, while the border markets were surveyed 3 times (May/June 2011, Aug. 2011 and Feb. 2012).

Across the year, trade volumes and species encounters varied considerably for all of the sites (Fig. 3.4). Seasonality and phenology likely affected the periods when individual species could be identified using flower characteristics, which explains part of the variability in species count. Even so, species-level identifications would not influence variation in overall trade volume, which likely accurately represents actual fluctuations in trade. This could have been affected by factors such as plant availability (harvest dynamics), peaks in enforcement and consumer demand.

3.3.3 Taxa targeted by trade

Despite the high observed richness, a comparatively small number of orchid genera accounted for the bulk of trade, with only 22 genera traded in volumes exceeding 500 individuals (Fig. 3.5, Table 3.3).

Table 3.3. Ten most abundant genera traded at four target plant markets

Jatujak		Mukdahan		Chedi Sam Ong		Dan Singkorn	
	RA[a]		RA		RA		RA
Dendrobium	29.9	*Dendrobium*	35.5	*Dendrobium*	19.3	*Dendrobium*	29.9
Rhynchostylis	6.4	*Aerides*	13.6	*Tacca*	15.9	*Aerides*	9.9
Paphiopedilum	6.4	*Paphiopedilum*	6.0	*Platycerium*	8.4	*Philodota*	8.6
Aerides	5.5	*Rhynchostylis*	5.5	*Rhynchostylis*	6.2	*Eria*	8.0
Bulbophyllinae [b]	5.4	*Vanda*	4.0	*Calanthe*	5.3	*Rhynchostylis*	7.9
Bulbophyllum	4.9	*Geodorum*	3.0	*Papilionanthe*	4.1	*Bulbophyllinae* [b]	6.3
Ascocentrum	3.0	*Bulbophyllinae* [b]	2.3	*Bulbophyllum*	4.1	*Platycerium*	4.9
Vanda	2.9	*Pleione*	2.1	*Cheirostylis*	3.6	*Paphiopedilum*	3.1
Phalaenopsis	2.3	*Habenaria*	2.1	*Eria*	3.6	*Eulophia*	2.2
Cleisostoma	2.1	*Cleisostoma*	2.1	*Philodota*	3.2	*Bulbophyllum*	1.7

[a] Relative abundance in trade as percent of trade volume at each market
[b] Subtribe *Bulbophyllinae* includes >100 genera, including *Bulbophyllum*, which also independently ranks in several lists.

While patterns varied somewhat across markets, trade was clearly dominated by plants in the genera *Dendrobium, Rhynchostylis, Aerides* and, to a lesser extent, *Paphiopedilum* (Table 3.4). These top raking genera were principally groups with charismatic, large-flowers. Several non-orchid genera were also highly ranked in trade (*Tacca, Platycerium*), but these are also conspicuous and attractive ornamental plants. Trade across all the markets was heavily dominated by orchids in the genus *Dendrobium*, the second largest in the region (after *Bulbophyllum*), which includes a particularly great number of species with charismatic flowers (Table 3.3; Photo 3.2).

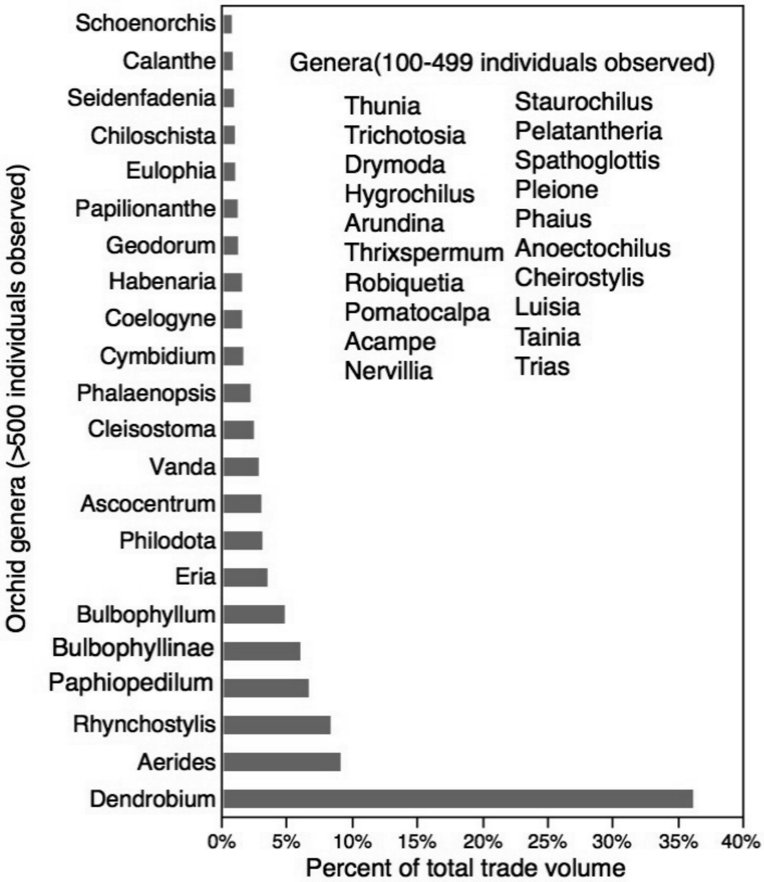


Figure 3.5. Relative abundance of orchid genera in trade (with >100 and >500 individuals observed during surveys)

Even within the genera that were common in trade, trade was dominated by a subset of species. Trader free lists of the most traded species at each market yielded short, similar lists that also matched market observations. The most commonly traded species were included *Rhynchostylis gigantea, R. retusa, Aerides rosea, Dendrobium chrysotoxum* and *D. lindleyi* (Table 3.4).

Table 3.4. Most traded plant species (by volume), as reported by traders [a]

Jatujak (N=7)		Mukdahan (N=20)		Chedi Sam Ong (N=9)		Dan Singkorn (N=48)	
	RA[a]		RA		RA		RA
R. gigantea	6	*R. gigantea*	16	*R. retusa*	7	*R. retusa*	31
D. delacourii	1	*R. retusa*	4	*D. lindleyi*	5	*A. rosea*	27
Ferns	1	*D. chrysotoxum*	3	*D. chrysotoxum*	4	*D. chrysotoxum*	7
R. retusa	1	*A. houlettiana*	2	*D. farmeri*	3	*R. gigantea*	5
		D. lindleyi	2	*A. curvifolium*	1	*D. lindleyi*	4
		A. rosea	1	*A. rosea*	1	*D. thrysiflorum*	3
		Bulbophyllum spp.	1	*R. gigantea*	1	*D. polyanthum*	2
		C. arietinum	1	*P. concolor*	1	*D. farmeri*	2
		D. farmeri	1			*Eria* spp.	2
		D. thyrsiflorum	1			*Huperzia* spp.	2
		P. cornucervii	1			*Cymbidum* spp.	1
		Paphiopedilum spp.	1			*D. jenkinsii*	1
						D. Sect. Rhopalanthe	1
						Ferns	1
						G. speciosum	1
						Hoya spp.	1
						Paphiopedilum spp.	1
						Platycerium spp.	1

[a] Trader free list of up to five species they sold in largest volumes
[b] Relative abundance in trade as frequency of mentions during interviews

Dendrobium Sections Callista (including *D. chrysotoxum, D. lindleyi, D. jenkinsii, D. farmeri, D. thyrsiflorum*) were disproportionately represented in overall trade, as evidenced by trader reports (Table 3.4) and market surveys (Fig. 3.6). *Dendrobium* Sections Dendrobium, Formosae and Stachyobium were also common in trade (Fig. 3.5). These groups are generally characterized by species that have large, brightly coloured flowers (Photo Panel 3.2).

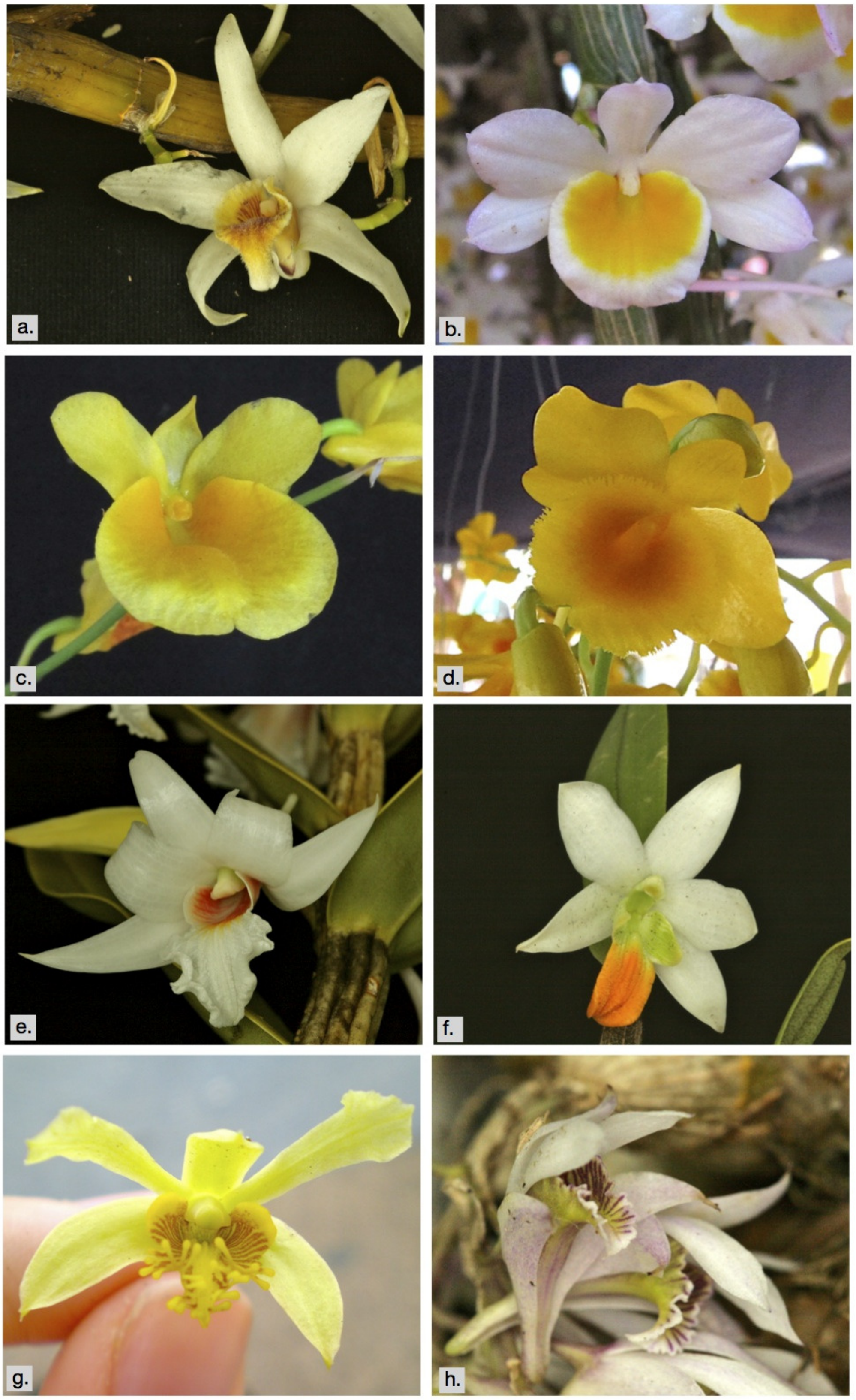


Photo 3.2. Four most abundant *Dendrobium* Sections

Section Dendrobium: a. *D. heterocarpum*; b. *D. crepidatum*

Section Callista: c. *D. capillipes*; d. *D. chrysotoxum*

Section Formosae: e. *D. scabrilingue*; f. *D. draconis*

Section Stachyobium: g. *D. delacourii*; h. *D. penguanum*

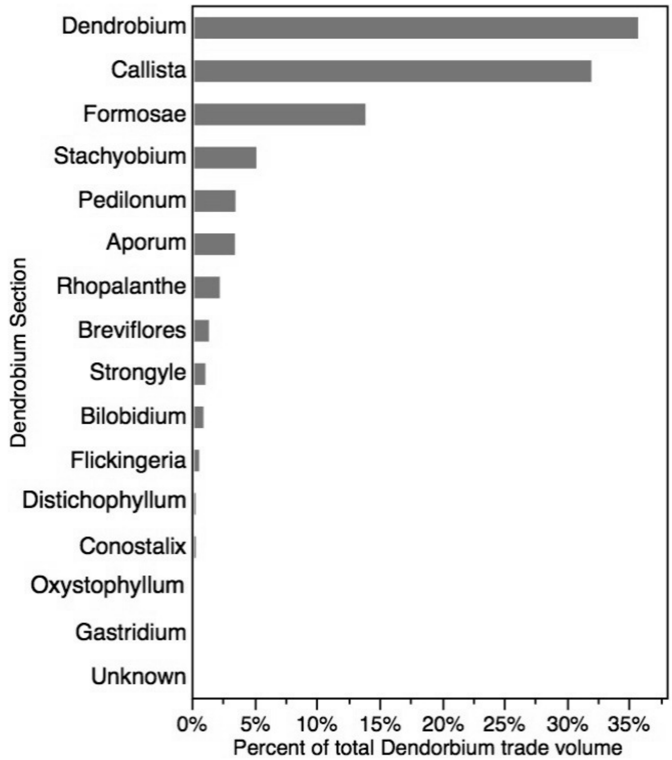


Figure 3.6. Relative abundance of *Dendrobium* Sections across all markets

Notably, the genus *Paphiopedilum* also ranked among the most abundant in trade (Table 3.3, 3.4), although all species in the genus are locally and globally endangered and are listed on the CITES Appendix I-listed, which prohibits their international trade. The most commonly traded species were from the Subgenus Brachypetalum, notably the widely distributed *P. concolor* (Fig. 3.7). However, most of the *Paphiopedilum* species present in the target countries were observed in trade, even if in relatively small volumes. The greatest volume and species richness of *Paphiopedilum* were found at Jatujak Market, although several species were also found at border markets in smaller volumes. Differences in species compositions among the border markets (e.g. Dan Singkorn vs. Mukdahan) almost certainly represent differences in the geographic distributions of these species (see Cribb 1987; Averyanov et al. 2003).

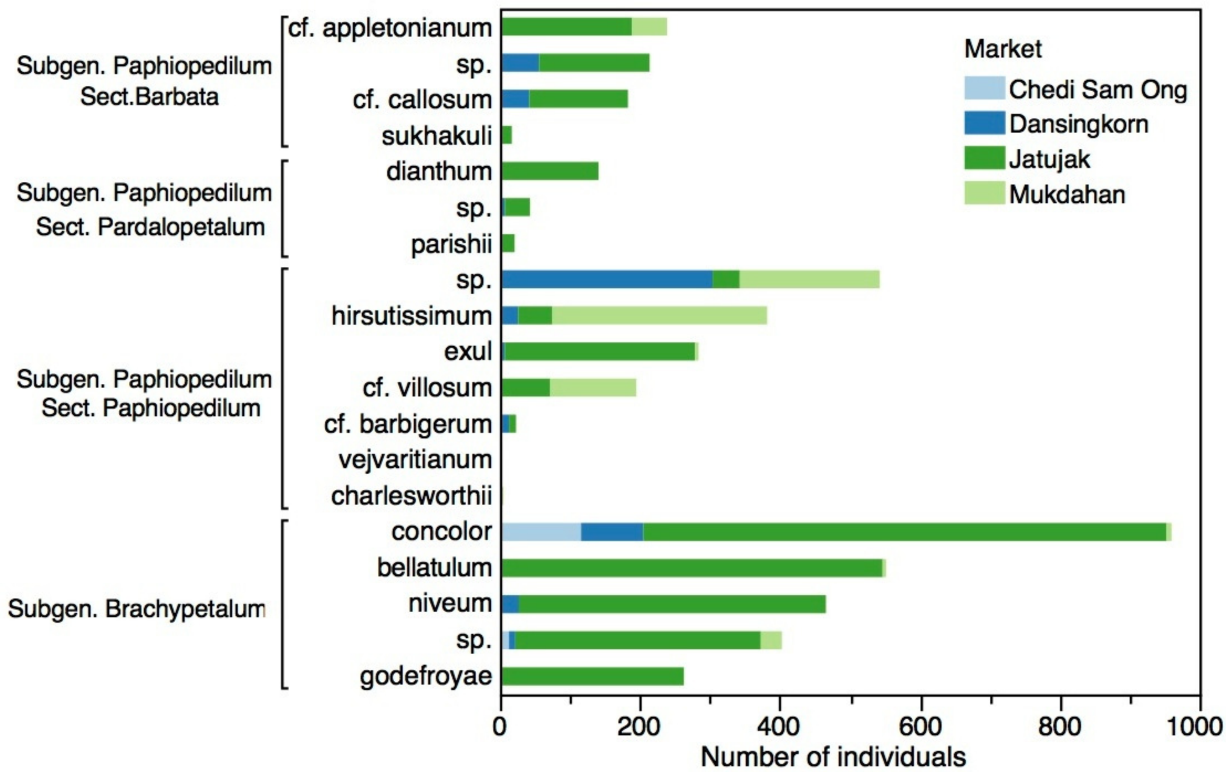


Figure 3.7. Abundance of *Paphiopedilum* in trade, by Subgenus/Section and species* and stacked by market where plants were observed. Species identifications in figure include both author-identifications and reasonable speculation based on trader-reported identification. Identification of cf. *P. villosum* includes related species *P. gratrixianum.* Identification of cf. *P. barbigerum* includes several subspecies. Some identifications of cf. *callosum* and cf. *appletonianum* potentially overlap and could also include *P. barbatum.* However, species list (Appendix 5) includes only author-identifications. Bunches of plants tied together by traders were treated as single individuals

3.3.4 Sale prices

Plant prices varied greatly, both across and within genera and single species at each site (e.g., Fig. 3.8; Appendix 7). For example, the median price of flowering plants at Jatujak was approximately US$2.67 per plant (IQR = $1.10-5.0), and reported prices ranged from approximately US$0.10-100 per individual (Fig. 3.8). We provide baseline price data for the genera and species encountered at each market (Appendix 7). The list is illustrative of the wide range of prices, and highlights the high prices fetched by some species.

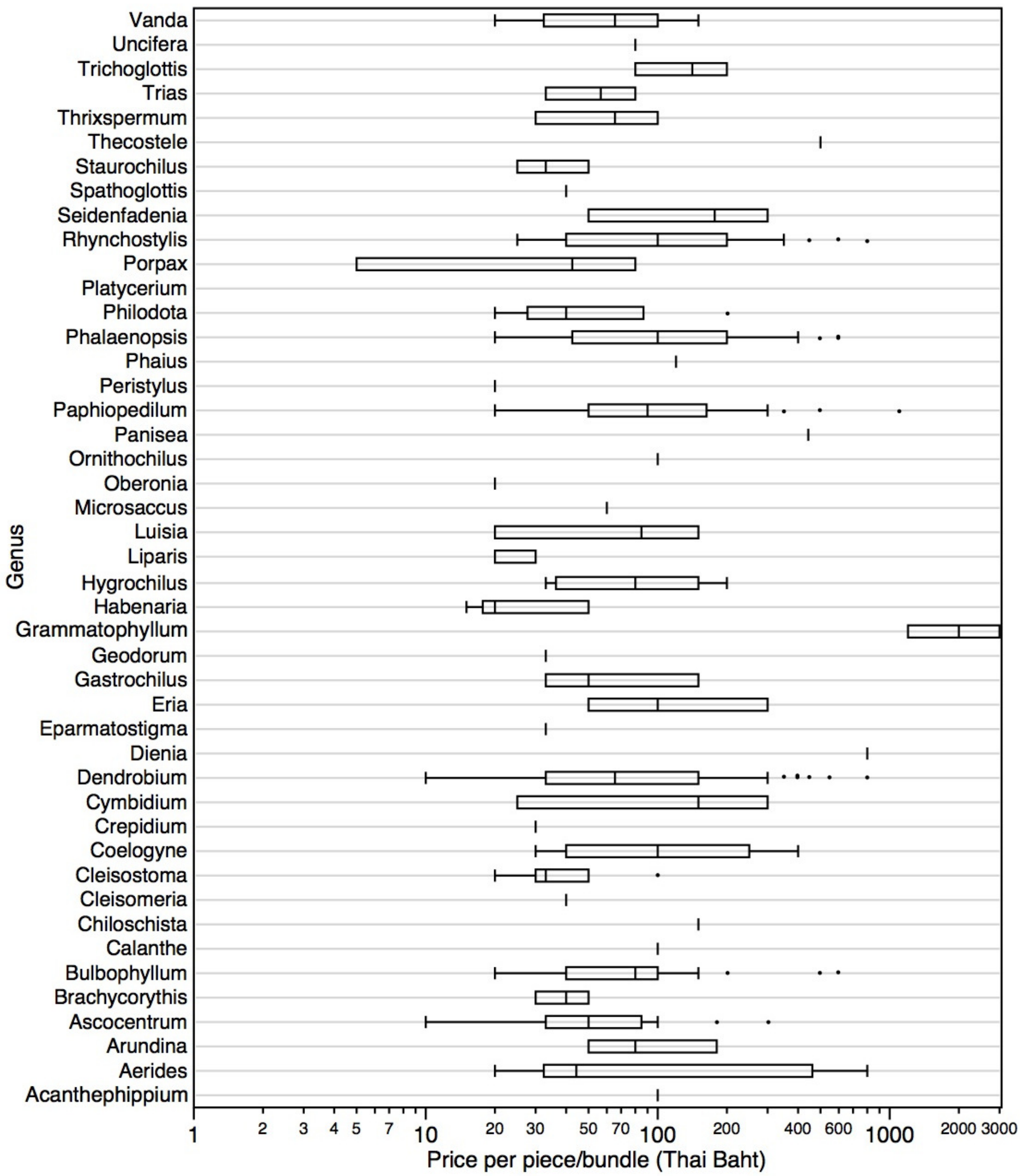


Figure 3.8. Reported prices of orchid genera encountered at Jatujak Market. Box and whisker plot shows median and 1st and 3rd quartile prices, whiskers 1.5 times the interquartile range, and outliers. Prices are per piece/bundle for bare-root plants only, but do not include prices quoted per kilo (see Chapter 2 for methods).

An Analysis of Means (ANOM) decision chart, to compare whether the mean price of each encountered genus and species was significantly different from the overall mean price, showed few diffrences. *Grammatophyllum speciosum* (monotypic genus) was an exception, depicted above the decision line (α=0.05) in Figure 3.9, and significantly more expensive than other genera and species, likely because of its extraordinary size assocaited harvest burdens and transport costs. In contrast, ANOM showed that *Habenaria* spp. and *Dendrobium peguanum* were less expensive than the mean price of flowering plants at Jatujak. Although not particularly common in trade (Appendix 5) the price difference could be due to their comparatively small size and relatively inconspicuous flowers.

However, the general lack of signiciant price difference across taxa is likely because of the high variability in prices, which likely reflects variables such as plant size, rarity and demand (cf. Tournant et al. 2012; see Chapter 6 on *R. gigantea*). For example, *Paphiopedilum* spp. were usaully sold in small pieces (subdivisions of large plants) that were comparatively affordable (Appendix 7), although they represented very high value species (US$11.70-20.00/kg). We lacked individual plant weight and ecological data to explore these relationships (see Methods; Chapter 4 discussion of value chain). A Kruskal-Wallis test showed that there was no significant relationship between number of encounters of any given species at Jatujak and plant price (3.65, 4 d.f., p=0.456), although encounter rate was probably a poor proxy of abundance because of taxonomic uncertainty when plants were out of bloom.

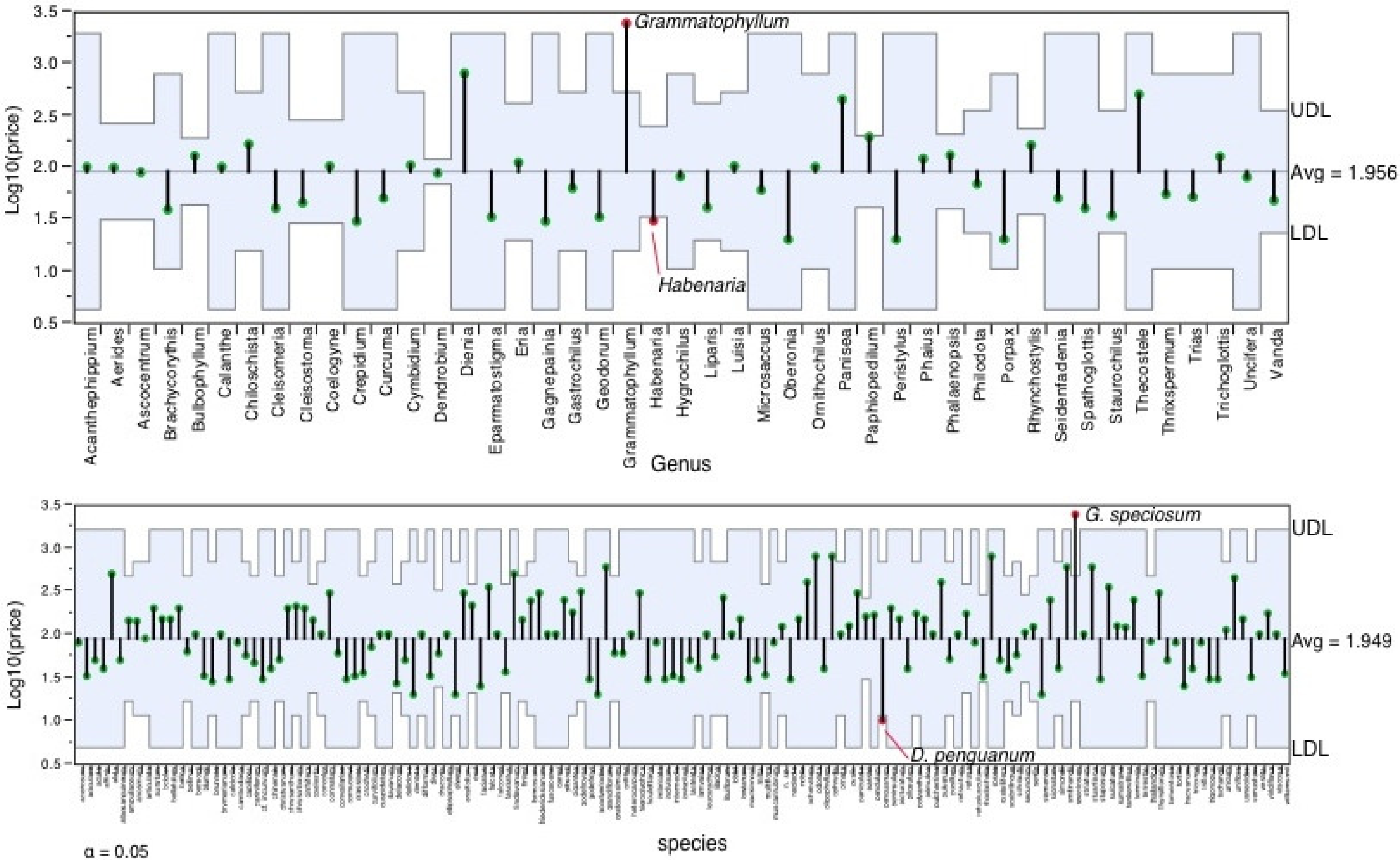


Figure 3.9. Analysis of Means decision chart for reported price (log normalized) by orchid genus and species (blooming specimen) encountered at Jatujak Market. Middle line shows average price, upper (UDL) and lower decision lines (LDL). Red points indicate mean prices that differed significantly from the overall mean.

3.3.5 Market trends

Overall generic and species compositions of the four markets also differed (Table 3.5, Table 3.6). The three border markets showed lower generic and species richness than Jatujak Market (Table 3.1), likely because traders at those markets sourced plant material from a smaller geographic area (see Chapter 4).

Table 3.5. Generic similarity between markets: Sorensen (above diagonal) and Morisita-Horn (below diagonal) similarity indices applied to 4 plant markets

Site	Chedi Sam Ong	Dan Singkorn	Mukdahan	Jatujak
Chedi Sam Ong	--	0.54	0.50	0.39
Dan Singkorn	0.87	--	0.55	0.70
Mukdahan	0.83	0.87	--	0.40
Jatujak	0.89	0.89	0.95	--

Table 3.6. Species similarity between markets: Sorensen (above diagonal) and Morisita-Horn (below diagonal) similarity indices applied to 4 plant markets

Site	Chedi Sam Ong	Dan Singkorn	Mukdahan	Jatujak
Chedi Sam Ong	--	0.39	0.26	0.21
Dan Singkorn	0.66	--	0.38	0.41
Mukdahan	0.37	0.33	--	0.23
Jatujak	0.50	0.55	0.76	--

Based on absence-presence data (Sorensen), the markets appeared to be only moderately similar in generic and species composition, with no clear trends emerging (Table 3.5, 3.6). Accounting for abundance (Morisita-Horn), however, highlighted greater similarities among the markets, particularly at the genus level. Differences between the two indices are unsurprising, as trade was dominated by a subset of taxa (Table 3.3), and most species were represented by a very small number of individuals (Appendix 5).

3.3.6 Threat assessment

Based on trader reports we concluded that whole plants were harvested (rather than cuttings). We identified no species-specific data on life history (including generation times) for the species encountered, except for some data on the genus *Paphiopedilum*.

We found no species for which population estimates had been established. There was also very limited detailed distributional and ecological data, although there is future potential to use herbarium records to establish specific Areas of Occupancy and documented number of locations (see IUCN criteria B; cf. Kurtzweil 2009). In lieu, we relied on Extend of Occurrence to identify species with particularly narrow distributions. However, based on the existing data, all species encountered would likely be listed as Data Deficient based on a rigorous application of IUCN Red List Criteria (IUCN 2012). Nevertheless, the 2006 Red List identifies several dozen

National-level conservation assessments were almost entirely absent for plant species in Myanmar and Lao PDR (Table 3.7). Preliminary conservation assessments for orchid species in Thailand were available for less than 1/3 of species encountered in trade (Appendix 8), but were neither systematic nor necessarily data-based. Global assessments were available for a very small number of encountered species, principally for *Paphiopedilum* based on CITES Appendix I listing. Evaluations from the United Nations were based on grossly outdated references (WCMC 2010), most of which are geographically-targeted, taxonomic references rather than conservation assessments. No species in the target region had been evaluated using the IUCN Red List guidelines (IUCN-OSG 2009; IUCN 2012).

Nevertheless, 58 of the orchid species found in trade had been designated as either threatened, vulnerable, endangered or rare (although not all based on IUCN Criteria) in one of the three target countries (16.7% of orchid species records). The encountered trade volumes for most of these species were relatively small. Expanded monitoring and an increase in species-level identifications (where it more possible to identify sterile specimen to species-level) would very likely increase documented trade volumes (Appendix 8). We identified no specific data on other possible drivers of loss, aside from the regionally ubiquitous threat of deforestation and forest degradation.

Our coarse threat analysis suggested that regional trade potentially threatened at least 30 species: *Aerides houlettiana, Ascocentrum ampullaceum, Dendrobium albosanguineaum, D. falconeri, D. lamyaiae, D. friedericksianum, D. nobile, Drymoda siamensis, Grammatophyllum speciosum, Habenaria carnea, H. rhodocheila, Pecteilis susannae, Phalaenopsis finleyi, P. sumatrana, Rhynchostylis gigantea, Vanda coerulea, V. bensonii* and all of the CITES Appendix I *Paphiopedilum* spp (Appendix 8).

Table 3.7. Summary of threat analysis for orchid species encountered in trade, divided by national-level threat analysis and at the global level (Appendix 8)

Conservation Status	Number of encountered species assessed
Thailand Assessment	
Threatened	57
Not threatened	10
No Assessment	108
Lao PDR Assessment	
Threatened	8
Not threatened	1
No Assessment	100
Myanmar Assessment	
Threatened	0
Not threatened	0
No Assessment	130
Global Assessment	
Threatened	20
Not threatened	23
Unknown	304

National Assessments include both domestic conservation assessments and any other scientific references that clearly indicate whether a particular species is common or rare in the wild in that country. Global Assessments are from the Most UNEP-WCMC database and also apply to endemic species that have national-level assessments

In the absence of conservation assessments and ecological data, interview data from harvesters in southern Myanmar suggests that commercial trade potentially affects a wide number of orchid species in that region. Most traders (N=18) reported harvesting all species they encountered, while two restricted harvest to high value species. Most (N=18) also reported harvesting from all trees in a target area, and repeatedly returning to the same areas to collect (N=17). However, most (N=13) also reported that they restricted harvest to larger, mature plants, and left immature plants.

All but one respondent reported harvesting on government lands (Burmese government, Democratic Karen Buddhist Army or Karen National Union), suggesting that like many non-timber forest products, these ornamental plants represent common pool resources. Limited interviews with collectors in Lao PDR (N=3) also reported harvest on government lands.

When asked to describe any changes in abundance of ornamental plants since they started collecting (median of 6 years trading, see Chapter 5), all respondents reported declines. Most (N=14) stated that all orchid species had declined, and the rest mentioned specific declines in *D. lindleyi, A. rosea, R. retusa, Huperzia* spp.*, D. chrysotoxum,* and *Eria* spp. Several traders (N=6) specifically described orchid extirpations around village areas that had been subject to heavy harvest, including forests within walking distance of Chedi Sam Ong and Dan Singkorn. This echoes findings of Schuiteman et al. (2008) during a orchidological survey of Lao PDR, during which "*on* more than one occasion villagers have told us, when we came looking for orchids near their village, that we should have come a few years earlier, before all the orchids were collected!". Although largely anecdotal and regional, these harvester reports suggest that trade from Myanmar is affecting wild populations.

3.4 Discussion

3.4.1 A neglected conservation issue

Commercial botanical trade has been almost completely overlooked in Southeast Asia, and there are no previous related studies in the region. We documented a substantial, widespread trade in wild-collected ornamental plants, involving hundreds of species and markets across Thailand (Appendix 5). We provide an initial list of the ornamental plant species in trade in Thailand, including almost 350 orchid species. Notably, we documented continued international trade of CITES Appendix I orchid species in the genus *Paphiopedilum*. This provides a baseline critical to future efforts to determine impacts of commercial trade on botanical conservation, inform harvest and trade regulation, and prepare future IUCN Red Listing.

Unsurprisingly, ornamental trade was dominated by Orchidaceae, a highly diverse family in continental Southeast Asia (~2000 species; Grovaerts 2013), many of which have charismatic flowers and have a long history of horticultural trade (Cribb et al. 2003). Similarly it is unsurprising that charismatic groups with large, colourful and fragrant flowers attracted particular horticultural attention, including *Dendrobium, Rhynchostylis, Aeries* and *Paphiopedilum* (Fig. 3.5).

However, we also identified significant trade in plants from the genera *Pholidota, Cleisostoma, Eria* and the Subtribe Bulbophyllinae (including *Bulbophyllum* and allied genera). Although *Eria* and *Bulbophyllinae* represent particularly large taxonomic groups, they are not characterized by particularly charismatic or large flowers, and were unexpected in ornamental trade. We also found a number of other, comparatively inconspicuously flowered species in trade. Although most were found in small volumes, these represented a considerable number of species records (Appendix 5), including several new species descriptions and country records (Table 3.2). This, in particular, highlights the potential for illegal commercial trade to affect a wide number of species, including threatened taxa not yet recognized by the scientific community (cf. Vermeulen and Lamb 2011; Phelps et al. in prep.; Vermeulen and Phelps, in prep.).

There were major barriers to evaluating the conservation impacts of trade (Appendix 8). We did, however, leverage limited existing data to highlight 30 species potentially threatened by trade that could be starting points for greater investigation. We also found significant anecdotal evidence that current trade is not sustainable. Harvester reports suggested broad impacts of harvest on wild populations, including local-level extirpations, and both species-specific impacts and broader effects across entire epiphyte communities. This suggests that existing CITES-based efforts to achieve sustainable orchid trade is not fully effective (see also Chapter 7). There is a clear need, however, to conduct more rigorous evaluations of conservation status of Orchidaceae in the region, particularly given the indication of a large commercial trade.

This failure to protect CITES-listed species within continental Southeast Asia may be attributed, in part, to a neglect of regional trade dynamics. Many previous characterisations of wildlife trade in Southeast Asia have focused on overseas consumption in Europe, Japan, China and USA (e.g., Cribb et al. 2003; Engler and Parry-Jones 2007). There is, however, growing recognition that Thailand, in particular, serves as a globally important conduit of wildlife trade (Nijman and Shepherd 2011) and that Thai domestic demand for wildlife goods is both significant and growing (World Bank 2005). This study specifically highlighted the importance of local and regional demand for wild ornamental plants. In particular, we highlighted the role of Bangkok's Jatujak Market as a regional centre of botanical trade, hosting a large and unique richness of wild plant species. While Jatujak has been long recognised as a centre of illegal wildlife trade, including ivory (Stiles 2009), turtles, tortoise, (Shepherd and Nijman 2007), frogs, snakes, chameleons (Todd 2011), newts (Nijman and Shepherd 2011b) and a number of other animal species, it had not been previously studied be considered within the context of illegal botanical trade.

Moreover, we documented high sale prices of many orchid species (Fig. 3.7). While many Non-timber Forest Products (NTFPs) are considered economically marginal, we found that wild ornamental plants are an economically valuable, yet under-recognised natural resource (Fig. 3.8; Appendix 7;). These suggest that the economic motivations for participating in illegal botanical trade may be high (see also Chapter 5), which could represent a major barrier to conservation. This also highlights ornamental plant trade as a topic not only of conservation concern, but economic significance, as sustainable harvest and native species propagation could generate significant income and tax revenue (cf. Lamxay 2008).

3.4.2 A case of CITES over-regulation?

Despite characterisation of the wild ornamental orchid trade as an undocumented conservation issue in the region, the results also suggest that Orchidaceae has been subject to over-regulation. Orchidaceae is one of the few taxonomic groups subject to family-wide CITES regulation, which restricts the trade of most species (Appendix

II), and bans the trade of a small group of especially vulnerable species (Appendix I; see Chapter 1).

The Convention regulates the trade of roughly 1,500 orchid species in the three target countries, but only a small number of these are used in ornamental or medicinal trade (cf. Thomas et al. 2006). We found fewer than 350 species in 93 genera in trade (Table 3.1). This represented only 13-22% of the target countries' known orchid floras. Moreover, while our trade estimates were highly conservative, most species were relatively rare in trade, which was dominated by a comparatively small group of genera and species. Five genera accounted for more than 50% of overall trade volume (Table 3.3).

Our results highlight the need for renewed discussion about the adequacy of such broad restrictions for botanical conservation. The recent listing of dozens of timber species to CITES Appendix II (2013) and new regulations on timber imports into the USA (Lacey Act) and Europe (Forest Law Enforcement, Governance and Trade programme), further highlight the challenges associated with regulating wildlife trade. This parallels growing debate over trade restrictions and bans to protect a wider range of other taxa, including parrots, rhinos, timber species, sea cucumbers and sharks (e.g., Bruckner et al. 2003; Cooney and Jepson 2006; Rivlan et al. 2007).

Over-regulating botanical trade is potentially problematic for several reasons. Notably, blanket restrictions across such broad taxonomic groups fail to discriminate among plants that are subject to different trade pressures and that have different life histories. We found that trade disproportionately targeted a small group of genera, sub-genera and species, while largely or entirely overlooking others. These groups also have divergent life histories, ranges and extinction vulnerabilities (e.g., Chung et al. 2012), but are treated as homogeneous under existing regulations. For example, we documented substantial trade in species that are widely distributed and not threatened (e.g., *Dendrobium secundum*; UNEP-WCMC 2010) that could potentially be traded without threatening species conservation. However, these taxa are regulated in the same way as threatened, narrow endemics (e.g., *D. umbonatum*; Santisuk et al. 2006)

Blanket restrictions also potentially introduce market distortions by restricting supply and encouraging black market transactions, which can increase prices and motivate further trade; restrictions can be particularly hard to enforce where they compete against powerful economic drivers (Rivlan et al. 2007; Biggs et al. 2013). We document that ornamental botanical trade is economically valuable (Appendix 7), which may present challenges to enforcement and creates considerable scope for rule-breaking and corruption (see Chapter 8). For example, despite a complete commercial trade ban, we documented ongoing trade of high-value *Paphiopedilum* spp.

Placing trade restrictions on non-threatened species may compromise not only effectiveness, but the credibility of CITES as a fair and useful regulatory mechanism, undermining legitimacy and compliance (discussed in Keane et al. 2008). It also represents lost economic opportunities, including for income generation among forest-dependent communities, entrepreneurial green sustainable development efforts, and tax revenue (see Cooney and Jepsen 2003; Lamxay 2008). Heavy regulation also potentially drives trade participants into criminality without there being a clear conservation justification (see Chapter 8; cf. Dickson 2008). There are broad calls for regulated market-based approaches to balancing conservation and sustainable harvest (Cooney and Jepsen 2003; Biggs et al. 2013). There are, however, considerable challenges to promoting both sustainable trade and specific-specific monitoring for groups with many “look alike” species, such as Orchidaceae.

3.4.3 Is sustainable trade possible?

There is a need to consider the potential for *in situ* management of wild ornamental plant species (cf. Flores-Palacios and Valencia-Diaz 2007). Many orchid species are found in low population densities (Pupulin 2004; Flores-Palacios and Valencia-Diaz 2007), suggesting limited potential for sustainable harvest. For example, a population viability analysis of *Guarianthe auranthiaca* forecast that harvest of more than 5% of the reproductive individuals in the population would result in extinction within 100 years (Mondragon-Chaparro 2009). Yet, harvest impacts groups differently (Ticktin 2004), and sustainable harvest approaches have been identified for some long-lived ornamental plant species, including cycads (Vovides and Iglesias 1994) and bromeliads (Ticktin and Johns 2002; Mondragón-Chaparro and Ticktin 2011; ARC 2013) and orchids (OEH 2013). Notably, there may be potential for sustainable harvest involving salvage (e.g., from fallen trees or from trees cleared for logging, agricultural or development), harvest of wild cuttings that can be grown on but leave mature plants in place, or selective harvest of immature plants. There are, however, considerable challenges to establishing a sustainable trade in wild orchids in continental Southeast Asia, including related to resource governance (see Chapter 8) and basic ecological data. Moreover, artificial propagation is feasible, and likely more appropriate than wild harvest, for most orchid species (see OEH 2013).

Importantly, the vast majority of plants observed during the market surveys were on CITES Appendix II, and were thus potentially eligible for legal international trade through CITES. The international trade of Appendix II species is restricted out of concern that trade could potentially harm their conservation, but trade is nonetheless allowed, and the Secretariat outlines regulatory guidelines for promoting sustainable use. As we demonstrate, CITES policies are currently not being effectively implemented in the region, as none of the specimens encountered during market surveys were imported with CITES permits (see Chapter 7). A recent review of conservation legislation in the region also revealed that Myanmar and Lao PDR lack the domestic legislation required to enforce CITES (CITES 2012). Moreover, there are considerable technical, financial and geographic barriers to securing CITES permits in the region (e.g., Wai 2013), and there is a need to ensure reporting and permitting requirements are accessible to small-scale participants (Laird et al. 2011)

Crucially, legal trade of CITES II species is contingent on permits from the exporting State's CITES Management Authority, based on legal harvest of wild specimens and on a Non-Detriment Finding (NDA) showing that "a Scientific Authority of the State of export has advised that such export will not be detrimental to the survival of that species" based on an evaluation of factors such as species population status, distribution, harvest and trade information, and population trends (CITES N.D.). During the attempted threat analysis for the species encountered during market surveys, we found that it would be impossible to conduct informed NDFs for almost all orchid species in the region due to lack of data (cf. Thomson et al. 2006). With the exception of *Vanda coerulea* (Sripotar 2008), there was also no documentation to suggest NDFs have bene recently conducted for plant species in any of the target countries.

Such data gaps are common in Southeast Asia, which lags behind others regions in basic ecological research (Sodhi et al. 2004). Southeast Asia's orchid flora—especially outside of Thailand—remains poorly studied. This likely means that many species remain undescribed, and that new country records are imminent (e.g., Table 3.2; Schuiteman et al. 2008). However, the lack of a stable flora also means that many existing taxa may not be properly circumscribed. Myanmar's orchid flora, for example, contains many outdated synonyms due to lack of rigorous contemporary study, but is also likely to expand with greater study (H. Kurtzweil, pers. comm).

Establishing sustainable harvest/management guidelines, trade quotas, licensing and resource management harvest strategies would require considerable additional research. This would have to extend beyond existing taxonomic efforts to also focus on epiphyte ecology and possible management strategies (e.g., in vitro, cultivation from wild cuttings). Notably, however, initial efforts would not need focus on thousands or hundreds of species, but on the relatively small number of genera and species that are most targeted by trade (Appendix 5). Focus on the orchid genera *Aerides, Rhynchostylis and Dendrobium* Sections Dendrobium and Callista could potentially address a majority of existing trade in the region.

Yet, there remains a need to better understand these trade patterns, including improved understanding of the behavioural dimensions of wildlife trade (see World Bank 2005). This includes both improved understanding of harvester and trader demographics and responsiveness to alternative livelihoods (see Chapter 5), and consumer buying patterns and preferences (see Chapter 5). For example, given the prevalence of 'non-charismatic' species in trade, it is possible that many consumers were not well informed. Similarly, there is a need to understand the nature and scale of demand for rare and endemic species among consumers (cf. Slone et al. 1998; Courchap et al. 2006; Tournant et al. 2012). Consumer profiles would be necessary to targeting interventions, including market-based approaches, evaluation of consumer interest in sustainably harvested wild plants (cf. Mondragón-Chaparro and Ticktin 2011). Profiles could also inform conservation education (see Yiming and Dianmo 1998; Zhang et al. 2008; Rosen and Smith 2010), including recent outreach campaigns by the Department of National Parks, Wildlife and Plant Conservation at Jatujak (DNP 2013).

The barriers to establishing sustainable wild orchid trade are significant. Nevertheless, there is precedent and an existing structure through which Southeast Asian ornamental plant harvesters and traders could potentially be integrated into a legal, regulated and sustainable trade of Appendix II species.

3.4.4 Monitoring botanical trade

In practice, both trade restrictions and sustainable harvest regimes rely heavily on effective monitoring and enforcement (e.g., Galetti and Fernandez 1998; Laird et al. 2011). These represent major barriers to resource management across Southeast Asia (Sodhi et al. 2004). However, this study not only highlights the gross inadequacies of existing monitoring and enforcement efforts, but demonstrates the value and viability of basic wildlife trade monitoring, particularly at open markets in the region (see Chapter 7). Importantly, survey effort of market-based botanical trade can be achieved with limited human and financial resources (see also Flores-Palacios and Valencia-Diaz 2007), and represents a 'low hanging fruit' for conservation in the region. Only basic training ise required to help customs agents to identify the family Orchidaceae, and other traded ornamental families such as Cycadaceae and Nepenthaceae.

However, monitoring botanical resources presents unique challenges associated with species identification, particularly for large groups such as Orchidaceae, and where trade involves “look-alike” species, sterile specimens or transformed products (e.g., timber) that can be especially hard to identify (e.g., Gasson et al. 2010). There may eventually be technological solutions to identification, including automatic identification and genetic profiling, though there remain considerable barriers (Gaston and O’Niell 2004; Alacs et al. 2009; see Chapter 2 discussion of methods for taxonomic identification). The list of targeted species could be used to identify priorities in the establishment of genetic libraries for future barcoding efforts.

In the meantime, the taxonomic demands of botanical trade monitoring remain significant. Many orchids can only be reliably identified at the species-level when in bloom, yet ~85% of specimens during surveys were sterile (see Chapter 2, Table 2.1). This highlights the challenges of monitoring Orchidaceae and a justification for broad trade regulation to manage “look-alikes”. It also explains the reliance on genus and subgenus-level identifications that are based on vegetative characters alone and require lower sampling effort. For example, most genera found at Jatujak observed were within 4 surveys (Fig. 3.2), and the most abundant genera were observed after only 2 surveys (Fig. 3.3). Genus-level identification can provide insights into which groups are being targeted. It is particularly valuable for smaller groups (e.g., *Rhynchostylis, Dendrobium* Section Callista, *Paphiopedilum*), which coincidentally included some of the most heavily traded species. Genus-level identification is especially relevant to the CITES Appendix I genus *Paphiopedilum,* as the whole group is threatened by trade. Moreover, with minimum training, orchids in the the genus *Paphiopedilum* can be readily distinguished from other groups (e.g., McGough et al. 2004). However, a genus-level taxonomic approach is too coarse to inform the conservation of very large groups such as *Bulbophyllum.*

Despite these taxonomic challenges, there is potential to provide minimum training and more accessible taxonomic references to facilitate botanical monitoring and implementation of existing regulations (see Chapter 7). Given that trade was dominated by a small group of taxa, targeted references could be created for both the most common and the most threatened species. Several small identification booklets have been prepared in Thailand, but neither focus on the most common or threatened species nor detail vegetative characters. Notably, Thailand also hosts several institutions with substantial taxonomic expertise that could be further leveraged to provide training and support occasional field surveys.

Increased botanical trade monitoring has the potential to dramatically increase burdens on customs officials and taxonomic experts. However, even slightly increased monitoring could yield significantly expanded baselines with which to evaluate regional trade. For example, although trade volumes and richness varied over the survey period (Fig. 3.4), likely affected by factors such as species phenology, as few as two market surveys throughout the year captured the salient trends at the border plant markets (Fig. 3.2). Low survey effort, requiring only 1-2 people for 1-2 days per survey, identified the majority of genera and species in trade, and was especially effective at markets with low overall species richness (Chedi Sam Ong and Mukdahan).

In contrast, the results suggest that Jatujak market requires considerably greater monitoring effort. Even 1 year of frequent surveys was insufficient to yield a complete species list for Jatujak. (Fig. 3.2). The accumulation of new species records was unsurprising given Jatujak's role as a regional centre of trade (see Chapter 4), the likelihood that plant collectors encountered different species as they explored new forest areas, and the demand among some consumers for unusual species. Continued surveys would undoubtedly continue to contribute new species. While most new records would probably be represented by a small number of individuals, it is possible that some could emerge in large volumes, even if they are not frequently traded. For example, the genera *Geodorum* and *Cheirostylis* were infrequently encountered during surveys, but were found in large volumes (Appendix 5). However, given the proximity of Jatujak Market to several institutions with botanical expertise, increased monitoring effort would be feasible.

The existing, broad approach to regulating trade of Orchidaceae is intended to reduce taxonomic demands of species-level identifications (see Clemente-Munoz 2009). However, we demonstrate that the precautionary "shotgun approach" to conservation is failing in continental Southeast Asia, and that increased monitoring and CITES permitting is very feasible. Moreover, the lack of reported trade means that potential revenue from CITES permitting is not being captured by the relevant authorities, which could potentially generate needed resources for improved wildlife trade monitoring. There is a clear need to both account for regional trade through improved monitoring and enforcement of existing restrictions (cf. Shackleton et al. 2007; see Chapter 4). However, there is also a need to distinguish among the hundreds of orchid species in the region. Data on which species are actively traded will better inform future interventions, including the prioritisation of species for ecological research and sustainable management, and the simplification of surveillance, identification and enforcement efforts.

Chapter 4:
Value Chain Analysis for exploring illegal wildlife trade dynamics

4.1 Introduction and VCA

There is a need to describe illegal botanical trade not only in terms of species composition or environmental impacts, but in terms of broader trade routes, trade dynamics, and socio-institutional and economic aspects. However, illegal wildlife trade research faces considerable challenges associated with logistics and the exploratory nature of research (e.g., Moyle 2009; Wyatt 2009), and there is a need to identify structure for descriptive study in the face of extensive data gaps, assorted anecdotes and eclectic datasets.

Value Chain Analysis (VCA) potentially provides a unifying framework for collecting and organizing data about illegal wildlife trade, integrating quantitative and qualitative data from interviews, informal discussions, observations and market botanical surveys. A valuable descriptive methodological tool, VCA helps to describe and map the range of activities involved from production through to the final purchase (and life) of a product (Kaplinsky and Morris 2000). It is useful to documenting not only trade routes, but to identifying steps in the market chain and actors along the market chain, including their different roles and activities, incentives (financial and other motivations), and ability to shape the market chain as a function of factors like profit margins, power, relations and institutions (Kaplinsky and Morris 2000; te Velde et al. 2006; Marshall et al. 2006; Belcher and Schreckenberg 2007). In this way, VCA also has analytic potential for investigating resource governance, networks and relations (cf. te Velde et al. 2006). As such, VCA can serve to identify policy interventions and opportunities within NTFP markets (te Velde et al. 2006; Marshall et al. 2006; Belcher and Schreckenberg 2007).

As a practical tool, VCA is often used to understand trade dynamics with the aim of increasing efficiency and competitiveness (Kaplinsky and Morris 2000; e.g., Augustin et al. 2011) and/or identifying new opportunities for commercialisation (e.g., of NTFPs Marshall et al. 2006). In fact, economic data is often the starting point for VCA, but is not an obligate part of the analysis, and there is growing focus on the value of VCA as a holistic approach that also considers environmental and socio-institutional aspects (Ingram and Bongers 2009). This includes considering multiple market channels, as a single product flow diagram, for example, does little to recognize heterogeneity across markets, even for the same good. A more nuanced approach requires subsector mapping to consider diversity across sites.

Value Chain Analysis has been successfully employed in research on Non-Timer Forest Products (NTFPs), but not in the context of illegal wildlife trade. We employ VCA to describe the illegal trade of wildlife from Lao PDR and Myanmar into Thailand. We specifically use it to structure 1) mapping an overview of regional ornamental plant trade networks to describe the routes plants follow, steps involved in the market chain, and the major actors involved in trade; 2) analysis of the patterns in the countries of origin of the wild plants traded in Thailand; 3) description and mapping of the harvest areas and trade routes within Lao PDR, Myanmar and Thailand; 4) discussion of trade profits along the value chain, and 5) discussion of internal network governance and the relationships among trade participants. These descriptions are leveraged to explore overall trade dynamics and inform conservation by identifying points of entry for future interventions.

As this case exemplifies, traditional VCA techniques are not always easily implemented in the context of illegal wildlife trade. Nevertheless, VCA is intuitive for studying wildlife trade from a conservation perspective because of its focus on market dynamics from production to consumption, its interest in network governance, and because it accommodates multidisciplinary data. We argue that VCA can be used to inform possible conservation interventions. There is considerable precedent for surveying wildlife/botanical markets and studying associated trade routes (e.g., van Song 2008; Oswell 2010) and, to a much lesser extent, for characterizing the participants of wildlife trade (e.g., Wyatt 2009). However, with some notable exceptions (e.g., Olsen and Bhattarai 2005), characterisations of wildlife trade are often prone to caricatures and over-generalisations, some of which are inevitable due to the lack of available data. VCA offers the flexibility and is amendable to a multi-methods approach needed to piece-together diverse, often scattered, information in order to create a composite capable of informing conservation interventions.

4.2 Methods

The VCA drew on the quantitative and qualitative methods described in Chapter 2, in order to map out major harvest sites, trade routes and stages in the market chain; determine how the value of plants changed across the market change, and identify actors and characterize the relationships among them. Methods specific to the VCA are described in this section.

4.2.1 Market interviews

The description of trade dynamics was principally derived face-to-face interviews with plant traders at four target markets across Thailand, supplementary observation and discussions (see Chapter 2; Appendix 3). While VCA is generally treated as linear, running from production to consumers, this study was based heavily around the points of open plant trade at public markets. However, market-based research thus provided insights and contacts to up- and downstream trade networks. For example, market traders participated in country ranking exercise to determine upstream plant origins. In this exercise, market traders were presented with cards with the names, flags and outlines of countries in Southeast Asia, and were asked to order them, from the country from which they received the most of their plants down to those from which they received the fewest or none. A similar exercise was used to rank who market traders sold their plants to, whether end customers, other traders or middlemen (Appendix 3), in order to determine downstream actors.

Follow-up interviews with up and down-stream trade participants was most feasible in Southern Myanmar, where middlemen, traders and harvesters often congregated near borders or visited border market sites. However, access to other participants was less feasible within Thailand and Lao PDR. Harvest and trade at many sites was geographically disbursed, some participants at those sites were secretive due to concerns over legality or were hesitant to share contacts with confidential business networks, many of which represented exclusive arrangements. As such, we documented only limited details on how and where harvest occurred within Thailand and Lao PDR. Where possible, this was supplemented with secondary accounts of trader within Lao PDR (Foppes et al. 1996; Lamxay 2008; Lovera and Laville 2009). Downstream interviews, however, did not extend to consumers[5].

[5] Research on consumers of ornamental orchids is a focus of another thesis by Amy HInsley at University of Kent.

4.2.2 Botanical surveys

Our understanding of regional trade dynamics was also derived from botanical surveys (see Chapter 2). In particular, we collected data on country of origin for all blooming plants encountered at Jatujak Market in order to track the value chain upstream. We also recorded reported origin for 19 target species (from 11 genera) at each survey encounter at all four markets in order to better understand plant origins and trade directions . We also used botanical survey data from Jatujak to visualize the variation in species composition of different traders (who sold >10 species) at Jatujak Market, using non-metric multidimensional scaling (NMDS) based on Jaccard distance calculated from presence/absence of species at each market stall over the survey period.

4.2.3 Mapping

We integrated major findings from the interviews and field observations to create maps that captured the salient trends in trade from Lao PDR, Myanmar and within Thailand. These were created using Ortelius 1.1.3. (Mapdiva 2010). These were produced using administrative layers from www.diva-gis.com. Major roads layer for Myanmar were obtained from the Myanmar Information Management Unit (2010), and protected areas layers were used from the World Database on Protected Areas (IUCN-WCMC 2010). Villages in Southern Myanmar were identified based on hand drawn maps from the Karen Human Rights Group (KHRG 2013).

4.2.4 Economic and profitability analysis

VCA often relies heavily on assigning economic values and profit margins to each step in the chain (e.g., Augustin et al. 2011). Similar practices have been used within NTFP trade research (e.g., Olson and Helles 1997; Wollenberg and Ingles 1998).

There are, however, challenges to economic analysis in the context of NTFP trade (cf. te Velde et al. 2006), especially where it represents an illegal trade and where dealing with a suite of goods. This study dealt with dozens of species in trade (see Chapter 3). As a result, we relied on a limited set of target species that were easily identified based on vegetative characteristics (described in Chapter 2; Appendix 2). While potentially a poor representation of many other less common species, for VCA economic analysis target species had to be found at all stages of the chain to ensure comparability and track prices across the value chain (9 species: *Ascocentrum curvifolium*, *Dendrobium chrysotoxum, D. lindleyi, D. secundum, Pholidota articulata Paphiopedilum concolor, Phalaenopsis cornuverci, Rhynchostylis retusa, R. gigantea,* see Fig. 4.5).

Sale price data for the target species was collected at every encounter during market surveys, and sale and purchase prices of target species were also collected during interviews. Prices were often given in different units, although we solicited for sale price per kilo wherever possible. We sought to use weight as a standard unit across the value chain for the target species (cf. Hersch-Martinez 1995; Cunningham 2001). While it was infeasible to weigh each individual during market surveys, we collected weight data for target species in order to calculate and average weight per individual. To this end, we identified traders at Dan Singkorn (N=6) and Jatujak Markets (N=2) that were willing to allow us to weigh plants on the target species list.

Transport costs were usually reflected in reported sale prices, but could not be reliably calculated because harvesters reported very irregular and variable travel patterns and we lacked direct contact with most middlemen and harvesters. Considering these types of challenges to conducting economic analysis, we focused on trade from

Southern Myanmar to Chedi Sam Ong and Jatujak Markets, to explore changing values both down the chain and across parallel chains, and to highlight the challenges limited potential for this type of economic analysis in the context of illegal wildlife trade.

4.2.5 Network governance

Kaplinsky and Morris (2000) highlight governance as a distinctive feature of VCA, including its interest in power relations and guiding rules and institutions both within and external to the chain. However, methods and tools proposed for studying chain governance (balance sheets, sales and firm records) are often infeasible or challenging in the context of illegal trade. Nevertheless, interviews and participant observation (see Chapter 2) yielded considerable insights into the governance arrangements internal to wildlife trade networks.

Chapter 8 specifically explores the relationship between botanical trade and the rules and power exerted by participants external to the value chain (i.e., *de jure* regulations). Here we principally consider governance dynamics involving participants internal to the value chain: harvesters, middlemen and market traders. We followed te Velde et al. (2006) in their application of the Gereffi et al. (2003) framework of governance arrangements to NTFPs. We specifically considered the complexity of inter-firm information and knowledge transfer, the potential of codifying information, and the capabilities of suppliers in order to characterize relationships among trade participants across the value chain.

4.3 Results

4.3.1 Overview of regional trade in ornamental plants

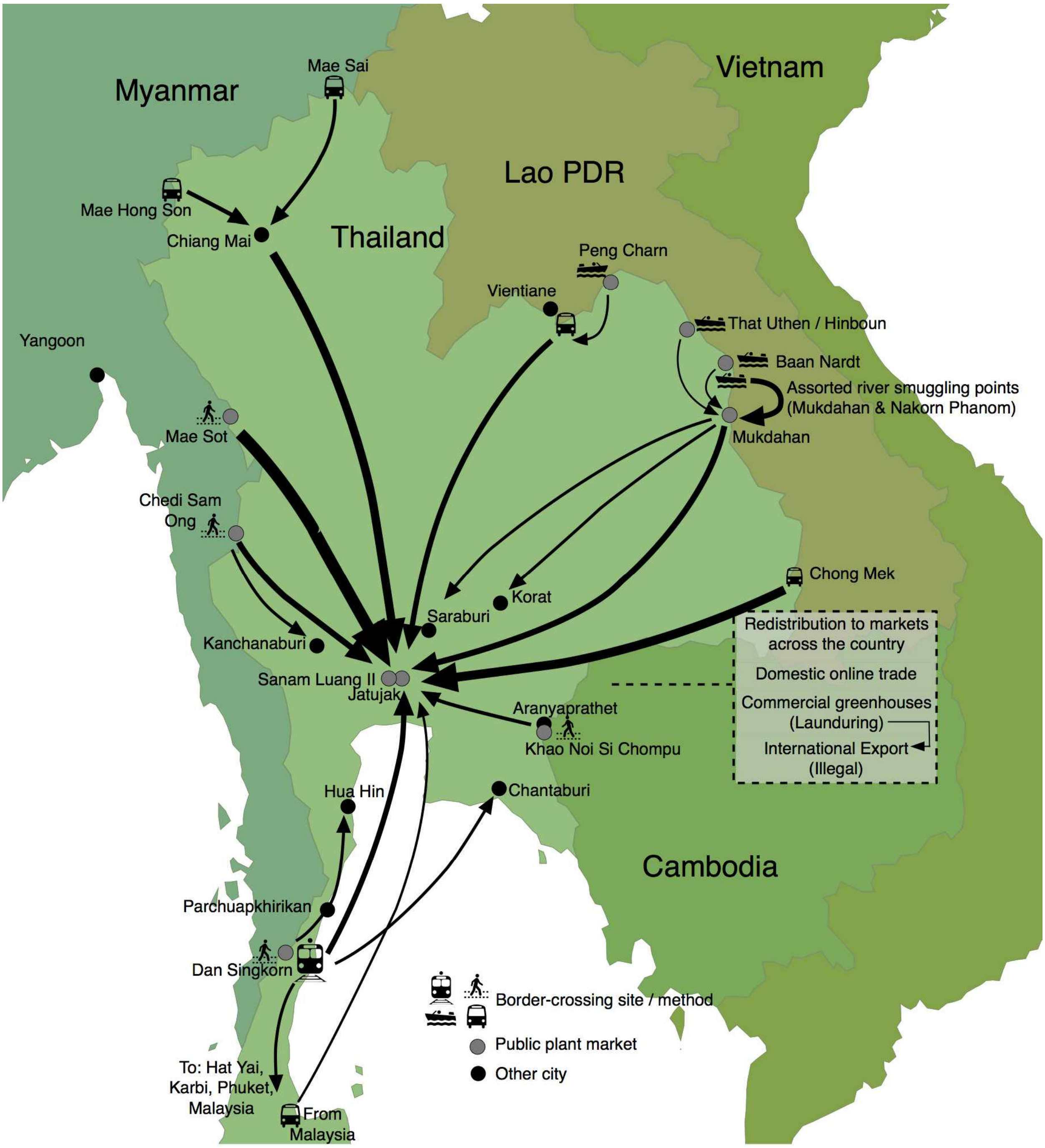
We documented a number of sites of trade in wild-collected ornamental plants (Map 4.1). Public sale of wild plants was observed at markets in Thailand originated principally from Thailand, Lao PDR and Myanmar (Table 4.1), with imports being channeled into the country through a limited number of border crossing points (Map 4.1). However, we identified complex trade networks between point of harvest and consumers, with some wild plants transferring ownership as many as 6 times. Although value chains differed considerably across sites, we identified five principle categories of trade participant (Fig. 4.1):

- Harvesters in Thailand, Myanmar and Lao PDR either sold directly to market traders or, more often, to middlemen;
- Middlemen were responsible for taking orders from traders and for ordering plants from harvesters within a target region, amassing product and transporting plants for re-sale. A subset of middlemen were responsible for organizing cross-border trade and transportation.
- Transportation providers, notably private bus drivers, moved plants across the value chain, including from harvesters to middlemen, across borders into Thailand, and among markets.
- Market traders openly sold plants at public markets throughout Thailand, principally to end consumers. A small sub-set of traders at each market also operated as middlemen that re-sold to other markets in Thailand.

- Some greenhouse operators purchased plants from middlemen and traders, and were involved in laundering wild plants as cultivated specimens so that they could be legally exported.
- Consumers were mostly within Thailand, and purchased plants at public markets throughout the country. Most consumers were members of the general public, although a subset were described as knowledgeable plant enthusiasts. Some consumers also made purchases via domestic online trade, and some were overseas and ordered plants for re-export.

Importantly, we found a number of parallel trades that were linked, but distinct in terms of scale, geography, governance and target species. We also found that trade flows differed across border points, requiring more detailed sub-sector analysis of harvest and trade within each Thailand, Lao PDR and Myanmar (Fig. 4.1; cf. Bista and Webb 2006).

In some contexts, principally related with smaller-scale trade (e.g., That Uthen, many traders at Dan Singkorn), harvest was reportedly fairly local, and often based on geographic and social relations between harvesters and traders. In contrast, larger-scale trade at the target markets reportedly drew from broader geographic areas and numerous harvesters, often mediated by middlemen that sourced plants form harvesters and other middlemen. However, most trade was generally specialized, in that participants focused principally on wild ornamental plant sales, although there were a few cases where plant traders also sold wild birds or timber, and where plants were smuggled across the Mekong alongside other untaxed products. There was, however, no evidence of links to other regional cross-border trades in weapons, drugs or humans.



Map 4.1. Simplified diagram of wild ornamental plant trade into Thailand from Myanmar and Lao PDR. Thickness of arrows represents author's perceptions of the relative differences in trade volumes from each site. Not depicted is the redistribution of plants within Thailand, including from Bangkok to other cities within Thailand and back to the border markets, and among border markets themselves (e.g., between Chong Mek and Dan Singkorn).

Notably, we found that much of the cross-border trade into Thailand occurred openly via public border markets, notably the large target border markets of Mukdahan, Chedi Sam Ong and Dan Singkorn. These markets were principally sites of public plant sales to local residents and domestic tourists. A subset of traders at these sites were also involved in re-sale to other markets in Thailand, serving as middlemen between traders at other markets in Thailand and middlemen in Myanmar and Lao PDR (Fig. 4.1).

We also identified a parallel trade through other border crossings from Lao PDR (Chong Mek, Vientiane) and Myanmar (Mae Hong Son, Mae Sai). These sites lacked border plant markets and instead served as sites of direct imports from middlemen to traders in Thailand, with plants usually via private bus (Fig. 4.1, not shown in Fig. 4.1).

Plants were principally destined for Jatujak Market, a regional hub of illegal wildlife trade. Traders at Jatujak made most sales to domestic botanical enthusiasts, although some traders also operated as middlemen, re-selling plants to traders at markets across the country, including to border markets. Some re-sale was also to commercial greenhouses that laundered wild plants as cultivated for international export (Fig. 4.1). We also identified parallel sales in medicinal plants and an online trade for ornamental plants.

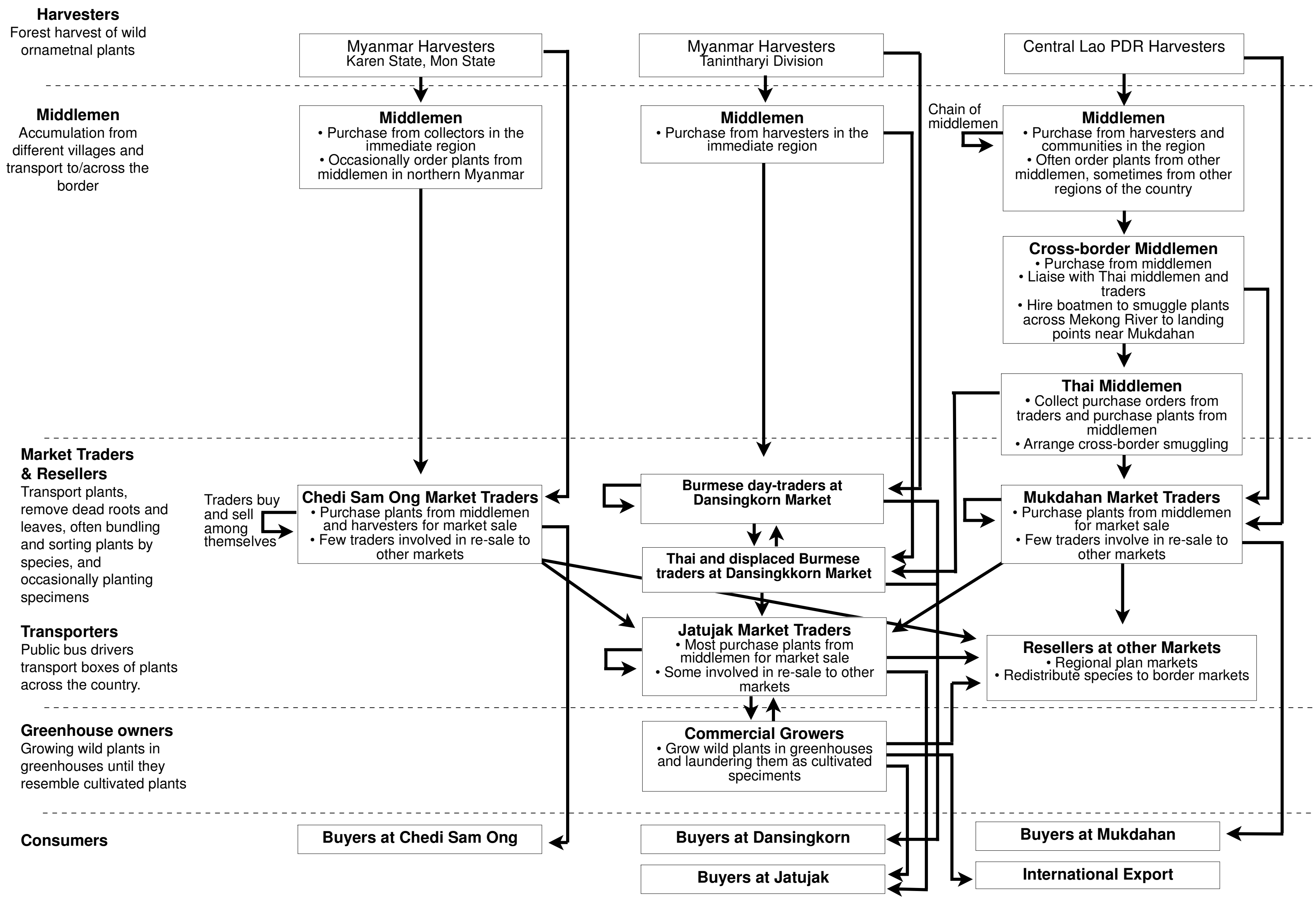


Figure 4.1. Market chain for wild ornamental plants. Diagram depicts trade networks from Myanmar and Lao PDR into Thailand based around four target markets: Chedi Sam Ong, Dan Singkorn, Mukdahan and Jatujak Markets.

4.3.2 Patterns in country of origin

Although the four target markets were within Thailand, traders reported sourcing wild plants from across the region, and Thailand was not ranked the leading source country at any of the four target markets (Table 4.1).

Table 4.1. Source countries of plants traded at four target markets in Thailand. Percent (and number) of traders at each market that ranked each source country (ranked from 1 to 6) in terms of the volume of plants they receive from each.

Traders at Jatujak (N=14; 2 respondents refused to report on plant origins)						
Rank	Thailand	Myanmar	Lao PDR	Malaysia [a]	Vietnam [a]	Other (Country)
First	21.4 (3)	21.4 (3)	**50.0 (7)**	-	-	7.1 (1) (Cambodia)
Second	**35.7 (5)**	14.3 (2)	14.3 (2)	7.1 (1)	-	14.3 (2) (Uncertain)
Third	14.3 (2)	**28.6 (4)**	7.1 (1)	7.1 (1)	14.3 (2)	-
Fourth	7.1 (1)	14.3 (2)	7.1 (1)	7.1 (1)	-	7.1 (1) (Uncertain)
Fifth	-	7.1 (1)	-	7.1 (1)	14.3 (2)	-
Sixth	-	-	-	7.1 (1)	-	-
None	21.4 (3)	14.3 (2)	21.4 (3)	64.3 (9)	71.4 (10)	71.4 (10)
Traders at Dan Singkorn (N=56)						
Rank	Thailand	Myanmar	Lao PDR	Malaysia	Vietnam	Other (Country)
First	5.4 (3)	**91.1(51)**	3.6 (2)	-	-	-
Second	**14.3 (8)**	3.6 (2)	3.6 (2)	-	-	1.8 (1) (Uncertain)
Third	5.4 (3)	1.8 (1)	3.6 (2)	-	-	-
Fourth	-	1.8 (1)	-	-	1.8 (1)	-
Fifth	-	1.8 (1)	-	1.8 (1)	-	-
Sixth	-	-	-	-	-	-
None	75.0 (42)	-	89.3 (50)	98.2 (55)	98.2 (55)	98.2 (55)
Traders at Chedi Sam Ong (N=12)						
Rank	Thailand	Myanmar	Lao PDR	Malaysia	Vietnam	Other (Country)
First	-	**100 (12)**	-	-	-	-
Second	-	-	-	-	-	-
Third	-	-	-	-	-	-
Fourth	-	-	-	-	-	-
Fifth	-	-	-	-	-	-
Sixth	-	-	-	-	-	-
None	-	-	100 (12)	100 (12)	100 (12)	100 (12)
Traders at Mukdahan (N=24)						
	Thailand	Myanmar	Lao PDR	Malaysia	Vietnam	Other (Country)
First	4.2 (1)	-	**91.7 (22)**	-	4.2 (1)	-
Second	**20.8 (5)**	8.3 (2)	8.3 (2)	-	**16.7 (4)**	4.2 (1) (Uncertain)
Third	**20.8 (5)**	-	-	-	8.3 (2)	-
Fourth	-	**12.5 (3)**	-	-	4.2 (1)	-
Fifth	-	-	-	-	-	**8.3 (2)** (Uncertain)
Sixth	-	-	-	4.2 (1)	-	-
None	54.2 (13)	79.2 (19)	-	95.8 (23)	66.7 (15)	87.5 (21)

[a] Vietnam and Malaysia were selected principally to enable cross-check regarding respondents awareness of their sourcing, as we knew *a priori* that comparatively few orchids were coming from these countries.

Most border market traders reported that they sourced the majority of plants from the nearest neighbouring country (Table 4.1), which could be plainly observed at markets on the Myanmar border. All traders at Chedi Sam Ong reported sourcing plants exclusively from Myanmar, as did most traders at Dan Singkorn (91.1%). Similarly, most traders at Mukdahan sourced principally from Lao PDR (91.7%). A subset of traders at Dan Singkorn and Mukdahan sourced plants for other regions, notably Thailand and Lao PDR.

Sourcing patterns of traders at Jatujak were less clear, lacking the bottlenecks of border-trade, and because plants were sourced from across the region. The majority of traders reported that plants originated from outside Thailand, notably Lao PDR (50.0%; Table 4.1). However, when trade volumes from market surveys were considered, the role of harvest within Thailand was much more prominent. The majority of blooming plants observed at Jatujak were harvested within Thailand (~55-65%), while only ~25-30% were from Lao PDR (Fig. 4.2). The pattern could have also been skewed by the procurement patterns of two Jatujak traders that specialized in sales of blooming plants (see Fig. 4.4); even when these traders were removed form the dataset Thailand remained the leading country of origin for blooming plants, followed by Lao PDR (Fig. 4.2, b).

Similar patterns in country origin emerged at Jatujak Market for the subset of the target species (Fig. 4.3). By cumulative volume, this diverse indicator group highlighted Thailand as the leading source country (49% of target species trade volume), followed by Lao PDR (34%) and Myanmar (14.5%) (Fig. 4.3). However, country origins for plants at Jatujak varied considerably across genera (and species). Trade in the genus *Phalaenopsis*, for example, was exclusively from Thailand, while trade of *Cleisostoma* and *Pholidota* was almost exclusively from Lao PDR.

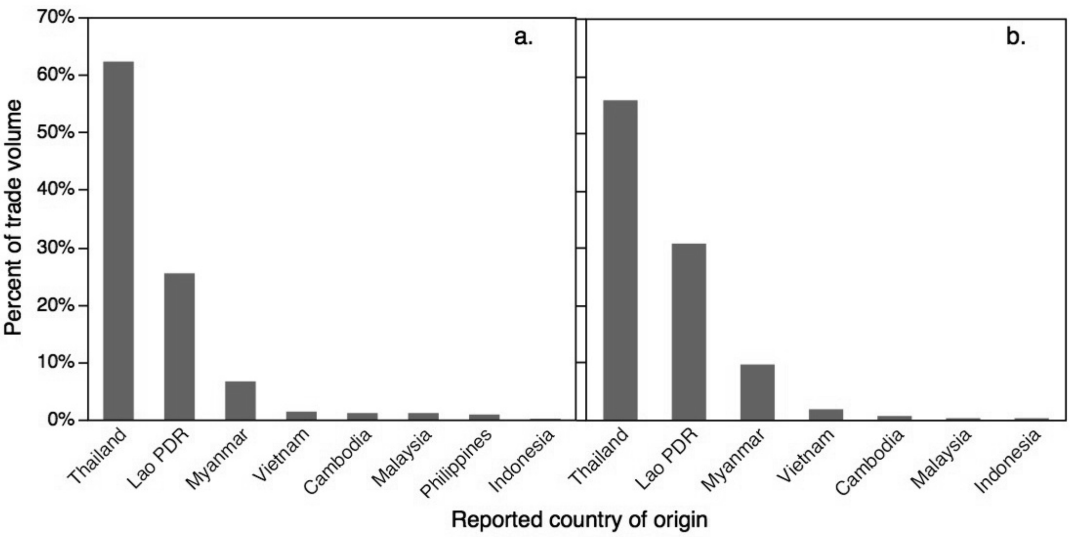


Figure 4.2. Reported country origins of blooming orchids encountered at Jatujak Market. a, percent of total blooming orchid records. b, excluding two traders that specialized in sale of blooming plants

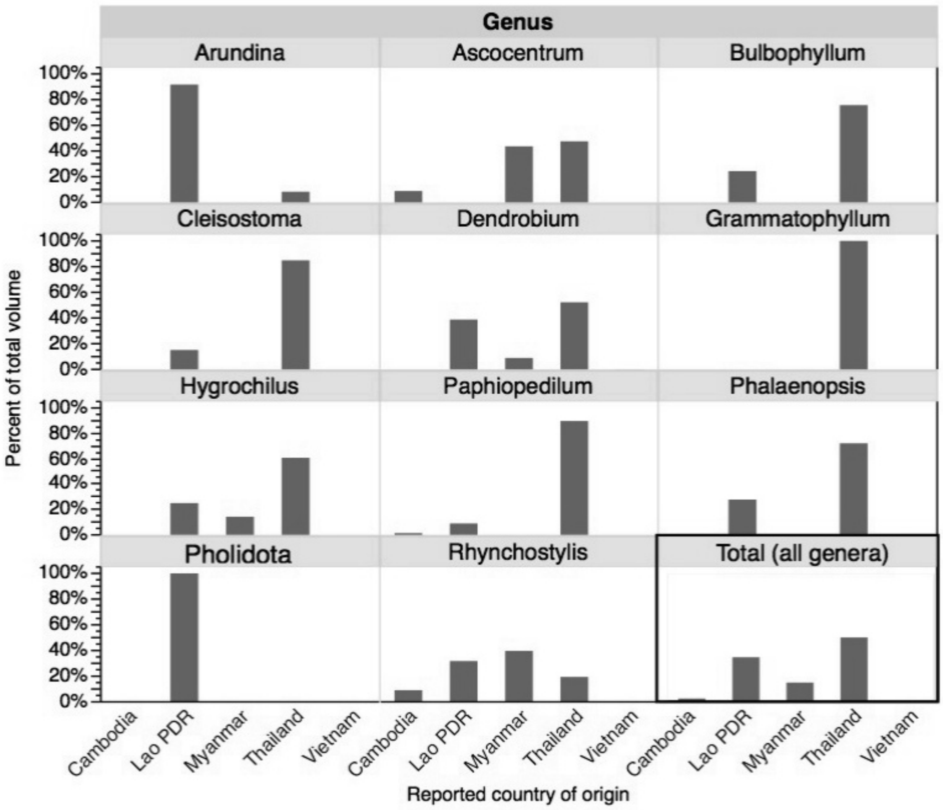


Figure 4.3. Reported country of origin for 19 target species in 11 genera traded at Jatujak Market. Subset of target species: *Ascocentrum ampullaceum, A. curvifolium, Bulbophyllum blepharistes, Cleisostoma arietinum, D. chrysotoxum, D. jenkinsii, D. lindleyi, D. parishii, D. pulchellum, D. secundum, D. senile, D. sulcatum, Gramatophyllum speciosum, Hygrochilus parishii, Paphiopedilum concolor, Phalaenopsis cornucervii, Phalaneopsis pulcherrima, Pholidota articulata, Rhynchostylis gigantea, Rhychostylis retusa*

Market survey data on country origins of plants identified to the species-level matched interview findings: border market traders principally sourced plants from adjacent countries, while Jatujak Market traders sold species both from within Thailand and the broader region, including a small number of species from Indonesia and Philippines (Table 4.2).

Table 4.2. Number of genera and species traded from each country at four target markets in Thailand. Origin reported by traders about specimens that were identified to the species-level during market surveys

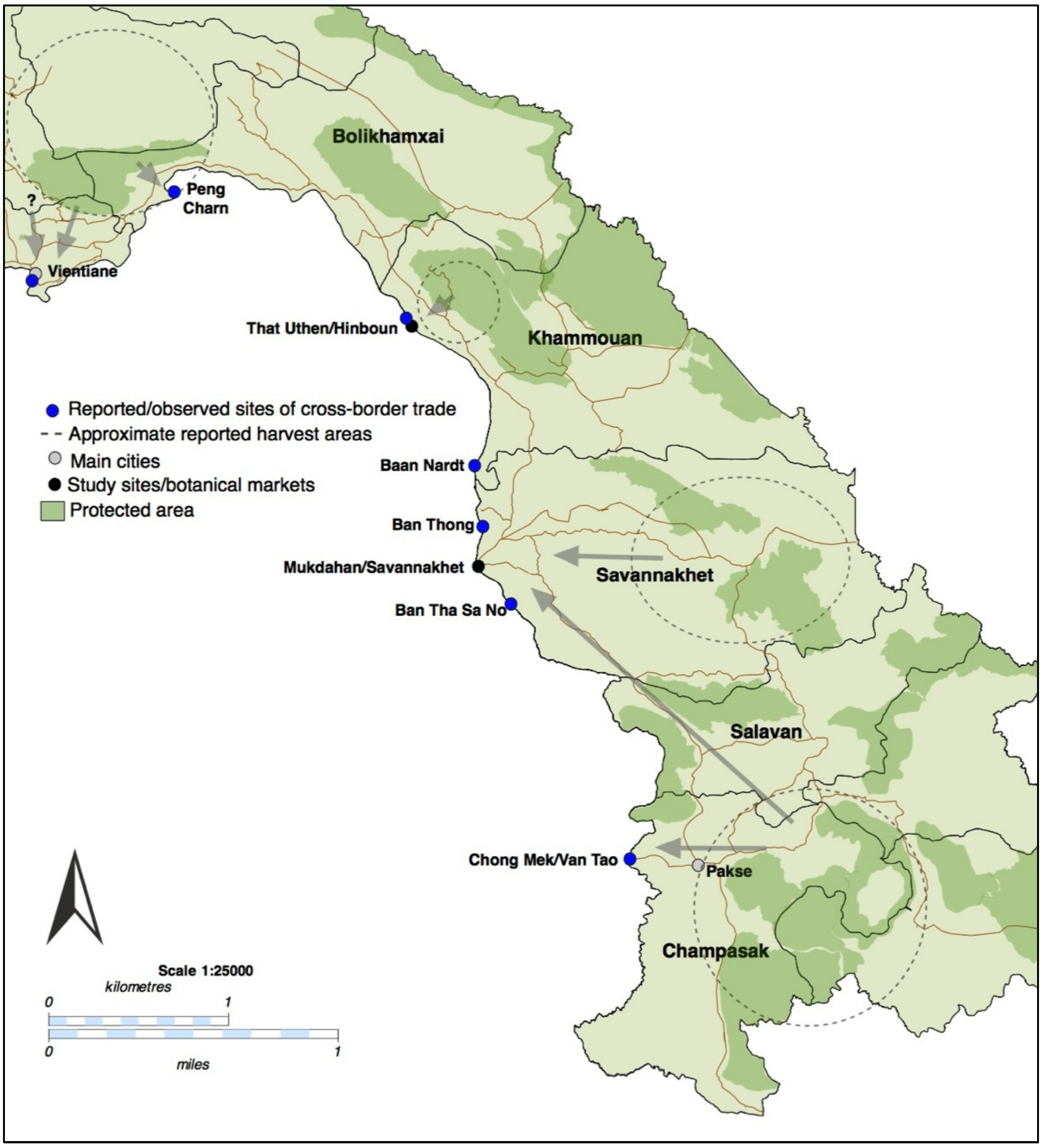
Country	Number of genera (species)				
	Total	Jatujak	Chedi Sam Ong	Dan Singkorn	Mukdahan
Thailand	56 (175)	52 (168)	0	9 (20)	12(16)
Myanmar	54 (130) [a]	15 (38)	35 (64)	46 (94)	2 (2)
Lao PDR	41 (109) [b]	33 (84)	0	10 (23)	20 (42)
Cambodia	7 (11)	5 (8)	0	3 (3)	1 (1)
Malaysia	5 (7)	5 (7)	0	0	0
Vietnam	4 (9)	3 (7)	0	0	3(3)
Indonesia	1 (1)	1 (1)	0	0	0
Philippines	3 (3)	3 (3)	0	0	0

[a] Includes records that traders specifically reported as from Myanmar and specimens sold by traders in Chedi Sam Ong and Dan Singkorn that we were certain (from interviews) acquired plants exclusively from Myanmar.

[b] Although situated on the Lao PDR border, not all plants from Mukdahan Market were assumed to originate from Lao, as many traders reported also acquiring plants from within Thailand

4.3.3 Lao PDR trade dynamics

Taking into account the importance of plants from Lao PDR to ornamental plant trade in Thailand, we documented the major trends in harvest and cross-border trade. We found trade occurred at a number of sites, but differed in scale and complexity. We identified 1) localized small-scale trade associated with several informal, weekly border markets at villages along the Thai-Lao border, 2) large-scale trade associated with Mukdahan Market on the Thai-Lao border, and 3) direct imports via bus at Vientiane and Chong Mek Border Crossings.



Map 4.2. Simplified map of wild ornamental plant harvest and trade from Lao PDR to Thailand.

4.3.3.1 Small-scale informal border market trade

Relatively small-scale, cross-border plant trade from Lao PDR was encountered at markets in Peng Charn, That Uthen and Baan Nadt (Map 4.2). This trade was associated with weekly, informal markets in which groups of Lao traders travelled to Thailand by boat to trade various manufactured, agricultural and forest products, including wild plants, insects, meat, and honey. These represented sanctioned cross-border exchanges, although restricted to low-volumes of wild plants (<7kg per person; see Chapter 8 discussion of rules at That Uthen).

Lovera and Laville (2009) seem to suggest that many small-scale orchid traders in Lao PDR collect plants themselves in their local areas, and this is likely characteristic of many smaller-scale orchid traders, including traders that sell along roadside plant stalls through Lao PDR and at the small border markets in Thailand. Interviews at That Uthen and informal discussions with traders at Peng Charn and Barn Nadt suggested that traders had harvested plants themselves, locally. For example, market traders at That Uthen (N=2) and a local forestry officer reported that plants were collected by the traders, or purchased from neighbourhood children. Harvest was reportedly local from the forests adjacent to Hinboun village, which include two large protected areas, the Nam Kading and Khammouane Limestone National Biodiversity Conservation Areas. There was no reported enforcement against small-scale harvest and trade, although large-scale harvest was reportedly prohibited (see Chapter 8). There were also no indications – from either interviews or the literature – to suggest that wild plant resources were part of any active managed processes, and resources were presumed to be open access.

4.3.3.2 Large-scale trade at Mukdahan Market

In contrast, cross-border trade encountered at Mukdahan Market was comparatively large scale, involved harvest from across a broad area and involved considerably more complex trade dynamics (Fig. 4.1). Most Thai traders at Mukdahan placed orders directly with Lao middlemen via telephone (87.5% respondents; Table 4.3).

Table 4.3. Reported sources of plants by traders at Mukdahan Market.

Source of plants	Percent (number) (N=24)
From middlemen in Myanmar	-
From middlemen in Thailand	-
From middlemen in Lao PDR	87.5 (21)
From middlemen in Cambodia	-
From middlemen in Vietnam	8.3 (2)
From middlemen (unknown/variable)	-
Directly from harvesters	-
From traders in the same market	-
Collect themselves/family collects	8.3 (2)
Travel to buy at other market	8.3 (2)

[a] Sums may be greater than total number of respondents, as some traders reported multiple procurement strategies

Middlemen in Lao PDR (N=5) sourced wild plants through visits or calls to harvesters with whom they had established contacts. We were unable to obtain specific locality details (see Methods), although most harvest reportedly occurred in central and eastern Savannakhet Province, >70-100 km away from Savannakhet City (Map 4.2) from a number of different communities, harvesters and forests. Central-east Savannakhet remains heavily forested (Dong et al. 2009), is well connected by the National Road 9, and hosts several large forests including the Dong Phou Vieng and Phou Xan He National Biodiversity Conservation Areas, where Lovera and Laville (2009) reported wild orchid harvest. No enforcement against harvest was reported by middlemen or collectors in Lao PDR, although two collectors stated that harvest in Savannakhet Province was legal and formalized, including a 7% tax that levied at checkpoints for which traders were given an official receipt.

In some cases (N=3), middlemen reportedly placed orders with fellow middlemen that had access to different communities. This included sourcing from other regions (Southern Lao PDR) to access species that were not locally available (Map 4.2). Middlemen arranged for transport by personal vehicle or bus for getting plants to Savannakhet City.

In Savannakhet, Lao middlemen either sold their plants to other middlemen responsible for cross-border smuggling, or partnered directly with boat drivers involved in professional smuggling of various goods across the Mekong River, including cigarettes, fish, garlic and onions (although reportedly not weapons or drugs). Smuggling partnerships were reportedly based on a profit-sharing agreements (reportedly 6-7% of the value of the goods), and were often mediated by counterparts in Thailand. Two Thai middlemen helped to coordinate cross-border smuggling of plants for Mukdahan market, purchased boats, served as points of contact points for Thai traders and Lao middlemen, and collected goods on the Thai side of the Mekong River.

Boats smuggled goods to a number of different landing points, including Baan Nadt, Baan Thong and Baan Tha Sa No (Map 4.2). Middlemen reported considerable enforcement along the Mekong River and reported that they often lost their shipments and boats. Successful crossings were met by the Thai middlemen that re-sold the plants to traders at Mukdahan market every Tuesday and Thursday from an undisclosed location. All communication was conducted via mobile phone, often using a disposable phone chip to avoid detection, and financial exchanges were via cash deposits into ATM accounts.

Once plants had evaded the detection of border enforcement and customs and were within Thailand, the plants could be openly sold at Mukdahan Market, both during the daily afternoon market, and the large Friday-Sunday weekend market, called Talart Indochine. Mukdahan Market is described and mapped in Chapter 2. Plants were sorted by species and tied into small bundles, usually sold in lots of 3, with little price differentiation among most of the more common species.

Traders reported that the majority of sales were to end consumers—botanical hobbyists/experts and members of the general public (Table 4.4). However, approximately half of traders also reported selling to middlemen or traders at other markets (Table 4.4, Fig. 4.1), including in Jatujak, Korat and Saraburi.

Table 4.4. Destination of plants sold at Mukdahan Market. Percent (and number) of traders at Mukdahan (N=24) that ranked (ranked from 1-5) each category of buyer by sale volume

Rank	Middlemen	Traders at other markets	Traders at same market	Experts / Hobbyists	General public
First	8.3 (2)	-	-	**54.2 (13)**	**37.5 (9)**
Second	8.3 (2)	8.3 (2)	4.2 (1)	37.5 (9)	37.5 (9)
Third	12.5 (3)	29.2(7)	8.3 (2)	-	8.3 (2)
Fourth	12.5 (3)	16.7 (4)	8.3 (2)	4.2 (1)	-
Fifth	4.2 (1)	-	20.8 (5)	4.2 (1)	8.3 (2)
None	**54.2 (13)**	**45.8 (11)**	**58.3 (14)**	-	8.3 (2)

4.3.3.3 Direct imports to Thailand via Chong Mek and Vientiane

In parallel with the market-based trade, we documented direct imports through Chong Mek and Vientiane Border Crossings (Map 4.2). Trade was not openly observed at either site, as neither hosted a border plant market (although as late as 2006 Chong Mek hosted a large plant market). However, Chong Mek has been previously recorded as a site of large-scale trade (Seidenfaden 1997), and four traders at Jatujak, including one of the largest volume traders in the market, and one large trader at each Mukdahan and Dan Singkorn Markets listed Chong Mek as a leading source of wild plants. Both import sites were also mentioned by traders during market surveys at Dan Singkorn and Jatujak.

As at Mukdahan, Thai traders placed orders with middlemen by telephone, who sourced plants within Lao PDR and delivered them packed in boxes via private regional bus. The trade dynamics associated with these sites remain poorly understood relative to those associated with open border marketplaces. It is uncertain specifically where plants were harvested, although illegal harvesting from within the Phou Khao Khouay National Biodiversity Conservation Area near Vientiane has been documented (Lovera and Laville 2009). In fact, *Dendrobium lamyaiae*, which was commercially traded in Thailand (see Chapter 3), is only known from that protected area (Schuiteman et al. 2008). In Southern Lao PDR, middlemen reported sourcing plants from around Pakse, and harvest has been previously recorded in northern Champasak Province, in Ponthong District and Pak Xong and Bachiang Districts on the Boloven Plateau (Foppes et al. 1996).

3.4.4 Myanmar trade dynamics

Botanical harvest and trade from Myanmar is considerably better understood. We found trade was principally associated with 1) border markets in Southern Myanmar, at Dan Singkorn and Chedi Sam Ong, 2) with direct imports via the Mae Sot Border Crossing, and 3) apparently small scale but little documented traded via border crossings with northern Thailand.

3.4.4.1 Large-scale trade at Dan Singkorn Market

Dan Singkorn represented one of the largest markets in Thailand, in terms of trade volume and number of vendors, which included Burmese traders as well as displaced Burmese and Thai traders within the same market (see Chapter 2). Traders at Dan Singkorn relied heavily on plants from Myanmar (Table 4.1), which they purchased directly from harvesters that had market access, from middlemen in Myanmar (69.7), or from other traders in the market (Table 4.5).

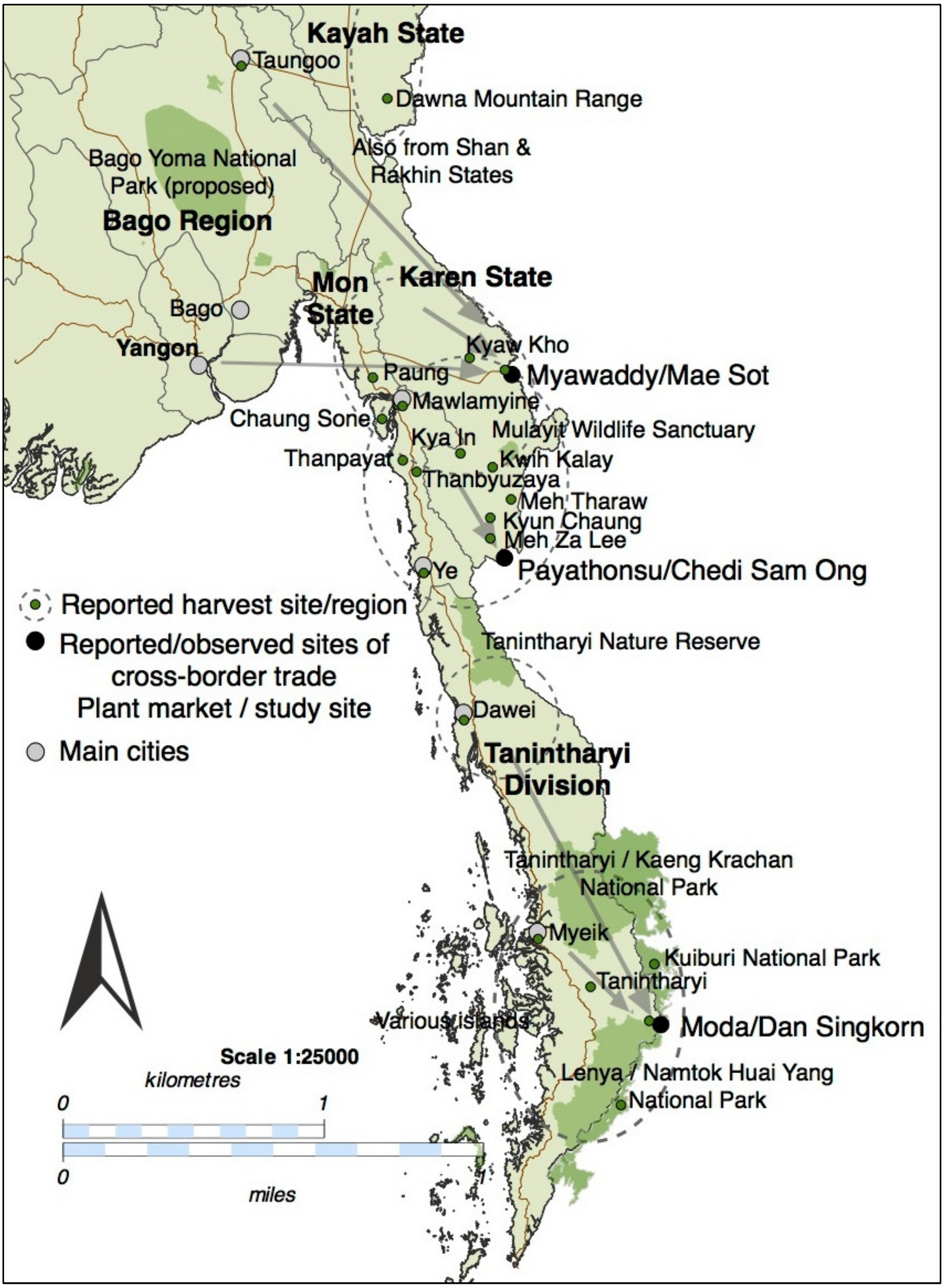
Table 4.5. Reported sources of plants purchased by traders at Dan Singkorn.

Source of plants	Thai traders (N=16)	Displaced Burmese (N=7)	Burmese traders (N=33)
From middlemen in Myanmar	25.0 (4)	-	69.7 (23)
From middlemen in Thailand	18.8 (3)	-	6.1 (2)
From middlemen in Lao PDR	6.2 (1)	-	-
Directly from harvesters	-	-	33.3 (11)
From traders in the same market	62.5 (10)	100.0 (7)	3.0 (1)
Collect themselves/family collects	6.2 (1)	-	21.2 (7)

[a] Sums may be greater than total number of respondents, as some traders reported multiple sources

Harvesters with access to the marketplace (N=6) reported harvest within the immediately region of Tanintharyi Division, either very locally or within a 2-3 hours motorcycle ride of the Market. Most reported (N=4) reported staying in the forests for several days to collect plants. Although they did not specify whether they collected inside protected areas, most (N=4) reported harvest on government lands. Harvest sites were in the immediate vicinity of Lenya and Tanintharyi National Parks, and illegal resource extraction has been confirmed in approximately one third of protected areas in Myanmar (Rao et al. 2002). However, all respondents reported that wild plant harvest was a legal job, and they faced no enforcement. As in Lao PDR, there were no licensing requirements or management strategies. Harvest also occurred in private lands; one trader reported buying harvest rights from private landholders, and one harvested epiphytes from trees already felled for timber or agriculture.

There were also at least two local middlemen that sold plants to traders Dan Singkorn, 12one of which was interviewed. She reported ordering plants by phone from personal contacts in Tanintharyi, Myiek, Dawei cities in Tanintharyi Division, from harvesters that collected in and around those areas but did not have direct access to the marketplace (Map 4.2).



Map 4.3. Simplified map of wild ornamental plant harvest and trade from Southern Myanmar to Thailand.

Notably, harvesters and middlemen sold almost exclusively to Burmese traders at Dan Singkorn. These traders brought the plants over the border on foot or by motorcycle via the Dan Singkorn Checkpoint for sale at the adjacent Dan Singkorn Market (Chapter 2, Map 2.5; Map 4.3). Traders reported no enforcement against import of wild plants, although they were subject to taxation at the border (see Chapter 8 for rules of trade). Burmese traders (N=33) sold plants in a part of the market designated by the Thai government for Burmese plant traders (see Chapter 8 for rules of trade). Most (N=21) also re-sold plants to Thai plant traders and displaced Burmese traders at Dan Singkorn that did not have equal access to the harvesters and middlemen operating within Myanmar (Table 4.5; Table 4.6).

Table 4.6. Destination of plants sold at Dan Singkorn Market. Percent (and number) of traders at Dan Singkorn (N=56) that ranked (ranked from 1-5) each category of buyer by sale volume

Rank	Middlemen	Traders at other markets	Traders at same market	Experts / Hobbyists	General public
Burmese traders (N=33)					
First	9.1 (3)	15.2 (5)	15.2 (5)	21.2 (7)	**36.4 (12)**
Second	12.1 (4)	**30.3 (10)**	12.1 (4)	**24.2 (8)**	12.1 (4)
Third	**33.3 (11)**	24.2 (8)	9.1 (3)	15.2 (5)	6.1 (2)
Fourth	21.2 (7)	15.2 (5)	3.0 (1)	15.2 (5)	12.1 (7)
Fifth	9.1 (3)	-	24.2 (8)	18.2 (6)	9.1 (3)
None	15.2 (5)	15.2 (5)	**36.4 (12)**	9.1 (3)	15.2 (5)
Displaced Burmese traders (N=9)					
Rank	Middlemen	Traders at other markets	Traders at same market	Experts / Hobbyists	General public
First	-	-	-	**55.6 (5)**	44.4 (4)
Second	-	-	-	44.4 (4)	**55.6(5)**
Third	-	33.3 (3)	-	-	-
Fourth	11.1 (1)	-	-	-	-
Fifth	-	-	-	-	-
None	**88.9 (8)**	**66.7(6)**	**100 (9)**	-	-
Thai traders (N=14)					
Rank	Middlemen	Traders at other markets	Traders at same market	Experts / Hobbyists	General public
First	-	7.1(1)	7.1(1)	**71.4 (10)**	14.3 (2)
Second	7.1(1)	28.6 (4)	-	14.3 (2)	**50.0 (7)**
Third	21.4 (3)	7.1(1)	7.1(1)	-	7.1(1)
Fourth	-	-	7.1(1)	7.1(1)	14.3 (2)
Fifth	-	-	-	7.1(1)	7.1(1)
None	**71.4 (10)**	**57.1 (8)**	**78. 6 (11)**	-	7.1(1)

Market-based sales across the three categories of traders at Dan Singkorn were overwhelmingly to end consumers (Table 4.6). However, a sub-group (N=12) of traders also reported selling to traders and middlemen at other markets, principally Bangkok (Jatujak and Sanam Luan II), as well as to Malaysia, Chantaburi Province, and cities in southern Thailand, including Hat Yai, Hua Hin, Prachuap Khirikan and in Krabi and Phuket. One trader also specifically reported to selling to greenhouses in Central Thailand.

3.4.4.2 Border market at Chedi Sam Ong

Chedi Sam Ong represented a significantly smaller, but established plant market that dealt exclusively in plants from Myanmar (Table 4.1). Traders (N=12) purchased plants from either middlemen in Myanmar (66.7%) or directly from harvesters that visited the market weekly.

Most harvester respondents (N=9) also reported local and regional harvest, within Karen and Mon States (Map 4.3). None reported enforcement against wild plant harvest, licencing or management requirements, although four reported some limits to forest access from the Karen National Union (KNU), concerned that harvesters would encounter hidden military camps. Three harvesters reported that they secured KNU permits to enter the forest.

Several harvesters (N=4) also reported illegally entering Thailand to collect plants because the forests were in better condition and because many epiphyte species had become locally scare. However, cross-border harvest was reportedly dangerous and penalties were stiff. Harvesters also reported widespread hardships, including a number of accidents and several deaths as a result of falling from trees and landmine explosions.

The market had only 2-3 middlemen, one of whom was interviewed and reported sourcing plants from harvesters around Ye, Thanbyuzaya, Mawlamyine and Kya In towns in Karen and Mon States (Map 4.3). Middlemen and traders (N=3) also reported that during previous years of higher demand and sale prices in Thailand they had also contacted middlemen from central and northern Myanmar to access different species.

As at other border markets, trader sales were principally to local consumers (Table 4.7), although a large number of traders also reported sales to middlemen and other traders in Thailand, reportedly in Kanchanaburi and Bangkok. One trader also reported commercial to greenhouses in Nonthaburi.

Table 4.7. Destination of plants sold at Chedi Sam Ong Market. Percent (and number) of traders at Chedi Sam Ong that ranked (ranked from 1-5) each category of buyer by sale volume

Rank	Middlemen	Traders at other markets	Traders at same market	Experts / Hobbyists	General public
First	8.3 (1)	8.3 (1)	-	**58.3 (7)**	25.0 (3)
Second	25.0 (3)	8.3 (1)	-	25.0 (3)	**41.7 (5)**
Third	**33.3 (4)**	25.0 (3)	16. 7 (2)	8.3 (1)	8.3 (1)
Fourth	8.3 (1)	**50.0 (6)**	-	8.3 (1)	16. 7 (2)
Fifth	8.3 (1)	-	33.3 (4)	-	8.3 (1)
None	16.7 (2)	8.3 (1)	**50.0 (6)**	-	-

3.4.4.2 Trade via Mae Sot

Unlike at Dan Singkorn and Chedi Sam Ong, there was only a small plant market at the Mae Sot Border Crossing, which principally operated as a site of import for other markets in Thailand. Three Burmese traders had stalls on the Thai-Burmese border, and all reported that sales were principally to middlemen and traders in Thailand—

including three Thai traders based on the Thai side of Mae Sot Market. Only one of these Thai traders informally answered questions about procurement and sales. However, he confirmed that the Thai traders at Mae Sot served as middlemen, sourcing plants from Burmese traders and middlemen for re-sale at other markets in Thailand. Two personal contacts were established between this middlemen and traders at Jatujak.

The Burmese traders at Mae Sot (N=3) reported purchase from family members (N=1), local harvesters and regional middlemen (N=3) operating from Yangon and Mawlamyine. Approximately 10 local harvesters reportedly supplied the Burmese traders at Mae Sot. Interviewed harvesters (N=5) reported local harvest around Myawaddy surrounding areas in Karen State (village names: Htee Wah Palaw, Kyaw Kho, Shwe Koteko, Mae Ka Ne, Par Chaung, Htee Mootar, Kwih Kalay, Mae Pale, Paloo, Intaw, Thinkannyinaung, Kyaut Taung). However, most interviewed harvesters (N=4) also reported 2+ hour car trips and/or many hours of hiking (Map 4.3), including within the Dawna Mountain Range in neighbouring Khya State. One harvester also reported that friends in Rakhine and Shan States regularly sent plants by bus to Thai middlemen at Mae Sot, likely indicative of a broader trade of wild plants via Mae Sot for market in Thailand. No harvesters reported enforcement against harvest in Myanmar, although one reported being taxed by forest officials.

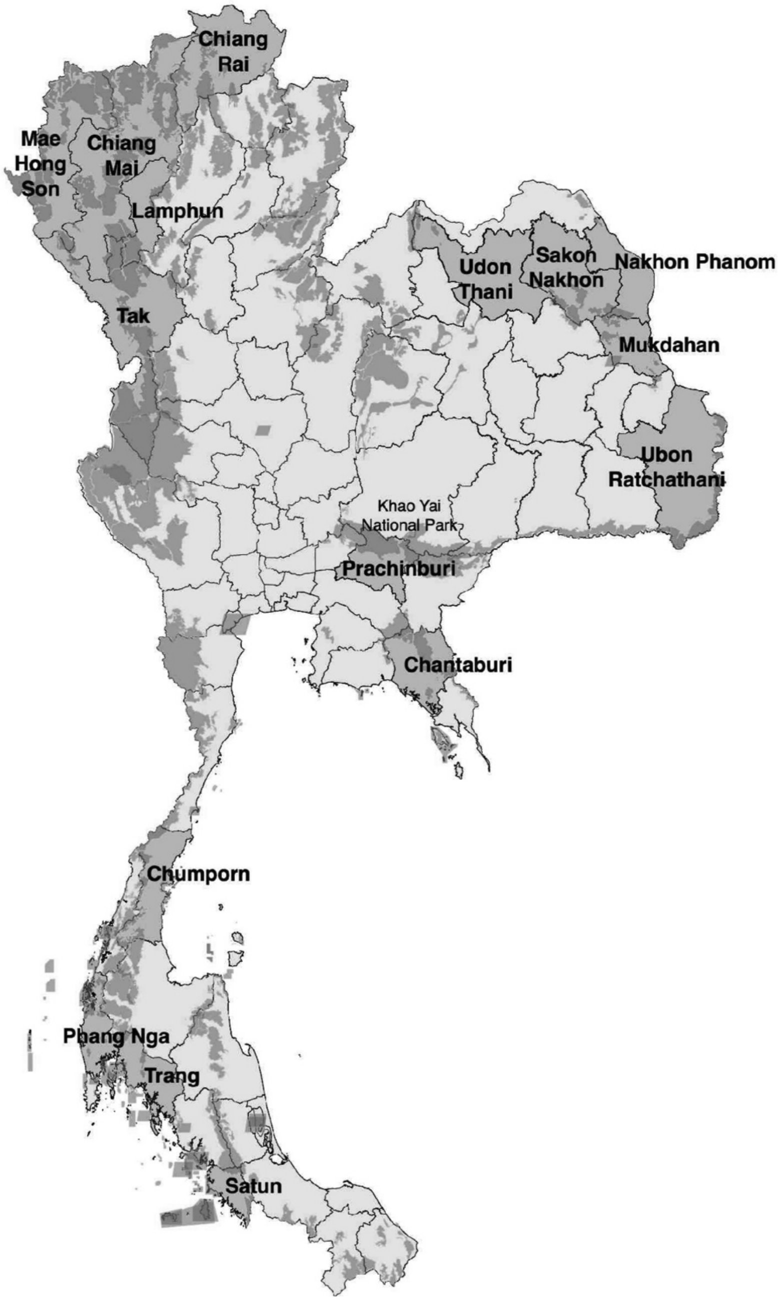
3.4.4.3 Trade via Mae Hong Son and Mae Sai

As at Mae Sot, trade via the northern Thailand-Myanmar checkpoints of Mae Hong Son and Mae Sai was not focused on open border-market sales but on imports for middlemen within Thailand. Imports were conducted secretly, with plants packed in boxes shipped via regional bus. They were not reportedly primary trade sites based on interviews and market surveys at Jatujak, and were not investigated in detail. However, at least two traders at Jatujak reportedly sourced plants from middlemen in Myanmar via these northern checkpoints.

4.3.5 Thailand trade dynamics

Trade of wild plants originating within Thailand centred around Jatujak Market, although Thai plants were also found at Mukdahan and Dan Singkorn (Table 4.1). A small number of traders at Jatujak (N=1) and Mukdahan (N=2) reported harvest themselves or by family members within Thailand, in Prachinburi and Mukdahan Provinces, respectively. Most other traders that sourced plants from within Thailand placed orders with middlemen (Table 4.5; Table 4.6), although no middlemen or harvesters in Thailand could be interviewed.

Harvest data was limited to market trader reports, and so limited to the province-level (Map 4.4). Trader interviews and market surveys suggested that harvest within Thailand was targeted in a small group of provinces in the Northwest, Northeast and South of the country. Reported source provinces overlapped with the significant remaining deciduous and evergreen montane (>1000m) forests in Northwestern Thailand, and pockets of remaining evergreen forests in central and southern Thailand (Stibig et al. 2004; Dong et al. 2009). Traders also reported considerable sourcing from Northeastern Thailand, despite little remaining forest cover (Stibig et al. 2004; Dong et al. 2009). Source provinces also hosted many protected areas (Map 4.4), although only one interview at Jatujak specifically reported harvest from within a protected area, Khao Yai National Park.



Map 4.4. Province origins of wild-harvested plants in Thailand. Origins reported by market traders during interviews and market surveys, relative to protected areas.

4.3.6 Jatujak trade dynamics

Jatujak Market is the principle plant market in the country (described in Chapter 2), and we found evidence that traders at all other markets visited had direct or indirect links to Jatujak (Map 4.1). Traders at Jatujak reported sourcing plants from across the region, principally via middlemen (Table 4.8), with order placed via telephone and deliveries by bus. We regularly observed that traders received large boxes of plants marked with the market name and telephone numbers (but no names), delivered by tuk-tuk from the nearby Mo Chit bus station. Particularly large shipments arrived very late on Tuesday nights/early Wednesday mornings in preparation for the weekly plant market held on Wednesdays and Thursdays.

Table 4.8. Reported sources of plants purchased by traders at Jatujak.

Source of plants	Percent (number) (N=16)
From middlemen in Myanmar	31.3 (5)
From middlemen in Thailand	31.3 (5)
From middlemen in Lao PDR	31.3 (5)
From middlemen in Cambodia	6.3 (1)
From middlemen in Vietnam	6.3 (1)
From middlemen (unknown/variable)	12.5 (2)
Directly from harvesters	12.5 (2)
From traders in the same market	6.3 (1)
Collect themselves/family collects	6.3 (1)
Travel to buy at other market	-

[a] Sums may be greater than total number of respondents, as some traders reported multiple procurement strategies

Despite this wide sourcing by traders at Jatujak, ordination analysis of market stall species compositions grouped most traders together (Fig. 4.4). Importantly, it highlighted five outliers, which represented larger-volume traders with high species richness. Three of these traders had strong regional links, to Northern Thailand/Myanmar or Lao PDR. Two extreme outliers represented stalls that specialized in blooming specimen, and highlight the diversity of trade practices within Jatujak.

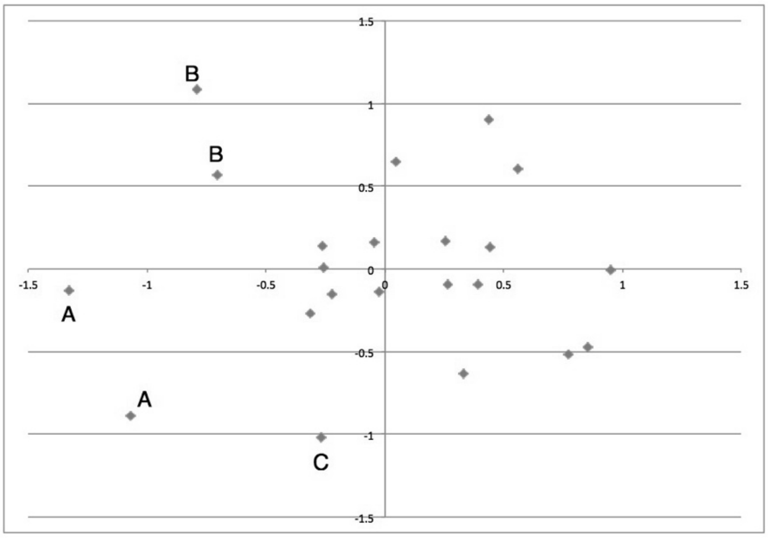


Figure 4.4. Ordination analysis (NMDS) of species composition of traders at Jatujak Market (with >10 species). Letters indicate clusters among the outliers. **A,** represent traders that specialized in blooming specimens, often including species uncommon in trade. **B**, represented traders that sourced principally from Lao PDR. **C,** represents traders that sourced principally from Northern Thailand and Northern Myanmar.

As elsewhere, traders at Jatujak reported that most sales were to final consumers that visited the market, although a subset of traders were also involved in re-sale to traders elsewhere (Table 4.9), including to Sanam Luang II market in Bangkok, and to traders in Nakorn Sawan, Krabi, Puket, Suphan Buri, Nakorn Phanom, and Saraburi Provinces.

Table 4.9. Destination of plants sold at Jatujak Market. Percent (and number) of traders at Jatujak (N=16) that ranked (ranked from 1-5) each category of buyer by sale volume.

Rank	Middlemen	Traders at other markets	Traders at same market	Experts / Hobbyists	General public
First	6.25 (1)	25.0 (4)	12.5 (2)	25 (4)	**31.25 (5)**
Second	-	25.0 (4)	12.5 (2)	**50.0 (8)**	12.5 (2)
Third	25.0 (4)	12.5 (2)	12.5 (2)	12.5 (2)	12.5 (2)
Fourth	12.5 (2)	-	12.5 (2)	12.5 (2)	12.5 (2)
Fifth	6.25 (1)	6.25 (1)	6.25 (1)	-	25.0 (4)
None	**50.0 (8)**	**31.25 (5)**	**43.75 (7)**	-	6.25 (1)

4.3.7 Evidence of parallel trades

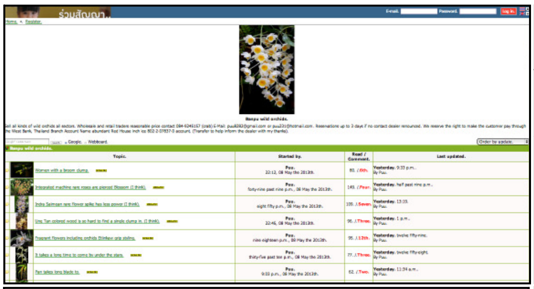
Research focused on the sale of ornamental plants at public markets. However, through the course of market surveys and interviews evidence also emerged of three additional, parallel trades in wild-collected orchids: 1) a specialist trade in high-value plants imported from outside continental Southeast Asia; 2) the purchase and laundering of wild plants by commercial greenhouses within Thailand, and 3) the trade of medicinal species to Vietnam and China.

4.3.7.1 Parallel trade in unusual high-value plants

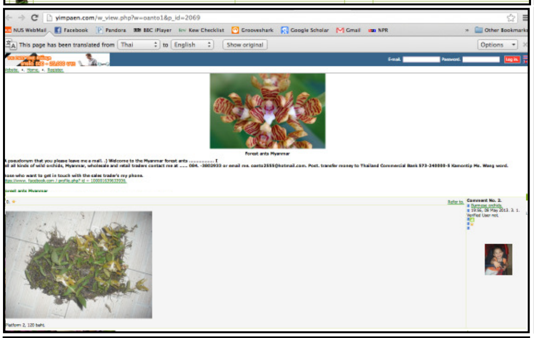
During market surveys at Jatujak, we encountered at least five species that were unique because they originated from outside continental Southeast Asia (Philippines and Indonesia; Table 4.2) and were sold for comparatively high prices (~US$20-35 per plant). These encounters, however, were coincidental, as these types of plants were generally not openly traded, but rather were kept out of sight, reserved for specialist collectors willing to pay a premium for unusual or hard to acquire species. A such, deeper study of this trade was infeasible, and would have potentially jeapordised the broader study by upsetting some of the traders in the market. The casually observed cases of trade, however, were potentially indicative of a parallel trade in rare species, confirmed during informal discussions with orchid enthusiasts in Bangkok. While restricted to a subset of traders (Fig. 4.4) and comparatively low volume, hobbyists related that a very wide diversity of wild-collected, uncommon species were available through these traders. One hobbyist related an anecdote in which several Jatujak traders routinely purchased large numbers of rare plants and held them in greenhouses to drive up market prices.

4.3.7.2 Parallel trade in domestic Internet sales[6]

During discussions with traders and botanical enthusiasts, it also emerged that there is an active online domestic trade of wild-collected ferns and orchids. both by commercial traders and among botanical enthusiasts. Online searches reveal a number of online, Thai-language message boards with regular postings that offer wild plants (e.g., yimpaen.com; board2.yimwhan.com; Photo Panel 4.2), as well as several Thai Facebook groups that serve to market wild-collected plants (Photo Panel 4.2).

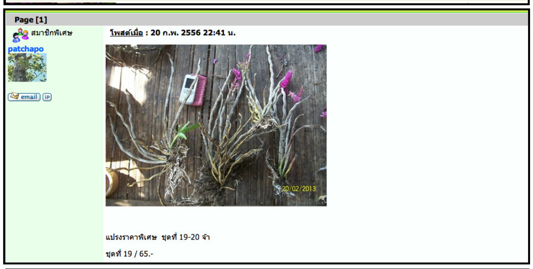


Online forum posting:
"We sell all kinds of wild orchids for wholesale and retail trade at reasonable prices. Contact 084-xxxxxxx. Email: xxxx.com. Plants can be reserved for up to 3 days. Payments are made through West Bank, account #xxxxx. Please inform me of any deposits."

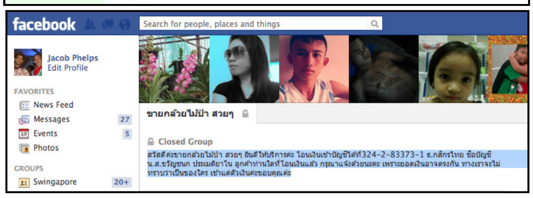


Online forum posting:
"I use a pseudonym online, so please email me. I sell all kinds of wild orchids from Myanmar. Wholesale and retail traders can contact me at tel. 084-xxxxxxx or email me at xxx@hotmail.com. Transfer payments to Thailand Commercial Bank account #xxxxxxxxx, name: xxxxxxx.

Sales posting for a *Coelogyne* from Myanmar, 2,120 Baht (~US$70)



Example online forum sales posting for 19 plants of *Dendrobium secundum* 65 Baht each (~US$2.20)



Facebook orchid sales:
"Hello and welcome. We sell wild beautiful orchids. If you are interested in our products, please transfer money to our bank account of Miss xxxxx, Kasikorn Bank, account number xxx-xxxxxx-x…"

Photo 4.2. Examples of Thai language online forums and Facebook groups advertising wild orchids for sale. Screenshots from May 2013.

[6] Internet-based trade of wild orchids is the current focus of Ph.D. research by Amy Hinsley at the Unviersity of Kent.

There was some anecdotal evidence to suggest increasing Internet-based botanical trade within Thailand—several traders reported new online sales platforms during the study period—which mirrors a broader trend in Internet-based wildlife sales in other taxa (Todd 2011) and other countries (McElwee 2012). However, there was no evidence to suggest that Internet sales were reducing market-based trade (cf. Todd 2011).

4.3.7.3 Parallel trade in laundered wild plants via greenhouses

We also encountered evidence of a parallel trade in which (illegal) wild plants were laundered as (legal) cultivated plants via commercial greenhouses. A small number of traders at the border markets (N=2) specifically reported selling to commercial greenhouses, and a key informant at Jatujak also reported that some traders sell large volumes of wild plants to greenhouses. Several traders at Jatujak and Sanam Luang II (N=4) also reported operating greenhouses based on wild plant stock. We further encountered and informally spoke with greenhouse owners from Thailand, Malaysia and Singapore that purchased wild plants at Jatujak.

It is probable that some of these wild plants were legally re-exported internationally as cultivated plants, as has been recorded in the laundering of other taxa in the region (e.g., Nijman and Shepherd 2010a; Shepherd et al. 2012). Indeed, several of the traders encountered host websites for international sales. In 2011, we encountered wild plants laundered via commercial greenhouses from Thailand and Malaysia to Singapore. Registered as greenhouse plants, traders obtained CITES permits and legally traded wild plants at the 20th World Orchid Conference in Singapore. Some of the plants were evidently widl-collected by known wild plant traders from Thailand and Malaysia, and several traders candidly advertised plants as wild collected.

4.3.7.4 Parallel trade in medicinal orchids to Vietnam and China

A comparatively small number of orchid species have been used in traditional medicines in China for hundreds, if not thousands of years (Bulpitt 2005), and there is evidence of a large and expanding trade in wild orchids from Myanmar and Lao PDR to satisfy demand in China and Vietnam (Lovera and Laville 2009; Lamxay 2009; Kurtzweil 2011). Lovera and Laville (2009) describe commercial greenhouses cultivating large volumes of wild-harvested *Dendrobium* to increase their size for export as medicinal plants, and Laxmay (2009) suggests that medicinal trade has notably impacted wild populations of *Anoectochilus lylei.*

We found no medicinal orchid trade into Thailand, but did encounter anecdotal evidence of medicinal orchid trade to China and Vietnam from Lao PDR. In seeking information on trade flows to Thailand, a number of prospective respondents reported involvement in medicinal orchid trade. Notably, the procurement networks for ornamental orchids to Thailand appeared to be separate from those of medicinal orchids.

4.3.8 Economic and profitability analysis

We targeted economic analysis on trade from Southern Myanmar to Chedi Sam Ong and Jatujak Markets. This illustrated case highlighted key trends in profits across the chain, and also highlighted the considerable challenges to applying VCA to illegal wildlife trade.

Importantly, we found that sale units varied considerably across the value chain, including sales of individual plants, by bundles and by kilo, as well as distinctions between bare-root and planted specimens. For example, harvesters in Southern

Myanmar generally sold plants by the sack and by weight, while most traders at Chedi Sam Ong and Dan Singkorn sold individual plants, and traders at Jatujak sold plants both individually and by weight, depending on the trader and species.

Plant sizes and weights also varied significantly across and within species (Table 4.10), so the assumption that plant units could be standardized based on weight did not hold, and could have only been resolved if plants were individually weighed during the market surveys, although this would not have been tolerated by the traders. Moreover, while size was an important determiner of price, we found that there are other significant variables that influence price, such as country of origin and flower (see example of *R. gigantea,* Chapter 6). Instead, we relied on traders that could report sales prices per kilo to consider how the value of the target species changed across the chain (Fig. 4.5).

Profit margins varied considerably across the target species (Fig. 4.5). For example, reported margins among traders at Chedi Sam Ong varied between 48%-89%, depending on species (for plants purchased from middlemen).

Table 4.10. Examples of high variability in the weights of plants traded. Weights of a subset of target species.

Species	N	Mean (kg/plant)	SD
P. articulata	176	0.21	0.20
R. retusa	743	0.21	0.23
R. gigantea	379	0.19	0.22
D. chrysotoxum	180	0.32	0.18
D. lindleyi	179	0.35	0.16

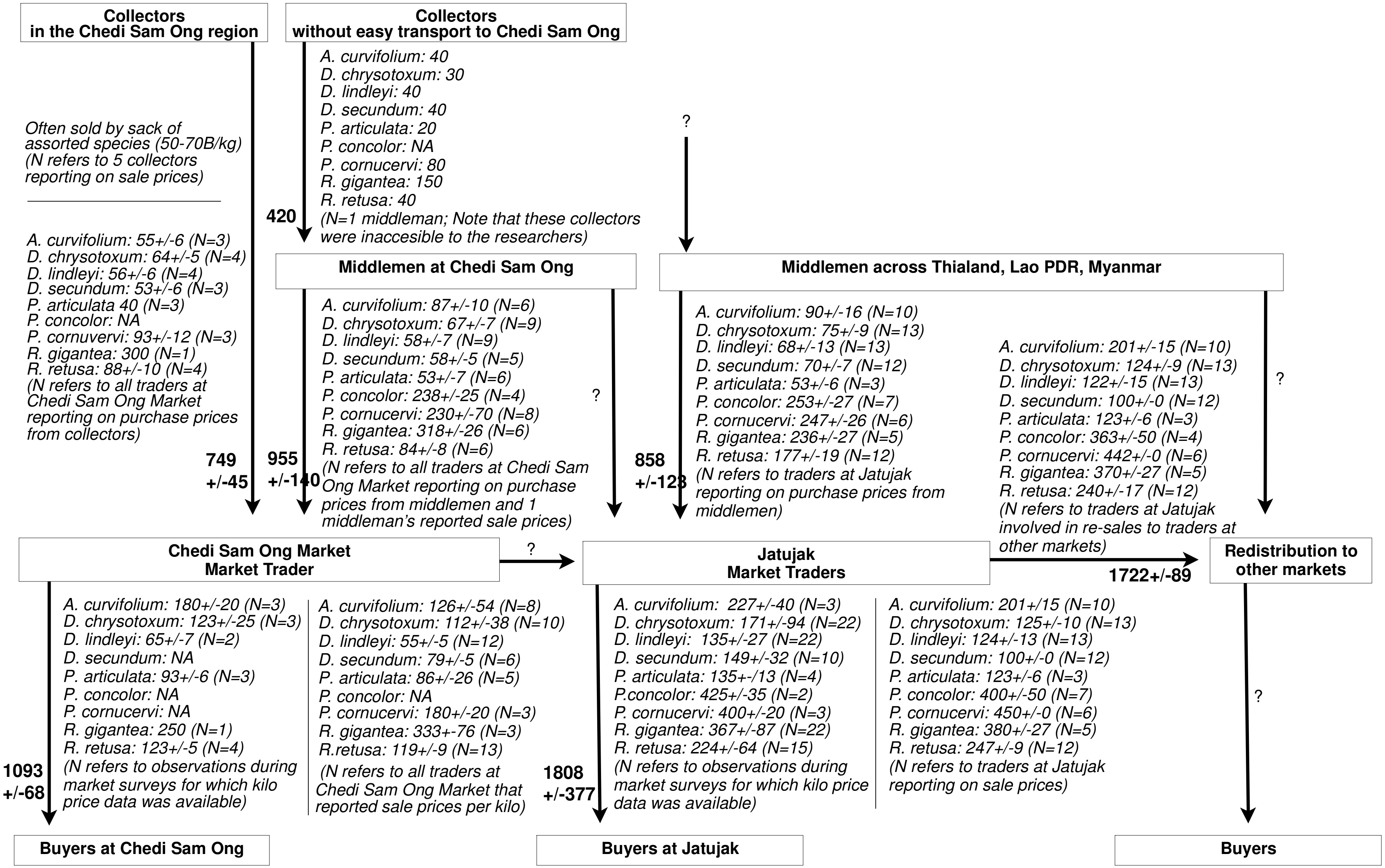


Figure 4.5. Mean sale prices per kilo (THB +/-SD) for 9 target species along the value chain from Southern Myanmar to Jatujak. Illustrative example tracking value from Southern Myanmar to Chedi Sam Ong and Jatujak Markets. Prices based on market observations during market surveys and trader reports of purchase and sale prices during interviews. Numbers in bold represent the sale value of a hypothetical basket holding 1kg of each target species (excluding *P. concolor*)

When we aggregated target species into a hypothetical basket holding 1 kilo of each target species, patterns emerged more clearly (Fig. 4.5). Notably, harvesters in Southern Myanmar that sold to middlemen reportedly captured only a fraction of final sale values; 23% of final sale values at Jatujak, and 38% of final sale values at Chedi Sam Ong. However, the analysis also highlighted the importance of considering the multiple, parallel trade paths, as harvesters with access to Chedi Sam Ong captured 78% more value than their more isolated counterparts (Fig. 4.5).

Middlemen and market traders at Jatujak captured significant value (56 and 53% profit margins), while margins of traders at Chedi Sam Ong were reportedly lower (13-31%). Notably, trader profitability depended on whether they sourced plants from harvesters, middlemen, or harvested themselves. However, the economic analysis overlooked factors such as transport costs, loss from dead plants and bribes, about which it was not possible to collect detailed data, but which would be required to accurately calculate profit margins along the value chain. These types of parallel trades, intermediate endpoints and hidden costs, not all of which were observable or accessible to researchers, limited the viability of the economic analysis.

4.3.9 Product transformation and transport

Trade networks that involve multiple steps usually also involve product transformation, including transformations in form (physical preparation for market), ownership (sale), space (transport) and time (storage) (Belcher 1998). Notably, the majority of wild-collected ornamental plants were not physically transformed, as a majority of traders sold bare-root plants (Table 4.11). Nevertheless, traders at different points in the value chain were observed to have physically transformed the plants, sorting bags of mixed species into bundles, and removing dead roots and leaves to make the plants more attractive. A subset of traders at all of the market sites further transformed the plants by potting them or tying them to pieces of wood to grow them, presumably adding value although we did not estimate these differences. A smaller group still further specialized in selling blooming plants, purchasing wild plants but reserving them until they were in bloom and could extract a price premium (e.g., Fig. 4.4). There were, however, no clear patterns in the ways these physical transformations occurred along the value chain.

Table 4.11. Percent of traders at each market selling three categories of wild plant

Categories	Jatujak [a] (N=16)	Mukdahan (N=24)	Chedi Sam Ong (N=12)	Dan Singkorn Burmese (N=31)	Dan Singkorn Displaced (N=9)	Dan Singkorn Thai (N=14)
Bare-root only	**87.5 (14)**	**70.8 (17)**	**66.7 (8)**	**77.4 (24)**	**22.2 (2)**	7.1 (1)
Potted/mounted plants [b]	0	29.2 (7)	33. (4)	24.2 (7)	77.8 (7)	**85.7 (12)**
Blooming plants [c]	12.5 (2)	0	0	0	0	(1)

[a] From interviews
[b] In addition to sales of bare-root plants
[c] Specialty in blooming plants

Notable, however, were the roles of middlemen in transformations of time and space. Te Velde et al. (2006) suggest that such entrepreneurs within non-timber forest product value chains, while potentially exploiting upstream actors (Fig. 4.5), often also provide services invaluable to the functioning of the value chains. We found considerable evidence of this in the ornamental plant trade. In particular, middlemen served as regional hubs for amassing plant and transporting them to border areas, often through regions isolated by geography and/or poor transport networks. In southern Myanmar, for example, transport reportedly represented high cost borne by middlemen. Middlemen supplying Mukdahan were furthermore involved in arranging and financing high-risk cross-border smuggling. Middlemen also served gate keeping roles, communicating orders between market traders and harvesters. Middlemen in

Myanmar and Lao PDR reported networks of personal contacts with harvesters, about which they were often secretive.

4.3.10 International chain governance

Our study of the interactions between actors across the value chain, based on interviews and field observations, suggest a heterogeneous governance structure across the value chain. We found variation across regions and market chains, scales of trade and stages of trade (Fig. 4.6). When we assessed trade complexity, potential for codification of trade, and supplier capabilities, ornamental plant trade networks could be best characterized as a mix of 'captive' and relational governance arrangements (Gereffi et al. 2005; cf. te Velde et al. 2006).

4.3.10.1 Complex transactions

We identified high levels of complexity in the transfer of inter-firm information and knowledge. Wild plants represented very simple products that underwent limited or no transformations. In the context of small-scale cross border trade where harvesters had direct access to customers in Thailand (e.g., That Uthen), trade complexity was low. However, at most of the study sites, getting wild ornamental plants to market was a complex process. We found complexity was mostly associated with transportation of plants to market, and as best illustrated by the large number of actors involved in transporting goods from harvester to consumer (Fig. 4.1).

We identified transport barriers, associated with geographic isolation of harvest communities, poor infrastructure and high transport costs. We also identified border barriers. Not all actors had the same rights to cross borders into Thailand, nor could wild plants be openly transported at all sites, so trade relied on intermediaries. For example, import to Mukdahan relied on smuggling networks; import at Dan Singkorn relied on Burmese traders who had permission to cross into Thailand on market day-passes, and trade at Chedi Sam Ong relied on participation of Burmese stall holders at the border market (see Chapter 8 on rules of import at each site). We also identified language barriers among Burmese harvesters and some traders who were limited in their ability to communicate and negotiate with Thai middlemen and traders and relied on sales to Burmese traders and middlemen.

4.3.10.2 Low potential for codification of relational trade

We found that the potential of codifying information about trade was low because trade networks were heavily relational, based on trust, reputation and, in some cases family and community links. Market traders at all the sites reported specific relationships with their providers. We also observed at Jatujak, for example, that specific traders had unique provision networks (e.g., Fig. 4.4). Similarly, the few middlemen interviewed reported individual relationships with certain harvesters and communities from whom they supplied plants. We also found multiple cases in which participants were protective and secretive about their trade networks and contacts with middlemen. This potentially maintained high barriers to market participation.

Many of the network relationships were based on geographic proximity. At point of harvest and trade, we documented cooperation among family members, friends and neighbours. For example, all of the displaced Burmese traders selling at Dan Singkorn Market were from Prachuap Khirikan, and most of the Burmese traders at Dan

Singkorn were from the same village (72%). Similarly, 92% of traders at Mukdahan were from the same village in Kham Ahuan Subdistrict, having entered into trade through personal connections, referrals and by cooperating with neighbours.

Relationships and trust were also very important to actors operating across broad geographical distances, such as between the border markets and Jatujak, because transactions were conducted via telephone and payments made via ATM. Several border traders at Chedi Sam Ong expressed concerns (N=3) over the reliability of payment from traders in other cities, and highlighted the need for trustworthy trade networks. Middlemen in Lao PDR and Thailand cooperated to carry out secretive cross-border smuggling (Figue 4.6). We also documented instances of plant sales based on credit without interest, and of cooperation among market traders to avoid enforcement (see Chapter 8). These varied instances point to a very low potential for codification at key points in the trade network.

4.3.10.3 Moderate harvester capabilities

We evaluated the capabilities of suppliers as moderate. We found that harvesters had access to wild plant resources, which in the context of low enforcement of conservation rules in Myanmar and Lao PDR generally represented open access resources. However, harvesters in Southern Myanmar also reported considerable, mounting barriers to accessing plants, particularly valuable species in the context of diminishing populations as a result of over-harvest (See Chapter 3). There were also considerable personal burdens associated with harvest. We also found that harvesters in all three countries were limited in their ability to access markets and consumers, and relied on middlemen for access to borders, cross-border transport and distribution.

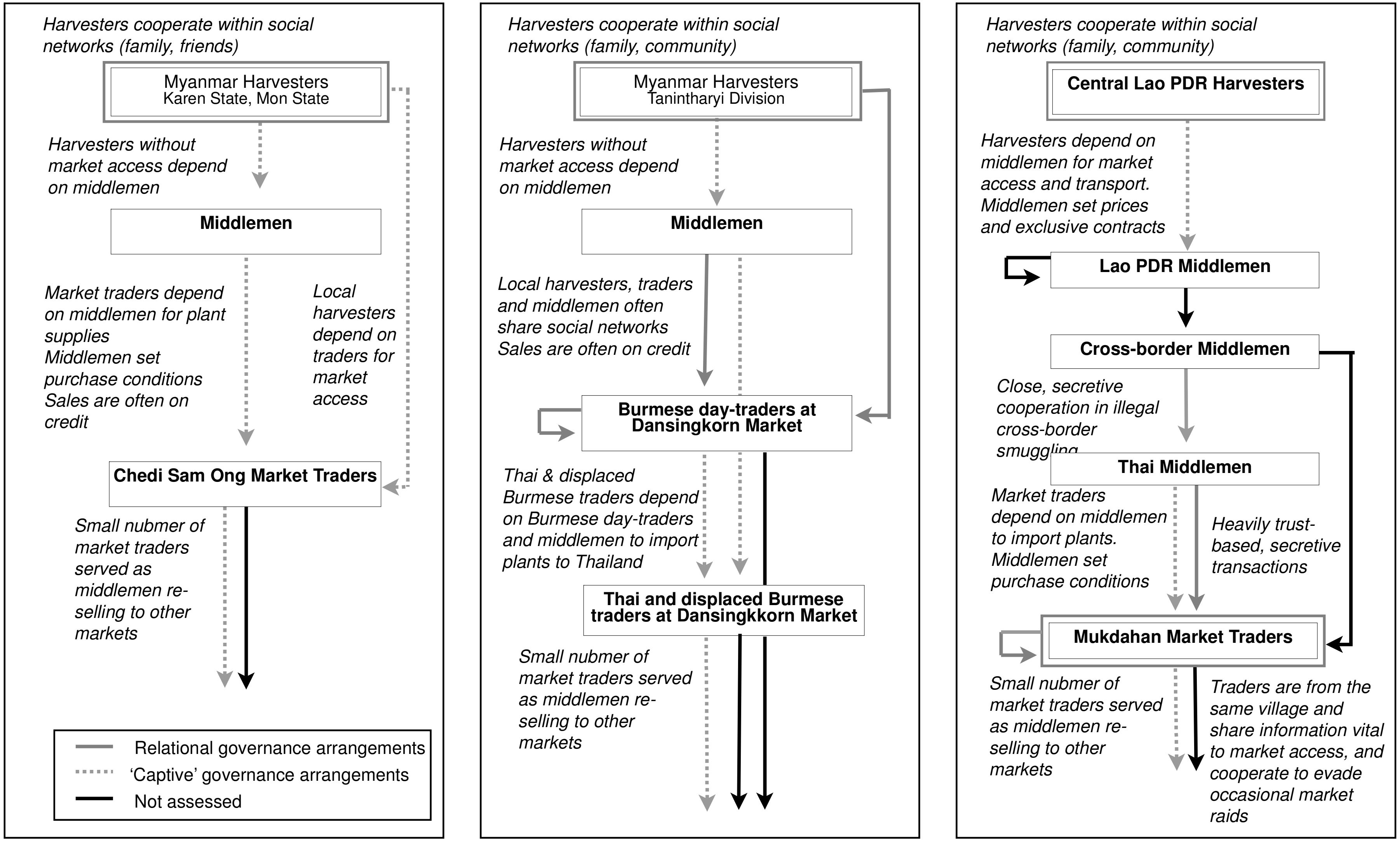


Figure 4.6. Internal governance arrangements among trade participants around three border markets: Chedi Sam Ong, Dan Singkorn and Mukdahan. Depicts 'captive' and relational arrangements within ornamental plant trade networks through the three target border markets.

4.3.10.4 'Captive' and relational trade governance arrangements

The high complexity of trade networks, low potential for codification due to relational dynamics, and the moderate capacity of middlemen suggest that ornamental plant trade networks relied on 'captive' governance arrangements, in which actors at different points along the market chain were heavily dependent on leading actors. (Fig. 4.6; Gereffi et al. 2003). Notably, middlemen acted as leading agents, often responsible for a leading share of chain activity (transportation), dominant in terms of buying power and control of technology (contacts and trade networks), and operating at key positions in the value chain upon which other actors depended (see Kaplinsky and Morris 2000).

As discussed, middlemen were important gate-keepers of contacts and information, and held leading roles in establishing communication among other actors, sourcing and amassing products, and financing transport and/or cross-border trade. Alternative trade arrangements were generally beyond the geographic, financial and logistical access of participants.

While we were generally not able directly evaluate relationships between middlemen and other actors, we nevertheless found considerable evidence that middlemen were involved in rule-setting. For example, harvesters that lacked market access were generally very dependent on middlemen to transport their goods, and recorded several cases where middlemen imposed exclusivity arrangements with harvesters. At the marketplace, most traders at Chedi Sam Ong (58%) reported that they had relationships with middlemen suppliers that required them to purchase all of the plants that middlemen brought for sale (all species, total volume), in order to maintain trade relationships. Many market traders at Mukdahan (37.5%) reported similar binding trade agreements with middlemen suppliers. Moreover, market traders at Mukdahan reported collectively posting bail for middlemen during instances where they were arrested for smuggling, because of their high level of dependence on them for trade. We also found that they captured considerable amounts of chain value (~50% profit margins; Fig. 4.5).

Yet, at a number of points, we found that trade was based on relational arrangements (Fig. 4.6). Harvest and local trade networks were often based on social networks, and geographically distant actors were also heavily based on trust. Moreover, in cases where actors faced enforcement, such as during market raids and cross-border smuggling (see Chapter 8), trust played an important role in ensuring secrecy and warning.

4.4 Discussion

4.4.1 Complex trade

Wild ornamental plants generally represented open access resources, and were widely accessible, even to poor households. Moreover, plants required little or no processing. Yet, we encountered complex and heterogeneous trade networks, far more elaborate than might be anticipated by value chain theory (see Kalipinsky and Morris 2000), and more complex than value chains for most other non-timber forest products (cf. te Velde et al. 2006; Bista and Webb 2006; Belcher and Schreckenberg 2007). Notably, VCA found that plants passed through a surprising number of hands (Fig. 4.1), often within small geographic areas. We also found that trade networks varied considerably among sites, which highlights the need for more tailored interventions.

The trade complexity we encountered was attributable to a range of financial and logistical barriers. Limited market access due to geographic isolation, poor infrastructure and high transport costs restricted many wild plant harvesters' access markets. Restrictions on border crossing and on importing wildlife products internationally also represented barriers at many sites. Various 'additional' participants filled transport and border-crossing roles, including those associated with specialized smuggling around Mukdahan, boundary traders at Chedi Sam Ong and 'day traders' at Dan Singkorn (see Chapter 8). These actors captured considerable amounts of the total product value (Fig. 4.5). Transport costs were also reportedly high. This complexity may be characteristic of trade in illegal products and smuggling, where otherwise basic processes such as transport require greater investment and sophistication (cf. Basu 2013).

VCA also revealed distinct types of trade within the regional trade of wild plants, highlighting the need for sub-sector analysis. For example, we distinguished between several different parallel trades, differentiating between medicinal and ornamental plant trades as separate geographically and in terms of participants. There were also distinctions between market-based, internet-based and greenhouse-laundered plant trades. We further distinguished between sales to hobbyist collectors with specialist knowledge versus members of the general public (Fig. 4.4; Table 4.7). These represented distinct aspects of the plant trade that would require tailored interventions.

Importantly, VCA highlighted different scales and dynamics within the cross-border and market trades. We distinguished between small-scale local harvest at some sites (e.g., That Uthen) and larger commercial trade at others, including at border and subsidiary markets that have not been previously identified as centres of wildlife trade. Transport and smuggling arrangements, internal governance arrangement and actors also differed among these sites (see Chapters 5 and 8). For example, some market traders sourced plants from family members and local harvesters, while others sourced from local or regional middlemen. These types of distinctions are evident even within the same markets, as traders sold not only different species (e.g., at Jatujak, Fig. 4.4) but also plants from different countries (e.g., Table 4.5). Analysis of the goods along the value chain also distinguished diversity among plant species and the associated prices and profit margins.

The recorded complexity and diversity are significant to conservation efforts, and highlight the challenges to improving wildlife trade management and conservation. The challenges faced during research also represent obstacles to effective monitoring and enforcement, and efforts to regulate complex trade networks will require adaptive management and non-traditional approaches (see Chapter 7). Improved efforts could adopt some of the strategies employed in this study, including a snow-ball approach to identifying sites of interest and trade participants, participant observation to identify rules and relationships, as well as methods adopted from other fields such as criminology (discussed in Chapter 9). The heterogeneity we encountered within trade networks also highlights the need for more targeted research, policies and enforcement to consider the actual complexity of patterns of harvest, use and trade (Belcher 2003; Laird et al. 2011). While enforcement is often blunt, the distinct trades we identified require more tailored interventions, targeting of bottlenecks, geographic targeting and interventions along the value chain. The VCA also suggests that conservationists need to recognize and embrace complexity to identify effective interventions.

4.4.2 Public markets as points of entry

VCA provides especially important information about *where* conservation interventions could be most successfully leveraged. Notably, the analysis highlighted key patterns in trade dynamics that represent prospective points of entry for conservation, including through research, education, alternative livelihood development and enforcement (see Chapters 5-8).

Most significantly, the study detailed large-scale trade in wild ornamental plants at public markets. Regiona, commercial-scale trade in ornamental plants has not been previously documented: Although Jatujak has been a focus of conservation enforcement in recent years (e.g, DNP 2013), plant trade has been almost completely overlooked. Crucially, we also identified other major sites of trade, notably the three border markets that had not previously been identified as centers of botanical trade. These four markets are ‘low hanging fruits’ for conservation, and represent immediate and conspicuous opportunities for intervention and enforcement.

While border markets were important sites of re-sales, we documented that considerable amounts of final sales to consumers were transacted at the marketplaces (e.g., Table 4.4; Table 4.7). As such, these sites also provide access to consumers of wildlife products. Markets would be very appropriate sites for public awareness campaigns about conservation, restricted species and regulations and penalties. Markets could potentially also be effective sites for enforcement against consumers that purchase restricted species.

Moreover, as we demonstrated, public plant markets represent unusual opportunities for studying wildlife trade networks that are otherwise hidden to researchers and enforcement because they are secretive and/or geographically disbursed. This includes data on upstream and downstream links (to harvesters, middlemen, re-sellers and consumers). Moreover, we found that participants often converged at public markets, so research situated at these sites can also yield links to secretive aspects of the wildlife trade. For example, market-based research provided links to parallel trades, including trade in animals; international wild plant trade via greenhouse laundering; online ornamental plant trade; smuggling to and from countries outside the region. Although this study was limited in its capacity to purse these separate lines of enquiry, it identified market-based observation as a viable point of entry for accessing other trade networks.

4.4.3 Upstream interventions

VCA also highlighted the need and potential for interventions along the value chain, including at sites of harvest. We provided a first evaluation of where traded plants are originating. Importantly, we found that target markets in Thailand were heavily dominated by wild plants imported from overseas (Table 4.2), principally from Lao PDR and Southern Myanmar. Burmese harvest via the target markets appeared to be primarily localized within Tanintharyi Division, Karen and Mon States (Map 4.2), although we also found some evidence of harvest from other regions. Harvest within

Lao PDR was heavy within Savannakhet Province, but was also reported from a number of other provinces (Map 4.1). We also found significant domestic trade in protected plants within Thailand. Trade was reportedly skewed towards a subset of provinces in Southern, Northwestern and Northeastern parts of the country, highlighting the need and opportunity for targeted conservation efforts in the most affected regions (Map 4.3).

Importantly, we also found a broad co-location between protected areas and reported regions of harvest in the three countries, where harvest was reported in areas of immediate proximity to protected areas in both Southern Myanmar and Thailand. The leading provinces of wild plant harvest within Thailand also hosted the country's largest protected areas (Map 4.3). We further identified specific evidence of commercial harvest within Phu Khao Khouay National Park in Northern Lao PDR and Khao Yai National Park in Central Thailand. Indeed, there is evidence that wild harvest most often tends to occur on state land, rather than on private or communally managed areas (Belcher et al. 2005). And, although protected areas can be effective at reducing deforestation, they are often less successful at reducing illegal wildlife harvest (Burner et al. 2001). There is considerable evidence that many protected areas in the region have not successfully curbed illegal resource extraction (e.g., Johnson et al. 2003; Rao et al. 2004; Peters et al. 2006). Improved protected areas management and monitoring are widely recognized as crucial conservation interventions (e.g., Sodhi et al. 2004). However, there is a need to ensure that botanical resources are also considered within any expanded regulatory and monitoring efforts (Laird et al. 2011)

4.4.4 Bottlenecks

Although harvest and trade along the value chain were geographically disbursed, we identified a number of bottlenecks, both geographic and involving lead agents, which potentially represent entry points for conservation. Unsurprisingly, trade clearly followed road networks, such as Road 9 in central Lao PDR, Myanmar's Southern Highway 8, and the Route 4 (Phetkasem Rd.) link to Southern Thailand. We also identified clear bottlenecks at border crossings (Map 4.1), particularly along the Myanmar border where poor infrastructure and geographic barriers limited points of import (Map 4.2). Trade from Lao PDR was wider due to the wider opportunities for cross-border trade via the Mekong River. However, we still found evidence of traders funneling through established checkpoints

These physical bottlenecks represent obvious opportunities for improved, targeted enforcement, including improved leveraging of inspections at border and road checkpoints. For example, there are Wildlife Border Checkpoints at the border with Myanmar at Dan Singkorn and Mae Sot, and we often encountered inspection checkpoints along the roads leading to Dan Singkorn and Chedi Sam Ong Markets. There is considerable opportunity for these sites to become more active sites of wildlife trade inspection and trade regulation (e.g., Shepherd et al. 2007; ASEAN-WEN 2012; see also Chapter 7).

Importantly, we found that the transport of plant resources both into and within Thailand was often conducted via bus, another potential bottleneck for interventions. A number of private transport companies have emerged to link the entire region, and drivers are often paid to transport goods between cities. There is some evidence that this expanding transport infrastructure is facilitating wildlife trade in the region (Shepherd et al. 2006), and transport networks may represent important and accessible points for disruption of illegal trade. Buses originating from border areas are already subject to frequent immigration checks, which could be leveraged to also inspect and caution against wildlife trade through expanded monitoring, given the necessary additional training and mandate. Engagement with the various private bus companies to establish standards and guidelines for transporting goods could also help establish self-moderation within the transport industry.

The VCA also helped to identify trade middlemen as important bottlenecks in the ornamental plant trade, as they played key roles in communication among participants, providing market access for harvesters, facilitating transport and cross-border smuggling. Although middlemen were elusive participants in wildlife trade, we found that there were relatively few middlemen operating at critical links in the trade network. For example, only a few traders at each market were involved in significant re-sale to other middlemen or to traders at other markets. Similarly, there were only 2-3 Thai middlemen actively smuggling plants for Mukdahan market, and limited numbers of middlemen supplying Dan Singkorn and Chedi Sam Ong. This evidence suggests that trade relied heavily on these leading agents within the 'captive' governance structure. Efforts to target these key individuals could be successful at disrupting illegal trade.

4.5 Conclusion

The illegality and complexity of trade, combined with the informality of the marketplaces and complexity of the goods presented unique challenges to VCA. Te

Velde et al. (2006) suggest that it is difficult to estimate profits along NTFP value chains, and to fit these into governance categories conceived for other contexts (cf. Gereffi et al. 2005). These critiques resounded throughout this study (e.g, Fig. 4.5; Fig. 4.6). Nevertheless, VCA provided a helpful framework and necessary structure for the description of the trade, serving to disentangle complex routes and networks that might otherwise appear monolithic.

Chapter 5: Characterizing trade participants

5.1 Introduction

While little is known about what ornamental plant species are exploited in the region, equally little is known about the people involved in harvest and trade (see Hinsley 2011 for a notable exception). This chapter characterizes the participants of botanical trade, specifically traders at the four target markets in Thailand and harvesters in Southern Myanmar (see Chapter 2, Map 2.1).

There are at least two important reasons why we need to characterize and understand the motivations of people involved in harvest and trade of non-timber forest products (NTFPs). First, effective conservation interventions depend on careful targeting—not only geographic (see Chapter 4), but demographic. Enforcement responses to small-scale local trade are necessarily different from efforts to target larger, more sophisticated commercial operations, and socio-economic data on trade participants can help to inform interventions. For example, prospective efforts to generate alternative livelihoods depend on understanding trader motivations, backgrounds and the incomes derived from trade. This includes not only consideration of harvester typologies, but consideration of the urban traders and middlemen who can play critical, if often overlooked, roles in wildlife trade (Stoian 2005; te Velde et al. 2006; Jepson et al. 2009).

Secondly, demographics and motivations are also important because there is a moral obligation to consider the impacts of conservation enforcement and regulation on trade participants (Dickson 2008). In 2004, Convention on International Trade in

Endangered Species of Wild Flora and Fauna (CITES) officially acknowledged that, while the international trade of threatened species is detrimental to the conservation of many species, it can also constitute an important part of rural incomes, which should also be considered [Res. Conf. 8.3 (Rev. CoP13)]. Dickson (2008) describes the CITES position as a stance weaker than the 'do no harm' approach to conservation, and highlights that trade of threatened species does not emerge as a globally important factor in sustaining the livelihoods of poor (Dickson 2008). However, the trade of wild ornamental plants in Southeast Asia may represent an important exception, and there is a need to consider how conservation interventions would affect participants.

5.2 Methods

The characterisations are based on semi-structured face-to-face interviews with traders and harvesters, methods of which are detailed in Chapter 2. Importantly, the descriptions are based principally on interviews with participants involved in open market-based trade at the four target markets and harvesters that sold directly to traders at markets in Southern Myanmar (Chapter 2, Map 2.1). It excludes middlemen, transporters and other important actors such as harvesters in other parts of Myanmar and within Lao PDR and Thailand. These participants could not be accessed within the scope of this study because they were too geographically disbursed, secretive and/or uncooperative. As such, this chapter provides only preliminary insights into the realities of those wild plant harvesters.

Estimates of trade-derived income were based on respondent estimates of gross and net monthly incomes for low and high sales seasons, for which they indicated the number of months, and which generally corresponded with the dry and rainy season (or, at Dan Singkorn, high sales over Lunar New Year and lower sales the rest of the year). These were then used to approximate annual income from plant trade for each respondent. With a few exceptions, participants reported not keeping any sales records, and where they were unable to provide estimates of net incomes, median profit margin from other traders at the same market/region were applied to calculate annual income (Table 5.4). Where possible, income data was transformed using a natural log function to allow for parametric tests.

We used a linear mixed effects model (*R* package nlme) to explore the relationship between income from plant trade (dependent variable) and fixed effect demographic variables (years trading, other household income, trader age, gender, education, stall size, whether traders were selling bare-root, and reported level of household income dependence on trade (N=81). Where possible, fixed variables were simplified; years trading and trader age were categorized by quartiles, and education was categorized into 'no education', 'low' and 'high' levels of education. We did not, however, consider interactions given the small sample size within each site and the lack of suspected interactions of significance to conservation or enforcement. Market site (four target markets) was considered a random effect, with trader category (Burmese, Displaced Burmese and Thai traders) considered a random effect within Dan Singkorn Market. The model was simplified using AIC. The same was done for harvesters (N=24) to consider the fixed variables (years harvesting, harvester age, gender and education and reported household dependence on trade).

5.3 Results

5.3.1 Scale of trade participation

Based on market observations and trader reports of friends and family members that regular work with them in trade, we conservatively estimated that ~160 traders were active at the open plant markets visited during the 2011-2012 study period, (Table 5.1). This included the country's largest markets and several small city markets throughout the country. There were also number of other similar city and roadside markets that were not included, although based on observations we know that most of these hosted relatively few traders, were comparatively small volume and many resold plants purchased from the large target markets.

The majority of active traders were present throughout the study period and almost all respondents reported trading full-time and year-round, with no indication of seasonal variation in employment (Table 5.2). However, there was considerable evidence that market participation was dynamic. Many traders and harvesters informally reported that 2011 and 2012 had been comparatively low demand years, and that a number of participants had left trade. We observed several cases where traders left the marketplace during the early part of the study, before interviews were conducted. A key informant at Dan Singkorn also reported that there were dozens more orchid traders ~7 years ago, but that profitability and demand had decreased so that most began trading other products. Trade at Jatujak was reportedly also much larger prior to 1998, when enforcement increased (see Chapter 8). Similarly, the number of traders at Peng Charn on the Lao PDR dropped dramatically in early 2011 as a result of an increase in enforcement prior to the study (Table 5.1).

Table 5.1. Observed and estimated number of trade and harvest participants

	Jatujak	Mukdahan	Chedi Sam Ong	Dan Singkorn	Mae Sot	That Uthen	Sanam Luang II	Kao Noi Si Chompu	Peng Charn	Harvesters (S. Myanmar [c])
Number of traders [a]										
Minimum observed	14	23	11	54	6	3	5	6	5	NA
Maximum observed	31	40	15	69		5	7	-	~50	NA
Number interviewed	15	24	12	51 (+5 also harvest)	4	2	4	-	-	23
Additional trade participants [b]	12	10	4	20	2	-	-	-	-	25

[a] Single stalls sometimes host multiple traders. Interview details and sampling in Chapter 2 (Methods).
[b] Reported by respondents as others also participating in trade with them
[c] Harvesters interviewed 3 sites in southern Myanmar : Mae Sot, Chedi Sam Ong, Dan Singkorn
- indicates that data was not collected

Table 5.2. Trading practices at four markets and among harvesters in Southern Myanmar

	Jatujak	Mukdahan	Chedi Sam Ong	Dan Singkorn			Harvesters (S. Myanmar [b])
				Burmese	Displaced	Thai	
Median number of years trading	5	6	10	5	4	6	5
Trade year-round (%)	100.0	91.7	100.0	89.7	100.0	100.0	96.0
Median number of trading days/week	4.5	3	7	7	7	7	5
Stall size [a] (%)							
<150 plants	37.5	87.5	33.3	66.7	100	42.9	NA
150-300 plants	50.0	12.5	50.0	27.3	0	50.0	NA
>300 plants	12.5	0	16.7	6.1	0	7.1	NA
Median number of traders/stall	2	1	1	1	1	2	2
Work with (percent):							
Alone	31.3	70.8	66.7	58.6	77.8	38.5	36.0
Spouse	31.3	20.8	8.3	17.2	22.2	38.5	32.0
Other Family	25.1	8.3	16.7	3.5	0	23.1	36.0
Children (<18)	6.3	12.5	8.3	24.1	0	7.7	8.0
Hired labour	6.3	0	0	0	0	0	4.0

[a] At time of interview, refers to number of individual plants or bunches (see Chapter 2 for methods)
[b] Includes respondents across 3 sites in southern Myanmar (Mae Sot, Chedi Sam Ong, Dan Singkorn)

Nevertheless, we also observed additional, short-term participants that entered and exited trade during the study period; we know anecdotally that these were principally people trying to break into the trade, often unsuccessfully. We also interviewed a number of new entrants into trade that had been involved for 1 year or less, at Jatujak (N=4) and Dan Singkorn (N=8), and observed two open plant markets on the Thai-Lao PDR (Peng Charn and Chong Mek) that shrank prior ot the study period as a result of increased enforcement. Cumulatively, these anecdotes point to more dynamic trends in market trade participation, subject to market changes and enforcement pressures (see Chapter 8).

Most harvest networks were highly decentralized and, in some cases, secretive, such that it was impossible to estimate the number of harvesters beyond the local harvesters that sold directly to Dan Singkorn, Chedi Sam Ong and Mae Sot Markets, which numbered ~50. It would not be unreasonable, however, to state that there are hundreds of others involved in the ornamental plant harvest across Thailand, Lao PDR and Myanmar, evident by the volume of plants in trade. The magnitude of ornamental plant harvesters in the region (Thailand, Lao PDR, Myanmar) is likely <1,000 participants.

5.3.2 Trader and harvester characteristics and demographics

Overall, the majority of traders at the four target markets had small-sized stalls, categorized as those that sold fewer than 150 individuals at the time of interview (63% of stalls). In comparison, only 6.6% of stalls observed sold more than 300 individuals. However, patterns were not even across the sites or across the trader categories at Dan Singkorn (Table 5.2).

Most market traders and harvesters had been involved in trade only between 4-6 years, with several exceptions: traders at Chedi Sam Ong had been involved with trade for a median of 10 years, and a small number of traders and harvesters at each site had been involved in trade for more than 15 years (N=11) (Table 5.2; Fig. 5.1). Importantly, ~37% of interviewed participants reported that they had been involved in trade for less than 5 years, and ~11% had been involved in trade for 1 year or less.

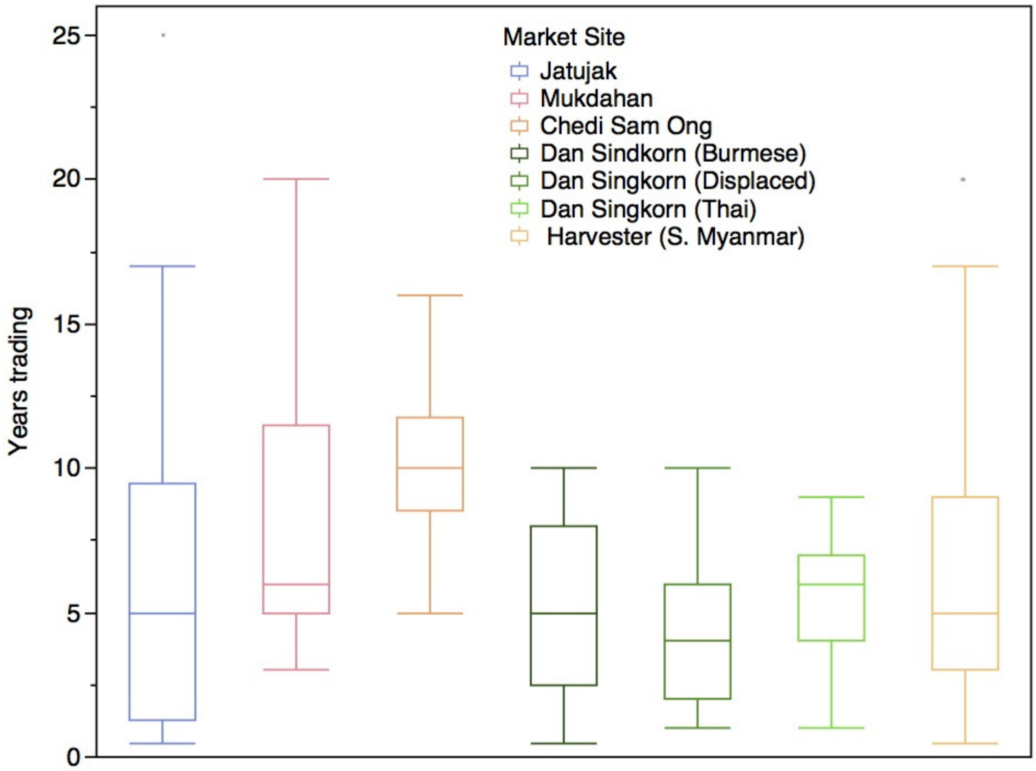


Figure 5.1. Median number of years in trade. Box and whisker plot shows median number of years respondents were involved in botanical trade, 1st and 3rd quartiles, whiskers 1.5 times the interquartile range, and outliers

Notably, botanical trade was heavily gendered; the vast majority of market traders were women, most between 30-50 years old (38+/-11.7; 80% female; Fig. 5.2; Table 5.3). In contrast, harvest in Southern Myanmar was overwhelmingly by men (75%), and the few harvesters encountered from Lao PDR were also men. The gendered nature of harvest is potentially attributable to the heavy physical demands and danger associated with harvest, particularly in Southern Myanmar. Female household members in Myanmar were, however, involved in coordination, sorting and sales.

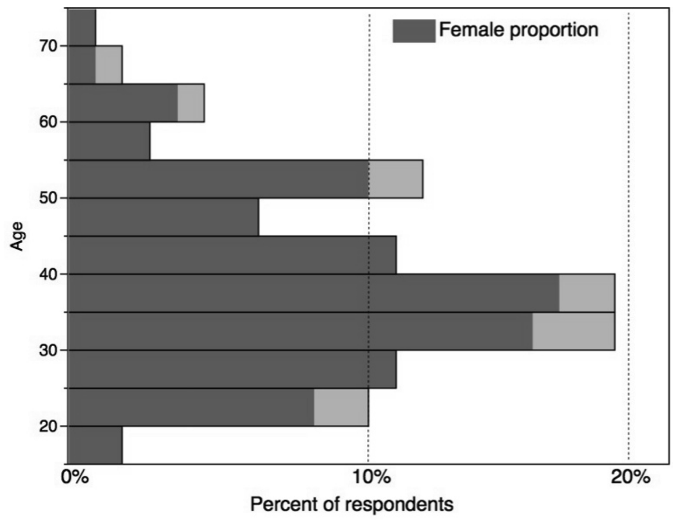


Figure 5.2. Age and gender distribution of traders at four target markets

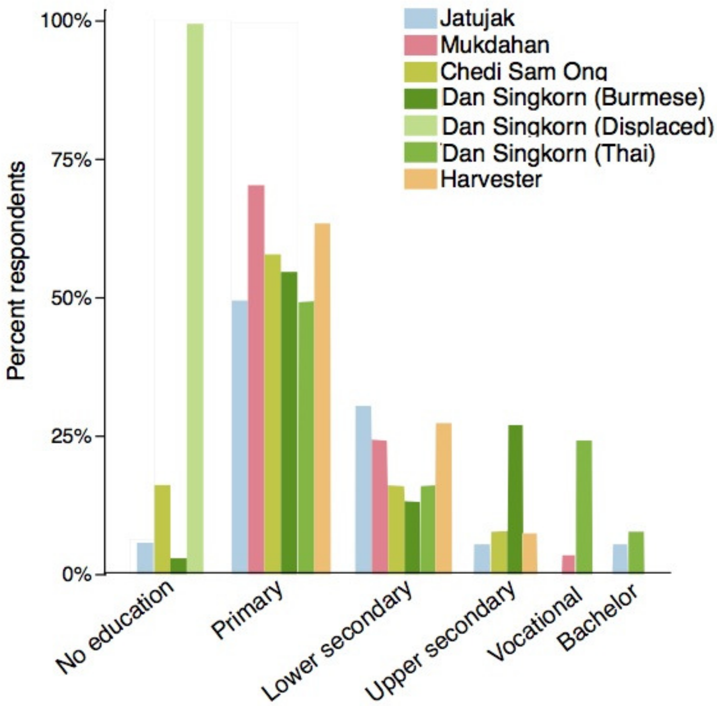


Figure 5.3. Highest educational attainment of traders at four target markets and harvesters in Southern Myanmar.

As explored in the discussion of network governance (Chapter 4), there were also distinct patterns in the origin of trade participants (Table 5.4). For example, respondents at Jatujak were primarily from Thailand’s northeastern Issan region (69%), which was also broadly representative of the other traders not formally interviewed.

Table 5.3. Demographics of botanical trade participants by site

	Jatujak	Mukdahan	Chedi Sam Ong	Dan Singkorn			Harvesters
				Burmese	Displaced Burmese	Thai	(S. Myanmar[c])
Gender (% Female)	74.4	79.2	91.7	97.0	100.0	78.6	25.0
Age							
Mean+/-SD	42.4+/-10.6	40.4+/-12.4	28.9+/-7.5	34.8+/-9.8	37+/-14.8	47.5+/-9.2	39.1+/-10.7
Median	42.5	37.0	29.5	34.0	30.0	50.0	36.0
Education (%)							
None	6.3	-	16.7	3.4	100.0	-	-
Primary	50.0	70.1	58.3	55.2	-	50.0	64.0
Lower Secondary	31.3	25.0	16.7	13.8	-	16.7	28.0
Upper Secondary	6.3	4.1	8.3	27.6	-	-	8.0
Vocational	-	-	-	-	-	25.0	-
Bachelor	6.3	-	-	-	-	8.3	-
Median household	4	4	5	5	4	4	5

[a] Gender based on interviews and surveys; others based on interviews only

[b] Includes respondents across 3 sites in southern Myanmar (Mae Sot, Chedi Sam Ong, Dan Singkorn)

Table 5.4. Hometown of trade participants by site

Jatujak		Mukdahan		Chedi Sam Ong		Dan Singkorn						Harvesters (S. Myanmar[c])	
						Burmese		Displaced		Thai			
Bangkok, TH	6.3	Bangkok, TH	8.3	Chonburi, TH	8.3	Mon, MY	6.9	Prachuap Khirikan, TH	100	Chiang Mai, TH	7.7	Bangkok, TH	8
Bueng Kan, TH	6.3	Mukdahan, TH	91.7	Kanchanaburi, TH	8.3	Tanintharyi, MY	93.1	-	-	Petchaburi, TH	7.7	Bago, MY	24.0
Buriram, TH	6.3	-	-	Karen State, MY	33.3	-	-	-	-	Prachuap Khirikan, TH	84.6	Karen, MY	28.0
Chiang Rai, TH	6.3	-	-	Mon, MY	16.7	-	-	-	-	-	-	Mon, MY	8.0
Nakhon Pathom, TH	6.3	-	-	Tanintharyi, MY	25.0	-	-	-	-	-	-	Raching, MY	4.0
Nakhon Ratchasima, TH	6.3	-	-	Yangon, MY	8.3	-	-	-	-	-	-	Shan, MY	4.0
Phetchabun, TH	6.3	-	-	-		-	-	-	-	-	-	Tanintharyi, MY	40.0
Prachinburi, TH	12.5	-	-	-		-	-	-	-	-	-	-	-
Ubon Ratchathani, TH	43.8	-	-	-		-	-	-	-	-	-	-	-

This is potentially representative of broader internal economic migration trends, including rural-to-urban moves and migration from the Northeast to Bangkok (Huguet et al. 2012). There were also several cases where entire groups of traders or harvesters were from the same communities (Table 5.4, see Chapter 4).

Most traders and harvesters had only primary-level education (Fig. 5.3). There was, however, a notable lack of educational opportunity among displaced Burmese traders at Dan Singkorn. At the other end of the spectrum, there was also a small number of wild plant traders at Dan Singkorn and Jatujak with high levels of educational attainment.

5.3.3 Motivations

Reported motivations for participating in wild plant trade varied considerably across the sites (Fig. 5.4). However, when provided with a list of potential reasons for choosing to trade wild plants, respondent motivations were principally economic, with most participants reporting botanical trade offered a better income than their alternative livelihood options (41%) and/or that trade provided supplementary income opportunities (17%) (Fig. 5.4). Notably, lack of livelihood alternatives was not a leading motivation for participating in trade at any of the sites. Market traders also reported other, non-economic motivations for botanical trade, including personal interests in plants, need to assist family members with trade, and a desire to own and manage their businesses (Fig. 5.4).

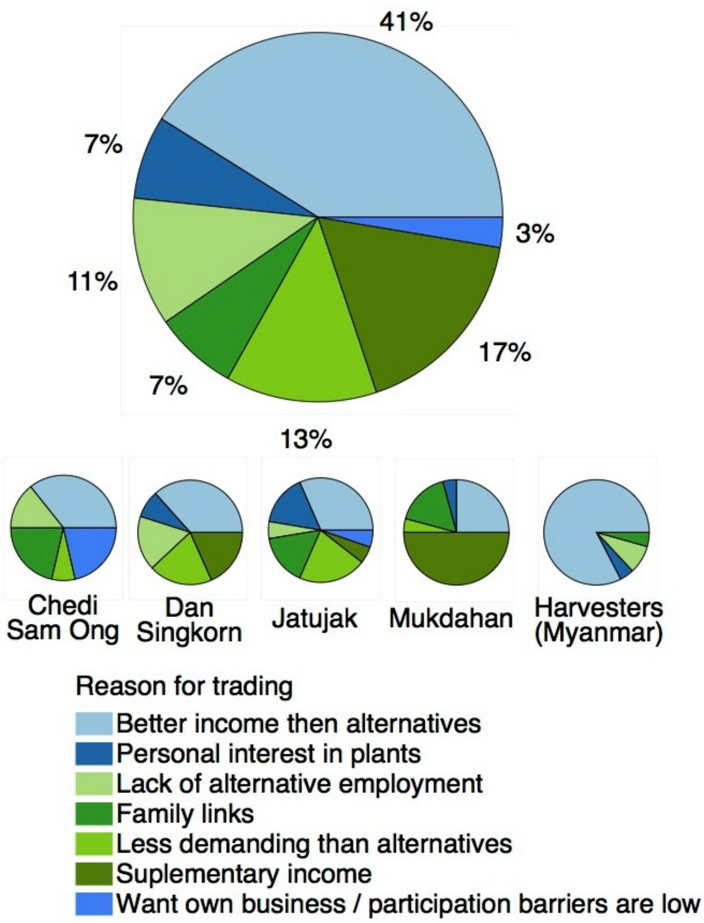


Figure 5.4. Reported reasons for participating in botanical trade (N=151). Respondents were allowed to provide more than one justification, although most (N=138) provided only one.

A small percentage of market-based traders (7-21%) reported that they participated in trade because it was less demanding than alternative forms of employment. Indeed, observed workloads at all the market sites were comparatively light: orders were placed via phone, at most sites deliveries by harvesters or middlemen were made directly to the point of sale, and stall management involved little physical work. Moreover, traders at several markets reported full-time employment in trade, but short work-weeks: traders at Mukdahan and Jatujak markets invested a median of 3 and 4.5 days per week (Table 5.2). In contrast, traders at Chedi Sam Ong and Dan Singkorn reported 7 days of trade per week (Table 5.2). Even in these cases, botanical trade potentially offered preferential workloads when compared with the alternatives, including agriculture and wage labour (factory or agricultural) (Fig. 5.9). Despite possible preferential working conditions, however, many traders faced uncertainty and risk associated with occasional enforcement, a marked “low-season” in sales, and fluctuations in supply (e.g, the trade of *R. gigantea,* see Chapter 6).

In contrast to traders, harvesters in Maynmar reported a median of 5 days of work per week, but significant hardships. Harvesters shared anecdotes of arduous trips to find plants, injuries and fatalities as a result of landmines and tree climbing accidents, and of being pursued by the Karen National Liberation Army and the Thai Forestry Department during harvesting trips. Several traders around Mae Sot and Dan Singkorn explained that officials allow them to trade wild plants specifically because they consider plant harvesters to be so disadvantaged. Despite these burdens, harvester motivations for trade were overwhelmingly economic (82.6% of responses).

5.3.4 Estimated incomes from harvest and trade

Taking the strong economic motivations for participating in trade into account, we estimated net incomes from trade, based on trader reports and profit margins. Traders at target markets reported 30-50% profit margins (Table 5.5).

Table 5.5. Median profit margins by market/region [a]

Market	Median profit margin
Jatujak Market traders (N=2) [b]	0.50
Mukdahan Market traders (N=3)	0.49
Chedi Sam Ong Market traders (N=7) [c]	0.48
Dan Singkorn Market traders (N=26) [b]	0.33
Harvester, Southern Myanmar (N=19) [d]	1

[a] Profit margins could not be collected from middlemen or harvesters in Lao PDR (see Methods)
[b] Only considers traders that purchased plants from harvesters or middlemen. Traders that harvested plant themselves are included under the “Harvester” category.
[c] Two outliers removed (Large volume traders that reported much higher income but lower profit margins than any other traders)
[d] Most harvesters reported zero costs (i.e. profit margins=1), although we know that some incurred considerable transport costs.

Median reported annual incomes were highest at Jatujak (US$4,500; Fig. 5.5). Median annual incomes at the three target border markets and among harvesters in Southern Myanmar were ~US$1,000 per year, with similar 1st and 3rd quartile incomes of ~$US650-2,300 per year (Fig. 5.5). Notably, however, harvesters interviewed had market access; harvesters that instead relied on middlemen for links to the marketplace received considerably less for their plants (see Chapter 4, Fig. 4.5).

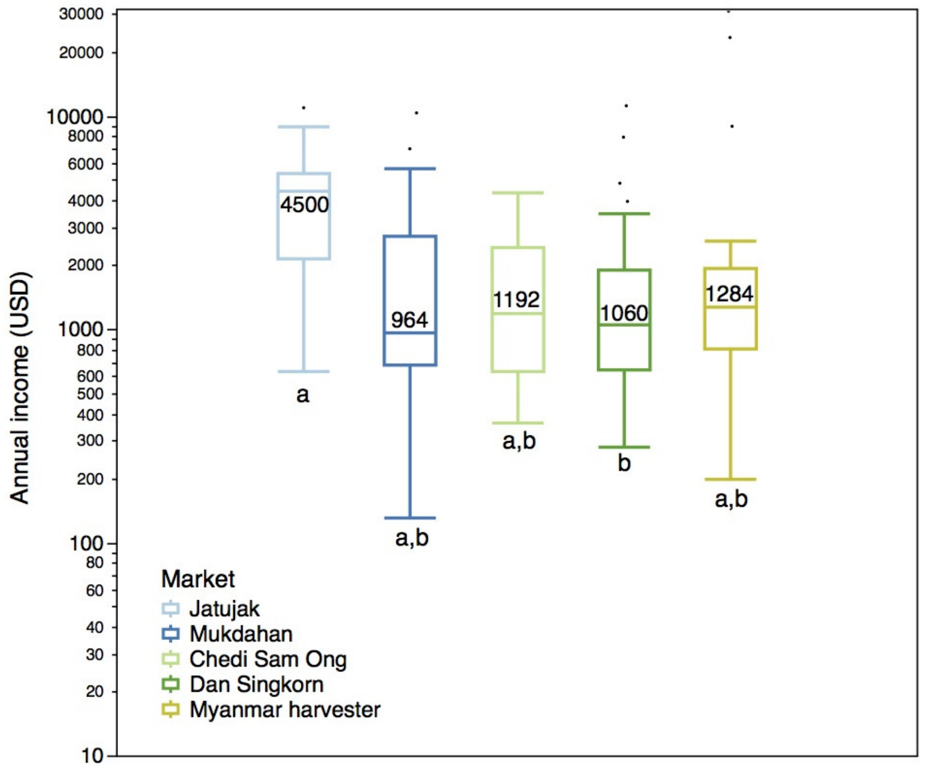


Figure 5.5. Median incomes from botanical harvest and trade. Box and whisker plot showing median incomes, 1st and 3rd quartiles, whiskers 1.5 times the interquartile range, and outliers for traders at four target markets and harvesters in Southern Myanmar. Levels not connected by the same letter are significantly different. In some cases more than 1 family member worked at the same stall, in which case income estimates were combined. One extreme outlier from Chedi Sam Ong removed (reported annual income of >US$50,000).

A Oneway Anova revealed that reported incomes were significantly different among the sites ($F=3.48$, $p=0.010$). However, pairwise comparisons using a Tukey-Kramer test showed that only Jatujak and Dan Singkorn were significantly different (Fig. 5.5; Appendix 9, Table A9.1).

Despite some regional clustering and similar median annual incomes across the border markets, traders reported wide income ranges, including within the same markets. These are evident from the wide gaps between 1st and 3rd income quartiles and the extreme outliners. At Dan Singkorn, for example, reported incomes varied between approximately $US280-11,000 per year, and the Gini coefficients for each site similarly revealed high inequality in income distribution (Table 5.6).

Table 5.6. Measures of income inequality among traders at four target markets and harvesters in Southern Myanmar.

Market	Gini Coefficient
Jatujak	34.73
Mukdahan	52.26
Chedi Sam Ong [a]	38.92
Dan Singkorn	47.95
Harvesters	67.46

[a] Extreme outlier removed (reported annual income of >US$50,000).

The clearest examples of income disparities occurred at Dan Singkorn, where the three clear groups of traders reported significantly different incomes, separated along socio-political lines ($F=5.57$, $p=0.007$; see site descriptions in Chapter 2; Fig. 5.6; Appendix 9, Table A9.2).

These types of skewing in reported incomes were likely due to a combination of factors, including different levels of foot traffic in different parts of the market (e.g., see Chapter 2 Map 2.5), language skills and ability to negotiate, trade volume, and species compositions. For example, while Burmese and displaced Burmese traders only traded plants from Myanmar, Thai traders also sourced plants from Thailand Lao PDR (Chapter 4, Table 4.5). At other markets several traders specialized in blooming and/or higher value plants.

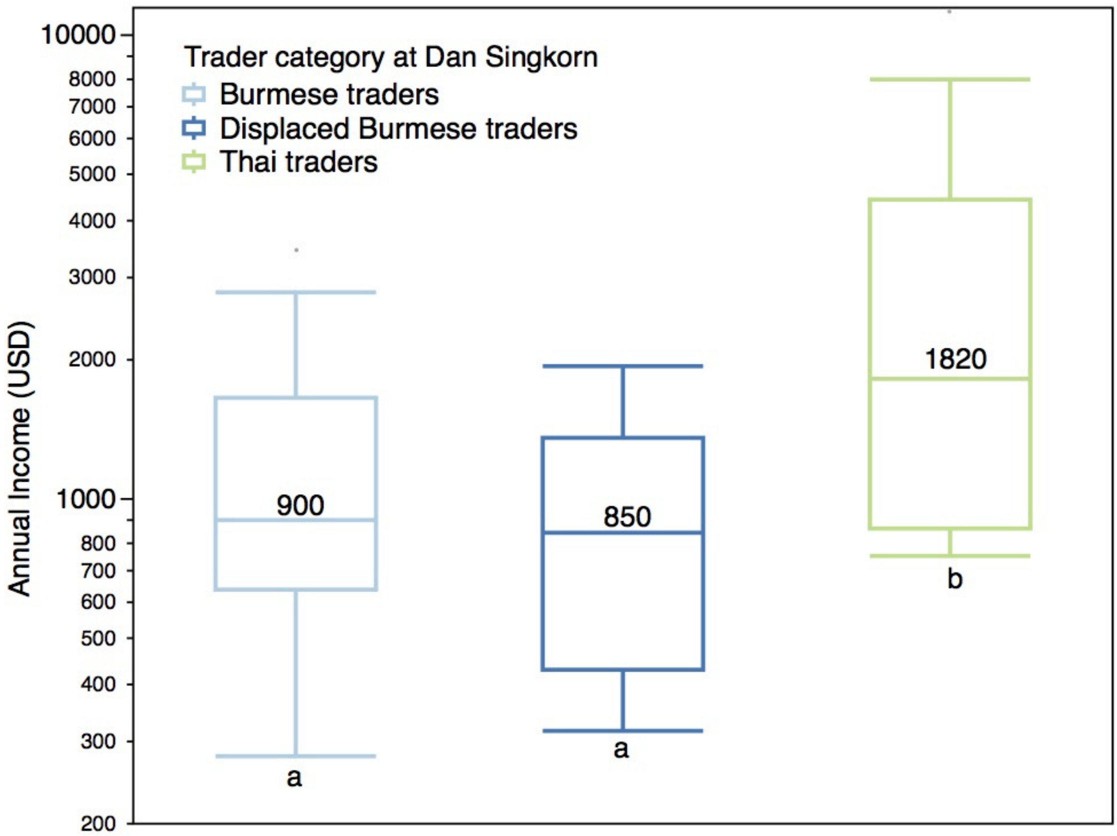


Figure 5.6. Incomes of three traders groups at Dan Singkorn. Box and whisker plot showing median incomes, 1st and 3rd quartiles, whiskers 1.5 times the interquartile range, and outliers. Levels not connected by the same letter are significantly different.

However, when we considered the relationships between eight demographic variables and trade-based income among traders using a linear multiple effects model, the only demographic variable significantly correlated with trader income from trade in the linear mixed effects model was education (F=4.05, 73 d.f., p=0.021). No variables were significant among the harvesters.

5.3.5 Level of household dependence

Botanical trade was considered important to overall household incomes, although a significant number of market traders reported only moderate levels of household financial dependence on trade (57.6% of respondents; Fig. 5.7).

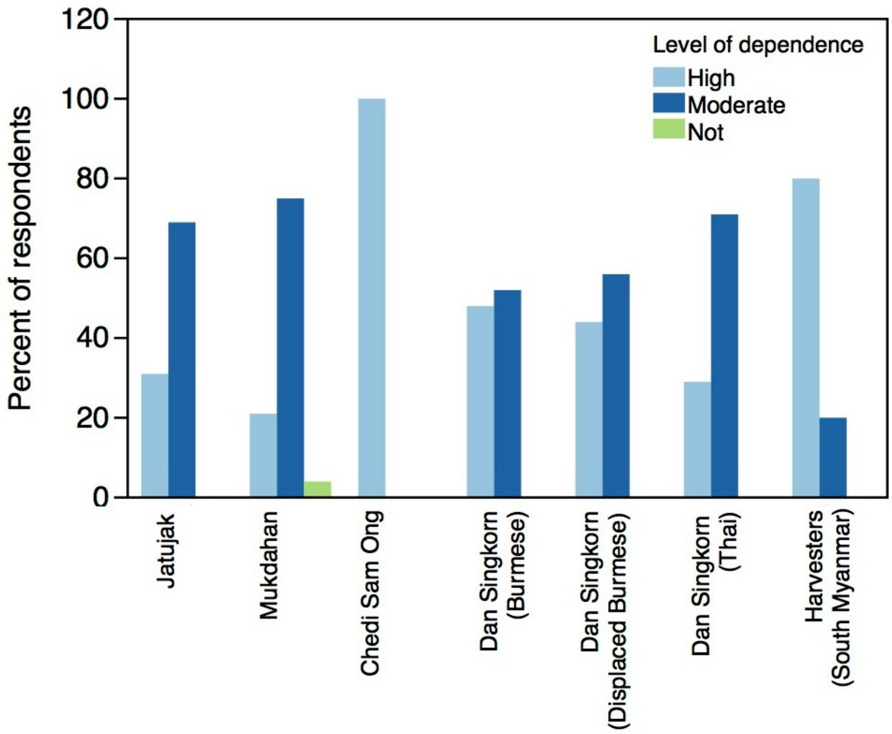


Figure 5.7. Reported level of household financial dependence on plant trade

A contingency analysis using Fisher's exact test (for small samples) indicated a significant difference in level of household dependence across the markets and harvesters. ($p<0.001$). Notably, traders at Chedi Sam Ong and harvesters in Southern Myanmar both reported high levels of household economic dependence on trade, although only about 20-40% traders at Mukdahan, Dan Singkorn and Jatujak reported high dependence (Fig. 5.7; Appendix 9, Table A9.3). However, a Oneway Anova showed no significant relationship between income from trade and reported level of household dependence ($F=0.036$, $p=0.850$). Considered as a percentage of overall reported household income, the importance of trade-derived income was hugely variable both across and within sites (Fig. 5.8).

A Kruskal-Wallis test (data could not be transformed for normality) did show a significant difference across the sites and harvesters (11.00, 3 d.f., $p=0.0117$). Similarly, Chedi Sam Ong and Dan Singkorn reported high levels of economic dependence, although when considered as percent of overall household income, considerable within-market diversity emerged (Fig. 5.8).

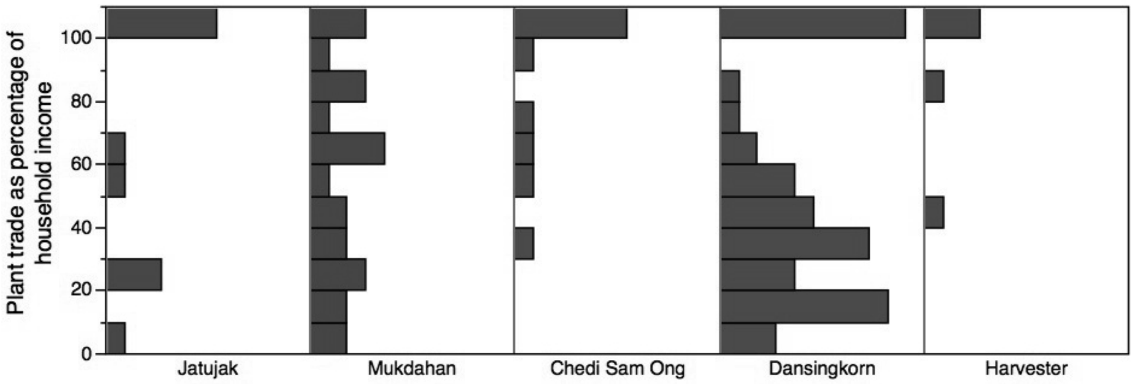


Figure 5.8. Income from plant trade as a percentage of household income. Histogram shows frequency of respondents reporting, based on reported incomes from trade and estimates of household income sources at four markets and among harvesters in Southern Myanmar.

5.3.6 Livelihood alternatives

A majority of the respondents reported at least one alternative livelihood option (88.3%), except at Chedi Sam Ong, where 36.6% of respodents reported no livelihood alternatives, and among Displaced Burmese traders at Dan Singkorn, 25.0% of which reported having no alternative (Fig. 5.9).

Types of alternative livelihoods varied across the sites. While most traders at Chedi Sam Ong and Jatujak reported that, in the absence of botanical trade, they would trade other products (41.7% and 56% of responses, respectively), most traders at Mukdahan reported that they would turn to agriculture (62.5% of responses), and traders at Dan Singkorn and harvesters in Southern Myanmar reported that they would turn to wage labour (25.0% and 45.0% of responses, respectively).

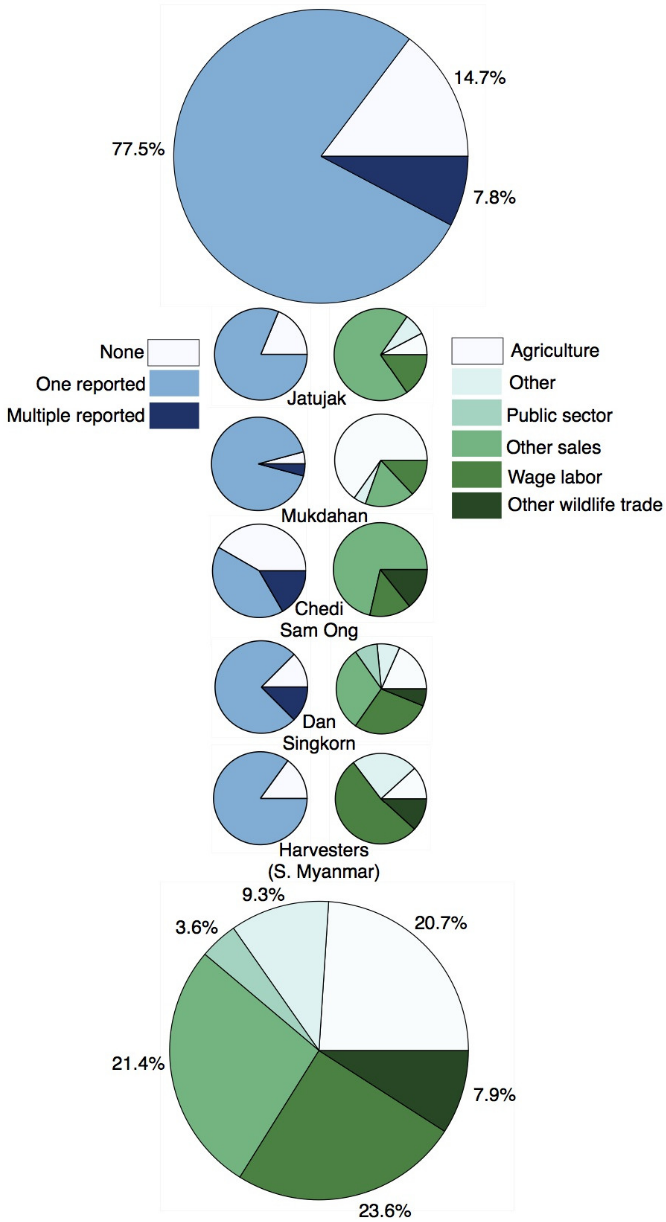


Figure 5.9. Percent of respondents reporting alternative employment, and types of alternative opportunities (N=128). Respondents were allowed to provide more than one alternative livelihood, although most (N=120) provided only one.

Importantly, a subset of trade participants on the Myanmar border reported that, in the absence of botanical trade, they could rely on other types of wildlife (wild birds and furniture made from illegally imported timber) to make a livelihood (Fig. 5.9). Several traders at Dan Singkorn reported that many former plant traders had already made the transition to furniture selling because of declines in price and demand.

Despite high rates of alternative livelihoods listed by trade participants, it remains uncertain whether these livelihoods represented viable or comparable alternative livelihoods. There is some evidence to suggest otherwise. Agriculture, for example, was often subsistence-level among harvesters and traders, and it is uncertain whether they could scale-up farming activities to achieve adequate surplus for trade.

It is, however, challenging to compare income from wildlife trade with prospective livelihood alternatives. Not only is reliable information on wages for the region elusive, but there are discrepancies across and within sectors (see Table 5.7).

Based on the available information from across the grey literature for Thailand, Myamar and Lao PDR, Table 5.6 provides crude estimates of 1) minimum wages from salaried work in the three study countries, all of which experienced a recent increase in minimum wages in 2012; 2) average nominal wages, and 3) GDP per capita (Table 5.7). Notably, national aggregate figures overlook considerable regional variations and most exclude on-farm incomes, which can be very important in rural Southeast Asia. These figures provide a necessary point for comparison against which to consider incomes from botanical trade (Fig. 5.10, 5.11).

Table 5.7. National/regional wage estimates for Thailand and Myanmar

	Reported Wage	Calculated Gross Annual Wage (USD)*
Thailand		
GDP per capita (2011)[a]	-	5,318
Average nominal wage (2011)[b]	9,935 THB/month	3,974
Minimum wage (2011)[b]	5590/month	2,236
Minimum wage (2011)[c]	176 THB/day	1,525
Minimum wage (2012)[d]	300 THB/day	2,600
Income per capita, Kanchanaburi Province (2010)[e]	104,022 THB/year	3,467
Income per capita, Prachuap Khirikan Province (2010)[e]	131,574 THB/year	4,386
Income per capita, Mukdahan Province (2010)[e]	49,416 THB/year	1,647
Income per capita, Bangkok Province	365,619 THB/year	12,187
Myanmar		
GDP per capita (2011)[a]	-	1,144
Average nominal wage in manufacturing sector (2008)[b]	32,332 kyat/month	451
Approximate wage of casual labourers in rural areas (2010)[f]	650 kyat/day	197
Reported on-farm daily wage in rural Tanintharyi Division and Karen State[g]	100-150THB/day	800-1,200
Approximate wage of unskilled urban labourers (2010)[h]	1000-3000 kyat/day	302-907
Minimum wage for factory workers (2012)[i]	$65/month	780
Lao PDR		
GDP per capita (2011)[a]	-	1,303
Unskilled worker (2011)[b,j]	348,000 kip/month	527
Unskilled worker (2012)[j]	626,000 kip	948

[a] United Nations Statistics Division. 2012. National Accounts main Aggregates Database. URL: http://unstats.un.org/unsd/snaama/Introduction.asp.
[b] International Labour Organization. 2013. Global Wage Database. URL: http://www.ilo.org/travail/info/db/lang--en/index.htm
[c] Median daily wage calculated from across provinces using statistics from Thailand Board of Investment's Investment Review. 2011. URL: http://www.business-in-asia.com/thailand/minimum_wage2011.html.
[d] Government Public Relations Department of Thailand. 04 April, 2012. 300-THB daily minimum wage. URL: http://thailand.prd.go.th/view_news.php?id=6223&a=2.
[e] All annual earners per person, including on and off-farm incomes. National Statistics Office of Thailand. 2010. Income per capita. URL: www.nso.go.th.
[f] UK Border Agency, Home Office. 02 Feb., 2012. Burma: Country of Origin Information Report. URL: http://www.ukba.homeoffice.gov.uk/sitecontent/documents/policyandlaw/coi/burma1/report-0212.pdf?view=Binary.
[g] Author's own data from interviews with traders/harvesters
[h] Agricultural workers earning less; United States Department of State. 2011. Country Report on Human Rights Practices 2010, Burma. URL: http://www.state.gov/documents/organization/160450.pdf.
[I] Wage including estimated 2hrs overtime per day, plus living allowances and performance rewards; Kent, J. 18 Oct., 2012. Can manufacturing succeeed in Myanmar? *Forbes*. URL: http://www.forbes.com/sites/connorconnect/2012/10/18/can-manufacturing-succeed-in-myanmar/; Anon. 14 June, 2012. Garment workers given minimum gaily wage: Gov't. *Mizzima News Online*. URL: http://www.mizzima.com/news/breaking-and-news-brief/7310-garment-workers-given-minimum-daily-wage-govt.html
[j] Wage in addition to existing benefits such as lunch, good performance and social welfare benefits; Anon. 15 Dec., 2011. Private sector to pay higher minimum wage from January. *Lao Voices Online*. URL: http://laovoices.com/private-sector-to-pay-higher-minimum-wage-from-january/; Anon. Feb. 22, 2013. Laotian firms fail to comply with minimum wage hike. *The Nation Online*. URL: http://www.nationmultimedia.com/aec/Laotian-firms-fail-to-comply-with-minimum-wage-hik-30200528.html
[*] Reported monthly wages calculated *12; reported daily wage *5*52; Conversions rounded 2011 average of 1USD=THB30=860 Burmese Kyat (market rather rate=7,920 Lao Kip)

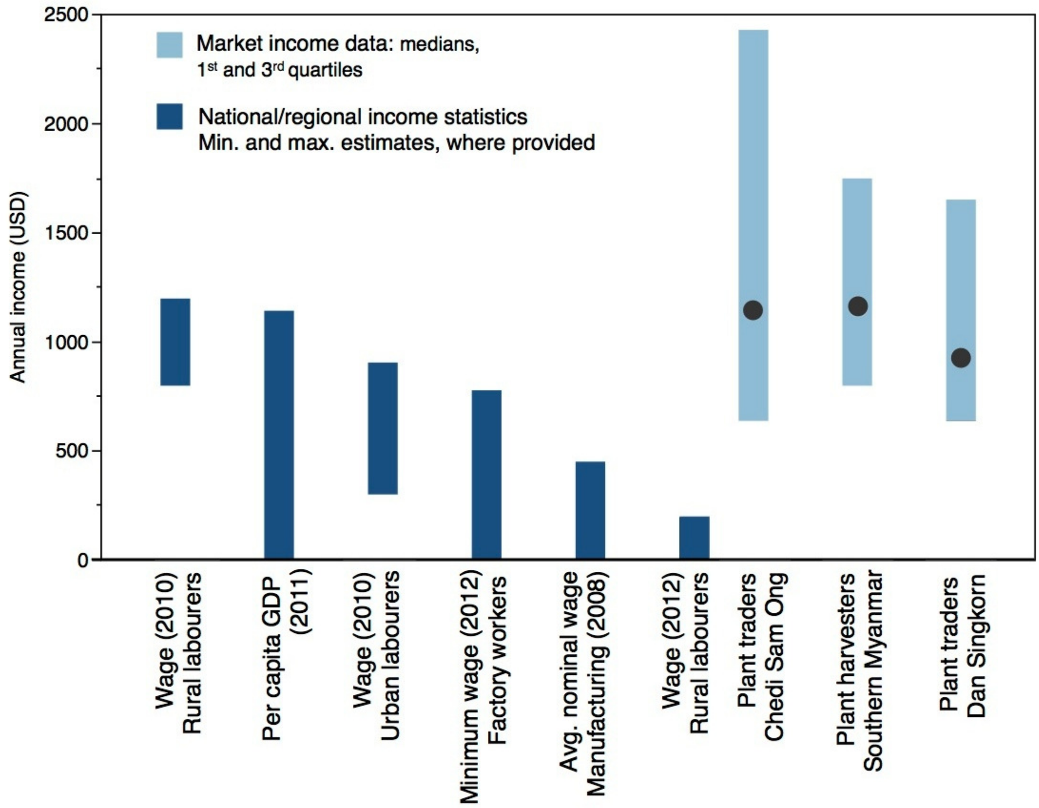


Figure 5.10. Comparison of national and region income statistics for Myanmar (from Talbe 5.7) compared against estimated incomes of botanical harvesters and traders working in Myanmar. Traders in Dan Singkorn refer only to Burmese traders that cross the border to trade, and not traders resident in Thailand.

Comparison of the reported incomes of plant traders and harvesters within Myanmar with national and regional statistics in Myanmar suggested that this was a highly competitive source of employment (See Fig. 5.10). When compared with alternative annual incomes from other employment in Myanmar, botanical trade represented a competitive livelihood option. When specifically compared against wage labour in the rural areas immediately surrounding the target sites, the main alternative employment opportunities reported by traders (Fig. 5.9), botanical trade provided a dramatically better livelihood. Even some of the lowest earning botanical harvesters and traders (1st quartile) in Myanmar were earning more than double what they could earn from a daily rural wage. While wild plant harvest was reportedly dangerous and often physically taxing, the relative financial returns may have represented powerful motivators for participants with limited employment alternatives. Income earning opportunities in other parts of the country, including urban factory work, were apparently better, and are also protected by new minimum wage laws. However, agriculture, hunting and forestry account for more than 50% of employment in Myanmar (UN-STAT 2013).

There were no similar extreme discrepancies between the incomes of botanical traders and national/regional statistics within Thailand. However, regional-level income comparisons suggested that traders earning at least at the 3rd quartile income level at Dan Singkorn were making competitive incomes compared to per capita incomes in Prachuap Khirikan Province (Fig. 5.11, c). However, these top-earners at Dan Singkorn these were principally the Thai traders rather than Displaced Burmese traders (Fig. 5.6).

Median incomes of traders at Mukdahan were roughly competitive with province-level per capita incomes (Fig. 5.11, b), and may be even more attractive when compared against agriculture, the leading reported alternative livelihood option (Fig. 5.9). Notably, however, the key informant at Mukdahan revealed that, since starting to trade orchids, many of the traders had build better houses, some had purchased cars, and many were in better economic position than their neighbours.

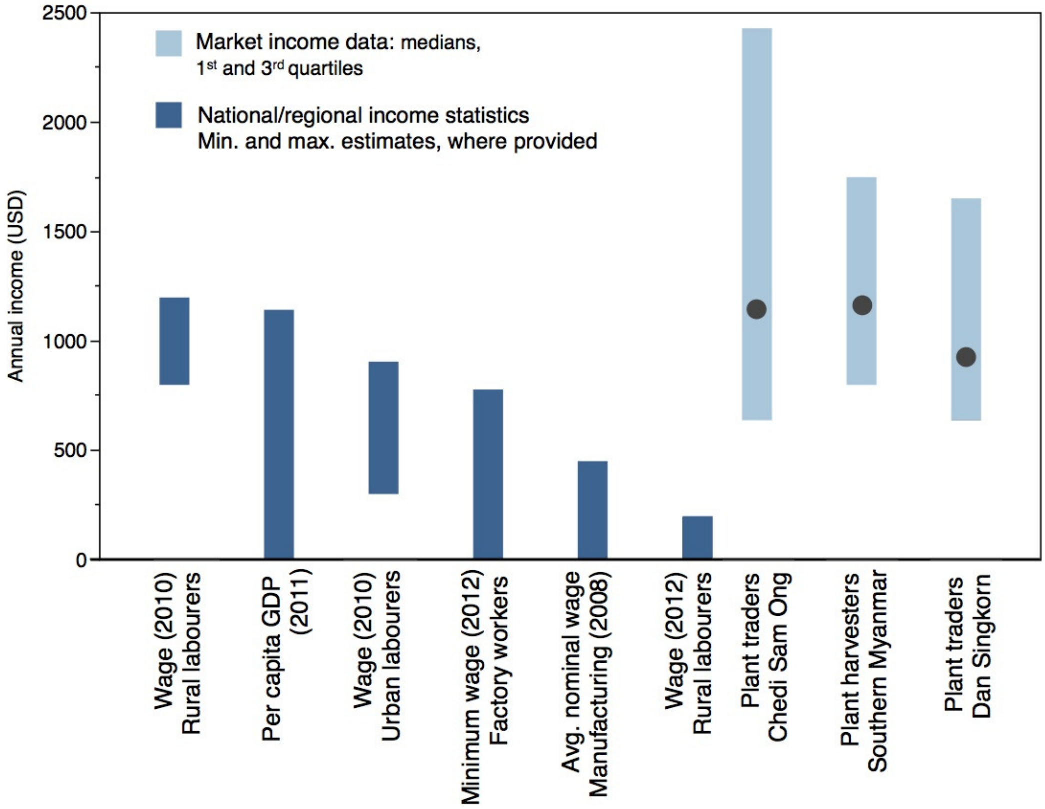


Figure 5.11. Comparison of national and region income statistics for Myanmar (from Talbe 5.7) compared against estimated incomes of botanical harvesters and traders working in Thailand. Letters indicate regional groupings most appropriate for comparison.

Trade-based incomes at Jatujak did not approach the Bangkok provincial per capita incomes. However, it was a very competitive option for most traders when compared with minimum-wage labour, which may have been more indicative of earning potential for traders with low levels educational attainment. Moreover, many for the traders at Jatujak were from northeastern Thailand, and incomes from plant trade may have been attractive relative to alternative employment opportunities in their home provinces (e.g., compare Jatujak with per capita incomes in Mukdahan Province).

5.4 Discussion

Interventions to address wildlife trade broadly include: substitution with other products, including cultivated specimens (see Chapter 6); education among participants and consumers; increased enforcement, and investment in alternative livelihoods or other conservation incentives to discourage trade. To date, interventions to protect threatened ornamental plant species in Southeast Asia have relied on regulation and enforcement, notably limits on international trade associated with CITES rules (see Chapter 7), and domestic restrictions on harvest in protected forests (see Chapter 8). An improved understanding of the botanical trade participants is important to strengthening interventions. It is also important to evaluating the impacts of wildlife trade restrictions on livelihoods.

5.4.1 Livelihood alternatives

Alternative livelihood development is an often-proposed strategy for reducing wildlife trade (e.g., TRAFFIC 2013). Within the context of botanical trade, plant propagation from seed, in vitro or from cuttings have been specifically proposed as more sustainable alternatives to wild harvest (WWF 2010; see Chapter 3, Chapter 6). However, our preliminary results suggest that it might be challenging to generate alternative livelihoods among the interviewed respondents.

Based on educational attainment alone, it might seem that botanical trade participants engaged in trade out of necessity, and would potentially embrace opportunities for alternative livelihoods. However, lack of alternative livelihoods was not a leading motivation among participants at any of the study sites. On the contrary, motivations were principally economic. Plant trade was more than an economic safety net or marginal economic supplement (cf. Shackleton and Shackleton 2004); for many participants across the study sites, trade represented a competitive livelihood.

Botanical trade was an especially attractive activity in Myanmar, where harvest and trade-derived incomes greatly surpassed reported alternatives.

For alternative livelihoods to be voluntarily adopted, they would have to be economically attractive. Relatively high returns from wild plant trade could be difficult to address, especially because most trade participants reported low levels of educational attainment, yet many matched or surpassed national and regional earning potential. Alternatives would be particularly difficult to identify for top earners, many of whom reported incomes substantially higher than national and regional averages.

Moreover, alternative livelihoods would also have to account for participants' non-financial motivations for participating in trade, including ease of work (among market traders), personal interests in working with plants, and interest in business ownership. Indeed, we identified some cases of skilled and educated respondents choosing to engage in trade (see also Chapter 6). As such, efforts to generate alternative livelihoods would have to consider heterogeneity among trade participants, including differences in educational attainment, regional livelihood practices, and motivations.

Given adequate financing, technical support (and potentially pressure to transition), alternative livelihoods, including unsustainable plant cultivation, could potentially represent a viable alternative livelihoods. Thailand has a particularly developed floriculture industry focused on Orchidaceae (Cheamuangphan et al. 2013), and has the domestic expertise to help catalyze small-scale orchid farming as an alternative livelihood opportunity (see Chapter 6). However, such interventions would also have to consider the considerable involvement of participants outside Thailand, and it is very unlikely that Thailand will invest in livelihood generation programming for foreign nationals engaged in illegal wildlife trade, although an external conservation initiative could potentially provide support (e.g., POP 2011). Even so, there are also considerable barriers to start-up, marketing and effort levels when compared to wild plant harvest (see Chapter 6). Additionally, no respondent reported plant cultivation as a livelihood alternative, and the transition from wild plant trade to cultivation represents a dramatic transition involving fundamentally different skills, technologies and markets. There may also be limited motivations to adopt alternative livelihoods where enforcement is weak. Nevertheless, the viability of alternative livelihoods, including plant cultivation, represents a theme for future research (Chapter 6).

5.4.2 Enforcement and impacts on participants

Enforcement-based conservation strategies are an especially likely intervention. To date, wild botanical trade has been little or irregularly enforced (see Chapter 7, 8). Nevertheless, there is some evidence that enforcement is effective in the context of border market botanical trade, as evidenced by fluctuating participation during the study period following enforcement (Table 5.1), and reports of historical market declines as a result of previous enforcement efforts.

However, actors' decision-making in response to conservation enforcement remains poorly understood (Keane et al. 2008). It is possible that increased burdens from enforcement could potentially drive participants to shift livelihood strategies, as most participants reported alternative livelihood opportunities. Moreover, with the exception of traders at Chedi Sam Ong, most traders had not been involved in trade for very long (~5-6 years), further suggesting that enforcement burdens could press participants to return to former occupations. However, we found that ornamental plant trade yielded surprisingly high incomes relative to alternative activities. While previous multi-taxa studies have suggested that commercial botanical traders tend to be poor relative to national averages (Belcher et al. 2005), high returns from ornamental plant trade mean that many participants may be willing to incur risks associated with increased enforcement.

We also found that increased enforcement could have unintended consequences. In particular, traders along the Myanmar border reported alternative livelihoods selling other wildlife products (birds and hardwood furniture), suggesting that increased conservation efforts to protect wild ornamental plants could drive participants to other environmentally deleterious activities.

Importantly, the majority of participants we encountered were relatively small-scale harvesters and traders that operated at a fairly local level (see Chapter 4). While plant trade-based incomes were comparatively attractive economic activities for many participants, many of them could still be categorized as poor, particularly around Dan Singkorn. Only a small minority of traders at all study sites were engaged in larger-scale trade operations (~6% total respondents). This potentially represents an important distinction in terms of enforcement. Not only do these involve different trade networks and scales of economic motivation, but there is also evidence that enforcement in the region is tolerant of small-scale botanical trade by poor residents on compassionate grounds (see Chapter 8). Both types of trade are illegal, and the distinction is arbitrary and does not necessarily represent a difference in overall conservation impacts. Nevertheless, in practice, some distinction between small and large-scale commercial trade has influenced enforcement.

There is growing recognition that additional restrictions on wildlife harvest should consider local livelihoods and traditions (e.g., Dickson 2008; Singh 2008). We crudely estimated that the trade of wild ornamental plants to Thailand involved <1000 active individuals during the study period, suggesting that the social impacts of enforcement would be relatively limited in scope. Many market traders also reported only moderate levels of household economic dependence on trade, such that increased enforcement among traders would probably not represent total income loss. The relatively short tenure of most traders demonstrated that ornamental plant trade did not represent traditional or long-standing livelihood patterns. Nevertheless, the effects of enforcement could be profound on some groups.

Notably, enforcement would have a disproportionate impact on harvesters, who reported high levels of household dependence on trade. Although we were limited to characterizing harvesters with market access in Southern Myanmar, anecdotal evidence suggests harvesters elsewhere in Myanmar and in Lao PDR are similarly dependent on trade-based income and from poor rural households. Although not adequately represented in our market-based interviews, these communities could be profoundly impacted by enforcement, are potentially among the most vulnerable and economically marginalized trade participants and merit greater attention. Enforcement impacts would also extend beyond rural and forest-dependent communities involved in harvest, to also affect many participants in border and urban markets, downstream impacts that should not be overlooked. Communities in Mukdahan, Chedi Sam Ong and Dan Singkorn would be adversely affected by enforcement, as botanical trade is economically important to numerous families within the same village. However, individual impacts among traders would be less predicable, as vendors varied considerably in terms of: their sale volumes, species targeted (see Chapter 3), and trade patterns (Chapter 4); the economic value of their products, and the significance of wild plant trade to their overall household incomes.

Enforcement would also have distinctly gendered impacts, although these dimensions have been largely neglected in most previous research on wildlife trade, which has failed to consider how enforcement can have disproportionate impacts on women and how paying greater attention to gender can potentially improve trade management (see McElwee 2012). While men were largely responsible for plant harvest, the prevailing role of women at most points of trade suggests that wild plant sales represent an important economic opportunity for women entrepreneurs. Particularly within the context of markets on the Myanmar border, where livelihood opportunities are often very marginal (e.g. Kusakabe and Pearson 2010), border market trade may represent unique and important opportunities for women (cf. Kusakabe 2004). Perhaps the clearest example of this was the participation of displaced Burmese women in botanical trade at Dan Singkorn.

The economic importance and participation in harvest and trade of different NTFPs can vary considerably across taxa and regions (Belcher et al. 2005). Our results suggest that, while the absolute number of wild ornamental plant traders is probably not very large, some participant groups are economically very dependent and enforcement would disproportionately affect groups that are already socially and economically marginalized. These are potentially priority sites and communities for prospective alternative livelihood considerations. An improved understanding of who is engaged in trade is important if conservation efforts aim to design more targeted conservation interventions, and safeguard against harming the most vulnerable participants.

Chapter 6:
Supply-side conservation: A framework applied to the ornamental plant trade in Thailand

Based on:
Phelps, J., Carrasco, R.L., Webb, E.L. Supply-side conservation interventions. *Conservation Biology*. In press

6.1. Introduction

6.1.1 Supply-side conservation

In many contexts, supply-side market-based interventions are more attractive and useful than traditional policy instruments that focus on enforcement and regulated harvest (Jepson & Ladle 2005). Supply-side interventions involve domestication and the cultivation, propagation, or breeding of target plant or animal species. Also known as wildlife farming, these interventions are often proposed as substitutes for wild-collected products (e.g., Jepson & Ladle 2005). Theory suggests that flooding the market with legal, high-quality, affordable domesticated products should lessen illegal collection of wild specimens because it will drive down market prices and result in conservation gains (Bulte & Damania 2005). Moreover, facing consumer demand and increased rarity of wild resources, harvesters are likely to face incentives to domesticate and farm target species (Homma 1992). Commercialization of domesticated specimens thus has the potential to provide alternatives for conscientious consumers, more reliable and consistent products for industry, and sustainable livelihoods for former harvesters (Larsen & Olsen 2007; Lubbe & Verpoorte 2011).

Wildlife farming has been implemented for a small, but diverse, group of fauna (e.g., bears for Chinese medicine [Dutton et al. 2011], porcupines for meat [Brooks et al.

2010], frogs for meat [Wakentin et al. 2009]). Similar strategies (cultivation) have been widely promoted as a way to conserve overharvested plant species (Larsen & Olsen 2007; Schippmann et al. 2002; CBD 2001; Sharrock 2011; Larsen & Olsen 2007; Stradby and Olsen 2008; Flores-Palacios and Valencia-Diaz 2006). Wildlife farming may also increase rural livelihood opportunities (Belcher & Schreckenberg 2007; Larsen & Olsen 2007).

However, "real life examples [of wildlife farming] are scarce and cannot guide decision making," thus, conservation professionals have resorted to model-based assessments (Bulte & Damania 2005). Support for supply-side conservation strategies is largely theoretical or model based (e.g., Abbot & van Kooten 2011). Although widely discussed and proposed, supply-side interventions have been applied to relatively few species (Sharrock 2011). Even where domesticated specimens are successfully commercialized, it remains uncertain whether they will be substitutes for wild-collected products in the marketplace (Kirkpatrick & Emerson 2010; Strandby & Olsen 2008). Clarifying conditions under which supply-side interventions can yield positive conservation outcomes remains a challenge (Sutherland et al. 2009). Lacking empirical study, supply-side strategies are hotly contested (Bulte & Damania 2005; Brooks et al. 2010; Kirkpatrick & Emerson 2010).

We provide a novel framework for conceptualizing the factors that shape wildlife harvest and trade through which we developed a list of conditions that shape supply-side interventions and their conservation outcomes. We applied the list of conditions to the Southeast Asian trade in the orchid *Rhynchostylis gigantea*, which has been intensely harvested in the wild and is now farmed commercially. We examined trade of the species at Jatujak Market, Bangkok, Thailand. Both wild-collected (illegal) and farmed (legal) specimens are available in Jatujak Market, so the case provided an opportunity for use to compare wild and farmed products. To our knowledge, this represents one of the first quantitative assessments of whether supply-side intervention has affected a wild-collected product in the marketplace (see Brooks et al. 2010).

6.1.2 Framework for conceptualizing supply-side interventions

Harvest, trade, and domestication of wildlife are affected by species' biophysical characteristics, supply and demand pressures, and regulations (Fig. 6.1).

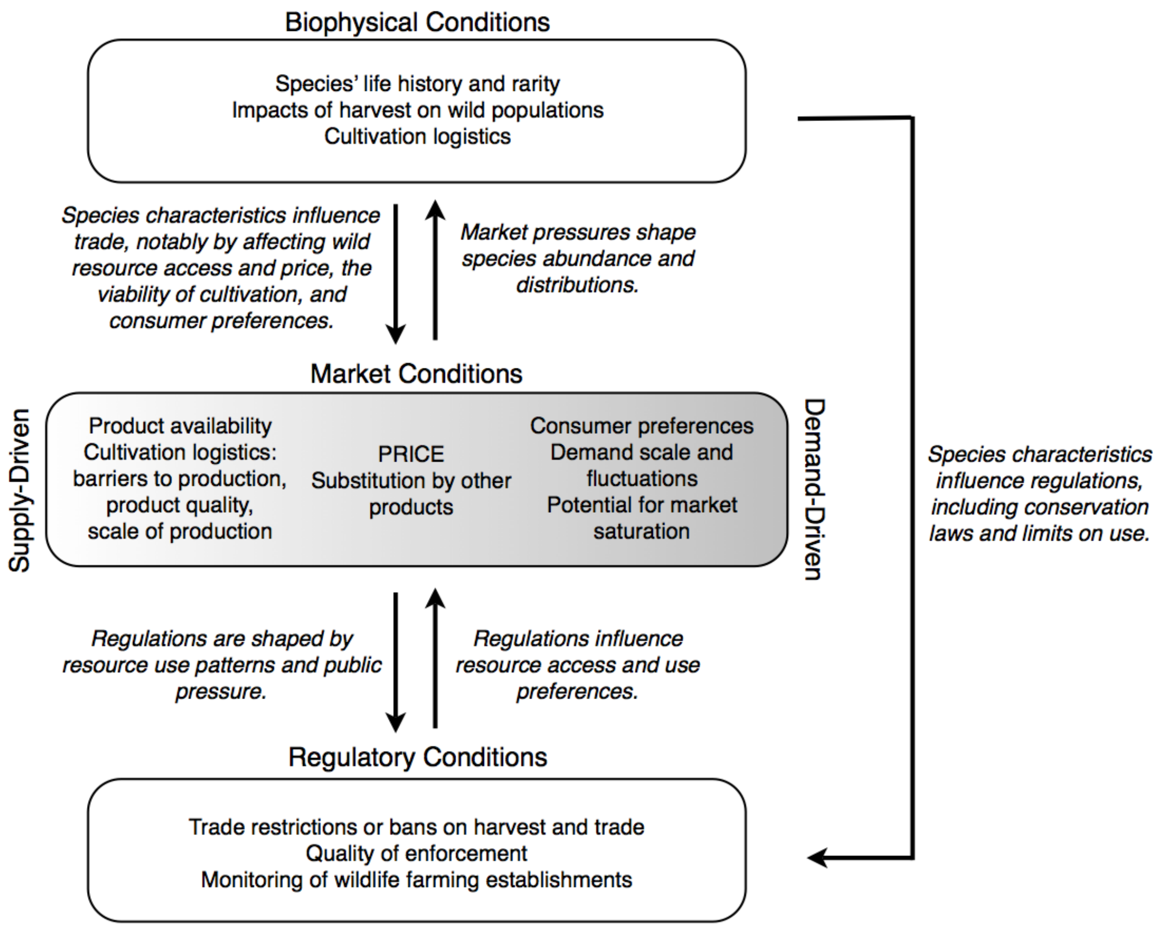


Figure 6.1. Interactions between biophysical, market, and regulatory factors that shape wildlife trade and farming.

Although economic factors heavily affect which species are farmed (Homma 1992; Larsen & Olsen 2007), other factors also shape supply-side interventions (Schippmann et al. 2002; CBD 2001). For example, a species' life history affects the ease of domestication and commercial production, which are also shaped by marketplace conditions such as consumer preferences. The viability of supply-side conservation strategies thus depends on the interplay of conditions within these 3 categories.

We based our list of the major biophysical, market, and regulatory conditions under which wildlife farming is likely to facilitate the substitution of wild-collected specimens in the marketplace (Table 6.1). Drawing principally on the NTFP literature (Table 6.1), we justified why each condition is relevant to determining the conservation outcomes of supply-side interventions and identified potential analytic tools and resources that can be used to assess each condition.

Table 6.1. General conditions under which farming is likely to displace wild-collected specimens in the marketplace*

Condition	Justification	Potential analytic tools and resources
Biophysical		
Wild resource generally scarce	• Rarity means harvest burdens and costs are likely greater, which increases the attractiveness of farming (Homma 1992; Larsen & Olsen 2007) • Price is likely to be higher because of rarity or perceived rarity[a, c]	• Data on species' abundance and distribution • Reported conservation assessments[*] • Collector interviews to assess resource availability[*]
Target species subject to destructive harvest	• Increases the threat of unsustainable harvest, and both depletes the wild resource and increase rarity[d, e]	• In situ observations to assess harvest methods • Collector interviews to assess harvest methods • Observations of product in market[*]
Access to the wild resource uncertain or irregular	• Farming may provide more reliable access and prove more attractive to market participants[f, g]	• Market surveys to determine product availability[*] • Trader interviews to determine product flow[*]
Market		
Targeted species of relatively high value	• Farming needs to be financially attractive[f, h]	• Market surveys to assess value, including relative to other goods • Trader interviews to assess value • Evaluation of whether product is already being farmed
High demand for the target species	• Market size needs to be large enough to make farming economically viable[d, g, f, i]	• Consumer and trader interviews to assess demand • Value chain analysis to assess demand and potential for growth • Evaluation of whether market already exists for farmed specimens[*]
Markets developed and accessible	• Producers need to be able to readily access customers[d, f, g, i]	• Value chain analysis to assess demand, potential for growth, market and production locations[*]
Demand for the target species reliable and not easily saturated	• Market fluctuations can limit the financial viability of commercialization and farming[d; f, g, i] • Market saturation can drive down prices and make farming	• Consumer and trader interviews to assess reliability of demand [*] • Market surveys to assess seasonal trade flows[*]

	unattractive[d]	
Farmed and wild specimens easily distinguishable in the marketplace	• Consumers and traders must differentiate among types of products, which may require certification [d, i]	• Market observations to determine ease of differentiation[*] • Consumer interviews to ensure ability to differentiate[*]
Target species not easily substituted	• If consumers accept substitutions (similar species, synthetic substitute) or are unaware a substitution has occurred, then farming may not be financially viable[j, g]	• Consumer interviews to determine how product is used and to establish consumer preferences[*]
Farmed specimens available for the same price or cheaper than wild-collected alternatives	• Farming needs to be financially competitive with wild harvest; farming can be capital and labor intensive[f, h]	• Market surveys to determine price differences[*]
Farming offers comparable or better profit margins than wild-harvested specimens	• Farming needs to be financially competitive with wild harvest[b, f]	• Trader interviews to determine profit margins or perceived differences in profit margins[*]
Farmed specimens can be produced at a large scale	• Substitution depends on farmed specimens being available enough to saturate the market[h]	• Producer or expert interviews to understand farming logistics • Market surveys to determine scale of existing production (if any)[*]
Quality of farmed specimens good or better than wild-collected specimens	• Substitution may depend on ensuring that farmed specimens are of comparable quality or potency[d]	• Measurement of individual characteristics to determine differences between wild and farmed specimens[*] • Development of qualitative indices through which to assess some characteristics (e.g., physical condition) [*] • Consumer interviews to assess perceived differences in quality[*]
There no (or limited) consumer preference for wild specimens	• If consumers prefer wild over farmed specimens then these may not be substitutable goods[k]	• Interviews with consumers of both wild and farmed specimens to determine preferences[*] • Study of changes in price of wild specimens when cultivated specimens are introduced into the market[*]

Rew (or reasonable) barriers to farming	• Lower cost of production helps ensure economic viability of farming[h, l] • Reduces time to commercialization[g] • Often includes land-tenure security because farming requires investment and long-term management[d] • Facilitates broader participation, including potentially by former harvesters • greater effort (e.g., for difficult-to-farm species) may be justified for high-value products.	• Producer or expert interviews to identify extent of barriers • Field trials to determine viability of farming • Market surveys to determine whether farmed plants are widely available*
Regulatory		
Target species subject to harvest or trade restrictions that are well enforced	• Increases detection and burdens of illegal activity, pushing wild-harvesters out of the market or creating greater incentives for farming; may not be possible in low-governance environments and may create incentives for black-market trade and corruption[m]	• Review of legislation* • Interviews with key informants (traders, NGOs, government agencies) to assess quality of enforcement • Long-term market observation*
Farming establishments adequately monitored	• Reduces laundering of wild specimens via wildlife farming[n]	• Review of legislation • Interviews with key informants (traders, NGOs, government agencies) to assess quality of enforcement

*Tools and resources used to varying degrees in our analyses.
[a] Homma 1992, [b] Larsen & Olsen 2007, [c] Slone et al. 1997, [d] Belcher and Kusters 2004, [e] Schipmann et al. 2002, [f] Lubbe and Verpoorte 2011, [g] Belcher and Streckenberg 2007, [h] CBD 2001, [i] Laird et al. 2009, [j] Streckenberg et al. 2006, [k] Dutton et al. 2011, [l] Bhattacharaya et al. 2008, [m] Abbot and van Kooten 2011, [n] Brooks et al. 2010

6.2 Methods

We used Table 6.1 to guide our evaluation of trade in *R. gigantea* . We used it to identify to what extent trade in this species at Bangkok's Jatujak Market (described in Chapter 2) met the conditions necessary for supply-side interventions to yield conservation outcomes. We used a subset of the tools and resources identified in Table 6.1 in a multidisciplinary approach to identify explanations for why farmed plants did not displace wild-collected specimens at Jatujak Market and to identify improvements to supply-side interventions.

6.2.1 Study species

R. gigantea is a charismatic orchid species distributed across Southeast Asia (northeastern India to Vietnam), where it is heavily collected and sold as an ornamental plant (it has no other common uses [Seidenfaden 1988; P.J.C., personal observation). Although its conservation status cannot be determined for most of its range (data deficient), the species is considered threatened in Thailand (Pooma 2005) and is protected by domestic regulations across much of its distribution (e.g., Thailand Forest Act B.E. 2484 1941) and globally under the Convention on International Trade in Endangered Species of Wild Fauna and Flora Appendix II (CITES 2013). International trade of all wild-collected orchids is regulated under CITES, and orchids represent >70% of CITES-listed species (2013). This is largely because many orchid species are subject to harvest for overseas ornamental plant markets, are difficult to differentiate, and often occur at relatively low population densities, making them vulnerable to overharvest (Flores-Palacios 2006). Moreover, as perennial plants subject to whole-plant harvest, species such as *R. gigantea* are especially vulnerable to harvest pressures (Schippman et al. 2002). Nevertheless, due to lax enforcement in the region (e.g., Phelps et al. 2010), wild-collected plants from Burma, Laos, Cambodia, and Thailand are sold openly to local plant enthusiasts at Jatujak Market, where it known by the Thai name *chang kra*, which refers to the spotted pattern on the flower that resembles freckles on an elephant.

Like many orchid species (e.g., AOS 2012; Paksong Orchid Project 2011; Whrithlington School Orchid Project 2012; Meyers Conservatory 2012), *R. gigantea* is commercially propagated (principally in vitro) and has been sold at markets across the country for over 10 years as part of Thailand's growing commercial floriculture industry. In addition to specimens with wild-type flowers, which is the color pattern most commonly found in the wild, greenhouse farmed specimens are also available with variegated, white, red, and peach flowers (Photo 6.1).

Photo 6.1. Main color patterns of farmed *R. gigantea*: a. wildtype, b. variegated, c. white, d. red, e. peach.

6.2.2 Market survey

As part of a broader survey of wild plant stalls at Jatujak Market (described in Chapter 2), we recorded all wild *R. gigantea* in the marketplace during monthly surveys that ran from 1 June 2011 to 23 May 2012. During the 2012 blooming season late January to mid-February), we surveyed all stalls selling propagated (N=17) and wild-collected (N=8) *R. gigantea* (during other times of the year wild and farmed plants are sold without flowers). Wild and farmed orchids can be easily distinguished by their physical condition (see Chapter 2)

We sampled (measured without purchasing) all wild-collected *R. gigantea* (N=401) and all propagated plants with wild-type flowers (N=128). For horticultural varieties (peach, white, red, variegated flowers), we sampled 50% of specimens in each price category (say what the price categories were) (N=341). We recorded the trader-reported price for each individual. Because most wild plants were sold by weight, we calculated prices by weight of each individual. For each individual, we recorded type of growing container, number of leaves, length of longest leaf , and length of longest live root as proxies of plant size. We could not weigh plants because some were grown in receptacles of different weights. For plants in bloom, we recorded the number of inflorescences and flower color. For wild plants, we recorded country of origin as reported by the traders. We photographed each individual orchid, from which we developed an index to assess plant and flower condition (Table 6.2).

Table. 6.2. Scoring of plant[a] and flower[b] condition

Plant damage category	Extent of damage	Deductions [a]
Physical damage: leaves *significantly* crushed, torn, bent, with insect damage or discolouration	<50% of leaves showing physical damage	-1
	≥50% of leaves showing physical damage	-2
Dehydration: leaves showing *significantly* collapsed cells and midrib cracking	<50% of leaves showing dehydration	-1
	≥50% of leaves showing dehydration	-2
Root damage: root system showing evidence of being cut and with dead roots	>2 live roots remain, but the overall root system showing damage	-1
	≤2 live roots remain, and the overall root system showing damage	-2
Flower damage category	**Extent of damage**	**Deductions [b]**
Physical damage to flowers: crushed, broken off, dried up / past bloom	<50% flowers damaged or dead	-1
	≥50% flowers damaged or dead	-2

[a] Scored out of total of 6 points
[b] Scored out of total of 3 points

Scoring did not include the number and spacing of flowers, differences in flower shape and size, or plant compactness or symmetry, characteristics that may have affected some (specialist) buyer decisions. However, few wild plants were in bloom at the time of sale (how do you know this? you observed sales? clarify) (<10%); thus, flower details may be less important than other physical characteristics.

6.2.3 Consumer and Vendor Interviews

We interviewed all willing wild plant traders (N=7, 87.5% of the wild-plant trader stalls). Respondents were all Thai females, most of working age. We interviewed all willing farmed-plant traders (N=6, 35% of all farmed plant stalls). Three respondents were Thai females, and none of respondents were of retirement age.

During interviews we asked about plant origins; whether they perceived customers had specific preferences for farmed or wild plants. For wild-plant traders, we asked why they sold wild plants instead of farmed plants. Sensitive information provided by the wild-plant traders was generally considered reliable because respondents were forthcoming and knew the lead researcher, who had made >60 market visits and had previously conducted interviews with the traders. A relationship-based approach to interviews can increase respondent candor about sensitive subjects (Burns & Miggelbrink 2011).

We conducted opportunistic interviews with consumers in the marketplace who purchased wild plants (N=8) and farmed plants (N=15). The purpose of interviews was to determine whether buyers could distinguish between wild and farmed plants; identify types of plant selection criteria; and determine whether they showed any preferences for wild plants. We positioned ourselves at plant stalls throughout the market and approached buyers observed purchasing the target species. We avoided double-counting by taking notes on each consumer and confirming that they had not been interviewed previously.

Both trader and consumer interviews were limited by sample size. Trader interviews were limited by the total number of potential respondents (only 8 traders in the market sold wild *R. gigantea*) and the number of willing respondents. Consumer interviews were limited by several factors: short blooming season of *R. gigantea* , buyers and stalls were scattered across a large market, and a request by several traders (>5) that we not disturb their customers. As a result of these limitations, we used interview data principally as supplementary information. We focused was on identifying common perceptions and themes, rather than assessing demand, identifying correlations, or measuring differences among groups. Similar themes recurred during successive interviews. In these types of cases, even very small nonprobabalistic sample sizes (e.g., 6 respondents) can provide reliable data for qualitative analyses (Guest et al. 2006).

6.2.4 Analyses

We divided the data set price categories into increments of 50 Thai Baht (THB) (THB50, THB100, etc.) (THB1 is approximately US$1.60) (edit may have changed meaning, but original was unclear). Although prices differed among traders, plants were generally priced in increments of THB50. We used independent samples *t* tests and Mann-Whitney tests to determine whether there were significant differences between farmed and wild plants for each physical characteristic in each price category. We used a mixed-effects generalized linear mixed model (GLMM) (Pinheiro & Bates 2000), with trader as a random effect, to determine whether plant origin (wild vs. farmed) was a reliable predictor of plant price after controlling for the measured physical characteristics. We performed analyses for the entire data set, including all flower colors. Wild-collected plants were usually only available with wild-type flowers, so we repeated this analysis with plants with only wild-type flowers.

6.3 Results

6.3.1 Plant supply

R. gigantea is subject to year-round trade at Jatujak Market, although volume fluctuated through the year (Table 6.3). Over 2000 wild plants were observed during the survey period, which represents a conservative estimate because surveys were monthly and overlooked wholesale transactions and informal transactions outside of market days. Traders reported country of origin for approximately 70% of plants, most of which originated from Thailand (26%) and Laos (33%) (Table 6.4).

Wild plants were traded throughout the year, peaking during the blooming season. Farmed plants were principally traded during the blooming season. Although farmed specimens were present in the marketplace during other times of the year, their numbers were low and traders confirmed that farmed plant sales were strongly skewed toward the blooming season.

Table 6.3. Comparison of farmed versus wild *Rhynchostylis gigantea* in bottom- and top-price class for 7 physical characteristics (see Appendix 10).

Price class*	Plant character	Farmed *n*	Farmed mean [SD]	Farmed median	Wild *n*	Wild mean (SD)	Wild median	Independent samples *t* or Mann Whitney test
≤50		85			210			
	longest leaf		8.5 [SD 2.1]			18.4 [SD 7.0]		t(277)=18.7, p<0.001
	longest root		6.3 [SD 4.0]			5.1 [SD 4.0]		t(293)=-2.38, p=0.018
	number leaves			5			4	U=312350, Z=-8.99, p<0.001
	number of inflorescences			0			0	U=8172.50, Z=-1.43, p=0.152
	flower condition						1	-
	plant condition			6			3	U=242.50, Z=-13.44, p<0.001
	number of additional shoots			0			0	U=8920.00, Z<0.001, p=1.00
>200		122			32			
	longest leaf		23.5 [SD 4.2]			30.4 [SD 6.5]		t(38)=5.72, p<0.001
	longest root		51.5 [SD 22.1]			18.6 [SD 12.8]		t(81)=-10.77, p<0.001
	number leaves			7			8	U=1658.50, Z=-1.26, p=0.208
	number of inflorescences			2			0	U=780.00, Z=-5.55, p<0.001
	flower condition			3			1	U=244.00, Z=-9.82, p<0.001
	plant condition			6			4	U=114.50, Z=-9.48, p<0.001
	number of additional shoots			0			0	U=1489.00, Z=-4.83, p<0.001

*Divided into THB 50 price classes (approximately US$1.60).

Table 6.4. Trader-reported country of origin for wild-collected *R. gigantea*

Origin	Percent
Laos	33.2
Myanmar	0.4
Cambodia	8.6
Thai	26.3
Uncertain / No country reported	32.4

During the February 2012 survey, traders sold 728 farmed plants and 401 wild-collected plants. Of these, 17 traders sold only farmed plants, 7 traders sold only wild plants, and 2 traders sold both types of plants. Wild-collected *R. gigantea* were generally sold by the kilogram. Plants were sold for THB350-45/kg (approximately US$11.60-15.00/kg), depending on plant size. Despite changes in the trade volume of both wild and farmed plants throughout the year, the price of wild plants did not change throughout the year, which was also confirmed by the traders. Notably, the price of wild plants did not change when farmed plants flooded the marketplace during the blooming season.

6.3.2 Plant characteristics

Farmed plants differed significantly from wild plants for most physical characteristics (Table 6.6). Wild plants had longer leaves than farmed plants. In each price category, farmed plants had more leaves, had longer roots, were in better physical condition, had more inflorescences, and had flowers that were in better condition (Table 6.3). Thirteen percent of wild plants were in bloom, 3.7% were planted into pots or baskets (the rest had bare roots). Eighty-two percent of farmed plants were in bloom, and 100% were planted in pots or baskets (Table 6.5).

Table 6.5. *R. gigantea* descriptive statistics

	Cultivated	Wild
Total number of individuals in marketplace in February 2012	728	401
Number of individuals with wildtype flowers	128	335
Plants in bloom (% sample)	81.9	13.0
Plants in pots or baskets (% sample)	100.0	3.7

6.3.3 GLMM Results

The GLMM showed that although plant origin (wild vs. farmed) was a predictor of plant price, it was among the least influential of the categorical variables we considered, positively affecting price by THB0.54 (US$0.02). Most other recorded categorical variables also significant in influencing plant price (Table 6.7). Notably, the variety and flower color of cultivated plant influenced price by anywhere between THB0.65-5.9 (~US$0.02-0.20). How the plants were grown was also a leading determiner of price. Plants that were grown on a piece of wood or were not grown in a plastic receptacle increased price by approximately THB2 (~US$0.07). Of the continuous variables assessed, longest leaf and root length most affected plant price, increasing price by THB1 (~US$0.03) /cm length (Table 6.6).

Table 6.6. Results of GLMM showing variables affecting price of *R. gigantea* – for plants with all flower colours

	Estimate	SE	z	Pr(>lzl)
Intercept	1.75	0.12	14.31	< 2e-16
Wild origin	-0.62	0.09	-7.23	4.77e-13
Wild-collected from Chan Buri Province, Thailand	0.25	0.59	0.43	0.67
Wild-collected from Lampoon Province, Thailand	-0.25	0.18	-1.41	0.16
Wild-collected from Sakun Nakorn Province, Thailand	0.42	0.10	4.36	1.30e-05
Wild-collected from elsewhere in Thailand (unknown province)	-0.76	011	-6.68	2.45e-11
Wild-collected from Laos	-0.53	0.10	-5.51	3.63e-08
Longest leaf length	0.07	0.00	104.40	< 2e-16
Longest root length	0.01	0.00	71.36	< 2e-16
Number of leaves	0.11	0.00	66.72	< 2e-16
Plant condition score	0.11	0.00	25.75	< 2e-16
Number of inflorescences	0.20	0.00	49.45	< 2e-16
Flower condition score	-0.02	0.00	-3.43	0.00
Not planted in a receptacle (bare rooted plant)	0.80	0.03	24.62	< 2e-16
Planted in a plastic basket	0.24	0.02	12.83	< 2e-16
Plant tied to a piece of wood	0.74	0.02	36.82	< 2e-16
Planted in a wood basket	0.38	0.03	15.25	< 2e-16
Flower colour: variegated *chang cartoon*	0.82	0.04	22.14	< 2e-16
Flower colour: variegated *chang ploy*	-0.26	0.04	-7.41	1.28e-13
Flower colour: peach	0.43	0.04	-11.63	< 2e-16
Flower colour: red	-0.37	0.03	-10.72	< 2e-16
Flower colour: white	-0.41	0.04	-11.60	< 2e-16
Flower colour: wildtype	-0.09	0.03	-2.66	0.007799
chang kom with short leaf variety [a]	1.78	0.15	11.54	< 2e-16

[*] US$1≈ THB30

[a] "Dwarf" variety is actually the greatest determiner of price (affecting price by ~THB6 (US$0.20), and any assumptions about consumer preferences for lager plants would not hold true for this variety. However, it is very infrequently encountered and so is not highlighted in our main results.

Table 6.7. Results of GLMM showing variables affecting price of *R. gigantea* – only for plants with wildtype flowers (blooming and sterile specimens).

Variable	Estimate	SE	*z*	Pr(>|z|)
Intercept	1.41	0.15	9.30	< 2e-16
Origin (wild)	0.72	0.62	1.15	0.25
Length of longest leaf	0.06	0.00	46.76	< 2e-16
Length of longest live root	0.01	0.00	43.53	< 2e-16
Number of leaves	0.14	0.00	38.94	< 2e-16
Number of inflorescences	0.15	0.01	19.36	< 2e-16
Plant condition score	0.14	0.01	24.04	< 2e-16
Bare-root or no receptacle	0.58	0.05	10.84	< 2e-16

Because wild-collected plants were generally only available with wild-type flowers, the data were partitioned by flower color. When only plants with wild-type flowers were considered, plant origin did not explain plant price (Table 6.7). However, a number of physical characteristics remained predictors of plant price, including leaf and root length, number of leaves and inflorescences, plant condition, and whether the plant had been potted, all of which affected price by approximately THB1-2 (Table 6.7). This result indicated wild-origin was not the cause of the price difference between wild and cultivated plants in the first analysis, but rather that price was principally linked to flower color.

6.3.4 Interview results

All 23 interviewed consumers knew the Thai species name of the plant they had purchased, and all but one could distinguish between wild and farmed plants. Eleven consumers stated exclusive preference for cultivated plants, 4 stated a preference for wild plants, and 8 stated no preference for either cultivated or wild plants. Respondents provided diverse justifications to support their preferences for wild plants, including that they were considered more fragrant, stronger, and easier to grow (Table 6.8). Preferences for cultivated plants were principally related to the flowers, which were available in a broader range of colors and often considered more attractive. Five respondents reported preferring cultivated plants because they were better for conservation, although this reply may have been biased by respondents seeking to please the interviewers (Table 6.8).

Traders (N=13) confirmed seasonality of farmed *R. gigantea* and that they were generally able to sell all or most of their stock. Three of the 6 interviewed farmed plant traders reported purchasing plants from commercial greenhouses, and 3 reported growing plants themselves (although seedlings may have been purchased from commercial greenhouses).

Table 6.8. Frequency of reported justifications for cultivated or wild plant preferences

Reported justifications for preferences	Reported by*	
	Consumers** (N=23)	Wild plant traders (N=7)
Consumer preference for wild plants	(N=8)	
Desire for "authentic" / rare forest products	2	2
Plant are stronger / easier to grow	4	2
Flowers are more attractive	1	2
Flowers have a better fragrance	3	2
Plants are larger	2	0
Consumer preference for cultivated plants	(N=8)	
Less expensive	0	1
Plants/flowers are in better condition	1	1
Flowers are more attractive and available in more colors	4	2
Plants are stronger / easier to grow	1	1
Allows for conservation of wild plants	5	0
Trader preference for selling wild plants		
Personal and consumer preferences for wild plants	NA	5
Familiarity with the job	NA	1
Lower start-up costs related to cultivated plants	NA	2

* Respondents were allowed to provide multiple preferences
** 9 consumer respondents did not provide reasons for their preferences

Wild-plant traders reported that plants were usually ordered from middlemen who bought the plants from traders and middlemen across the region. No wild-plant trader thought there was a difference in profit between wild and farmed plants sales and none considered relative profit margins a factor in their decision to sell wild plants. Five of the wild-plant traders explained their decision to trade wild plants as a matter of personal and consumer preferences for wild over farmed plants (Table 6.8). Two traders also identified the high cost of purchasing farmed plant stock as a barrier that restricted them to wild sales.

Both traders of wild and farmed plants described their customers as a combination of members of the general public and hobbyists with specialist knowledge. Vendor reports of consumer preferences for wild versus farmed plants were consistent with the reasons stated by consumers themselves (Table 6.8). Traders of wild plants further reported that the supply of *R. gigantea* plants and other species were greatest when flowering, but were variable across seasons and also from week to week, presumably affected by collector ability to find wild stock, which is also a documented challenge of commercializing NTFPs (Belcher & Streckenberg 2007).

6.4 Discussion

6.4.1 Framework applied to *R. gigantea*

Affordable and high-quality propagated *R. gigantea* orchids were widely available, and illegal wild specimens remained common in trade even though harvest is illegal. Although it is possible that farming reduced demand for wild specimens from an undocumented historical high, farmed plants did not fully substitute for wild plants in this marketplace. Persistence of wild-collected specimens could not be attributed to differences in price. Farmed plants were priced comparably to wild-collected plants and were physically superior to wild plants for almost every character. Several noneconomic factors may havae limited the conservation outcomes of farming, including the short season of farmed-plant trading and preferences by some consumers and traders for wild plants. Our results suggest the wild-plant market was separate from and operated in parallel to the farmed plant market. We reviewed the evidence on *R. gigantea* relative to conditions in Table 6.1 to determine possible reasons the supply-side intervention was not fully effective in displacing wild-collected specimens.

Limited by historical and biological data and resources, we used only some of the proposed analytic tools (Table 6.1), and focused only on market-based actors. Where possible, we used multiple lines of evidence to determine whether a condition was met and where evidence was based on a limited data set, we considered the condition uncertain (Table 6.9).

Rhynchostylis gigantea met most of the conditions for successful commercialization of a farmed plant species, including conditions related to the economic viability of farming. Farmed specimens were available for the same price as wild-collected specimens. This contrasts with many wild-collected products, which are often less expensive than their farmed alternatives (Belcher & Streckenberg 2007; Lubbe & Verpoorte 2011) or attract a price premium where there are widespread preferences for wild origin (e.g., Dutton et al. 2011). If consumers were to seek the largest, healthiest plant in bloom for any given price category, our results suggest they would consistently choose farmed over wild-collected plants. Although some consumers may prefer smaller ornamental plants, on the basis of other selection criteria, and our longer-term (2 year) observations at Jatujak Market suggest that consumers tended to prioritize plant size and health, both of which were greater among farmed plants. Yet, wild-collected plants remained common in trade.

Table 6.9. Assessment of the evidence on *R. gigantea* in meeting criteria identified in Table 6.1.

Condition from Table 1	Condition met for *R. gigantea*?	Evidence
Wild resource is generally scarce	yes	• Traders report supply is erratic, presumably because plants are sometimes difficult to find in the wild • Species listed as “threatened” in Thailand
Species subject to destructive harvest	yes	• Species subject to whole-plant harvest
Access to wild resource is uncertain or irregular	yes	• Monthly surveys reveal large variability in market volumes • Traders report inconsistent supply of wild plants
Targeted species is of relatively high value	yes	• Species already subject to large-scale farming, which suggests it is of high enough value to be attractive for commercialization
High demand for the target species	yes	• Presence of farmed plants at the market implies adequate demand to have spurred farming
Markets developed and accessible	yes	• Plants farmed in large-scale greenhouses, most near Bangkok • Jatujak plant market is well established and many plant traders sell cultivated *R. gigantean* there • Market for wild orchids may be more specialized and less developed than the market for farmed plants
Demand for target species reliable and not easily saturated	no or uncertain	• Demand for farmed plants highest during the blooming season (~1 month), as confirmed by vendors and evident because plant volumes are much smaller during other times of the year • Sales of wild plants peak during the blooming season, but plants are available ayear-round • Lack of data on demand
Farmed and wild specimens easily distinguishable in the marketplace	yes	• 2 categories of plants can be easily distinguished
Target species not easily substituted	uncertain	• Many other orchid species, hybrids, and other flowering plants available in the market place, which may be substituted for *R. gigantea* • *R. gigantea* well known in Thailand; all consumers interviewed knew the name of the orchid they had purchased and may have been specifically seeking this species
Farmed specimens available for the same price or cheaper than wild-collected alternatives	yes	• Generalized linear model (GLMM) showed that after all physical variables had been controlled for, there was no difference in price between wild and farmed plants

Farming offers comparable or better profit margins than wild-harvested specimens	yes or uncertain	• Wild-plant traders reported that they did not think there was a different in profit margins between wild and farmed plant sales; did not emerge as a major factor in decision to sell wild plants • From GLMM results, farmed plants not commanding a premium and may not present a financial incentive for wild-product traders to transition to
Farmed plants can be produced at a large scale	yes or uncertain	• During the blooming season, farmed plants outnumbered wild plants in the marketplace •Farmed plants only seasonally available in large quantities in the marketplace
Quality of farmed specimens is good or better than wild-harvested specimens	yes	• Univariate tests showed that for each price category, farmed plants were generally of superior quality to wild-collected plants • Some consumers perceived differences in flower quality and fragrance and in the “authenticity” of cultivated plants
No (or limited) consumer preference for wild specimens	no	• Price of wild plants does not respond to the introduction of farmed plants during the blooming season, suggesting they are distinct commodities • Half of interviewed consumers who purchase wild plants expressed a clear preference for wild plants • Traders who sell farmed plants were not the same traders in wild plants, suggesting that these are separate goods
Few (or reasonable) barriers to farming	yes or uncertain	• Species was commonly farmed and sold in Thailand, which suggests limited barriers • Most traders of farmed plants purchased stock from large wholesale greenhouses, suggesting a production barrier exists for small traders • Plant harvesters (although beyond the scope of the study) was very unlikely to be able to participating in commercial growing • Cost of purchasing initial wild orchid stock probably lower than purchasing farmed plants
Target species subject to harvest or trade restrictions that are relatively well enforced	no	• Although illegal, wild plants openly sold at the market; enforcement erratic
Farming establishments adequately monitored	no or uncertain	• As most farmed plants are horticultural varieties (distinguished by their flowers), laundering is not likely a major issue for this species at this market. There is, however, no regulation of these commercial plant farms.

Other explanations for this phenomenon include the possibility that wild and farmed plants were nonsubstitutable goods that represented parallel markets (Table 6.9), as has been noted for some other NTFPs (e.g., Christmas trees [Strandby & Olsen 2008], Himalayan medicinal plants [Larsen & Olsen 2007]). First, the price of wild plants did not change when farmed plants flooded the marketplace; the price of substitutable goods would have likely changed with the influx of a competing product (Bulte & Damania 2005). Second, some buyers showed specific preferences for wild plants. The presence of farmed specimens in the marketplace would have little effect on these buyers' decisions. Third, all but 2 traders specialized in either wild or farmed plants, suggesting a division between products. Moreover, wild-plant traders expressed a personal preference for selling wild plants. This factor was not considered in our framework but supports the separate-market conclusion. This separation was probably the result of not only vendor and consumer preferences, but also of trader networks and differences in capital demands between wild and farmed plants.

It is possible that barriers to farming limited some vendors' transition to farmed plants, although this could not be fully assessed with the available data (Table 6.9). *R. gigantea* is widely farmed by large commercial greenhouses, from which some farmed plant vendors purchased seedlings or mature plants for resale. However, there are likely barriers to participating in plant cultivation by individuals because orchid farming requires specialized knowledge and a substantial capital investment. In addition, some traders indicated the costs of buying plants from greenhouses may be higher than buying plants collected in the wild. The barriers to cultivation may also be great for plant harvesters, particularly if they these are poor or live in isolated forest regions.

Another factor that could explain the persistence of wild plants in the marketplace is that farmed plants were only widely sold during the short blooming season; traders also reported that sales were seasonal (Table 6.9). In contrast, wild plants were rarely traded in bloom (even in the blooming season flowers were heavily damaged or removed, so their sale demand and prices may be less influenced by seasonality. The seasonal flooding of the market with farmed plants may be inadequate to force a substitution. Moreover, it seems likely that farmed specimens were traded largely for their flowers, whereas wild specimens were traded based on characteristics other than their flowers.

The lack of regional enforcement of wildlife harvest and trade regulations (Phelps et al. 2010; Todd 2011; Shepherd & Nijman 2008) may also have contributed to the substitution failure (Peres 2010) (Table 6.9). Traders faced few disincentives to selling wild-harvested protected plants. As they reported personal preferences for wild plants and did not perceive differences in profit margins between wild and farmed plants, those traders may have had few incentives to transition to selling farmed plants.

6.4.2 Conservation implications

Results of our approach can guide more critical evaluations of supply-side interventions to assess species' suitability for wildlife farming, anticipate potential shortcomings, and identify additional interventions needed to strengthen conservation outcomes. There are many other wild and farmed plants sold at Jatujak Market (already established), including in specimens in the genera *Nepenthes, Adiantum, Platycerium, Asplenium, Cycas, Aerides, Dendrobium, Ascocentrum, Vanda*, and the

CITES Appendix I-listed genus *Paphiopedilum*. The approach could also be applied to threatened animal species to inform associated debates, such as recent proposals to allow tiger farming to produce traditional Chinese medicines (Kikpatrick & Emerton 2010).

Our observations on *R. gigantea* are especially relevant to species for which consumers prefer wild-collected specimens, including some medicinal products such as tiger parts and rhinoceros horn; luxury wildlife products, including ornamental plants, caviar, bluefin tuna, and some bushmeat; and collectible wildlife, including butterflies, beetles, and exotic pets (e.g., Robbins 2003; Gault et al. 2008; Tournant et al. 2012). The problem is compounded by consumer preferences for rare species, which drive trade, increase rarity, and promote further demand (Courchamp et al. 2006). However, as highlighted by our example, neither product price nor consumer preferences necessarily fully explain supply-side dynamics; seasonality, participation barriers, and trade scale may also have substantial effects.

Our framework and case study further highlight where additional interventions may facilitate conservation; supply-side interventions may not present perfect self-regulating market solutions (Abbott & van Kooten 2011). On the contrary, interventions to curb wildlife trade generally require both a holistic approach and a mixture of policies (Abbot & van Kooten 2011; Laird et al. 2009). Complementary interventions for *R. gigantea* might include consumer and vendor education about botanical conservation and regulations; technical and microcredit assistance for wild-plant vendors and harvesters to gain access to new technologies or farmed plant trade networks; basic ecological research on *R. gigantea*; and tracking of wild-plant sale volumes and origins to determine scale of trade. Conservation outcomes may further depend on accompanying supply-side interventions with unambiguous disincentives for wild-product trade that require clear regulations and increased enforcement at points of harvest, import, and sale. Increased enforcement aimed at harvesters of wild products can be contentious (Dickson 2008), costly, and challenging in low-governance environments (Peres 2010; Abbot & van Kooten 2011).

Although the economic logic and theoretical underpinnings of supply-side interventions may be robust, there remain logistical challenges to addressing socio-ecological problems involving international market chains. The design and evaluation of supply-side interventions is complex in practice and limited by substantial knowledge gaps. There is a need for expanded and creative approaches to gathering and evaluating multiple lines of evidence—not only about the technical viability of cultivation or farming, but also about consumer preferences, consumer ability to distinguish among products, and differences in quality and characteristics between cultivated and wild specimens. The specifications in Table 6.1 provides a starting point for integrating these data to feed into a broader, more multidisciplinary enquiry of supply-side interventions. They can they be applied to other species and further developed to help identify whether interventions will yield conservation outcomes.

Chapter 7:
Boosting CITES to regulate international wildlife trade

Based on:
Phelps, J., Webb, E.L., Bickford, D.P., Nijman, V., Sodhi, N.S. 2010. Boosting CITES. *Science* 330:1752-1753.
and
Phelps, J., Bickford, D.P., Webb, E.L. Letter: Work together to crack wildlife crime. *Nature* 483:407.

7.1 Introduction

With 175 member countries, the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) is the most important global initiative to monitor and regulate international trade of plants and animals (Sand 1997). CITES regulates trade of nearly 34,000 species, gathering trade data, monitoring and enforcing the trade of CITES-protected species (see Chapter 1).

However, there remains considerable debate and concern over the viability of the CITES mechanism to regulate trade of protected wildlife. An eclectic mix of studies have documented illegal resource trade, though only occasionally contrasting official trade statistics against observed dynamics (e.g., Shepherd 2006; Shepherd and Nijman 2007). Notably, the non-governmental wildlife trade monitoring network, TRAFFIC, has documented a wide range of cases of illegal wildlife trade (see http://www.traffic.org/bulletin/ and references for work of Shepherd and Nijman). Similarly, Chaber et al. 2010 estimated the volume of bushmeat smuggled into Europe via the Paris Charles de Gaulle airport in personal luggage each week. Davenport and Ndangalasi (2003) documented trade of millions of terrestrial orchid tubers of 85 species between Tanzania and Zimbabwe, none of which is captured by CITES data. Similarly, Giles et al (2006) documented the harvest of millions of seahorses annually for export, but which is not accounted for in official records. These diverse examples highlight the inadequacy of existing CITES implementation.

These types of gross inaccuracies, however, are unrecorded, limited by fieldwork and analysis. There remains notable lack of supplementary data against which to compare official figures, needed to assess regulatory effectiveness (see Gavin et al. 2009; Nijman 2010). There is equally a lack of comprehensive analysis of the challenges facing the CITES mechanism, instrumental to improving transnational conservation agreements and domestic trade policies.

Southeast Asian botanical trade offers a unique and accessible opportunity for assessing the regional effectiveness of international CITES legislation to regulate wildlife trade. Trade in Orchidaceae is particularly relevant since all species are CITES-listed (2012) and their trade is widely monitored (see Chapter 1). We drew on the example of orchid trade into Thailand to highlight CITES shortcomings and identify areas for improvement, and reviewed the wildlife trade literature to identify strategies for strengthening the effectiveness of CITES implementation. We categorized these recommendations into four themes, related to 1) systematic data collection, 2) responsive monitoring, 3) rigorous data analysis, and 4) peer review. We further evaluated the potential solutions according to their benefits and feasibility (Table 7.3).

7.2 Methods

We conducted botanical surveys of four wild plant markets, Jatujak Market in Bangkok, two markets on the Thai borders with Myanmar (Dan Singkorn and Chedi

Sam Ong Markets) and one market on the border with Lao PDR (Mukdahan Market) (see Chapter 2, Map 2.1). The markets were the largest of their kind and were sites of public trade, where protected species were openly sold, often in the presence of enforcement (see Chapter 8). Notably, trade was dominated by plants illegal imported from the adjoining countries, in clear violation of CITES (cross-border trade detailed in Chapter 4 and Chapter 8).

Jatujak Market in Bangkok was surveyed monthly (with additional checks for new species every 2 weeks), and border markets were surveyed in May/June 2011, August 2011 and February 2012. All specimens were identified to the level of genus/subgenus, and blooming specimen were identified to the species-level (see Chapter 2 for full methods). Trader-reported country of origin was collected for a subset of target species, blooming specimen, and plants in the genus *Paphiopedilum*. In addition, plants recorded at Dan Singkorn and Chedi Sam Ong Markets for which we were confident originated in Myanmar, based on trader interviews, were documented as originated in Myanmar. Observed count was based on the number of plant bundles (potentially including multiple individuals) plus the number of individuals (potentially divisions of larger plants), both recorded as single counts (see Chapter 2). This provided a highly conservative accounting of trade from border countries, notably Lao PDR and Myanmar into Thailand, and was treated as indicative of broader trade dynamics.

We compared market findings with international trade volumes reported in the CITES database (2013). This database, managed by WCMC, records import, export and re-export of CITES-listed species reported by signatory countries. We considered records between 2004, when Lao PDR and Myanmar became CITES signatories, until 2012.

The botanical trade example informed an initial list of recommendations for how CITES monitoring and enforcement could be strengthened. We further conducted a broad, though non-systematic review of the literature on CITES and on wildlife trade regulation using Google Scholar and Web of Science using term including “CITES” (and the full name of the Convention), “wildlife trade”, “NTFP trade”, “protected species + trade”, and “conservation + trade”. These were used to refine the list of recommendations and identify themes for why CITES statistics had often failed to capture actual trade dynamics. Based on this, we created an referenced list of policy recommendations for strengthening CITEs to better protect flora and fauna threatened by international trade.

7.3 Results

7.3.1 Southeast Asian trade in Orchidaceae

Market surveys in Thailand documented a large-scale, species-rich trade in wild plants harvested from neighbouring countries. Observed trade volumes and richness during the surveys over 1 year greatly exceeded CITES-reported trade volumes over the period since 2004, by when all countries in mainland SE Asia has become signatories to the convention (Appendix 5; Table 7.1). Notably, CITES statistics reported no wild orchid trade into Thailand from Myanmar, Cambodia, Indonesia, Malaysia, or Philippines, although wild plants were found in open trade during surveys (Table 7.1).

Table 7.1. Comparison of CITES records and observed trade. CITES records [a] of live orchid imports into Thailand from countries in SE Asia since 2004 [b] compared with trade observed during 1-year of market surveys [c]

Lao PDR → Thailand			
CITES Database	Import volume	Genus count	species count
Artificially propagated [d]	0	0	0
Wild-collected	20	3	4
Observed in this study	9251	41	109
Myanmar → Thailand			
CITES Database	Import volume	Genus count	species count
Artificially propagated	0	0	0
Wild-collected [e]	0	0	0
Observed in this study	18850	54	130
Vietnam → Thailand			
CITES Database	Import volume	Genus count	species count
Artificially propagated	0	0	0
Wild-collected	1650	4	4
Observed in this study	159	4	9
Cambodia → Thailand			
CITES Database	Import volume	Genus count	species count
Artificially propagated	0	0	0
Wild-collected	0	0	0
Observed in this study	1194	7	11
Philippines → Thailand			
CITES Database	Import volume	Genus count	species count
Artificially propagated	3673	20	81
Wild-collected	0	0	0
Observed in this study	5	3	3
Indonesia [e] → Thailand			
CITES Database	Import volume	Genus count	species count
Artificially propagated	126487	7	7
Wild-collected	0	0	0
Observed in this study	48	1	1
Malaysia → Thailand			
CITES Database	Import volume	Genus count	species count
Artificially propagated	8224	54	165
Wild-collected	0	0	0
Observed in this study	163	5	7

[a] The CITES count is based on records on the WCMC-CITES database (CITES 2013), method unreported. Observed count is based on the number of plant bundles (potentially including multiple individuals) plus the number of individuals (potentially divisions of larger plants), both recorded as single counts. This is conservative relative to traditional customs recording, but not necessarily representative of the number of genetically distinct individuals.

[b] Signatory nations are intended to submit trade statistics of CITES-listed species annually, but submissions are often less frequent. Since 2006, when National Annual Reports to the CITES Secretariat were made available online, Thailand and Malaysia have submitted annually, Lao PDR submitted in only 2010; Myanmar in 2009, 2010 and 2012; Cambodia in 2009 and 2013, and Philippines in 2007, 2008 2011.

[c] Represent significant under-estimates, as origin data was only collected for a sub-set of specimens (target species, blooming plants, *Paphiopedilum*) at only four markets. Observed trade was also skewed toward Myanmar and Lao PDR because of the location of the study sites.

[d] Artificially propagated plants include hybrids

[e] Very small volumes of wild plants were also imported for exhibition

CITES-reported trade of wild orchids from Lao PDR since 2004 represented only 0.22% of the trade volume observed during surveys. Were trade volumes observed during the surveys representative of the 2004-2012 period, CITES records would have captured only 0.02% of trade. The gross incongruence between official statistics and observed trade is perhaps best exemplified anecdotally: in a single day, one small-scale trader on the Thailand-Lao PDR border sold more plants of a greater diversity then were recorded by official statistics since 2004 (Table 7.2).

Table 7.2. Comparison of CITES statistics since 2004 and trade conducted by a single trader in February 2010.

	Genera identified	Count for each genus
CITES Trade database [a]	*Ascocentrum*	5
	Dendrobium	5
	Rhynchostylis	10
	Total count	20
Market observations [b] (single trader, one-day)	*Aerides*	60
	Arundina	14
	Ascocentrum	7
	Bulbophyllinae	50
	Dendrobium	10
	Eria	5
	Vanda	6
	Vanilla	16
	Total count	168

However, observed trade volumes were highly conservative, as we captured only a small volume of actual trade based on extent of survey effort, and were able to attribute country of origin only to a minority of records. Observed volumes were also strongly skewed towards Myanmar and Lao PDR given the geography of our study and locations of our study market sites. Broader surveys would very likely indicate larger-scale illegal trades from other countries in the region.

These discrepancies are, in part, attributable to the lack of CITES reporting to the CITES Secretariat (see Table 7.1), and more complete trade datasets may be available within National Secretariat archives. Improved annual reporting would surely help to make trade statistics more representative of actual trade dynamics. Nevertheless, it is plainly evident that CITES statistics differe from actual dynamics in scales of magnitude.

7.3.2 Themes in recommendations for strengthening CITES

Based on the trade of Orchidaceae in Southeast Asia and the conservation literature, we identified broad themes in the limitations to CITES effectiveness and recommended strategies for improving implementation. These related to systematic data collection, responsive research methods, rigorous data analysis, and peer review.

7.3.2.1 Systematic and standardized data collection

The CITES Secretariat, Animals and Plants Committees (APC) and external agencies (e.g., International Union for Conservation of Nature (IUCN) Specialist Groups) depend on national agencies to monitor and report trade. Yet many CITES Parties fail to systematically monitor and report international wildlife trade. The case of wild orchid trade in Southeast Asia, all of which should be monitored in accordance, is indicative of the lack of systematic enforcement and data collection, although this is also a broader global phenomenon (e.g., Yi-Ming and Dianmo 1998; Giles et al. 2006; Amir 2006). Some of the largest exporters and importers of wildlife products are non-compliant: Brazil, a significant source country for illegal fauna (RENCTAS 2001), lacks a functioning central mechanism for reporting wildlife confiscations (Pistoni and Toledo 2010). The U.S., a leading importer of wildlife, lacks a coordinated national authority for monitoring wildlife imports (Smith et al. 2009). Many CITES Parties fail to collect domestic population and harvest data, and CITES lacks a standard international reporting mechanism for species-level information (Gerson et al. 2008). Yet this information is central to CITES function (Nijman 2010; Pistoni and Toledo 2010), as exporters must complete Non-Detriment Finding (NDF) reports to prove that international trade is not harming populations of regulated species (CITES ND). Such baseline data are also fundamental to listing species for CITES protection; commercially high-value species have been listed based on robust, empirical population data (Blundell 2004; Ghering and Ruffing 2008). However, most taxa are understudied, and there is a lack of coordinated, systematic data collection within and among Parties.

Data collection at all levels depends on proper species identification (Rosen and Smith 2010), which remains a leading challenge. For example, over 50% of documented live animal imports into the U.S. from 2000-2006 were identified only by class; only about 14% were identified to species (Smith et al. 2009). Weak datasets overlook species introductions, substitutions and exporter misidentifications, and are a particular challenge for taxonomically 'obscure' species (e.g., sterile orchid specimens), and products for which it can be hard to identify species (e.g., frog legs, Vieth et al. 2000; sawn timber, Gasson et al. 2010) Traditional identification protocols and methods are proving inadequate (Smith et al. 2009; Pistoni and Toledo 2010), and require revision and innovation to consider the needs of customs and enforcement agents and leverage new identification technologies (Green and Hendry 1999; Rosen and Smith 2010; Gasson et al. 2010).

Moreover, there is a need for improved monitoring of regional and South-South trade dynamics, which are often overlooked, largely because the relevant Parties have generally lacked the resources, legislation and capacity to respond (Davenport and

Ndangalasi 2003; Shackleton et al. 2007; Warkentin et al. 2009). The Southeast Asian ornamental plant trade is a prominent example of this (see Chapter 4). Similarly, Zambian demand for edible orchid tubers from Tanzania (Davenport and Ndangalasi 2003) and Thai and Chinese demand for wild cat parts from Myanmar (Shepherd and Nijman 2008) represent cases of regional trade that are of potential CITES concern. However, in these cases, a lack of systematic and standardized monitoring have meant that important issues went unnoticed until they were flagged by external organisations.

7.3.2.2 Responsive monitoring

Wildlife trade occurs openly at public border markets (Van Song 2008) and discrete black markets (Moyle 2009). Moreover, trade shifts and cycles among countries as wild populations deplete (Giles et al. 2006; Carpenter et al. 2009), and innovative smuggling techniques are adopted in response to enforcement pressures (Moyle 2010). However, trade data are collected using conventional techniques implemented along easily accessed trade routes.

At present, many government agencies are largely limited to regulating wildlife trade confined to airport checkpoints, which cannot capture the true dynamics. As the example of Southeast Asian orchid trade demonstrates, trade often occurs through other routes that can be completely overlooked by CITES recording strategies. Similar trade inaccuracies are evident across taxa (bears, edible tubers, medicinal plants, seahorses, bushmeat, frogs) and regions (Veith et al. 2000; Davenport and Ndangalasi 2003; Olsen and Bhattarai 2005; Giles et al. 2006; Van Song 2008; Nijman and Shepherd 2008; Mohneke et al. 2010). Some efforts have been made to integrate alternative, investigative approaches into CITES (e.g. the Lasuka Agreement and CITES-Interpol collaborations) but the overall CITES "airport bias" fails to detect the majority of illicit trade.

Similarly, the focus on data collection only at point of enforcement does not necessarily yield information about up and down-stream trade dynamics. More responsive monitoring also depends on improved understanding of trade, including of broader value chains. Related information could be collected through improved data collection about specimen origins and destination during confiscation events, as well as collection of samples for future study. Associated research on trade dynamics and value chaims (see Chapter 4) could also feed into developing more responsive monitoring, although these would require both expanded resources and collaborations.

7.3.2.3 Rigorous analysis

When trade and ecological data are available, analyses under the CITES Secretariat, APC and their collaborators often remain insufficient to identify species threatened by trade, and detect trade inaccuracies and loop-holes. For instance, approximately 20% of species threatened in four mega-diversity countries (Brazil, China, Colombia and Philippines) have not been assessed at the international level (Brito et al. 2010). Similarly, the IUCN holds "no information" about the status of most of the Orchidaceae (UNEP-WCMC 2010); only three species were added to the Red List of Threatened Species from 2007-2009 although sufficient information exists to list many others (IUCN-OSG 2009).

Similarly, open-access trade data on wild flora and fauna (CITES 2013) and complementary trade statistics (e.g., US Fisheries and Wildlife, UN Statistics) remain underutilized by the CITES community, though a handful of independent studies have demonstrated the need for bolstered data analysis. A comparison of United States' CITES trade data and Customs data from 1997-2002 revealed massive inaccuracies across diverse taxa and years, with important implications for trade management, conservation efforts and resource allocation (Blundell and Mascia 2005). Analysis of CITES data has uncovered loop-holes within the international trade of threatened and endangered poison arrow frogs from South America into Asian pet markets, identifying inconsistencies between CITES reported exports and imports and complex trade networks (Nijman and Shepherd 2010b). Similarly, analysis of historical CITES data revealed huge shifts in trade patterns of protected African chameleons (Carpenter et al. 2010). Analysis of CITES data and field-based research recently revealed that the CITES National Authority of Indonesia approved exports of reportedly captive bred reptiles that were likely wild-collected (Nijman and Shepherd 2010a). Drawing on a wider range of data sources, Warkentin et al. (2009) identified massive inconsistencies between reported frog leg exports from Indonesia and India and reported imports by the United States and France, highlighting the scale and routes of a previously under-recognized trade.

The CITES Secretariat and Parties must be able to identify these types of inconsistencies and trade dynamics in order to achieve their mandate. Encouragingly, CITES partners are developing tools to enhance analysis capacity, such as the Trade Data Dashboard (CITES 2012b). Yet critical trade linkages often remain undetected when CITES relies on the interest, resources, and often informal or irregular input of independent researchers and organizations (Wilson-Wilde 2010).

7.3.2.4 A peer-review process

CITES shortcomings may be overlooked because the Convention lacks internal and external checks-and-balances. CITES relies exclusively on country self-reporting and evaluations for Non-detriment Findings upon which to grant permits for Appendix II species (NDFs; CITES 2013), though incentives are high for biased analyses and misreporting (Courchamp et al. 2006), and most CITES-listed species occur in the tropics where governance is often weak and corruption high (Sodhi et al. 2006). This is especially problematic in regions such as Southeast Asia, where many of the CITES-signatory countries lack formalized CITES Management and Scientific Authorities capable of providing transparent, data-based recommendations and permits.

Problems can also arise when CITES National Management Authorities lack independence from their advisory Scientific Authorities, and because Parties' submissions to CITES are not publically available (Reeve 2006). The international trade of live wild dolphins from the Solomon Islands offers a quintessential example; In the face of broad expert consensus that the trade is likely deleterious, the CITES authorities of the Solomon Islands justify continue trade by citing insufficient data and lack of peer review (Parsons et al. 2010). Cases where data is deficient are especially susceptible to political maneuvering (see Ghering and Ruffing 2008). Critical, independent peer-review offers a legitimate means of Party validation, particularly when addressing contentious issues such as harvest quotas, approvals of NDFs, proof of captive breeding, and national management procedures for protected species (Nijman and Shepherd 2010a). These reviews may meet with Party resistance that could hamper future investigative efforts, especially if they are followed by legal action.

However, the recent pilot CITES Policy Review Project in four exporting countries provides an encouraging precedent for future external reviews (CITES 2008). Reviews conducted 2006-2008 in Madagascar, Nicaragua, Uganda and Viet Nam offer an example of the type of checks-and-balances that CITES required to enhance data quality and the objectivity of Party decisions. Among the key problems we identify are the relationships between Party Management and advisory Scientific Authorities. For example, in Singapore and Thailand both Authorities lie within the same agencies, which hinders transparency and objective review. In a number of other countries, including Cuba and Azerbaijan, Management and Scientific Authorities are separate, and the Scientific Authority is tied to academic institutions (see CITES 2013).

Table 7.3. Proposals for strengthening CITES.

Challenge	Proposed Solution	Principle benefit	Major socioeconomic barriers	References
Systematic and nested data collection				
	Increased number of inspections. Higher effort is a prerequisite for a number of the following proposed solutions.	Improved data quality to inform conservation interventions. Improved CITES enforcement.	High cost to Parties. Party capacity limitations.	Clarke 2004; Nijman and Shepherd. 2010a; Warkentin et al. 2009; Smith et al. 2009; Rosen and Smith 2010; Chaber et al. 2010
	Establish standardized, species-level reporting, such as through the use of coded forms established through the Conference of Parties.	Increased specificity of reported trades. Would make data more retrievable and comparable. An affordable tool with costs shared among Parties.	Challenges in achieving international consensus on reporting and with database and protocol harmonization. Challenges associated with species-level identification in many taxa.	Gerson et al. 2008
	Also prioritize monitoring of South-South and regional trade dynamics.	Improved monitoring/data collection at sites of trade that are often overlooked.	Party resource limitations, particularly in tropical developing regions. Many examples of porous borders.	Shackleton et al. 2007
	Provide standardized training for customs officials, drawing on domestic expertise to provide support.	Improved species-level statistics. Increased identification of non-compliant traders. Increased communication and information exchange between government officials and the scientific community. Achievable at a low internal cost to Parties.	Party resource limitation. Lack of available domestic expertise. Challenge identifying “look-alike” species	Clarke 2004; Shepherd et al. 2007; Rosen and Smith 2010; Nijman 2010
	Develop tested, taxon-specific identification guides decision-trees and decision-making tools	Improved species-level statistics.	Party resource limitations.	Green and Hendry 1999; Clarke 2004;

Challenge	Proposed Solution	Principle benefit	Major socioeconomic barriers	References
	for customs officials. This can be done in collaboration with local and/or scientific experts.	Increased identification of non-compliant traders. Avoid broad trade restrictions (e.g., orchids) in favour of more targeted, efficient taxon-specific regulations.	Extreme diversity and endemism in tropical regions, and the need for local taxonomic guides. Particular taxonomic challenges with some taxa (e.g. corals, orchids) with many "look-alike" species.	Rosen and Smith 2010
	Integrate DNA bar-coding with inspections. This could be done as part of random spot checks and in collaboration with universities or research institutes.	Improve identification. Provide accurate estimates of misidentifications using traditional techniques. Reveal accidental or intentional species introductions and substitutions. Could increase communication and information exchange between government officials and the scientific community. Especially relevant for taxonomically challenging groups (e.g. plants, corals).	Equipment limitations. Human capacity and training. Laboratory facilities. Cost will correlate with intensity, but could be prohibitive in species-rich exporting countries.	Clarke 2004; Alacs et al. 2009
	Establish joint research agendas and agreements among Parties and academic institutions to collect domestic baseline data for target species, using common methodologies.	Larger data sets on populations. Comparable data Could increase communication and information exchange between government officials and the scientific community Peer review	Institutional barriers Political barriers, e.g. consensus on investment in data collection Academic interest in collecting monitoring data Consensus on target species and methodologies	

Challenge	Proposed Solution	Principle benefit	Major socioeconomic barriers	References
		Opportunities for CITES-relevant research to access new sources of academic and institutional funding (e.g. National Science Foundation, National Institutes of Health, etc.)	High diversity in tropical regions and the need for species-specific information High cost to Parties, and general lack of funding for basic research	
	Develop more private sector engagement in point-of-harvest data collection.	Increased precision and accuracy of harvest data. Increasing awareness of status of resource with collectors. Potential long-term involvement of harvesters in efforts to sustainably manage the resource.	Strong incentive to misreport. Low levels of trust between harvesters and government. Real and perceived opportunity costs to harvesters. Lack of political will to place requirements on private sector.	
Responsive methods				
	Establish and/or strengthen regional CITES support networks. This could be done through the creation of formalized networks as well as informal, online and face-to-face forums sponsored by the CITES Secretariat and Parties, and NGOs.	Increased experience sharing among stakeholder groups (e.g. customs officials). Timely information exchange about innovative smuggling techniques and ways to counter them. Opportunity to increase involvement of civil society (academia, citizenry) in CITES.	Achieving political consensus. Long-term functionality of volunteer networks.	Rosen and Smith 2010
	Establish domestic procedurs and systems for collecting data the on origin and destination of confiscated CITES-listed specimen during enforcement events.	Improved understanding of the associated value chains. Potential to target conservation interventions, including enforcement.	Increased burdens on enforcement and Customs. Need for additional procedures and data management systems.	
	Develop and implement flexible monitoring methods (e.g. for non-traditional trade networks,	Capture data where the vast majority of CITES-listed species are traded.	Novel, possibly country-specific, methodological and training needs.	

Challenge	Proposed Solution	Principle benefit	Major socioeconomic barriers	References
	local-level and self-monitoring especially for small-scale and artisanal harvest, adoption of molecular techniques). This will require enhanced collaboration with academic institutions to maximize expertise and resources.	Improved communication between government and civil society.	Political feasibility, particularly related to sovereignty near poorly demarcated national borders. Lack of institutional support in remote regions, increasing the chance of violence. High cost to the Parties for increased manpower and mobility. Possible lack of academic interest in monitoring.	
	Identify opportunities for complementary research on socio-economic and institutional dimensions of wildlife trade management, including on CITES implementation, livelihood impacts of trade regulation, value chains and actors involved in trade of priority species.	Potential for interventions along the value chain, beyond at point of customs enforcement. Ethically sound approach to management.	Beyond the capacity and mandate of CITES agencies. Require additional resources and collaborations.	Ingram and Bongers 2009
Rigorous data analysis				
	Formalize, strengthen and expand analysis networks (e.g. UNEP-WCMC, TRAFFIC) to utilize CITES and non-CITES data for robust analyses, such as Significant Trade Reviews.	Periodic, planned analyses will increase scientific rigor of APC recommendations. Will uncover previously overlooked trade issues. Will provide more permanent institutional linkages.	Will require consistent funding to the external partners.	WB 2005
	Identify opportunities to draw on wildlife trade data/lines of evidence outside of the CITES database.	Increased robustness. Provides opportunities for triangulation.	Increased burdens. Additioanl data is often not available.	
Implement peer-review processes				

Challenge	Proposed Solution	Principle benefit	Major socioeconomic barriers	References
	Facilitate external scientific reviews of international-level CITES decisions, such as pertaining to allowing trade (NDFs), trade quotas, suspensions and up/down-listing of species.	Increased rigor and credibility of decisions. Reduce space for political haranguing. Increased communication and information exchange between government officials and the scientific community.	Acceptance and implementation of review findings.	IPBES 2010
	Engage 3rd parties and scientists in external reviews of individual Party decisions.	Scientifically robust analyses and decisions. Greater CITES transparency. Increased access to scientific expertise.	Increased administrative burden on Parties. Assurance of independence of reviewer.	
	Review guidelines for decisions pertaining to allowing trade (NDFs), trade quotas, and suspensions, to ensure that they are objective and science-based.	Increased confidence that allowable trade is biologically sustainable. Reduces opportunity for political maneuvering. Review / revision would be low-cost to the Secretariat.	Possible difficulty in achieving Party consensus on revisions necessary. Implementation of requirements would require empirical data. Compliance with stricter guidelines would be high cost to Parties.	Wasser et al. 2010, see also Cooke et al. 2010
	Review and enhance standards for Parties to monitor and better differentiate captive-bred and artificially propagated specimen from wild-caught individuals. This is especially relevant for high-value, rare species, and could be done as part of strengthened, random spot checks of CITES-approved breeders.	Improve credibility of legitimate breeders. Reduce instances of misreporting wild individuals as captive bred or artificially propagated, reducing pressures on wild populations.	Challenges associated with increasing the collaboration of breeders. Human capacity and training Cost will correlate with intensity, but could be shared or carried by breeders, especially for high value species.	Nijman and Shepherd 2010a

7.4 Discussion

7.4.1 Simple solutions

CITES credibility, effectiveness and success at catalyzing consensus depend heavily on punctilious data collection, analysis, and synthesis. Despite fairly broad recognition that the CITES mechanism and its implementation need to be strengthened, there remains a tendency towards narrow policy solutions. Toledo et al. (2012) largely attribute to CITES failures to the lack of resources in tropical countries, proposing that centralization of national wildlife trade data could feed into the CITES database and significantly improve regulation. Gerson et al. (2008) propose that tracking trade with required, universal taxonomic codes could improve tracking and decision-making. Chaber et al. (2010) propose increased airport inspections and enhanced penalties.

These proposals represent valuable approaches to strengthening the CITES mechanism. However, there is a clear need for improvement across diverse areas of CITES design and implementation (Table 7.3). Single and simple policy solutions generally conflict with our understanding of environmental problems as complex socio-ecological phenomena (Ostrom 2007). A broad review of the literature suggests that there is no single strategy through which to improve international monitoring and enforcement of illegal wildlife trade, especially since trade can be so widespread, diverse, adaptive and sophisticated (see Rosen and Smith 2010). Extensive reforms are needed to expand government monitoring and reporting, and to include a wider range of detection strategies and non-government stakeholders.

7.4.2 Solutions in context

Yet the Convention is bound by political and economic realities. We present general strategies through which to improve CITES (Table 7.3), cognizant that some measures overlap, prioritization depends on Party needs and resources, and recommendations vary in their political feasibility. And while credible biological and trade data are core to informing CITES decisions and garnering political will and consensus (Gehring and Ruffing 2008), they do not preclude Party bargaining, as occurred at the March 2010 Conference of Parties during debate over bluefin tuna (e.g., Milius 2010). Nevertheless, CITES decisions may frequently be hindered by a lack of basic data (e.g. Nijman 2010; Parsons et al. 2010).

The international trade of shark fins offers a particularly prominent and well-documented example of how associated data gaps have profound implications for trade and management decisions (Godin and Worm 2010). Five commercial shark species were proposed and rejected for CITES listing and trade restriction during the 2010 Doha Conference of Parties (CoP), only to be listed to Appendix II during the 2013 Bangkok CoP. While financial, cultural and political factors heavily influenced the negotiations, data gaps also hindered science-based decision-making. Although harvest and bycatch data for shark fins is collected in a number of different fisheries, uncertainties linger due to illegal harvest, non-compliance, under-reporting and failures to systematically gather species-specific information (Clarke et al. 2006; Clarke 2008; Dulvy 2008). In the absence of robust baseline data, scientists turned to sophisticated models to interpret existing shark harvest and trade data and filter species level information (e.g., Clarke et al. 2006; Clarke 2008). Models returned estimates that are at least 3-4 times higher than official records (Clarke et al. 2006), suggesting the need for heightened protection and more accurate data collection. However, as CITES negotiations struggle to catalyze consensus on contentious issues among member countries with diverse interests (Parsons et al. 2010; Morell 2010), arguments for increased regulation are only as strong as their supporting data, and are more likely to garner support with more empirical data rather than models. Given significant uncertainties over wildlife harvest and trade, regulations may fail to materialize or prove, at best, arbitrary (Newton and Soehartono 2001).

CITES has improved Party compliance and science-based decision-making despite political sensitivities, through provision of technical support, mission visits and recommendations, simplified reporting procedures, and legal strategies such as warnings and threats of trade suspensions (Reeve 2006; Ghering and Ruffing 2008). Such progress demonstrates CITES recognition of the importance of enhanced enforcement and data collection. Further increasing the demands on CITES Parties and Secretariat is necessary, but remains administratively demanding, costly and politically challenging.

Some of the most urgent solutions (Table 7.3) require the greatest coordination among Parties and institutions. For example, collection of baseline biological data on traded species will require unprecedented levels of coordinated activities among diverse stakeholders, ranging from rural harvesters to multilateral agencies.. CITES has already enhanced data sharing and analysis through collaborations with non-governmental organizations and partnerships such as the Wildlife Enforcement Monitoring System. At the March 2010 CoP, CITES instituted an illegal trade database working group to enhance data collection and analysis (CITES 2010). The majority of proposed solutions depend on enhanced active, sustained and reciprocal engagement of CITES Parties with external partners.

Funding remains a principle limitation to CITES, especially for on-the-ground execution of mandates and for proposed enhancements (Table 7.3; Wilson-Wilde 2010). The Secretariat operates on meager Party donations (Reeve 2006; Wilson-Wilde 2010) of US$5.2M per year for 2009-11 (CITES 2011). National-level funding for CITES enforcement is similarly restricted, especially in many tropical exporting countries. There is a need for Parties, particularly importing nations, to dramatically increase contributions. CITES costs should also be extended to participating industries and consumers, consistent with the “polluter pays” principle, while doing no harm to poor harvesters (Dickson 2008). This can be accomplished through trade levies on CITES-listed wildlife (Nijman 2010), increased infraction penalties (Rosen and Smith 2010; Chaber 2010) and wildlife certification schemes (Warkentin et al. 2009). Only through increased resources can CITES move towards proactive, real-time monitoring and regulation to strengthen enforcement and data quality.

After 35 years, the CITES framework remains highly relevant, and the Secretariat and Parties should continue to facilitate progress among non-compliant countries, and exercise legal tools to create consensus. However, current rigors are inadequate and meaningful improvements will require greater financial and political commitments. We propose targeted CITES negotiations to establish new partnerships, review financial commitments, and develop clear rules and progressive standards for data collection, analysis and review. The challenges are substantial, but improved implementation of the Convention is essential to protect imperiled biodiversity.

Chapter 8:
Local responses to restrictive conservation laws

8.1 Introduction

Conservation legislation that restricts resource access and use is ubiquitous—rules prohibit timber harvest, protect certain species, impose harvest quotas, and limit access to protected areas. The past 20 years have seen a "conservation boom" (in Robbins 2006; Pfeffer et al. 2011), and the large-scale implementation of REDD+ forest carbon policies have the potential to dramatically increase the scope of these restrictions, legislating new limits on extensive farming, fuel wood harvest and small-scale timber extraction.

However, conservation rule-breaking is equally common. In many contexts, restrictive conservation policies conflict with local livelihoods, activities and norms, representative of tensions between state and socially-sanctioned activities and rules (Abrahams and van Schendel 2005; Abrahams 2006; Fig. 8.1).

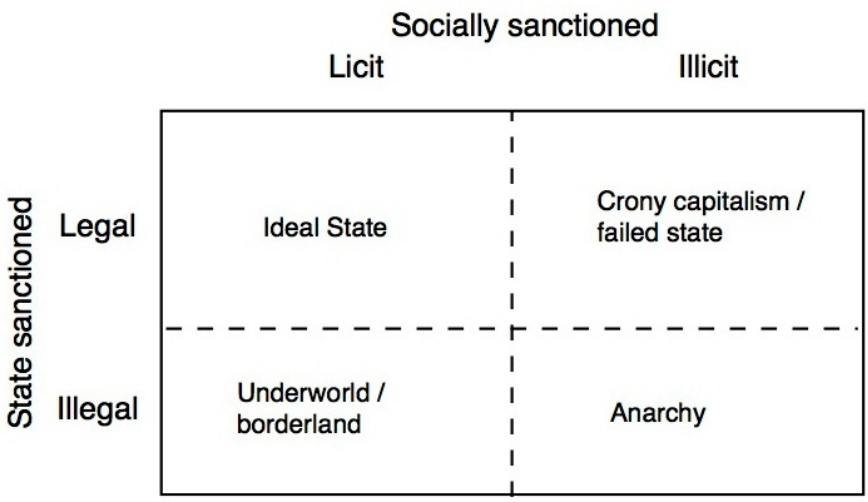


Figure 8.1. Forms of state and social authority (From Abraham 2006)

As a result, illegal resource access is both widespread and often overt. Resource harvest and grazing within protected areas (Weckerle et al. 2010; Robbins et al. 2009) and public sale protected wildlife (Allebone-Webb et al. 2011; Phelps et al. 2010a) often occur within plain view of government agents (e.g., Photo 8.1).

Photo 8.1. Wild ornamental plant market at Chedi Sam Ong, on the Thailand-Myanmar border, and Thai and Burmese government officials from the neighbouring city discuss structural improvements to the Chedi Sam Ong plant market, May 2011.

This gap between *de jure* conservation legislation and *de facto* practices represents a leading challenge to formulating effective conservation policies. There is a need for greater, direct research on how local actors respond to and circumvent restrictive conservation policies (Batterbury and Fernando 2006), especially where state and social norms diverge.

We considered the operationalization of highly restrictive conservation regulations that limit the harvest and trade of protected ornamental plants in continental Southeast Asia. We employed direct study of rule-breaking and document the *de facto* “rules in use” at public plant markets across Thailand. We compared these against declared environmental regulations, highlighting differences between state and socially sanction policies (Fig. 8.1). This reflects a broader interest in governance along the ornamental plant value chain, including relations internal to the trade and their interactions with external forces (i.e. declared conservation policies). We documented evidence that conservation rule-breaking and corruption can be structured around local rules that become locally institutionalized (cf. Robbins' theory natural resource corruption 2000). We looked across to the sites to consider how rule-breaking is operationalized, and discuss the implications of responses to future conservation regulation.

8.2 Methods

We reviewed Thai national regulations related to botanical conservation and the trade of plants to identify the *de jure* regulations, as a basis for identifying and understanding rule-breaking.

We compared these against the rules in practice identified during interviews with traders at six wild plant markets in Thailand , including along the borders with Myanmar and Lao (see Chapter 2 for methods; Map 2.1). The diverse market sites allow for comparative study of conservation rule-breaking—although all within Thailand, trade protected ornamental plant species and are subject to the same national laws and international agreements (CITES), the markets are geographically spread, fall under different local jurisdictions, are of different sizes, and involve plants and traders from different regions and countries.

Site selection and interview methods are detailed in Chapter 2. Notably, sensitive questions about rule-breaking were last during the interviews. They were based on the following questions, which provided a basis for further enquiry about types of rules, frequency of official visits, payments and bribes, confiscations and arrests.

Are there rules against selling wild plants/orchids at this market?

What are the rules for trading plants at this market?

What kinds of government officials visit the orchid stalls in this market, and what do they usually do when they visit?

8.3 Results

8.3.1 Review of *de jure* regulatory context[7]

There have been state restrictions on botanical harvest and trade in Thailand since at least 1941, when selected species and products were declared "Restricted Minor Forest Products", banning their wild harvest except for research purposes (*Forest Act B.E. 2484*)[8]. While the Act allows for household use of 20 plants per species, harvest of all forest products is prohibited within national parks, under a penalty of one-month imprisonment and/or THB1000 fine (~US$33 [*National Park Act B.E. 2504*]). Harvest within national forest reserves is also prohibited, with penalties of 6 months – 5 years imprisonment and/or THB5,000-50,000 fines (*National Forest Reserve Act B.E. 2507*). The 1926 Customs Act further imposes a fine of four times the amount of the price of the goods and/or imprisonment of not more than ten years (*Customs Act 2469*).

[7] Government of Thailand regulations on botanical resource harvest and trade:
Forest Act B.E. 2484, URL: http://thailaws.com/law/t_laws/tlaw0108.pdf;
National Parks Act B.E. 2504, URL: http://www.dnp.go.th/npo/html/law_rule/Law/Law_ENationPark_2504.htm;
National Forest Reserve Act B.E. 2507, URL: http://www.thailawonline.com/en/thai-laws/laws-of-thailand/211-national-reserved-forest-act-be-2507-1964.html
Plant Quarantine Act No. 2 BE 2535, URL: http://www.doa.go.th/ard/download/prb_21.pdf
Customs Act 2469, URL: http://www.customs.go.th/wps/wcm/connect/14026c8a-44db-49a9-9095-7d8eedfd5d13/Customs_Act_2469.pdf?MOD=AJPERES

[8] Nijman and Shepherd (2008) not that the *Wild Animal Reservation and Protection Act 2535* only applies to native species, and cannot be applied to the illegal trade of non-native species, whichi is an important loop-hole for smuggling. Although this act does not apply to flora, similar loopholes may exist.

In 1983, Thailand ratified the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), an international agreement to ensure that international wildlife trade does not threaten species' survival (2012a). Neighbouring Lao PDR and Myanmar became CITES signatories in 2004 and 1997, respectively. The Convention divides species threatened by trade into three tiers of protection (CITES Appendix I, II, III), which are subject to different levels of trade restriction (detailed in Chapter 1). Importantly, CITES Appendix I species cannot be commercially traded, and exceptional permits for cultivated individuals must provide evidence of the source of the plant, the method of propagation, and a CITES registration number. Plants listed on CITES Appendix II can be traded with permits, even if they are of wild origin. However, trade is at the discretion of the national CITES Scientific and Management Authorities, and requires a "Non-Detriment Finding" to demonstrate that the trade will not prejudice conservation (CITES N.D.).

CITES implementation, however, depends principally on individual signatory nations (see Chapter 7). The CITES National Legislation Project rated Thai wildlife trade legislation as a Category 1 standard, considering it "generally adequate to meeting requirements for the implementing CITES regulations" (CITES 2012). This is in contrast to neighbouring Lao PDR and Myanmar, where national legislation failed to meet the requirements for CITES implementation (both Category 3, CITES 2012).

Thailand began to align its national legislation with its CITES commitments in 1992. Notably, the *Plants Act (B.E. 2518)* was modified to include the control, monitoring and management of the trade of endangered plant species; support for propagation and reintroduction of threatened species; control of botanical exports via CITES permitting, and registration of greenhouses propagating CITES-listed species (*Plants Act No.2 B.E. 2535;* the *Plant Quarantine Act No. 2 B.E. 2542* was also modified to represent these changes).

The updated *Plants Act* further charged the Ministry of Agriculture's Department of Agriculture (Plant Varieties Protection Division) with responsibilities as the Thai CITES Secretariat for Flora—including the Management Authority responsible for permitting, and the Scientific Authority responsible for providing advice on wildlife trade decisions and guidelines. Although the Ministry of Natural Resources and Environment remains responsible for conservation monitoring and enforcement in the field, the Department of Agriculture is responsible for CITES permitting, policy guidance, and inspecting imports/exports at Thai points of entry to check permits, uphold regulations, and seize illegal imports. Crucially, in 1998 the Department issued a declaration that only artificially propagated plants could be exported from Thailand (Sripotar 2008). Thai law further outlines specific penalties for illegal wildlife trade: illegal import/export carries 3 months imprisonment and/or a THB3,000 fine (~US$100), and obstruction of an official inspection carries a penalty of 1 month imprisonment and/or THB1,000 fine (~US$33). Additionally, the law specifies that greenhouses growing CITES Appendix I plants must be inspected by the Department prior to receiving a 5-year permit, at a cost of THB500 (~US$16.70). Greenhouses producing plants listed on Appendix II and III require no inspection and receive permits at no cost (*Plants Act B.E. 2535*). In 2008 there were 193 greenhouses registered with the Department, 80% of which principally produced orchids (Sripotar 2008).

8.3.2 Documented *de facto* "rules in use"

Market sites are described in Chapter 2, and the trade networks are described in Chapter 4. Here we document the specific "rules in use" that govern wildlife trade in practice at the six markets, which are summarized in Table 8.1. We employ Abrahams and van Schendel's typology of state versus socially sanctioned activities (2005), and distinguish between legal and illegal activities in reference to *de jure* state legislations, and between licit and illicit activities in refenrence to actions sanctioned by local actors, including local government agents (Fig. 8.1).

Table 8.1. Summary of botanical trade "rules in use" at six plant market sites

Market site	Documented local "rules in use"
Bangkok, Thailand: Jatujak Market	• All wild plant trade was illegal and subject to enforcement. However, traders paid bribes to a number of local government agencies (e.g., local police, Forest Department) in exchange for reduced enforcement, notification of raids and leniency. • The right to trade was heavily contingent on monthly payments to government agents and occasional informal payments to individual officers • Large-scale trade was restricted to a market area out of public view, although small stalls were allowed in the main market on plant market days. • Market rules varied over time, depending on shifts in enforcement priorities. • Greenhouse cultivated plants were legally sold by some traders
Bangkok, Thailand: Sanam Luang II Market	• Wild plant trade was illegal and subject to occasional enforcement. • Wild specimens planted into a pot or tied to piece of wood to resemble cultivated plants could be sold. • Greenhouse cultivated plants were legally sold by some traders
Thai-Lao border: Mukdahan Market	• Smuggling wild plants across the border into Thailand was illegal and subject to enforcement, although traders regulated detection. • Once plants from Lao PDR had entered Thailand, their sale was licit, but the sale of plants harvested in Thailand was illegal and prohibited. • Traders were permitted to sell only small numbers of individual plants; high-volume bulk by the kilo trading was prohibited. • Only market traders from Thailand were permitted to sell plants in the marketplace. • Animal products, including from CITES-listed species, were openly sold by other traders in the market.
Thai-Lao border: Tha Uthen Market,	• Traders were permitted to sell only small numbers of plants; high-volume bulk trading was prohibited • Small payments and gifts were made to local Forest Department officials. • Wild plant trade was permitted only for poor traders with limited livelihood options, but payments of THB10-20 per sack were required by the Forest Department officer on duty. Additionally, traders gave small gifts (food, soft drinks) to the local Forest Department office. • Large-scale trade (>6 sacks) was not permitted and were confiscated; perpetrators were fined by Forest Department at THB200-300 per sack
Thai-Myanmar: Chedi Sam Ong Market	• Wild plant trade was licit and openly permitted, with the exception of orchids protected by Royal decree—those in the genus *Paphiopedilum*, • Wild plant trade was permitted only on the Burmese border within a designated area.

	• Only plants harvested in Myanmar can be sold. • Only trade by Burmese market traders was permitted; sale by Thai traders was prohibited. • Traders were permitted to sell only small amounts of plants, but high-volume bulk trading was prohibited • Thai buyers were permitted to purchase two plastic carrier bags of plants per person. • No regular payments were observed or reported, but traders were over-charged by Burmese officials responsible for a market upgrade in 2012.
Thai-Myanmar border: DanSingkorn Market	• Wild plant trade was considered licit and openly permitted. • Burmese traders were charged a border tax for importing plants, and Immigration officers occasionally took plants for themselves. • Thai traders paid 120 Bhat (~US$4) /month to enforcement, but Burmese traders paid nothing. • Wild plant trade was licit and was openly permitted, with the exception of orchids protected by Royal decree—those in the genus *Paphiopedilum*, which was both illegal and illicit. • Burmese traders were restricted to selling in a designated area, under threat of penalty. However, trade of plants by Thai market traders and displaced Burmese residents was permitted throughout the market. • Burmese children were often sent to make sales through the market because they did not face enforcement. • A small number of Burmese traders (3-5) occasionally sold CITES-listed wild birds, but reported that it was often subject to enforcement.

8.3.2.1 Bangkok: Jatujak

Wild plant traders at Jatujak were formerly allowed to sell openly in the market, but in 1998—concurrent with the Department of Agriculture degree halting wild plant exports—enforcement increased and the number of traders decreased. Remaining traders were directed by government officials to use a separate, more secluded market area on private land, where they paid THB5,000 (~US$167) per month for a permanent stall (Chapter 2, Map 2.2). However, enforcement has again declined, and although large-volume orchid sales were largely restricted to this site, many traders set up smaller temporary stalls at the main plant market.

Traders widely acknowledged that wild plant sales were illegal, and reported paying regular bribes to government officials to secure trading rights. Traders reported collectively gathering THB10,000 (~US$330) each month for bribes, with individual contributions negotiated amongst themselves based on how much they traded. Bribes were given to a low-ranking police officer who reportedly subsequently redistributed it to the local police, officers in the Thai Forest Department, municipal leaders and 911-emergency responders. In exchange, traders were warned prior to official raids, which occurred about once per month and involved both local police and often Forest Department officials. The warning allowed traders to store the bulk of their plants away from view and leave their stalls unattended. If traders were present when officials visit the stalls (sometimes unannounced), they usually informally gave them a small amount of money (~US$8.30). If both types of bribes were paid, the traders reported that they avoided official fines and arrest. During most raids the police and officials only confiscated a few plants as a public demonstration that they conducted a raid.

Occasionally, however, enforcement increased or raids were conducted by other government agencies. In February 2012, for example, several raids were independently led by officials from the Department of National Parks, Wildlife and Plant Conservation. Traders were not warned, and plants were confiscated and traders were arrested on several occasions. Traders reported that these instances usually carried a fine of THB1,000 (~US$33.30), which corresponds with the minimum fine of the *Plant Quarantine Act BE 2542*. Traders reported that the 2012 increase in enforcement might have been the result of growing public controversy over wildlife trade and corruption within the Forest Department in Thailand (e.g., Anon 2012).

8.3.2.2 Bangkok: Sanam Luang II

Traders reported that wild plants sales were illegal at the market, and that they were subject to occasional enforcement that usually involved only confiscation of the plants. However, traders also reported that regulations could be easily circumvented if wild plants were disguised as legal greenhouse-grown plants. Wild plants were planted in pots or tied to pieces of wood and then sold, or were taken into a greenhouse for a few months until they were established and resembled cultivated plants. Traders reported that local officials were familiar with this practice, and that it was accepted.

8.3.2.3 Thai-Lao: Mukdahan

Plants were smuggled across the Mekong River in small boats, at night, with other contraband (e.g., untaxed cigarettes and garlic) (see Chapter 4). Middlemen reported overall increased border enforcement along the River, such that sales among middlemen and to the Mukdahan traders are now highly secretive, usually conducted at night, by special appointment and at undisclosed locations. Plants from Lao PDR were then sold to Thai market traders, as Lao traders were not allowed to sell in the market. There was considerable secrecy regarding cross-river smuggling—market traders were very willing to discuss their plant sales, but most refused to discuss details regarding plant importation into Thailand.

Once the plants entered Thailand, they could be openly traded in the Mukdahan Marketplace (Chapter 2, Map 2.3) which was within 300 meters of a police station, and police were regularly observed on patrol in the market. Almost all traders acknowledged that selling wild plants was illegal, but stated that they were still allowed to trade at the public market if they complied with local rules. Traders reported that Thai Forest Department officials occasionally visited the market and warned them to sell only small volumes of plants. They were also told to trade only plants from Lao PDR, as the Department's responsibility were restricted to protecting Thai wildlife. To this end, several traders reported that they did not trade Thai plants because it is "more illegal" and "more risky" than trading plants from Lao PDR, although some traders also sold plants from Lao PDR (Chapter 4, Table 4.1). Several traders reported that some forestry officials even purchased plants for themselves, or to return them to the wild.

However, traders reported that 1-2 times each year, Forest Department officials made unannounced raids on the market, to confiscate wild plants as a show of force—traders accepted this as a cost of doing business, and several expressed an understanding that government officials were required to perform official responsibilities. Most traders reported fleeing during these raids, although officials very occasionally made arrests. Where arrests did occur, these resulted in a court visit and relatively small fine (~US$33). Key informants reported that the middlemen responsible for importation from Lao PDR were more frequently subject to police action than market traders because they were involved with the cross-border smuggling. In cases of arrest of middlemen and traders, key informants reported that traders generally help one another to pay for bail and fines. However, no payment of bribes was observed or reported by the traders or key informants at Mukdahan.

Several traders in the marketplace were engaged in large volume wholesale within Thailand (Chapter 4, Table 4.4), but these larger exchanges were not carried out in the open and relied on evading enforcement—most were transacted via telephone, used ATM-payments and relies on public buses to transport boxes of plants between markets.

Although beyond the scope of this research, Mukdahan Market also hosted 3-5 traders that openly sold animal products, primarily talismans and collectible items, smuggled in from Lao PDR. This included cat claws and teeth (possibly fake), bear gall bladders, mutjac skulls (*Muntiacus* spp.), serow horns (*Capricornis* spp.) various antlers, pieces of snake skin, primate teeth, squirrel tails, and many boar tusks. This was the only market studied where animal parts were common in open trade.

8.3.2.4 Thai-Lao: Tha Uthen

Respondents confirmed that wildlife trade was illegal. A Lao PDR Forest Department official was regularly at the border crossing on market days to prohibit large-scale plant trade and all animal trade. However, small-scale plant trade by poor traders was openly tolerated in both Lao PDR and Thailand. This was reportedly because traders lacked other income generating opportunities, and all observed trade was relatively small scale. In exchange, officials occasionally received small gifts (food, soft drinks) from traders, and collected a fee of THB10-20 (~US$0.35-0.65) per sack of plants. Larger scale trade (>6 sacks, usually of ~7kgs) was officially prohibited, and plants were reportedly confiscated and traders fined by the Forest Department at 200-THB300 (~US$6.60-10) per sack.

8.3.2.5 Thai-Myanmar: Chedi Sam Ong

Traders reported that officials from the Thai Forest Department infrequently inspected the market (Chapter 2, Map 2.4). Thai traders were prohibited from selling wild plants at the market, but trade by Burmese vendors was permitted. However, Burmese traders reported that they had been warned by Thai officials to sell only plants from Myanmar and not to sell plants in the genus *Paphiopedilum* (CITES Appendix I), and not to sell large volumes of plants. Moreover, Burmese plant traders were required to stay within Myanmar, with their stalls located directly on the borderline. Thai consumers bought products from the traders across the borderline, officially completing the importation themselves, although without clearing immigration or customs. Nevertheless, consumers were limited to two bags of plants per person. This rule was enforced by a Thai police checkpoint on the road leading away from the market, which we frequently encountered.

In 2011, government officials from Thailand and Burma collaborated to further formalize the stalls situated on the borderline, in order to make the site more attractive for Thai tourism. The local Burmese government charged the market traders THB10,000 (~US$330) per mandatory stall upgrade, which was a substantial burden for most of the traders. Several respondents suggested represented corruption by Burmese officials, as the sum far exceeded the costs of the project. However, traders and key informants reported that no direct bribes were paid at this site.

8.3.2.6 Thai-Myanmar: Dan Singkorn

Dan Singkorn market was established as a “special free-trade zone” market by the Prachuap Khirikan Provincial Government (Chapter 2, Map 2.5). The objective was to relax trade restrictions in order to bolster Thailand-Myanmar trade, and to create economic opportunities for displaced Burmese residing in Thailand (many of whom are 2nd generation Thai residents but lack identification cards and have limited rights). Despite signs against wildlife trade and although the market was immediately next to a Thai Immigration and Department of Agriculture CITES checkpoint, traders overwhelmingly reported that wild plant trade at the market is legal, licit and permitted, and traders reported no arrests, confiscations or enforcement. Nevertheless, there were a number of local rules governing the botanical trade in the market.

Burmese plant vendors were traditionally allowed throughout the market for a fee of THB20 (~US$0.66) per weekend day. In 2012, Burmese traders were restricted to the new market area managed by the provincial government (Chapter 2, Map 2.5), with the explanation that they could only be “protected” from the Forest Department if they traded on government land. Burmese traders, however, were exempt from market fees because they were poor and elicit the sympathy of local enforcement. Traders nevertheless sold in the private market opportunistically because it received greater traffic, and often sent children on their behalf because they were not subject to enforcement. Burmese traders did, however, pay to bring wild plants into Thailand. In addition to a standard immigration fee of THB5 (~US$0.17) per person, wild plant traders paid Burmese Customs and Immigration THB50-100 (~US$1.70-3.30) per cart or motorcycle of orchids imported, or paid nothing if they only small imported bags of orchids that they could carry themselves. As the undocumented import of wild orchids into Thailand was illegal, these payments presumably represented instances of corruption. Traders also reported that Thai Immigration officers occasionally took plants for themselves (for their own gardens) without paying. However, traders made no mention of the Thailand Department of Agriculture cross-border checkpoint that is intended to regulate agricultural and wildlife trade into Thailand (Fig. 6). A small number of Burmese vendors (~3-5) also sold wild Hill Minah (*Gracula religiosa*) and Red Breasted Parakeet (*Psittacula alexandri*) from Myanmar, although they reported this was illegal and often subject to enforcement. No other wild animals were observed at the market.

Thai vendors and displaced Burmese living within Thailand traders were required to pay THB120 (~US$3.80) each month for "permission" to trade. Also collected from traders that sold wood furniture, the funds entered communal pot of THB30,000 (~US$1,000) for Thai Customs, Immigration and Border Police. Although a relatively small amount relative to the value of sold goods, these funds were candidly described as requisite for permission to trade.

All groups of traders reported having been warned by the Thai Border Patrol not to sell large volumes of plants, although there did not appear to be particular enforced limits (as compared with, for example, That Uthen). Traders also referenced a prohibition on selling species that the Thai Queen had declared protected, notably orchids in the genus *Paphiopedilum* (CITES Appendix I).

8.4 Discussion

8.4.1 Plant trade relative to forms of authority

Some of the cases encountered at Jatujak and Samam Luang II, where legitimately cultivated greenhouse grown plants were sold (see Chapter 4), were both legal and socially sanctioned (Fig. 8.2, A.). We also encountered cases involving the illegal trade of plants in the genus *Paphiopedilum*, which was also considered illicit (socially unsanctioned), as the genus was protected by Royal Decree. Although also a form of state sanction, the Monarchy holds a unique and pronounced role in Thai society (Bunbongkarn 2010), such that the Royal Decree likely represented overlapping state and social forms of authority (Fig. 8.2, C.). There were, nevertheless, assorted cases of *Paphiopedilum* sales at many markets, suggesting that financial incentives may supersede social sanctions, or that this particular form of social authority is not equally respected by all participants (see Chapter 3).

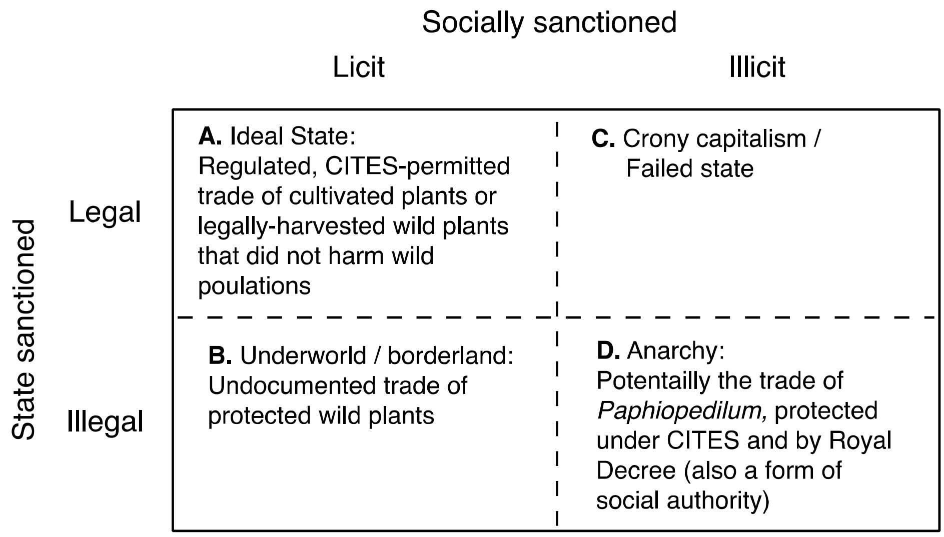


Figure 8.2. Forms of state and social authority applied to ornamental plant trade (Based on Abrahams 2006).

However, the vast majority of documented trade represented activities that were illegal. Regulations against the commercial wild harvest and trade of protected plant species in Thailand were unambiguous, and all cases of wild plant trade at the six study sites represented clear, punishable violations. However, local rule-breaking was widespread, overt and socially sanctioned (Fig. 8.2, B.). These rule-breaking responses to conservation policies were representative of discord between national-level regulations and their local operationalization

8.4.2 Structured, institutionalised rule-breaking

Depictions of conservation rule-breaking in the mainstream conservation literature often allude to smuggling, opportunism, criminality, corruption and weak governance (e.g., Sodhi et al. 2004; Bennett 2011). We documented a number cases that neatly matched these prevailing views of rule-breaking, including organized smuggling across the Mekong River and extensive bribes of officials at Jatujak and Dan Singkorn Markets.

However, we found that the majority of illegal botanical trade did not represent a lack of government control, unrestricted resource access or abandonment of all environmental regulations (see Robbins 2000). On the contrary, a majority of rule-breaking represented illegal but licit practices (Fig. 8.2) that were structured around sets of market-specific rules (Table 8.1). And although traders across the six sites dealt with the same resources and operated within the same national regulatory context, the local exception-based rule systems were heterogeneous. These rules allow for continued resource use and commercialisation, but still placed various restrictions on the scale and nature of trade.

Indeed, *de facto* resource use practices are often governed by local "rules in use" that can be informed by, but differ from declared policies (e.g., Ostrom 1990). As found in several studies on illegal encroachment into protected areas, rule-breaking often indicates the presence of extra-legal or alternative rule systems (Robbins 2000; Wardell and Lund 2006; Ali and Nyborg 2010; Pfeffer et al. 2011). Despite the illusion of strong state control, local actors can heavily shape how national regulations are operationalized (Nagendra and Ostrom 2012). Restrictive policies may be particularly vulnerable to this local reshaping (Wardell and Lund 2006), “so as to be more consistent with the needs of the local population” (Pfeffer et al. 2011). This potentially includes locally interpreting regulations to also accommodate the needs of local state agents, who may gain personal benefits via corruption, or may informally tax rule-breakers in order to support their institutions (e.g., Nyborg and Ali 2010).

However, previous research that has directly studies rule-breaking behaviours has generally described informal social arrangements—payments and resource access that differed from individual to individual based on social networks; were based on individual offenders’ resources; depended on particular government agents’ needs, and/or dependent on the micro-politics within particular agencies (e.g., Wardell and Lund 2006; Robbins 2009; Ali and Nyborg 2010). In contrast, most of the rule-breaking we observed was based on explicit, known rules that guided interactions to “create stable expectations of the behavior of others” (Hodgson 2006; cf. Robbins 2000). Respondent descriptions of the rules at each site were broadly consistent, and rules were consistently applied to the groups/sites/resources to which they applied, independent of social networks or negotiation.

Moreover, trade regularly occurred in the immediate presence of government agents (police, customs, forestry officials), including those with conservation mandates (e.g., Photo 8.1; Chapter 2 site descriptions). Traders reported on interactions with government officials, including inspections without enforcement, warnings to restrict trade volumes, 'soft enforcement' that included token small-scale seizures of illegal products, and bribes (Table 8.1). There was also evidence to suggest that local agents enforced local rule systems, forbidding Thai traders for selling at Dan Singkorn, restricting large-scale traders to the subsidiary market at Jatujak, and specifically warning traders to avoiding selling *Paphiopedilum*. This collective suggests that the rule-based systems we observed were not only recognized by traders themselves, but by many of the local government agents with which they interacted.

8.4.3 Exception-based rule-breaking

Notably, the documented rule-breaking systems were heavily based around exceptions to declared policies. Although still officially illegal, these involved socially-sanctioned exceptions that allowed trade by specific participants, of specific goods/scales, and within specific spaces and jurisdictions (Table 8.2).

Table 8.2. Types and examples of exception-based rules

Types of exceptions	Examples of exception-based rules from the ornamental plant trade
Participants	• Exceptions only for Thai traders at Mukdahan • Exceptions only for poor Lao traders at That Uthen • Exceptions only for Burmese traders at Chedi Sam Ong • Exceptions for the import of plants between Thailand and Myanmar only by Burmese traders at Dan Singkorn • Spatial partitioning of the different categories of traders to different parts of the market at Dan Singkorn
Products and scale	• Exceptions made for trade of wild plants at all the sites, but animal trade prohibited • Exceptions made for trade of 'common' species, but trade of genus *Paphiopedilum* forbidden • Exceptions made for trade of plants harvested from outside Thailand (i.e. plants from Myanmar and Lao PDR) • Exceptions made for wild plants disguised as cultivated plants • Exceptions made for small-scale trade at a number of markets
Space and jurisdiction	• Exceptions made for large-scale trade at Jatujak, but restricted to a separate market area hidden from public view • Exceptions made for trade at Chedi Sam Ong, but restricted to Burmese side of the market • Exceptions made for wild plants from Maynmar at Dan Singkorn, but restricted to a designated part of the government market

At most sites, trade was sanctioned only for a specific community, such as only Burmese traders at Chedi Sam Ong, or only Thai traders at Mukdahan (Table 8.2). Socially-sanctioned exceptions also defined what plants could be traded, and at what scales. For example, traders at the border markets could sell wild orchids harvested from Myanmar and Lao PDR, but not those harvested within Thailand. Most of the markets also had exceptions for small-scale trade, but restricted large-scale commercial trade. Exceptions applied to all ‘common’ orchid species, but trade of *Paphiopedilum* was restricted.

Socially-sanctioned exceptions also had spatial and jurisdictional dimensions. Most notably, plant trade at Chedi Sam Ong trade was allowed on immediately on the Thailand-Myanmar border, but not within Thailand, representative of the nuanced nature governing some of the wildlife trade. At Dan Singkorn, sales by Burmese traders were allowed within the government market but not the private market, and at Jatujak large volume sales were restricted to an isolated part of the market.
The issue of plant origins also represented this jurisdictional issue, as Thai enforcement and conservation agencies were apparently first concerned with protecting domestic wildlife, but not *necessarily* wildlife from overseas.

Collectively, the documented rules allowed for illegal resource commercialization. However, rules also restricted trade scale and participants, selectively operationalizing *de jure* regulations. Even where traders paid bribes to government officials for the rights to trade, they were still subject to restrictions about who, how much, what and where plants could be traded. These restrictions may have been associated with conservation motivations. However, it seems likely that restrictions were also motivated by a need to fulfill official obligations to restrict wildlife trade, while also accommodating local practices and economic needs. There was also evidence, however, that personal gain was an important motivator at some sites, as officials extracted significant resources from wildlife traders, both through bribes, unofficial tax and stall fees at some sites. In this context, remaining regulations (associated with exceptions) may have represented efforts by local government agents to avoid unwanted outside attention, by limiting trade volumes and operationalizing some restrictions, appearing to uphold the law. Indeed, traders at Mukdahan and Jatujak reported that they understood that state officials occasionally had to conduct enforcement raids, so that they could demonstrate they were doing their job.

The reasons, logic and negotiations that have shaped these exceptions are context-specific, ongoing processes shaped by historical context, local politics and institutions, shifts in national and international policy and sentiment (Batterbury and Fernando 2006; e.g., Singh 2008; Wardell and Lund 2006). Better understanding the processes that have given rise to these exception-based rule-systems would offer valuable context for future interventions and improving design of enforcement-based conservation.

8.4.4 Improving monitoring and enforcement

Improved conservation clearly depends on strengthened environmental regulations, monitoring, training, and enforcement (Schaedla 2007). To this end, in 2007 Thailand led the establishment of the Association of Southeast Asian Nations Wildlife Enforcement Network, a regional network of enforcement agencies collaborating to help address illegal wildlife trade through international collaboration and training

(Nijman and Shepherd 2011; ASEAN-WEN 2012). In Chapter 7 we identified a number of strategies through which to further strengthen these efforts. However, more bottom-up approach to understanding of the structure of local rule-breaking highlights several additional strategies through which to strengthen botanical conservation and better address wildlife trade.

Notably, documentation of the marketplace rules identified that botanical trade resources was not considered a pressing issue (cf. Larson 2002). We documented widespread ambivalence towards botanical conservation relative to the conservation of animals, which was generally prohibited (except at Mukdahan Market). There is a clear need to increase awareness of existing environmental laws among the local enforcement bodies charged with implementation. This includes training on the scope of laws, penalties, monitoring and data collection requirements, as well as increased pressure to ensure they implement national laws. There is also a need to integrate botanical conservation at a higher level, including into the ASEAN-WEN policy platform, which has focused principally on fauna. The relegation of plant resource as marginal is often inaccurate (see Chapter 4, Chapter 5), and neglects many species potentially threatened by trade (see Chapter 3).

Rule-breaking analysis at the markets also highlighted that the implementation of existing conservation laws was often limited by jurisdictional ambiguities. For example, many of rules involved exceptions for certain types of cross-border trade. Rule analysis further suggested that enforcement bodies within Thailand generally viewed overseas wildlife as unimportant and/or beyond their purview. There is a clear need for increased cooperation among agencies in the region to address these trans-boundary issues, which could be facilitated via the ASEAN-WEN platform.

Domestic jurisdictional issues also emerged (see also Thitiprasert et al. 2007; DNP 2011a). For example, we documented heavy enforcement against plant smuggling into Thailand from Lao PDR, but once plants were inside Thailand they fell outside their jurisdiction of border police. Similarly, while the Department of Agriculture was responsible for import and export of CITES-listed wildlife, it had limited control over resources already within the country, or for sale at public markets. Officers from the Department of National Parks, Wildlife and Plant Conservation were also limited in their ability to regulate trade once poached wildlife had left protected areas (DNP 2011a). There is a clear need for increased cooperation among these agencies, as well as further legal review to identify existing legislative barriers and opportunities for enhanced cooperation.

In 2011, Thailand began to establish an Office of Conservation Management with 16 regional offices. The Office was placed under the Ministry of Natural Resources and Environment, and will reportedly focus largely on botanical conservation. The Office is to help meet CITES commitments on plant conservation, and to improve collaboration among related government agencies, including the Department of Agriculture, border policy patrol, plant quarantine offices, local government units and natural resources officers responsible for monitoring (DNP 2011b).

8.4.5 Aligning state and social forms of authority

However, analysis of market practices also suggested that that rule-breaking was institutionalized, recognized not only by traders but local government agents charged with implementing conservation laws. These arrangements are potentially hard to address because they suggest that existing regulations conflict with social norms, and that rule-breaking was widely accepted. In fact, analysis the market rules suggested that local livelihood needs were often prioritized over conservation.

As such, there is apparently a need to go beyond traditional enforcement training to also engage local government agents to better appreciate and respect conservation regulations, including for botanical resources. This represents an important distinction between simply increasing environmental knowledge and deeper environmental education capable of shifting attitudes and beliefs (Pooley et al. 2000). ASEAN-WEN and conservation NGOs are particularly well positioned to help provide this support, although they too have potentially lacked a broad environmental education focus (in contrast with more technical training).

Increased public educational engagement could also play an important role in increasing awareness about regulations (Keane et al. 2011), and potentially better aligning state and social authority (cf. Zhang et al. 2008). For example, rule analysis highlighted that while exceptions were created to allow for the trade of most orchids, species protected under Royal decree, which had been widely publicised via television, were recognized by traders at several sites (Figure 8.2; although see Chapter 3, Fig. 3.7). Similar efforts have aligned conservation objectives with social norms in Southeast Asia based on religious associations (e.g., Darlington 1998;

Gayalwang Karmapa and Dorje 2011). Theses cases highlight the potential for motivating conservation through alternative and supplementary interventions, rather than relying exclusively on traditional enforcement.

8.4.6 Scope for polycentric governance?

Juxtaposing socially sanctioned practices and *de jure* policies potentially reasserts a somewhat artificial dichotomy; our results confirm that resource management practices are informed by multiple levels of governance. The criminalization of local activities did not necessarily stop local practices or even drive them into hidden black market trade (cf. Abrahams and van Schendel 2005). On the contrary, we documented a diversity of local responses, as local agents sought to implement national laws while accommodating local practices and needs, and gain personal benefits through corruption. The alternative systems we observed suggest significant resilience and local ability to circumvent state legislation, challenging traditional enforcement-based conservation approaches.

There is also growing recognition of the flaws of "policy panaceas" such as increased regulation and enforcement, and the need for more nuanced "diagnosis" and more critical solutions that better consider the socio-ecological complexity of resource management (Ostrom 2007; Robbins et al. 2009; Ostrom and Cox 2010). These factors suggest a need to consider shifts in the ways wildlife and forest resources are governed. Polycentric governance approaches that recognize and engage actors at the different levels of governance may represent a more realistic and functional approaches to resource management (see Nagendra and Ostrom 2012).

Notably, many of the exception-based rules we identified in the ornamental plant trade related to the tensions between broad-reaching state regulations and local livelihoods. In particular, many rules existed to accommodate small-scale resource harvesters and traders. While there is a need to operate within the restraints of CITES decisions and for national laws to protect threatened wildlife, there is also a need for implementation that accounts for local needs, and to ensure that precautionary conservation measures do not place excessive burdens on resource users (see Chapter 3, Chapter 5).

To this end, there is potential for more nuanced domestic management of botanical resources and to the trade of Appendix II plant species that are not threatened. This could potentially involve greater local-level engagement in managing ornamental plant resources, including sustainable harvest or cultivation from cuttings (see Chapter 3). There are existing cases of successful multi-level governance of natural resources in Thailand (e.g., Lebel et al. 2008; Yong et al. 2003). Myanmar has also devolved considerable rights and responsibilities for forest resource management toward rural communities (Oo 2003), and there is growing focus local resource management (e.g., Triraganon 2012).

Efforts to move from exploitative resource extraction toward more deliberate and sustainable management would require not only considerable ecological research and economic incentives, but improved resource governance (Chapter 3; Chapter 6, Fig. 6.1). There are also considerable challenges to operationalizing polycentric governance (Nagendra and Ostrom 2012). Most notably, rule analysis at the plant markets documented corruption at many, but not all, of the sites. Although a known phenomenon within regional wildlife trade, we were able to document the scale of the associated payments and found that these were often accepted, formalised and public facets of the trade. We also documented the coordination of bribes across government agencies at single sites. For example, different government agencies jointly collected bribes at Jatujak and Dan Singkorn Markets, and Thai and Burmese officials cooperated to charge plant traders at Chedi Sam Ong for a mandatory market upgrade. Similar phenomena are also likely in the botanical trade networks within Maynmar and Lao PDR. However, improved multi-level governance could potentially help by increasing accountability and communication, and by formalizing checks-and-balances. To this end, some degree of central oversight seems necessary, in order to harmonize implementation of trade regulations across the country. Thailand's new Office of Conservation Management could serve a critical role in helping to improve coordination and recognition of the multiple levels at which wildlife trade management occurs.

A more multi-level governance approach might also involve a review existing conservation legislation and its implementation within Thailand . There is, for example, potential to engage provincial and local-level authorities in order to understand the nature of wildlife trade in their regions, and to design and formalize domestic policies and action plants that better reflect realities on the ground. This process might simply result in increased enforcement to comply existing laws, but could foreseeably also yield more diverse proposals. For example, there might be scope to decriminalize some types of botanical trade, while increasing enforcement against others (large-scale, commercial); increase public education efforts and gradually increase enforcement, or even formalize some of the exception-based rules we identified at markets. Greater multi-level engagement might also help to identify and address jurisdictional ambiguities, and/or identify the institutional arrangements best suited to managing and enforcing wildlife trade at different sites. This type of engagement might not only yield more effective plans of action, but is critical to ensuring “buy-in” to align state and social forms of authority (cf. Pascual, Phelps et al. in prep.).

8.5 Conclusion

Comparing *de jure* rules against *de facto* practices highlights the challenges of operationalizing top-down conservation policies to protect a range of wildlife resources; our study sites also hosted illegal, small-scale trade of medicinal plants, wood furniture, pet animals and live birds, bushmeat, and wild animal-based talismans, trophies and medicines. The restrictive policies placed on many ornamental plant species also mirror global CITES policies and wildlife regulation in many tropical developing countries.

Moreover, increased regulation on timber exports to Europe and the United States, as well as incipient interventions to Reduce Emissions from Deforestation and forest Degradation (REDD+) are likely to increase regulation and prohibitions on local resource access and trade (Phelps et al. 2010b). These expanding regulations are likely to face similar rule-breaking responses. Forest degradation resulting from local practices such as fuel wood harvest and small-scale forest encroachment by subsistence farmers, REDD+ restrictions could place significant burdens on local resource users. This may spur conflict in some contexts (e.g., Beymer-Farris and Bassett 2012), but potentially also various forms of rule-breaking. These may involve informal social arrangements, corruption and collusion in many cases. We further suggest that they can also result in more structured *de facto* local rules that conflict with, but supersede national regulations.

Within this context of mounting environmental regulations (see also Robbins 2000; Pfeffer *et al.* 2011), it is important to understand how rule-breaking differs from declared policies, and to view rule-breaking from the perspective of its participants (cf. de Sardan 1999). There are admittedly considerable challenges to directly studying and documenting rule-breaking practices, although it is feasible and can yield useful outcomes. We identified on-the-ground rules that could not have been disentangled from a single-site/single-nation study, model-based approaches, official government sources, secondary sources, or interviews with non-government organisations and key informants alone (see von Lampe 2012). The resulting insights are valuable to developing effective, just interventions and to identifying more optimal resource management arrangements. The approach also avoids heavy reliance on the assumptions and caricatures that have often guided conservation policy, and potentially moves beyond simplistic calls for improved enforcement (Robbins 2000; Robbins et al. 2009).

Chapter 9: Conclusion

This exploratory study documents a previously unrecognized facet of the region's wildlife trade. It provides a baseline of the ornamental plant species and regions most targeted by trade, documents principle trade dynamics and main participants, and highlights wild ornamental plants as economically valuable, if under-recognised, natural resources. It provides data critical to targeting future interventions. This baseline, however, has relevance beyond the conservation of ornamental plants. It identifies sites of trade and patterns that may also be significant to other taxa. It further leverages the case of ornamental plants to explore broader trade phenomena including: the potential for wildlife farming to yield conservation outcomes and alternative livelihoods; the effectiveness of existing CITES regulations, and the challenges associated with local rule-breaking practices to circumvent environmental regulations. The study also provides broad insights into the complexities of botanical resource governance, including issues such as over-regulation, the challenges of enforcement of "look-alike" species, barriers to monitoring complex trade networks and "complex goods", and the need to account for various human dimensions of wildlife trade.

9.1 Revisiting CITES

Notably, the study details a trade phenomenon that was not apparent from CITES data (cf. Blundel and Mascia 2005). Our market survey data and official statistics differed dramatically, exemplifying the inadequacy of existing wildlife trade monitoring and enforcement in the region. It also illustrates a particular neglect of botanical resources. Independent, external reviews can serve a critical role in identifying emerging and 'hidden' trade issues (e.g. Davenport and Ndangalasi 2003; Shepherd and Nijman 2007). It seems likely that there are other, significant trade phenomena in species that are either not covered under CITES legislation or are not detected because of weak monitoring and enforcement.

These discrepancies fundamentally challenge the credibility of CITES data and its effectiveness as a multilateral agreement. It also potentially undermines analyses based on CITES data, including evaluations used during CITES negotiations (e.g., Appendix listing processes) and IUCN Red Listing processes that consider trade as part of their threat evaluations. The study plainly highlights the need for improved CITES implementation, and proposes some strategies through which this could be achieved.

Yet, the research also highlights the challenges associated with over-regulation. We found that trade restrictions applied to hundreds more species than are actually in trade, and consider the benefits and challenges of more targeted interventions to protect species most targeted and potentially threatened by commercial trade. It also highlights the potential for, but substantial challenges to establishing a more sustainable regional trade in wild orchids.

The discussion of plant resource management mirrors a broader debate about the suitability and effectiveness of broad trade restrictions. This is particularly challenging in the context of "look alike" species and taxonomic obscurity, and whether a precautionary conservation approach is efficient, effective or fair to resource users. This debate is particularly relevant in the context of the recent CITES listing of valuable, threatened timber species and new timber trade legislation in the United States and European Union.

9.2 Accounting for complex networks and value chains

It has been previously suggested that wildlife trade networks are often complex, which constrains enforcement efforts (see Wyatt 2009; Moyle 2009; Nijman 2010). However, the challenges of wildlife trade research have limited in-depth exploration or mapping of these dynamics. Research on botanical trade provides a comparatively accessible point for study on illegal wildlife trade dynamics (when compared with, for example, trade in tiger parts). As a result, this study provides unusually detailed insights into the nuances and complexity of wildlife trade dynamics, uncovering a diversity of stakeholders, site-specific rules, and geographic trade routes.

These serve to identify priority sites for intervention, many of which are specific to the ornamental plant trade, including geographic areas of targeted harvest and bottlenecks. However, some of the findings are potentially applicable to other taxa, including timber and wildlife harvested in Lao PDR and Myanmar for Thai markets (e.g., Shepherd and Nijman 2007). For example, we highlighted the importance of bus-based transport to wildlife trade and its potential to serve as a novel point of entry for conservation interventions. We also highlighted possible strategies through which local actors *may* respond to restrictive conservation policies. Such direct observations of rule-breaking across the value chain highlight the need for more targeted conservation interventions that consider local needs and context, including how resources are managed at each site according to local rule sets. The results also highlighted the need, as in the case of *Rhynchostylis gigantea,* to consider conservation interventions along the value chain, rather than as isolated actions (cf. Bowen-Jones et al. 2003). Interventions should include: increased and more dynamic monitoring and enforcement at multiple points along trade routes, as well as alternative livelihood development, substitutions and wildlife farming, and conservation education. This broader approach may be necessary to creating more systemic changes, and starkly contrasts with the traditional approach based on occasional, site-specific enforcement.

9.3 Governing "complex goods"

We documented large-scale, high-value and largely unregulated trade of wild plants, including threatened and endangered species, suggesting that formal regulation is indeed appropriate. Increased monitoring effort and improved training are obvious and achievable goals for improving botanical conservation in the region. However, the example of ornamental plant trade also highlights the challenges of managing and regulating "complex goods".

Botanical resources include a wide range of species, characterized by specific life history traits, harvest intensities and management systems. Yet, they are often conceptualized and managed as similar goods (see Belcher 2003); the ensuing legislation has generally neglected complexity (Laird et al. 2011). Recent research has increasingly reflected on the challenges of governing such "complex goods", and resoundingly calls for more nuanced approaches to managing botanical resources (e.g., Wynberg and Laird 2007; Laird et al. 2011; Ros-Tonen and Kusters 2011).

Within the Southeast Asian ornamental orchid trade we identified hundreds of species and identified differences in levels of trade intensity, rarity, prices, trade participants and patterns. For example, trade was so variable among sites that it was difficult to even identify a suite of species that were common to all of the target markets, in order to allow for cross-site comparisons. Trade volumes and targeted species also varied, even during the short duration of the study.

Despite this considerable heterogeneity and dynamism, all of the species and sites were subject to generic trade restrictions under both CITES and domestic legislation. The only distinction was the CITES Appendix I designation for a small number of species. This lack of nuance echoes critiques about the conceptual and practical challenges associated with managing broad categories of NTFP species as single goods (Belcher 2003; Laird et al. 2011). This fallacy of ambiguity can lead to false assumptions about harvest sustainability, the importance of NTFP to rural livelihoods, the adequacy of existing regulations, or the viability of using wildlife farming to yield conservation outcomes (see Belcher 2003).

This study similarly noted the need for greater regulatory specificity, although this admittedly faces considerable practical challenges. The taxonomic obscurity associated with "look alike" species stymies many species-level identifications and makes genus-level identification challenging in many cases. Moreover, there is a need to avoid monitoring burdens and limit bureaucratic processing. Nevertheless, regulated ornamental plant trade could potentially be managed through a limited number of sites capable of the processing demands, and there is clear potential to improve capacity among customs and enforcement. There is also potential to provide training and taxonomic keys to distinguish among the major orchid genera, notably distinguishing CITES Appendix I species. Existing regulatory mechanisms would allow for more nuanced management, as most Orchidaceae are already listed on CITES Appendix II. Given non-detriment findings and permitting, there is potential to explore a regulated trade of wild ornamental plants, at least of some species. Despite the associated challenges and costs, the high value of many wildlife species and potential for tax revenues could mean that additional effort may be financially viable and attractive. These types of debates are increasingly important and challenging as more high-value taxa, including valuable timber and shark species, are added to the CITES Appendices.

9.4 Factoring-in human dimensions of wildlife trade

This study considers various human dimensions of conservation with the explicit aim of improving the management of botanical resources through strengthened monitoring and enforcement. However, improved management must also reflect lessons from environmental governance by also accounting human dimensions such as for livelihood needs, transparent decision-making, social equity and legitimacy (Ros-Tonen and Kusters 2011; Pascual, Phelps et al. in prep.). Evidence from across the NTFP literature suggests that rules to govern botanical resources are strengthened where they also reflect stakeholders' needs and hold local legitimacy (Wynberg and Laird 2007; Laird et al. 2011).

To this end, we characterized wild plant harvesters and traders, considering household economic dependence, gender, years of involvement, personal motivations, levels of educational attainment, and access to alternative employment. The study also considered the microinstitutions that governed wild plant trade practices at the target plant markets. These types of more nuanced socio-economic and institutional analyses are important to moving away from coarse characterizations of criminal wildlife traders, and to informing more targeted interventions, and weighing the potential for alternative livelihoods. Notably, our focus on socio-economic dimensions of trade helped to evaluate the social costs of enforcement.

However, with this baseline, there would be benefits to consulting trade participants and consumers in order to improve regulations and implementation in ways that also seek to accommodate existing needs and practices (cf. Laird et al. 2011). Notably, there may be scope for limited trade in CITES Appendix II species and non-CITES listed ornamental plants. Regulated trade would require not only ecological research and improved enforcement, but engagement with plant harvesters and traders. There is potential to borrow tools from participatory NTFP planning and commercialisation (e.g., ANSAB 2010) to further understand existing trade, and to collaboratively identify opportunities and barriers to improved management and regulation. Where sustainable trade is not possible, engaging wildlife harvesters and traders could help to identify viable alternatives—whether alternative livelihoods, education or incentives—that can help to manage conflicts over wildlife. Far from naïve, managing conservation conflicts, while challenging, often involves participatory and deliberative processes (Redpath et al. 2012).

Accounting for human dimensions of wildlife trade also extends across the value chain to consumers. Although we did not focus on the role of consumers, they emerged as important factors. There is a need to better understand patterns in consumer demand, awareness about conservation laws, preferences for supply-side interventions and emerging Internet-based trade, and responses to increased enforcement. Similarly, there is a need to better consider institutional dimensionsof trade, by engaging government agencies and official in order to better understand the various barriers to implementing existing laws, training and resource needs, opportunities to harmonize rules and roles across agencies.

9.5 Conducting research on illegal wildlife trade

This study also yielded insights for future research on illegal wildlife trade.
With a few notable exceptions, wildlife trade research has relied heavily on government statistics and "snap-shot" assessments of wildlife markets. Moreover, commercial botanical trade has been largely overlooked. These gaps are indicative of the considerable barriers to conducting wildlife trade research. Nevertheless, it is clearly possible and valuable to conduct direct research on conservation rule-breaking, including illegal wildlife trade.

9.5.1 Identifying "points of entry" for research

In the face of highly complex trade networks, it can be challenging to follow entire value chains and identify participants, limiting both research and enforcement. Identifying accessible "points of entry" is critical to documenting and understanding trade dynamics. We found that focus on these "points"—certain goods, sites and points in the value chain about which it was feasible to gather data—allowed us to reflect on broader trade dynamics. This nodes yielded insights into dimensions of the trade that were otherwise geographically inaccessible (e.g., upstream collectors), secretive (e.g., cross-border smuggling, corruption), invisible (e.g., roles of middlemen) or uncodified (e.g., market-specific rules). These details are necessary in order to geographically target interventions, identify bottlenecks and help to identify the viability of interventions such as alternative livelihood development and enforcement.

As demonstrated by this study, public markets present particularly valuable points of entry through which to conduct research on illegal trade. As public spaces, they are accessible, products are often on display, transactions are readily observable, and participants from across the market chain often converge at public markets. Markets also provide access to consumers, and opportunities to study their preferences and motivations. In the Southeast Asian context, markets are often sites of wildlife trade, and so are particularly appropriate sites for research and enforcement.

Moreover, markets—particularly borderland markets—can provide further insights within the broader trade value chain, as they can serve as geographic funnels and are also often spaces where different goods, people and rule-systems converge to form unique arrangements (cf. Kusakabe 2004; van Schendel 2006; Burns and Miggelbrink 2011). As a result, markets can provide not only direct access to market-based actors, but links up, down and across market chains, and access to respondents who often know a good deal about broader trade dynamics.

While points of entry implies a geographic focus, specific goods can also serve as point for exploring broader sets of issues. While the trade of rare, high-value, tightly enforced goods such as ivory and big cats may be particularly secretive and hard to study, many other wildlife products are publicly traded, including medicinal plants and animals, bushmeat, pets, trophies and talismans. These can provide opportunities for research. In the case of this study, the open trade of ornamental plants provided a "point of entry" for understanding an illegal trade, which in many cases is closed to researchers. The ornamental plant case study was used to consider issues related to regional enforcement, the effectiveness of trade bans, the challenges to CITES enforcement, the viability of wildlife farming, and the nature of local rule-breaking. While there is a need to be cautious with extrapolation, the accessible case studies can be successfully leveraged to draw much broader conclusions (e.g., Phelps et al. 2010; Phelps et al. In press).

9.5.2 Human dimensions influence methods

This study also highlighted the importance of recognising the human dimensions of trade, and to look beyond a purely legalistic view of conservation. However, not only are these social dimensions important to informing future interventions, they also heavily shape research methods.

Traders and harvesters had a great deal of information about the plants they collected and traded, yielding insights about plant origins, trade networks and regulatory failures, points instrumental to improving conservation interventions and enforcement. We found that, despite concerns over legality, traders were willing to share many details. However, access to information and social networks often depended heavily on relationships (see de Albuquerque et al. 2007; Sylvester and Avalos 2009; Burns and Miggelbrink 2011), which were slow to develop, required language skills, and considerable "hanging out" prior to the start of research, particularly at sites subject to greater enforcement where participants were more wary. While direct study of conservation rule-breaking is not possible in all contexts, there are perhaps greater opportunities than is often acknowledged. And there is clear need for conservationists to more confidently borrow social science methods, including but also beyond traditional socio-economic surveys to include ethnographic methods with which many natural scientists are potentially unfamiliar and/or uncomfortable.

Government institutions and individual agents are also critical stakeholders when considering implementation of conservation rules. Engaging the actors in research and improved implementation, however, can represent a challenge that also bears influence on research methods. This experience highlighted the limitations of cold-calling relevant government agencies to participate in research, as well as of efforts to establish both ground-up and informal collaborations. While potentially effective in some contexts, this study highlighted the need for high-level institutional buy-in to ensure cooperation and information exchange. This may best be achieved through institutional-level memoranda of understanding, joint funding commitments (i.e. providing some funding to government patterns while requesting some financial or staff commitments), and early joint drafting of carefully-worded research proposals that represent the interest of all parties.

9.5.3 Limitations of traditional methods

We faced limitations when to trying to apply traditional analytic techniques and frameworks to illegal wildlife trade. The informality of the market places and the complexity of the target goods meant that most traders did not keep records, did not order consistent volumes or the same species over time. Moreover, goods (both species sold and sale units [kilo or piece]) varied across sites and among actors. This informality limited, for example, our ability to conduct traditional value chain economic analysis.

We also found that traditional taxonomic methods, including collecting multiple vouchers, collecting live plants to bloom in greenhouses for later identification, were challenging or infeasible in the context of illegal wildlife trade research because of concerns over legality and budget. As a result, we had to identify alternative, more applied taxonomic methods, including selection of target species and establishing an identification hierarchy. Accurate identification also represented a challenge when asking traders to identify species, even when using photographs to refer to specific species. As such, we generally did not rely on trader identifications. Volumes of ornamental plant were also difficult to document because units were not consistent and transactions were highly informal, unlike, for example, most agricultural commodities or charcoal. This also made it difficult for traders to recall trade volumes over time.

Some botanical trade also occurred beyond our access, either on the black market or via the internet. We were also unable to follow all of the trade routes to their source due to secrecy, principally by middlemen regarding their plant sources. These barriers fundamentally limited our ability to fully document trade dynamics. Similarly, while we were able to collect considerable information about trade networks, it proved infeasible to collect enough, reliable data to conduct a formal Social Network Analysis (cf. Scott 2000).

These types of challenges are intrinsic to research on sensitive topics. Nevertheless, we found it possible to capture and describe salient trade dynamics in a level of detail unusual to wildlife trade studies. This required heavy reliance on exploratory, investigative approach that depended on word of mouth, relationships, introductions and observations, including to identify market sites and up and down-stream respondents. It also required careful design and trial of interview instruments to accommodate for informal discussion and anecdotes. We found that ranking exercises provided insights into broader trade dynamics, including geographic networks, relationships among actors and rules. Cross-checking details with multiple respondents was also productive; details that could not be clearly determined from one interview could be explored during discussions with other respondents and key informants. Most notably, this approach required careful respondent management and sensitivity.

However, this type of study is incapable of yielding the empirically robust quantitative results possible in other research environments. In this context, we found that efforts to conduct exhaustive interviews and sampling were potentially unnecessary to identifying the salient trends (see Guest et al. 2006) that are most necessary to inform conservation interventions and policy. Future research efforts should consider whether saturation sampling is truly necessary, and how resources might be better allocated.

For example, greater resources could be invested into non-traditional research methods in order to extract more detailed information about wildlife trade. Notably, there is considerable opportunity to explore tools from fields such as criminology and transport security, particularly black market wildlife trade (cf. Warchol 2004). Covert and deceptive methods such as market and participant surveillance to identify key actors (such as middlemen) and create participant profiles; physical tracking of participants; interception of telephone conversations; use of paid or planted informants, and/or product marking (e.g., using ultraviolet marking or microchips) likely represent valuable supplements to understanding illegal wildlife trade. The current study provides the baseline necessary to potentially explore more alternative methods.

9.5.4 Structuring and conceptualizing wildlife trade dynamics

Given the limitations of wildlife trade research, the resulting eclectic datasets, remaining data gaps and the complexity of associated trade dynamics, there is a particular need to provide structure, coherence and conceptual clarity. This research employed several complementary conceptual frameworks, not only as heuristic tools, but to identifying appropriate methods and identify prospective conservation interventions.

For example, we relied on the contrast of state and social forms of authority developed by Abrahams and van Schendel (2005; 2006) to think about conservation laws and their relationships to local practices (see Chapter 8). The framework helped not only to structure the discussion of rule-breaking, but informed our methods. In particular, it highlighted the need to more formally document local practices in order to understand how they differed from declared policies. The ensuing comparison helped to reveal existing limitations in the implementation of wildlife trade laws and areas for future interventions.

The study also relied heavily on a Value Chain Analysis (VCA) to provide structure to our study, particularly considering the complexity of the market chains. The VCA approach has been used in research on NTFPs, but had not been previously exploited as a framework for studying illegal wildlife trade. Despite some important limitations (see Chapter 2 and 9.5.3), we found that VCA was helpful to guiding questions about the various geographic, economic, participant and governance factors that are critical to describing and understanding wildlife trade and to identifying appropriate interventions. The framework was also helpful for triangulation and for integrating qualitative and quantitative datasets. As discussed, this approach yielded information on geographic targeting and bottlenecks important to tailoring conservation interventions.

Additionally, we developed two descriptive category-based frameworks through which to organize our understanding of wildlife trade interventions. This included four broad approaches to enhancing the implementation of CITES (see Chapter 4). This helped to identify and categorize sets of specific policy interventions from across the wildlife trade literature and our experience in order to improve wildlife trade regulation. We used a similar category-based approach to integrate lessons from the wildlife literature to create a checklist of the major factors that influence the success of wildlife farming efforts. This served to structure the assessment of *Rhynchostylis gigantea*, helping to guide data collection and identify future interventions (Chapter 6).

The study also relied on a framework for conceptualizing the relationships between the various biophysical, market and regulatory aspects that influence wildlife trade (see Chapter 6). That framework served principally to structure the analysis of wildlife farming, linking farming into the broader set of issues discussed across the thesis, including alternative employment, trade dynamics and enforcement. This specifically highlighted the importance of conservation interventions across the value chain.

Especially in the context of exploratory and descriptive research on highly complex topics, conceptual frameworks are necessary to better understand and organize research on wildlife trade networks. They can help to guide research questions, data collections and analysis, including development of proposed interventions. Indeed, this research highlights not only the need and challenges associated with improved wildlife trade monitoring and regulation, but the need for conceptual clarity over wildlife trade dynamics and associated conservation interventions.

References

Abbot, B., van Kooten, G.C. 2011. Can domestication of wildlife lead to conservation? The economics of tiger farming in China. *Ecological Economics* 70:721-728.

Abrahams, I. 2006. Illegal but licit. *International Institute for Asia Studies Newsletter* 42, Leiden, Netherlands. URL: www.iias.nl/nl/42/IIAS_NL42_02.pdf.

Abraham, I., Van Schendel, W. 2005. The making of illicitness. In: Van Schendel, W., Abraham, I. (Eds.). Illicit Flows and Criminal Things: States, Borders, and the Other Side of Globalization. Indiana University Press, Bloomington.

Adams, B., *et al.* 2004. Biodiversity conservation and the eradication of poverty. *Science* 306:1146-1149.

Alacs, E.A., Georges, A., FitzSimmons, N.N. 2009. DNA detective: a review of molecular approaches to wildlife forensics. *Forensic Science, Medicine, and Pathology* 6:180-194.

Ali, J., Nyborg, I.L. 2010. Corruption or an alternative system? Re-assessing corruption and the role of the forest services in the Northern Areas, Pakistan. *International Forestry Review* 12:209-220.

Allebone-Webb, S.M., et al. 2011. Use of market data to assess bushmeat hunting sustainability in Equatorial Guinea. *Conservation Biology* 23:597-606.

Amir, O.G. 2006. Wildlife trade in Somalia. IUCN Species Survival Commission, Antelope Specialist Group, Northeast African Subgroup. URL: www.madhiban.com/somali-wildlife-trade.pdf.

Anantarangasi, S. 2011. Study of cross-border trading of Myanmar and Thailand: Review of the unseen importance of Maw Danung and Dan Singkorn Checkpoints. *SIU Journal of Management* 1:41-57.

Anon. 18 Jan., 2012. Assistant park chief surrenders in elephant case. Bangkok Post. URL: http://www.bangkokpost.com/news/local/275594/assistant-park-chief-surrenders-in-elephant-case.

(ANSAB) Asian Network for Sustainable Agriculture and Bioresources. 2010. Participatory inventory of non-timber forest products. Kathmandu, Nepal. URL: http://www.ansab.org/wp-content/uploads/2010/10/2.-PARTICIPATORY-INVENTORY_05102010.pdf.

(ARC) Alliance of Religions and Conservation. 2013. Sacred orchids and Sunday palms in Mexico conservation project. URL: http://www.arcworld.org/projects.asp?projectID=311

(ASEAN-WEN) Association of Southeast Asian Nations-Wildlife Enforcement Network. 2012. URL: http://www.asean-wen.org.

(ASEAN-WEN) Association of Southeast Asian Nations-Wildlife Enforcement Network. 2012b. Thai-WEN and ASEAN-WEN PCU Visit to Myanmar-Thailand Wildlife Border Checkpoint in Mae Sot. URL: http://www.asean-wen.org/index.php/news-announcements/335-thai-wen-and-asean-wen-pcu-visit-to-myanmar-thailand-wildlife-border-checkpoint-in-mae-sot.

Ashwell, D., Walston, N. 2008. An overview of the use and trade of plants and animals in traditional medicine systems in Cambodia. TRAFFIC Southeast Asia, Ha Noi. URL: www.traffic.org/medicinal-reports/traffic_pub_medicinal3.pdf.

Augustin, K.N. 2011. Functioning of farm-grown timber value chains: lessons from the smallholder-produced teak (*Tectona grandis* L.f.) poles value chain in Southern Benin. *Forest Policy and Economics* 15:98-107.

Averyanov, L., Cribb, P., Loc, P.K., Hiep, N.T. 2003. Slipper orchids of Vietnam. Kew Publishing, UK.

Averyanov, L., Loc, P.K., Hiep, N.T., The, P.V., Canh, C.X., Vinh, N.T. 2010. Assessment of distribution and natural status of *Paphiopedilum canhii*, Vietnam. Report for The Rufford Small Grant Foundation. URL: http://www.rufford.org/rsg/projects/leonid_averyanov.

Barrett, C.B., Gibson, C.C., Hoffman, B., McCubbins, M.D. 2006. The complex links between governance and biodiversity. *Conservation Biology* 20:1358-1366.

Basu, G. 2013. The role of transnational smuggling operations in illicit supply chains. *Journal of Transportation Security*. 10.1007/s12198-013-0118-y.

Batterbury, S.P.J., Fernando, J.L. 2006. Rescaling governance and the impacts of political and environmental decentralization: an introduction. *World Development* 34:1851-1863.

Belcher, B.M. 1998. A production-to-consumption systems approach: lessons from the bamboo and rattan sectors in Asia. In: Wollenberg, E., Ingles, A. (Eds.) Incomes from the Forest: Methods for the development and conservation of forest products for local communities. Center for International Forestry Research, Bogor. URL: www.cifor.org/publications/pdf_files/Books/Incomes.pdf.

Belcher, B., and K. Kusters. 2004. Non-timber forest produce commercialisation: development and conservation lessons. In Kusters, K and Belcher, B. (Eds.) Forest Products, Livelihoods and Conservation. CIFOR, Bogor, Indonesia. URL: http://www.cifor.org/ntfpcd/pdf/NTFP-Asia-R.PDF.

Belcher, B. 2003. What isn't an NTFP? Centre for International Forestry Research, Bogor, Indonesia. URL: www.cifor.org/ntfpcd/pdf/IFR_Defn_final.pdf.

Belcher, B., Ruiz-Perez, M, Achdiawan, R. 2005. Global patterns and trends in the use and management of commercial NTFPs: implications for livelihoods and conservation. *World Development* 33:1435-1452.

Belcher, B., Schreckenberg, K. 2007. Commercialisation of non-timber forest products: a reality check. *Development Policy Review* 25:355-377.

Bennett, E.L., et al. 2002. Hunting the world's wildlife to extinction. *Oryx* 36:328-329.

Bennett, E.L. 2011. Another inconvenient truth: the failure of enforcement systems to save charismatic species. *Oryx* 45:476-479.

Bernard, R.H. 2002. Research methods in anthropology: qualitative and quantitative methods. Walnut Creek: Alta-Mira Press

Beymer-Farris, B.A., Bassett, T.J. 2012. The REDD menace: resurgent protectionism in Tanzania's mangrove forests. *Global Environmental Change* 22:332-341.

Bhattacharaya, P., Prasad, R., Bhattacharayya, R., Asokan, A. 2008. Towards certification of wild medicinal and aromatic plants in four Indian states. *Unasylva* 59:35-44.

Biggs, D., Courchamp, F., Martin, R., Possingham, H.P. 2013. Legal trade of Africa's rhino horns. *Science* 339:1038-1039.

Blundell, A.G. 2004. A review of the CITES listing of big-leaf mahogany. *Oryx* 38:84-90.

Blundell, A.G., Mascia, M.B. 2005. Discrepancies in reported levels of international wildlife trade. *Conservation Biology* 19:2010-2025.

Bowen, Jones, E., Brown, D., Robinson, E.J.Z. 2010. Economic commodity or environmental crisis? An interdisciplinary approach to analysing the bushmeat trade in central and west Africa. *Area* 35:390-402.

Bruckner, A.W., Johnson, K.A., Field, J.D. 2003. Conservation strategies for sea cucumbers: Can a CITES Appendix II listing promote sustainable international trade? *SPC Beche-de-mer Information Bulletin* 18:24-33. URL: www.spc.int/DigitalLibrary/Doc/FAME/.../BDM18_24_Bruckner.pdf.

Briceno-Linares, J.M., Rodrigues, J.P., Rodriguez-Clark, K.M. 2011. Adapting to changing poaching intensify of yellow-shouldered parrot (*Amazona barbadensis*) nestlings in Margarita Island, Venezuela. *Biological Conservation* 144:1188-1193.

Brito, D., et al. 2010. How similar are national red lists to the IUCN Red List? *Biological Conservation* 143:1154-1158.

Brooks, E.G.E., Roberton, S.I., Bell, D.J. 2010. The conservation impact of commercial wildlife farming of porcupines in Vietnam. *Biological Conservation* 143: 2808-2814.

Bukovansky, M. 2006. The hollowness of anti-corruption discourse. *Review of International Political Economy* 13:181–209

Bulte, E.H., Damania, R. 2005. An economic assessment of wildlife farming and conservation. *Conservation Biology* 19:1222-1233.

Bulpitt, C.J. 2005. The uses and misuses of orchids in medicine. *Quarterly Journal of Medicine* 98:625-631.

Bunbongkarn, S. 2010. Democracy and Monarchy in Thailand. URL: http://www.thailandtoday.org/monarchy/elibrary/article/194/.

Burns, B., Miggelbrink, J. 2011. Introduction. In: Burns, B., Miggelbrink, J. (Eds.) Subverting borders: doing research on smuggling and small-scale trade. Springer, Germany.

Bush, T. 2002. Authenticity – reliability, validity and triangulation. In: Coleman, M., Briggs, A.R.J. (Eds.). Research Methods in Educational Leadership and Management. SAGE Publications, London, pp. 59-72.

Bussmann, R.W., Sharon, D., Vanderbroek, I., Jones, A., Revene, Z. 2007. Health for sale: the medicinal plant markets of Trujillo and Chiclayo, Northern Peru. *Journal of Ethnobiology and Ethnomedicine* 3:37-45.

Carpenter, A.I., Rowcliffe, J.M., Watkinson, A.R. 2004. *Biological Conservation* 120: 291-301.

(CBD) Convention on Biological Diversity. 2001. Sustainable management of non-timber forest resources. CBD Technical Series 6. URL: http://www.cbd.int/doc/publications/cbd-ts-06.pdf.

(CBD) Convention on Biological Diversity. 2009. Proposed Updated Global Strategy for Plant Conservation 2011-2020. URL: www.cbd.int/gspc/gspcreview.

Cheamuangphan, A., Panmanee, C., Tansuchat, R. 2013. Value chain analysis for orchid cut flower business in Chiang Mai. Business and Information Conference, 7-9 July, 2013, Bali. URL: www.ibac-conference.org/BAI2013/Papers/8.../81127..doc.pdf.

Chaber, A.L., Allebone-Webb, S., Lignereux, Y., Cunningham, A.A., Rowcliffe, J.M. 2010. The scale of illegal meat importation from Africa to Europe via Paris. *Conservation Letters* 3:317-323.

Chung, M.Y., Lopez-Pujol, J., Maki, M., Kim, K.J., Chung, JM, Sun, B.Y., Chung, M/Y. 2012. Genetic diversity in the common terrestrial orchid *Oreorchis patens* and its rare congener *Oreorchis coreana*: inference of species evolutionary history and implications for conservation. *Journal of Heredity* 103:692-702.

(CITES) Convention on International Trade in Endangered Species of Wild Flora and Fauna. 1973. Text of the Convention. URL: http://www.cites.org/eng/disc/text.php.

(CITES) Convention on International Trade in Endangered Species of Wild Flora and Fauna. 2008. Wildlife trade policy reviews. URL: http://www.cites.org/eng/prog/policy/index.shtml.

(CITES) Convention on International Trade in Endangered Species of Wild Flora and Fauna. 2012. Notification to the Parties concerning national laws for implementing the convention. No. 2012/036, Geneva, 18 April 2012. URL: http://www.cites.org/eng/notif/2012/E036.pdf.

(CITES) Convention on International Trade in Endangered Species of Wild Flora and Fauna. 2012b. CITES Trade Data Dashboards. URL: www.cites-dashboards.unep-wcmc.org.

(CITES) Convention on International Trade in Endangered Species of Wild Flora and Fauna. 2013. CITES Species Database. URL: http://www.cites.org/eng/resources/species.html.

(CITES) Convention on International Trade in Endangered Species of Wild Flora and Fauna. N.D. Non-detriment findings. URL: www.cites.org/eng/prog/ndf/index.shtml.

Clarke, S.C. et al. 2006. Global estimates of shark catches using trade records from commercial markets *Ecology Letters* 9:1115-1126.

Clarke, S.C. 2008. Use of shark fin trade data to estimate historic total shark removals in the Atlantic Ocean. *Aquatic Living Resources* 21:373-381.

Clarke, S.C. 2004. Shark product trade in Hong Kong and Mainland China and implementing of the CITES shark listings. TRAFFIC East Asia, Hong Kong. URL: www.traffic.org/species-reports/traffic_species_fish16.pdf.

Clemente-Munoz, M.A. 2009. Orchid conservation and trade: are these concepts incompatible? In: Pridgeon, A.M., Suarez, J.P. (Eds.). Proceedings of the Second Scientific Confernece on Andean Orchids, University Tecnica Pardicular de Loja, Loja, Ecuador. URL: www.margaritaclemente.com/img/1fame_1264268836_a.pdf.

Colwell, R. K. 2013. EstimateS: Statistical estimation of species richness and shared species from samples. Version 9. URL: http://purl.oclc.org/estimates.

Cooke, J., Holt, S., Leaper, R., Papastavrou, V. 2010. Call for science to clear whaling confusion. *Science* 18:1481.

Cooney, R., Jepson, P. 2003. The international wild bird trade: what's wrong with blanket bans? *Oryx* 40:18-23.

Cotton, C.M. 1996. Ethnobotany Principles and Applications. Wiley & Sons, Chichester.

Courchamp, F., E. Angulo, P. Rivalan, R.J. Hall, L. Signoret, L. Bull, and Y. Meinard. 2006. Rarity value and species extinction: the anthropogenic allee effect. *PLOS Biology* 4:2405-2410.

Cribb, P.J. 1987. The Genus Paphiopedilum. Collingridge Books, London, UK.

Cribb, P.J., Kell, S.P., Dixon, K.W., Barrett, R.L. 2003. Orchid conservation: a global perspective. In: Dixon, K.W., Kell, S.P., Barrett, R.L., Cribb, P.J. (Eds.). Orchid Conservation. Natural History Publications, Borneo.

Cunningham, A.B. 2002. Applied Ethnobotany: People, Wild Plant Use and Conservation. Earthscan, London.

Darlington, S.M. 1998. The ordination of a tree: the Buddhist Ecology Movement in Thailand. *Ethnology* 37:1-15.

Daszak, P., Cunningham, A.A., Hyatt, A.D. 2000. Emerging infectious diseases of wildlife - threats to biodiversity and human health. *Science* 287:443-449.

Davenport, T.R.B., Ndangalasi, H.J. 2003. An escalating trade in orchid tubers across Tanzania's Southern Highlands: assessment, dynamics and conservation implications *Oryx* 37:55-61.

de Albuquerque, U.P., Monteiro, J.M., Ramos, M.A., de Amorim, E.L.C. 2007. Medicinal and magic plants from a public market in northeastern Brazil. *Journal of Ethnopharmacology* 110:76-91.

De Sardan, J.P.O. 1999. A moral economy of corruption in Africa? *The Journal of Modern African Studies* 37:25-52.

Dickson, B. 2008. CITES and the livelihoods of the poor. *Oryx* 42:548-553.

(DNP) Dept. of National Parks, Wildlife and Plant Conservation, Ministry of Natural Resources and Environment. 2011. Research Report for the Instruction of Suppression of Crime related to Plant Genetic Resources, Office of Conservation and Management Area 10: Udon Thani Province. URL: http://www.mfcd10.com/letter/data/aongkamroo12oct11.pdf

(DNP) Dept. of National Parks, Wildlife and Plant Conservation., Ministry of Natural Resources and Environment. 2011b. Office of Conservation Management. URL: http://www.mfcd10.com/letter/data/aongkamroo12oct11.pdf.

(DNP) Dept. of National Parks, Wildlife and Plant Conservation., Ministry of Natural Resources and Environment. 2013. Organized regional mobile exhibitions: Jatujak Market. URL: http://www.citescop16thai.com/en/gallery/62.html.

Dong, J., Xiao, X., Sheldon, S., Biradar, C., Dinh Duong, N., Hazarika, M. 2012. A comparison of forest cover maps in Mainland Southeast Asia from multiple sources: PALSAR, MERIS, MODIS and FRA. *Remote Sensing of Environment* 127:60-73.

Dulvy, K., et al. 2008. You can swim but you can't hide: the global status and conservation of oceanic pelagic sharks and rays. *Aquatic Conservation: Marine and Freshwater Ecosystems* 18:459-482.

Dulvy, N.K., Y. Sadovy, and J.D. Reynolds. 2003. Extinction vulnerability in marine populations. Fish and Fisheries 4:25–64.

Dutton, A.J., C. Hepburn, and D.W. Macdonald. 2011. A stated preference investigation into the Chinese demand for farmed vs. wild bear bile. *PLOS One* 6:e21243.

Engler, M., Parry-Jones, R. 2007. The role of the European Union in global wildlife trade. TRAFFIC Europe, Brussels, Belgium. URL: www.traffic.org/general-reports/traffic_pub_trade15.pdf.

Ferrero, P. 2005. Corruption and conservation: the need for empirical analyses. A response to Smith & Walpole. *Oryx* 257-259.

Finlay, L. 2002. Outing the researcher: the provenance, process, and practice of reflexivity. *Qualitative Health Research* 12:531-545.

Fisher, R.J. 1993. Social desirability bias and the validity of indirect questioning. *Journal of Consumer Research* 20:303-315.

Flores-Palacios, A. and S. Valencia-Diaz. 2007. Local illegal trade reveals unknown diversity and involves a high species richness of wild vascular epiphytes. *Biological Conservation* 137:372-387.

Foppes, J., Soukaseum, B., Patoumthong, H., Sengkeo, K., Bounsou, S. 1996. Trade in orchids and other ornamentals at the Lao-Thai border market. NTFP Project Field Report 10.

Galetti, M., Fernandez, J.C. 1998. Palm heart harvesting in the Brazilian Atlantic forest: changes in industry structure and the illegal trade. *Journal of Applied Ecology* 35:294-301.

Gardiner, L.M. 2012. New combinations in the genus *Vanda* (Orchidaceae). *Phytotaxa* 61:47-54.

Gasson, P., Miller, R., Stekel, D.J., Whinder, F., Zieminska, K. 2010. Wood identification of *Dalbergia nigra* (CITES Appendix I) using quantitative wood anatomy, principal components analysis and naïve Bayes classification. *Annals of Botany* 105:45-56.

Gastañaga, M. et al. *2011.* A study of the parrot trade in Peru and the potential importance of internal trade for threatened species. *Bird Conservation International* 21:76–85.

Gaston, K.J., O'Niell, M.A. 2004. Automated species identification: why not? *Philosophical transactions of the Royal Society B* 359:655-667.

Gault, A., Y. Meinard, and F. Courchamp. 2008. Consumers' taste for rarity drives sturgeons to extinction. *Conservation Letters* 1:199-207.

Gavin, M.C., Solomon, J.N., Blank, S.G. 2009. Measuring and monitoring illegal use of natural resources. *Conservation Biology* 24:89-100.

Gayalwang Karapa, H.H. 17th, Dorje, O.T. 2011. Walking the path of environmental Buddhism through compassion and emptiness. *Conservation Biology* 25:1094-1097.

Gehring, T., Ruffing, E. 2008. When arguments prevail over power: the CITES procedure for listing of endangered species. *Global Environmental Politics* 2: 123-148.

Gereffi, G., Humphrey, J., Sturgeon, T. 2005. The governance of global value chains. *Review of International Political Economy* 12:78-104.

Gerson, H. et al. G. 2008. Monitoring international wildlife trade with coded species data. *Conservation Biology* 22:4-7.

Gibson, C.C., Williams, J.T., Ostrom, E. 2005. Local enforcement and better forests. *World Development* 33:273-284.

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

Gigot, G., van Alphen-Stahl, J., Bogarin, D., Warner, J., Chase, M.W., Savolainen, V. 2007. Finding a suitable DNA barcode for Mesoamerican orchids. *Lankesteriana* 7:200-203.

Godin, A.C., Worm, B. 2010. Keeping the lead: How to strengthen shark conservation and management policies in Canada. *Marine Policy* 34:995-1001.

Gootenberg, P. 2009. Talking about the flow: drugs, borders, and the discourse of drug control. *Cultural Critique* 71:13-46.

Govaerts, R. 2012. World Checklist of Orchidaceae. Royal Botanic Gardens, Kew. URL: http://apps.kew.org/wcsp/

Green, E.P., Hendry, H. 1999. Is CITES an effective tool for monitoring trade in corals? *Coral Reefs* 18:403-407.

GreenCustoms. ND. Differentiating wild-collected and artificially-propagated plants. Prepared by the CITES Secretariat for the United Nations Development Programme GreenCustoms Knowledge Series 8. URL: https://eva.unia.es/cites/mod/resource/view.php?id=58&lang=en.

Guest, G., Bunce, A., Johnson, L. 2006. How many interviews are enough? An experiment with data saturation and variability. *Field Methods* 18:59-82.

Harding, S. 1991. Whose Science? Whose Knowledge?: Thinking from Women's Lives. Cornell University Press, Ithaca, NY.

Harré, R., Van Langenhove, L. 1999. Positioning Theory: Moral Contexts of Intentional Action, Blackwell, Malden, MA.

Hinsley, A. 2011. Notes on the trade of orchids in the Cardamom Mountains, Pursat and Koh Kong Provinces. *Cambodian Journal of Natural History* 1:11-13.

Hodgson, G.M., Jiang, S. 2007. The economics of corruption and the corruption of economics: an institutionalist perspective. *Journal of Economic Issues* 41: 1043-1061.

Hollingsworth, P.M., et al. 2009. A DNA barcode for land plants. *Proceedings of the National Academy of Sciences of the United States of America* 106:12794–12797.

Homma, A.K.G. 1992. The dynamics of extraction in Amazonia. A historical perspective. *Advances in Economic Botany* 9:23-31.

Huguet, J., Chamratrithirong, A., Natali, C. 2012. Thailand at a crossroads: challenges and opportunities in leveraging migration for development. International Organization for Migration and Migration Policy Institute Issue in Brief 6. URL: http://www.migrationpolicy.org/pubs/LeveragingMigration.pdf.

Huntington, H.P. 2000. Using traditional ecological knowledge in science: methods and applications. *Ecological Applications* 10:1270-1274.

Hutton, J., Adams, W.A., Murombedzi, J.C. 2005. Back to barriers? Changing narratives in biodiversity conservation. *Forum for Development Studies* 32:341-37

Ingram, V., Bongers, G. 2009. Valuation of non-timber forest produce chains in the Congo Basin. CIFOR, Yaounde, Cameroon. URL: http://www.rainforestfoundationuk.org/files/Forest%20Products%20Low%20PDF.pdf.

Irland, L.C. 2008. State failure, corruption, and warfare: challenges for forest policy. *Journal of Sustainable Forestry* 27:189-223.

(IPBES) Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. 2010. Gland, Switzerland. URL: http://www.ipbes.net

(IUCN) International Union for Conservation of Nature. 2012. The IUCN Red List of Threatened Species, Geneva, Switzerland. URL: http://www.iucnredlist.org/.

(IUCN-OSG) International Union for Conservation of Nature - Species Survival Commission Orchid Specialist Group. 2009. Orchid Specialist Group General Meeting, Quito, Ecuador, 7 Feb. 2009. URL: www.orchidconservation.org/osg/Docs/GM0703.doc.

(IUCN and UNEP) International Union for Conservation of Nature and United Nations Environment Programme. 2010. The World Database on Protected Areas (WDPA). United Nations Environment Programme-World Conservation Monitoring Centre, Cambridge, UK. URL: www.protectedplanet.net.

Jennings, D.E., Rohr, J.R. 2011. A review of the conservation threats to carnivorous plants. *Biological Conservation* 144:1356-1363.

Jensen, A., Meilby, H. 2008. Does commercialization of a non-timber forest product reduce ecological impact? A case study of the Critically Endangered *Aquilaria crassna* in Lao PDR. *Oryx* 42:214-221.

Jensen, A. 2009 Valuation of non-timber forest products value chains. *Forest Policy and Economics* 11:34-41.

Jepson, P., Ladle. R.J. 2005. Bird-keeping in Indonesia: conservation impacts and the potential for substitution-based conservation responses. *Oryx* 39:442-448.

JMP, Version 7. 2007. SAS Institute Inc., Cary, North Carolina.

Johnson, A., Singh, S., Dongdala, M., Vongsa, O. 2003. Wildlife hunting and use in the Nam Ha National Protected Area: Implications for rural livelihoods and biodiversity conservation. Wildlife Conservation Society, Vientiane. URL: www.nafri.org.la/document/uplandproceedings/15_wildlife_wcs.pdf.

Kaufmann, D., Kraay, A., Mastruzzi, M., 2008. Governance Matters IV: Governance Indicators for 1996–2004. World Bank Institute, Washington, D.C. URL: http://info.worldbank.org/governance/wgi/index.asp.

Kaplinsky, R., Morris. M. 2000. A Handbook for Value Chain Research. University of Sussex, Institute of Development Studies, Sussex. URL: http://www.srp-guinee.org/download/valuechain-handbook.pdf.

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

Keane, A., Ramarolahy, A.A., Jones, J.P.G., Milner-Gulland, E.J. 2011. Evidence of the effects of environmental engagement and education of knowledge of wildlife laws in Madagascar. *Conservation Letters* 4:55-63.

(KHRG) Karen Human Rights Group. 2013. KHRG Maps of Karen State. URL: http://khrg.org/maps/index.html.

Keping Ma, et al. 2010. The First Asian Plant Conservation Report: A Review of Progress in Implementing the Global Strategy for Plant Conservation. Beijing, China. URL: http://data.iucn.org/dbtw-wpd/edocs/2010-056.pdf.

Kew. 1999. A survey of the orchid trade in Thailand. In: Walter, K.S., Gillett, H.J. (Eds.) IUCN Species Survival Commission 1997 IUCN Red List of Threatened Plants. Royal Botanic Gardens, Kew. URL: www.ec.europa.eu/environment/cites/pdf/studies/orchids_thailand.pdf.

Kirkpatrick, R.C., Emerton, L. 2010. Killing tigers to save them: fallacies of the farming argument. *Conservation Biology* 24:655-659.

Kong, J.M., Goh, N.K., Chia, L.S. Chia, T.F. 2003. Recent advances in traditional plant drugs and orchids. *Acta Pharmacologica Sinica* 24:7-21.

Koopowitz, H., Lavarack, P.S., Dixon, K.W. 2003. The nature of threats to orchid conservation. In: Dixon, K.W., Kell, S.P., Barrett, R.L., Cribb, P.J. (Eds.). Orchid Conservation. Natural History Publications, Borneo.

Kurtzweil, H. 2011. Collaborative research on Myanmar's orchids. *GardenWise* 37: 1-13. URL: http://www.sbg.org.sg/publications/87.pdf.

Kurtzweil, H. 2009. The genus *Habenaria* (Orchidaceae) in Thailand. *Thai Forestry* Bulletin 7:1-105

Kusakabe, K. 2004. Women's work and market hierarchies along the Border of Lao PDR. *Gender, Place and Culture* 11:581-594.

Kusakabe, K., Pearson, R. 2010. Transborder Migration, Social Reproduction and Economic Development: A Case Study of Burmese Women Workers in Thailand. *International Migration* 46:13-43.

Kusters, K., Belcher, B. 2004. Forest products, livelihoods and conservation: case studies of non-timber forest product systems, Volume 1: Asia. CIFOR, Bogor, Indonesia. URL: www.cifor.org/publications/pdf_files/Books/.../TOC-Chapter5.PDF.

Laird, S.A., R. Wynberg, and R.J. McLain. 2009. Wild products governance: laws and policies for sustainable and equitable non-timber forest product use.

Policy brief by United Nations University, Centre for International Forestry Research, People and Plants International, Environmental Evaluation Unit, University of Cape Town, Institute for Culture and Ecology, Cape Town, South Africa. URL: http://www.unutki.org/news.php?news_id=83&doc_id=103.

Laird, S.A., Wynberg, R., McLain, R.J. 2011. Regulating complexity: policies for the governance of non-timber forest products. In: Shackleton, S., Chackleton, C., Shanley, P. (Eds.) Non-timber Forest Products in the Global Context. Springer-Verlag, Amsterdam.

Lamxay, V. 2008. Case study on orchid exports from Lao PDR: Recommendations for using the Convention on International Trade in Endangered Species of Wild Fauna and Flora to increase sustainable orchid trade. National University of Lao PDR, International Union for Conservation of Nature Swiss Agency for Development Cooperation, Vientiane. URL: www.cmsdata.iucn.org/.../piloting_cites_case_study_iucn_jul_09.pdf.

Larsen, H.O.,C.S. Olsen, C.S. 2007. Unsustainable collection and unfair trade? Uncovering and assessing assumptions regarding central Himalayan medicinal plant conservation. *Biodiversity Conservation* 16:1679-1697.

Larson, A. 2002. Natural resources and decentralization in Nicaragua: are local governments up to the job? *World Development* 30:17-31.

Lebel, L., Daniel, R., Badenoch, N., Garden, P., Imamura, M. 2008. A multi-level perspective on conserving with communities: Experiences from upper tributary watersheds in montane mainland Southeast Asia. *International Journal of the Commons* 2:127-154.

Lwin, U.S. (2005) Conservation of orchids in Myanmar. In: Taordoff, A.W., Eames, J.C., Eberhardt, K., Balzer, M.C., Davidson, P., Leimgruber, P., Uga, U., Aung Than, U. (Eds.) Myanmar: investment opportunities in biodiversity conservation. Birdlife International, Yangon.

Lovera, P., Laville, B. 2009. Orchids trade study Laos.Vientiane Orchidees Company, Vientiane, Lao PDR. URL: http://www.vientianeorchidees.com/en/a-propos-de-nous.html.

Mapdiva. 2010. Ortelius 1.1.3. URL: https://www.mapdiva.com/ortelius/.

Marshall, E., Rushton, J., Schreckenberg, K. 2006. NTFP Commercialization Research Methods. UNEP-World Conservation Monitoring Centre, Cambridge. URL: http://www.odi.org.uk/publications/2993-tools-researching-successful-non-timber-forest-products-commercialization-manual.

McElwee, P. 2004 You say illegal, I say legal: The relationship between 'illegal' logging and land tenure, poverty, and forest use rights in Vietnam. *Journal of Sustainable Forestry* 19: 97-135.

McElwee, P. 2012. The gender dimensions of the illegal trade in wildlife: Local and global connections in Vietnam. In: Cruz-Torres, M.L, McElwee, P. (Eds.) Gender and Sustainability: Lessons from Asia and Latin America. Unviersity of Arizona Press,

McGough, N.H, M. Groves, M. Mustard, and C. Brodies. 2004. CITES and plants: a user’s guide, version 3. Royal Botanic Gardens, Kew. URL: http://www.kew.org/conservation/CITES_User_Guides/CITESPlants/English CITESPlantsPack.pdf.

McNeely, J.A., Kapoor-Vijay, P., Zhi, L., Olsvig-Whittaker, O., Sheikh, K.M., Smith, A.T. 2009. Conservation biology in Asia: the major policy challenges. *Conservation Biology* 23:805-810.

Meyers Conservatory. 2012. Why our flasking program is different. URL: https://lab.troymeyers.com/flasking/article.php?about=Unusual_Flasking_Program.

Milius, S. 2010.Wildlife trade meeting disappoints marine scientists. Science News. URL: http://www.sciencenews.org/view/generic/id/57679.

Milner-Gulland, E.J., Bennett, E.L. 2003. Wild meat: the bigger picture. *Trends in Ecology & Evolution* 18:351–357.

(MIMU) Myanmar Information Management Unit. 2010. Transport Network. Myanmar Information Management Unit, Yangon, Myanmar. URL: http://www.themimu.info/GIS/GIS_Shape_Files/.

Mohneke, M., Onadeko, A.B., Hirschfeld, M., O.Rodel, M. 2010. Trade in wild meat in Central Africa: West Africa's market for frog meat. TRAFFIC Bulletin. 22, 117-128.

Mondragón-Chaparro, D. 2009. Population viability analysis for Guarianthe aurantiaca, an ornamental epiphytic orchid harvested in Southeast México. *Plant Species Biology* 24:35-41.

Mondragón-Chaparro, D.,, Ticktin, T. 2011. Demographic effects of harvesting epiphytic bromeliads and an alternative approach to collection. *Conservation Biology* 25:979-807.

Monteiro, J.M., de Lima Araujo, E., Amorim, E.L.C., de Albuquerque, U.P. 2010. Local markets and medicinal plant commerce: a review with emphasis on Brazil. *Economic Botany* 64:352-366.

Moyle, B. 2009. The black market in China for tiger products. *Global Crime* 10, 124-143.

Myers, N., Mittermeier, R.A., Mittermeier, C.G., da Fonseca, G.A.B., Kent, J. 2000. Biodiversity hotspots for conservation priorities. *Nature* 403:853-858.

Nagendra, H., Ostrom, E. 2012. Polycentric governance of multifunctional forested landscapes. *International Journal of the Commons* 6:104-133.

Newton, A.C., T. Soehartono, T. 2001. CITES and the Conservation of Tree Species: The Case of Aquilaria spp. in Indonesia. *International Forestry Review* 3:27-33.

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

Nijman, V., Shepherd, C.R. 2007. Trade in non-native, CITES-listed, wildlife in Asia, as exemplified by the trade in freshwater turtles and tortoises (Chelonidae) in Thailand. *Contributions to Zoology* 76:207-212.

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

Nijman, V., Shepherd, C.R. 2011b. Open trade in Kaiser's spotted newt in South-East Asia. *Oryx* 45:472-473.

Nijman, V., Shepherd, C.R. 2010. Wildlife Trade from ASEAN to the EU: Issues with the Trade in Captive-Bred Reptiles from Indonesia TRAFFIC Europe Report, Brussels. URL: www.traffic.org/species-reports/traffic_species_reptiles26.pdf.

Nijman, V., Shepherd, C.R. 2010b. The role of Asia in the global trade in CITES II-listed poison arrow frogs: hopping from Kazakhstan to Lebanon to Thailand and beyond. *Biodiversity Conservation* 19:1963-1970.

Nijman, V., Nekaris, K.A.I., Bickford, D.P. Asian medicine: small species at risk. *Nature* 481:265.

Nowell, K. 2012. WWF Wildlife Crime Scorecard. URL: http://awsassets.panda.org/downloads/wwf_wildlife_crime_scorecard_report.pdf.
(OEH) Office of Environmental Heritage, New South Wales. 2013. The commercial harvest, salvage and propagation of protected whole plants: sustainable management plan 2013-2017, Sydney. URL: http://www.environment.nsw.gov.au/resources/wildlifelicences/20130001plantsmp.pdf.
Oldfield, S. (Ed.). 2002. The Trade in Wildlife: Regulation for Conservation. Earthscan, London.
Olsen, C.S., Helles, F. 2009. Market efficiency and benefit distribution in medicinal plant markets: empirical evidence from South Asia. *International Journal of Biodiversity Science and Management* 5:53-62.
Olsen, C.S. 2005. Quantification of the trade in medicinal and aromatic plants in and from Nepal. *Acta Horticulturae* 678:29-35.
Olsen, C.S., Bhattarai, N. 2005. A typology of economic agents in the Himalayan plant trade. *Mountain Research and Development* 25:37-43.
Oo, H.P. 2003. Forestry for community development in Myanmar: research issues. In: Sim, H.C., Appanah, S., Hooda, N. (Eds.). Proceedings of the workshop on Forests for poverty reduction: changing role for research, Development and training institutions, Food and Agriculture Organisation of the United Nations, 17 - 18 June 2003, Dehradun, India. URL: http://www.fao.org/docrep/008/af349e/af349e00.HTM.
Ostrom, E. 2007. A diagnostic approach for going beyond panaceas. *Proceedings of the National Academy of Sciences of the United States of America* 104:15181–15187.
Oswell, A.H. 2010. The big cat trade in Myanmar and Thailand. TRAFFIC Southeast Asia, Selangor, Malaysia. URL: www.traffic.org/species-reports/traffic_species_mammals61.pdf.
(POP) Paksong Orchid Project. 2011. Paksong, Laos. URL: http://osssu.org/main/laos.html.
Parsons, E.C.M, Rose, N.A., Telecky, T.M. 2010. The trade in live Indo-Pacific bottlenose dolphins from Solomon Islands—a CITES decision implementation case study. *Marine Policy* 34:384-388.
Pascual, U., Phelps, J., Garmendia, E., Brown, K., Corbera, E., Martin, A., Muradian, R. Social equity matters in conservation payments. in prep.
Pedersen, H.A.E., Ormerod, P. 2009. Notes on the orchid flora of Thailand. *Taiwania* 54:213-218.
Peh, K.S.H., Drori, O. 2010. Fighting corruption to save the environment: Cameroon's experience. *Ambio* 39:336-339.
Peres, C. 2010. Overexploitation. In Sodhi, N.S., Eherlich, P. (Eds.) Conservation Biology for All. Oxford University Press, Oxford.
Peskett, L., Huberman, D., Bowen-Jones, E., Edwards, G., Brown, J., 2008. Making REDD work for the poor. Poverty Environment Partnership, London. URL: www.odi.org.uk/resources/docs/3451.pdf.
Peters, C.M., Henderson, A., Muang, U.M., Lwing, U.S., Ohn, U.T.M., Lwing, U.K., Shaung, U.T. 2007. The rattan trade of northern Myanmar: species, supplies, and sustainability. *Economic Botany* 61:3-13.
Pfeffer, M.J., Schelhas, J.W., Day, L.A. 2001. Forest conservation, value conflict, and interest formation in a Honduran National Park. *Rural Sociology* 66:382-402.

Phelps, J., E.L. Webb, D.P. Bickford, V. Nijman, and N.S. Sodhi. 2010a. Boosting CITES. *Science* 330:1752-1753.
Phelps, J., Webb, E.L., Agrawal, A., 2010b. Does REDD+ threaten to recentralize forest governance? *Science* 328:312-313.
Phelps, J., Bickford, D.P., Webb, E.L. 2012. Letter: Work together to crack wildlife crime. *Nature* 483:407.
Phelps, J., Carrasco, R.L., Webb, E.L. In press. Supply-side conservation interventions. *Conservation Biology*. in press
Phelps, J., et al. Problematic taxonomic discoveries via illegal trade. in prep.
Pinheiro, J.C. and D.M. Bates. 2000. Mixed-Effects Models in S and S-PLUS. Springer.
Pistoni, J., Toledo, L.F. 2010. Amphibian illegal trade in Brazil: what do we know? *Brazilian Society of Herpetology* 5:51-56.
Pooley, J.A., Psych, M., O'Connor, M. 2000. Environmental education and attitudes: emotions and beliefs are what is needed. *Environment and behaviour* 32:711-723.
Pooma, R. (Ed.). 2005. A Preliminary Check-list of Threatened Plants in Thailand. Forest Herbarium, National Park Wildlife and Plant Conservation Department. Bangkok, Thailand.
Pupulin, F. 1998. Orchid flora of Parque Nacional Manuel Antonio, Quepos, Costa Rica. *Revista de Biología Tropical* 46:961–10317.
Pupulin, F. 2004. Population survey of *Kefersteinia retanae* (Orchidaceae): just an academic exercise? *Orchid Conservation News* 4:1-5. URL: www.orchidconservation.org/osg/PubArt/OCN04-En.pdf.
Pryer, K.M., et al. 2009. DNA barcoding exposes a case of mistaken identity in the fern horticultural trade. *Molecular Ecology Resources* 10:979-985.
Rabinowitz, D. 1981. Seven forms of rarity. In: Synge, H. (Ed.) The Biological aspects of rare plant conservation. Wiley, New York.
Rao, M., Rabinowitz, A., Tun Khaing S. 2002. Status review of the protected-area system in Myanmar, with recommendations for conservation planning. *Conservation Biology* 16:360-368.
Redpath, S.M., et al. 2012. Understanding and managing conservation conflicts. *Trends in Ecology & Evolution* 28:100-109.
Reeve, R. 2006. Wildlife trade, sanctions and compliance: lessons from the CITES regime. *International Affairs* 82:881-897.
(RENCTAS) Brazilian National Network to Fight the Trafficking of Wild Animals. 2001. Primer Relatorio Nacional Sobre o Trafico de Fauna Silvestre. Brazilian National Network to Fight the Trafficking of Wild Animals, Brazil. URL: www.renctas.com.br/files/REL_RENCTAS_pt_final.pdf.
Rivlan, P., Delmas, V., Angulo, D., Bull, L.S., Hall, R.J., Courchamp, F. Rosser, A.M., Leader-Williams, N. 2007. Can bans stimulate wildlife trade? *Nature* 447:529-530.
Robbins, C.S., editor. 2003. Prickly trade: trade and conservation of Chihuahuan Desert cacti. TRAFFIC North America. URL: http://www.traffic.org/species-reports/traffic_species_plants5.pdf.
Robbins, P. 2000. The rotten institution: corruption in natural resource management. *Political Geography* 19:423-443.
Robbins, P., McSweeney, K., Chhangani, A.K., Rice, J.L. 2009. Conservation as it is: illicit resource use in a wildlife reserve in India. *Human Ecology* 37:559-575.
Rose-Ackerman, S. 1978. Corruption: A Study in Political Economy. Academic

Press, New York.
Rosen, G.E., Smith, K.F. 2010. Summarizing the evidence on the international trade in illegal wildlife. *EcoHealth* 7:24-32.
Rosser, A., Haywood, M. 2002. Guidance for CITES Scientific Authorities: Checklist to assist in making non-detriment findings for Appendix II exports. Occasional Paper of the IUCN Species Survival Commission 27. URL: http://www.data.iucn.org/dbtw-wpd/edocs/SSC-OP-027.pdf.
Ros-Tonen, M.A.F., Kusters, K. 2011. Pro-poor Governance of Non-timber Forest Products: The Need for Secure Tenure, the Rule of Law, Market Access and Partnerships. In: Shackleton, S., et al. (Eds.). Non-Timber Forest Products in the Global Context. Tropical Forestry 7, Springer-Verlag, Berlin.
Rusea, G., et al. 2009. Malaysian limestone orchid status: diversity, threat and conservation. *Blumea* 54:109-116.
Sand, P.H. 1997. Whither CITES? The evolution of a treaty regime in the border land of trade and environment. *European Journal of International Law* 8: 29-58.
Santisuk, T., Chayamarit, K., Pooma, R., Suddee, S. 2006. Thailand Red Data: Plants. Office of Natural Resources and Environmental Policy and Planning, Bangkok Thailand. URL: http://chm-thai.onep.go.th/chm/publication.html.
Schaedla, W.H. Wildlife smuggling: augmenting Southeast Asia's intergovernmental response. 22 March, 2007. In: Elliott, L. (Ed.) Transnational environmental crime in the Asia-Pacific: A workshop report, Canberra, Australia. URL: http://ips.cap.anu.edu.au/ir/tec/publications/Transnational_environmental_crime_Asia_Pacific_workshop_report_TEC_Workshop_Report_2007.pdf#page=46.
Scherr, S.J., White, A., Kaimowitz, D. 2003. A new agenda for forest conservation and poverty reduction: making markets work for low-income producers. Forest Trends, Washington, D.C. URL: www.lib.icimod.org/record/11339/files/3107.pdf.
Schippmann, U., Leaman, D.J., Cunningham, A.B.. 2002. Impact of cultivation and gather of medicinal plants on biodiversity: global trends and issues. Food and Agriculture Organization, Rome. URL: http://www.fao.org/DOCREP/005/AA010E/AA010e00.htm.
Schreckenberg, K., Marchall, E., Newton, A., te Velde, D.W., Ruston, J., Edouard, F. 2006. Commercialisation of non-timber forest products: what determines success? Overseas Development Institute Forestry Briefing 10. URL: http://www.odi.org.uk/resources/docs/796.pdf.
Schuiteman, A. 2011. *Dendrobium* (Orchidaceae): To split or not to split? *Gardens' Bulletin Singapore* 63:245-257.
Schuiteman, A. 2013. Kew species profile: *Dendrobium aphyllum*. Royal Botanic Gardens, Kew. URL: http://www.kew.org/plants-fungi/Dendrobium-aphyllum.htm.
Schuiteman, A., Bonnet, P., Bouakhaykhone, S., Barthelemy, D. 2008. An annotated checklist of the Orchidaceae of Lao PDR. *Nordic Journal of Botany* 26:257-316.
Schuiteman, A, de Vogel, E.F. 2000. Orchid Genera of Thailand, Lao PDR, Cambodia and Vietnam, National Herbarium Nederland, Leiden.
Schuiteman, A., de Vogel, E., Vermeulen, J., Kressler, P., Vogel A. 2008b. Malesian Orchid Genera Illustrated. University of Leiden, Flora Malesiana, National Herbarium Nederland. URL: http://www.nationaalherbarium.nl/pubs/orchidweb/Malesian%20orchid%20gen

era.htm.
Scott, J. 2000. Social Network Analysis: A Handbook, 2nd Edition. Sage, London.
Seidenfaden, G. 1975-2003. Orchid genera in Thailand I–XIV. In: *Dansk Botanik Arkiv* 29(2-4), 31(1, 3), 32(2), 33(1, 3), 34(1) & *Opera Botanica* 62, 72, 83, 89, 95 & *Nordic Journal of Botany* 22(6).
Shackleton, C., Shackleton, S. 2004. The importance of non-timber forest products in rural livelihood security and as safety nets: a review of evidence from South Africa. *South African Journal of Science* 100:658-664.
Shackleton, S., Shanley, P., Ndoye, O. 2007. Invisible but viable: recognising local markets for non-timber forest products. *International Forestry Review* 9:697-712.
Sharrock, S. (Ed.). 2011. A guide to the Global Strategy for Plant Conservation: all the targets, objectives and facts. URL: http://www.bgci.org/resources/news/0910/.
Shepherd, C.R. 2006. The bird trade in Medan, north Sumatra: an overview. *BirdingAsia* 5:16-24.
Shepherd, C.R., Nijman, V. 2007. The trade in bear parts from Myanmar: an illustration of the ineffectiveness of enforcement of international wildlife trade regulations. *Biodiversity Conservation* 17:35-42.
Shepherd, C.R., Nijman, V. 2008. Pet freshwater turtle and tortoise trade in Chatuchak Market, Bangkok, Thailand. TRAFFIC Southeast Asia, Selangor, Malaysia. URL: http://www.traffic.org/species-reports/traffic_species_reptiles13.pdf.
Shepherd, C.R., Nijman, V. 2008b. The Wild cat trade in Myanmar. TRAFFIC Southeast Asia, Selangor, Malaysia. URL: www.traffic.org/species-reports/traffic_species_mammals40.pdf.
Shepherd, C.R., Compoton, J., Warne, S. 2006. Transport Infrastructure and Wildlife Trade Conduits in the GMS*:* Regulating Illegal and Unsustainable Wildlife Trade Paper presented at Biodiversity Conservation Corridors Initiative (BCI) International Symposium, 27-28 April 2006, Bangkok, Thailand. URL: https://www.cbd.int/doc/meetings/for/lgbushmeat-02/other/lgbushmeat-02-traffic-pangolin-workshop-asia-en.pdf#page=15.
Shepherd, C.R., Stengel, C.J., Nijman, V. 2012. The export and re-export of CITES-listed birds from the Solomon Islands. TRAFFIC Southeast Asia, Selangor, Malaysia. URL: http://www.trafficj.org/publication/12_The_Export_and_Re-export_of_CITES-Listed_Birds.pdf.
Singer, E., Von Thurn, D.R., Miller, E.R., 1995. Confidentiality assurances and response: a quantitative review of the experimental literature. *The Public Opinion Quarterly* 59:66–77.
Singh, S., Boonratana, R., Bezuijen, M., Phonvisay, A. 2006. Trade in Natural Resources in Attapeu Province Lao PDR: An Assessment of the Wildlife Trade. TRAFFIC, Vientiane, Lao PDR. URL: http://www.traffic.org/general-reports/traffic_pub_trade13.pdf.
Singh, S. 2008. Contesting moralities: the politics of wildlife trade in Laos. *Journal of Political Ecology* 15:1-20.
Slone, T.H., Orsak, L.J.,. Malver, O. 1997. A comparison of price, rarity and cost of butterfly specimens: implications for the insect trade and for habitat conservation. *Ecological Economics* 21:77-85.
Small, E. 2011. The new Noah's Ark: beautiful and useful species only. *Biodiversity* 12:232-247.

Smith, J., Obidzinski, K., Subarudi, Suramenggala, I. 2003. Illegal logging, collusive corruption and fragmented governments in Kalimantan, Indonesia. *International Forestry Review* 5:293-302.

Smith, R.J., Walpole, M.J. 2005. Should conservationists pay more attention to corruption? *Oryx* 39:251–256.

Smith, K.F., et al. 2009. Reducing the risks of the wildlife trade. *Science* 324: 594-595.

Sodhi, N.S., Brook, B.W., Bradshaw, C.J.A. 2007. Tropical Conservation Biology. Blackwell Publishing, Oxford.

Sodhi, N.S., Koh, L.P., Brook, B.W., Ng, P.K.L. 2004. Southeast Asian biodiversity: an impending disaster. *Trends in Ecology and Evolution* 19:654-659.

Sodhi, N.S., et al. 2006. Biodiversity and human livelihood crises in the Malay Archipelago. *Conservation Biology* 20:1811-1813.

Sodhi, N.S., Posa, M.R.C., Lee, T.M., Bickford, D., Koh, L.P., Brook. B.W. 2010. The state and conservation of Southeast Asian biodiversity. *Biological Conservation* 19:317-3238.

Sripotar, D. 2008. Non-detrimental finding of *Vanda coerulea.* Prepared by Thailand for the Non-detrimenal Findings Workshop Case Studies, Geogrphytes and Epiphytes Working Group, Mexico. Plant Varieties Protection Division, CITES Management Authority of Thailand, Thailand Department of Agriculture, Bangkok. URL: http://www.conabio.gob.mx/institucion/cooperacion_internacional/TallerNDF/Links-Documentos/WG4%20CS4.pdf.

St. John, F.A.V., Edwards-Jones, G., Gibbons, J.M., Jones, J.P.G. 2010. Testing novel methods for assessing rule breaking in conservation. *Biological Conservation* 142:1025-1030.

Stibig, H.J., Achard, F., Fritz, S. 2004. A new forest cover map of continental southeast Asia derived from SPOT-VEGETATIOn satellite imagery. *Applied Vegetation Science* 7:153-162.

Stiles, D. 2009. The status of the ivory trade in Thailand and Vietnam. TRAFFIC *Bulletin* 22:83-91. URL: http://www.environmentportal.in/files/Ivory%20trade.pdf.

Stoian, D. 2005. Making the best of two worlds: rural and peri-urban livelihood options sustained by nontimber forest products of the Bolivian Amazon. *World Development* 33:1473-1490.

Sutherland, W.J. et al. 2009. One hundred questions of importance to the conservation of global biological diversity. *Conservation Biology* 23:557–567.

Sylvester, O., Avalos, G. 2009. Illegal palm heart (*Geonoma edulis*) harvest in Costa Rican national parks: patterns of consumption and extraction. *Economic Botany* 63:179-189.

Te Velde, W.D., Rushton, J., Schreckenberg, K, Marshall, E., Edouard, F., Newton, A., Arancibia, E. 2006. Entrepreneurship in value chains of non-timber forest products. *Forest Policy and Economics* 8:725-741.

Ticktin, T., and T. Johns. 2002. Chinanteco management of *Aechmea magdalenae* (Bromeliaceae): implications for the use of TEK and TRM in management plans. *Economic Botany* 56:43–57.

Ticktin, T. 2004. The ecological consequences of harvesting non-timber forest products. *Journal of Applied Ecology* 41:11–21.

Thitiprasert, W. et al. 2007. FAO/Government Cooperative Programme Country Report On The State Of Plant Genetic Resources For Food And Agriculture In

Thailand (1997-2004). Department of Agriculture and Ministry of Agriculture and Cooperatives, AG: GCP/RAS/186/JPN; Field Document No. 2007/09. URL: http://www.fao.org/docrep/013/i1500e/Thailand.pdf.

Thomas, P., Newman, M., Svengsuksa, B., Ketphanah S. 2006. A review of CITES Appendices I and II plant species from Lao PDR. Darwin Initiative. London. URL: http://darwin.defra.gov.uk/documents/13007/3139/13-007%20FR%20Ann13%20Review%20of%20CITES%20plant%20species.pdf.

(TI) Transparency International. 2011. Corruption by Country. URL: http://www.transparency.org/country.

Todd, M. .2011. Trade in Malagasy reptiles and amphibians in Thailand. TRAFFIC Southeast Asia. Selangor, Malaysia. URL: http://www.trafficj.org/publication/11_Trade_in_Malagasy_Reptile.pdf

Toledo, L.F., Asumssen, M.C., Rodriguez, J.P. 2012. Track illegal trade in wildlife. *Nature* 36:483.

Tournant, P., Joseph, L. Goka, K., Courchamp, F. 2012. The rarity and overexploitation paradox: stag beetle collections in Japan. *Biological Conservation* 21:1425-2440.

(TRAFFIC) Wildlife Trade Monitoring Network. Bilateral meeting sets stage for efforts to curb wildlife smuggling at Thailand-Lao PDR border. URL: http://www.traffic.org/home/2013/1/3/bilateral-meeting-sets-stage-for-efforts-to-curb-wildlife-sm.html.

Triraganon, R. 2012. Scoping a Path for Community Forestry in Myanmar. The Center for People and Forests (RECOFTC) Blog. URL: http://recoftc.wordpress.com/2012/08/23/scoping-a-path-for-community-forestry-in-myanmar/.

(UN-STAT) United Nations Statistics Division. World Statistics Pocketbook, Myanmar. URL: http://data.un.org/CountryProfile.aspx?crName=MYANMAR

(UNEP-WCMC) United Nations Environmental Programme – World Conservation Monitoring Center. 2007. Analysis of trade in newly described orchid species 1995-2005. UNEP-WCMC, Cambridge. URL: http://www.unep-wcmc.org/medialibrary/2011/11/21/db13f0cb/Analysis%20of%20Trade%20in%20Newly%20Described%20Orchids%201995-2005.pdf.

(UNEP-WCMC) United Nations Environmental Programme – World Conservation Monitoring Center. 2010. UNEP-WCMC Threatened Species Database. UNEP-WCMC, Cambridge. URL: www.unep-wcmc.org.

Van Schendel, W. 2006. Spaces of Engagement: How Borderlands, Illegal Flows, and Territorial States Interlock. In: Van Schendel, W., Abraham, I. (Eds.). Illicit Flows and Criminal Things: States, Borders, and the Other Side of Globalization, Indiana University Press, Bloomington, Indiana.

Van Song, N. 2008. Wildlife trading in Vietnam: situation, causes and solutions. *The Journal of Environment Development* 17:145-165.

Vitousek, P.M., D'Antonio, C.M., Loope, L.L., Westbrooks, R.R. 1996. Biological invasions as global environmental change. *American Scientist* 84:468-478.

Veith, M., Kosuch, J., Feldmann, F., Martens, H., Seitz, A. 2000. A test for correct species declaration of frog legs imported from Indonesia into the European Union. *Biodiversity Conservation* 9:333-341.

Vermeulen, J.J., Phelps, J. Species discoveries via illegal ornamental plant trade: new species of *Bulbophyllum* from Thailand. in prep.

Vermenulen, J.J., Lamb, A. 2011. Endangered even before formally described: Bulbophyllum kubahense n.sp., a beautiful and assumedly narrowly endemic orchid from Borneo. *Plant Systematics and Evolution* 295:51-53.

Von Lampe, K. 2012. Transnational organized crime challenges for future research. *Crime, Law and Social Change* 58:179-194.

Vovides, A.P., Iglesias, C.F. 1994. An integrated conservation strategy for the cycad *Dioon edule* Lindl. *Biodiversity and Conservation* 3:137-141.

Wai, S.H. 2013. The Export Import Licensing System of Myanmar, Law Gazette. URL: http://www.lawgazette.com.sg/2013-02/676.htm.

Warchol, G.L., 2004. The transnational illegal wildlife trade. *Criminal Justice Studies* 17:57-73.

Wardell, D.A., Lund, C. 2006. Governing access to forests in Northern Ghana: micro-politics and the rents of non-enforcement. *World Development* 34:1887-1906.

Wasser, S., et al., 2010. Elephants, ivory, and trade. *Science* 328:1331-1332.

Warkentin, I.G., D. Bickford, N.S. Sodhi, and C.J.A. Bradshaw. 2009. Eating frogs to extinction. *Conservation Biology* 23:1056-1059.

(WB) World Bank, Environment and Social Development Unit, East Asia and Pacific Region. 2005. Going, Going, Gone: The Illegal Trade in Wildlife in East and Southeast Asia. URL: www.worldbank.org/biodiversity.

Weckerle, C.S., Yang, Y., Huber, F.K., Li, W. 2010. People, money, and protected areas: the collectin of the caterpillar mushroom *ophiocordyceps sinensis* in the *Baima Xueshan* Nature Reserve, Southwest China. *Biodiversity Conservation:* 19:2685-2698.

(WHO) World Health Organization. 2005. National Policy on Traditional Medicine—Report of the WHO Global Survey. URL: http://apps.who.int/medicinedocs/en/d/Js7916e/.

Whrithlington School Orchid Project. 2012. URL: http://wsbeorchids.daniel-groves.co.uk/about/.

Wilson-Wilde, L. 2010. Wildlife crime: a global problem *Forensic Science, Medicine,* and Pathology 6:221-222.

Wollenberg, E., Ingles, A. (Eds.) 1998. Incomes from the forest. Center for International Forestry Research, Bogor, Indonesia. URL: http://www.cifor.org/ntfpcd/pdf/Incomes.pdf.

Wyatt, T. 2009. Exploring the organization of Russia Far East's illegal wildlife trade: two case studies of the illegal fur and illegal falcon trades. *Global Crime* 10:144-154.

Wynberg, R.P., Laird, S.A. 2007. Less is Often More: Governance of a Non-Timber Forest Product, Marula (*Sclerocarya birrea* subsp. *caffra*) in Southern Africa. *International Forestry Review* 9:475-490.

(WWF) World Wide Fund for Nature. 2004. Thailand-Lao PDR border market surveys field reports. Unpublished.

(WWF) World Wide Fund for Nature. 2009. WWF Baseline Survey of Prechuap Kirikan Market. Unpublished.

(WWF) World Wide Fund for Nature. Thailand. 2010. Research proposal: Green market survey and endangered species conservation of flora nad fauna project (Thailand—WEN:2). Unpublished.

Yiming, L., Dianmo, L. 1998. The dynamics of trade in live wildlife cross the Guangxi border between China and Vietnam. *Biodiversity Conservation* 7:895-914.

Yong, U.T.K., Burns, P.C., Burns, B.R., 2003. The emergence of polycentric water governance in Northern Thailand. Workshop on Asian Irrigation in Transition–Responding to the Challenges Ahead, April 22-23, 2002, Asian Institute of Technology, Bangkok, Thailand. URL: http://www.bryanbruns.com/Ping-Yom9l.pdf.

Zhang, Y.B., Shaw, P.C., Sze, C.W., Wang, Z.T., Tong, Y. 2007. Molecular authentication of Chinese herbal materials. *Journal of Food and Drug Analysis* 15:1-9.

Zhang, L., Hua, N., Sun, S. 2008. Wildlife trade, consumption and conservation awareness in southwest China. *Biodiversity Conservation* 17:1493-1516.

Appendix 1: Participant Information Sheet

PARTICIPANT INFORMATION SHEET

I am a student at the National University of Singapore and am researching wild orchids in Thailand Laos and Burma.As you know there are many orchid species here but scientists know very little about them.I would appreciate your help with my research..

1. **Project title:** Wild orchids in Southeast Asia

2. **What is the purpose of this research?**
I am interested in the names of orchids where they come from which are common and which are rare and which are most commonly traded.This is information that many orchid sellers already know but has not been recorded by scientists.This information is important so that we can understand how orchids can be both harvested and protected. We also know that orchids are very important to many peoples' livelihoods but we do not know why people chose to work with orchids or how they trade them.

   This sheet provides you with information about my research. Please feel free to ask any questions.

3. **How do I participate?What is expected if I participate?**
Participating will not take up much of your time.I would like permission to study and photograph your orchids when I visit the markets.Please just let me know if I am inconveniencing you and I can move or come back later.If you do not want me to study your plants please let me know.

   I would also like to hear about your experiences trading orchids.Later this year I will ask permission to arrange a time to talk with you about orchids with the help of a translator. We can do this at your stall during the day after hours or somewhere else – whatever you prefer.This discussion will take about 30 minutes and the questions will be easy so that everyone can participate.If there are questions that you do not want or cannot answer that is OK.If you do not want to participate that is also OK.

4. **How will my privacy be protected?**
All of my research is conducted anonymously and I will not share your name or details with anyone else. I am not part of any business or government program.

5. **Will there be payment for participation?**
Participants will not be paid for participating in this research.

6. **Do I have to participate?**
Your decision to participate is voluntary. Also you may allow me to study your orchids but decide that you do not want to participate in the interview.You can withdraw from the research at any time without giving any reasons.

7. **Whom should I call if I have any questions or problems?**
Please talk with meif you have any concerns.Otherwise you can also
contact my Supervisor (Attn: Dr. Webb at telephone 65-6516-4184)

   For an independent opinion regarding the research and the rights of participants you may contact a staff member of the National University of Singapore Institutional Review Board (Attn: Mr Chan Tuck Wai at telephone 65-6516-1234 or email at irb@nus.edu.sg).

Appendix 2: Target species

Table A2.1. Distinguishing vegetative characteristics of target species

Species	Thai name	Distinguishing vegetative characteristics	Possible misidentifications
Ascocentrum curvifolium (Lindl.) Schltr.	Khem Daeng	• Leaves: cross-section is v-shaped light green 26cm long distinctly recurved not rigid	
Ascocentrum garayi Christenson	Khem Saet	• Leaves: <15cm and usually shorter than other species dark green and sometimes purple spotted not very recurved rather stiff and rectangular very thick leaves relative to other species • Distinguishing characters evident in Seidenfaden (1985) drawing of *A. miniatum*	Confused with *A. miniatum* which is a Philippine species
Ascocentrum ampullaceum (Roxb.) Schltr.	Khem Muang	• Leaves: much thinner than *A. garayi* though still very rectangular often spotted but variable (spotted unspotted; leaf tips vary from praemorse to orbicular bilobate).	
Bulbophyllum blepharistes Rchb.f.	Singto Samoa Hin	Pesudobulbs: ovate but flattened on bottom, with deep grooves, white sheathes, often yellow or light orange, separated (~5cm) along a woody rhizome Leaves: 2 at apex of pseudobulb, bilobed, thick and waxy, elliptical, slender at base Inflorescence: very long and stands far above rest of plant	
Cleisostoma arietinum (Rchb.f.) Garay	Khao Phae	• Stem: monopodial, often short (<10cm) • Leaves: several, distichous, terete, heavily curved • Inflorescence: axillary, sometimes branched	
Dendrobium chrysotoxum Lindl.	Ueang Kham	• Pseudobulbs: <30 cm long clustered angled narrow at base and apically thickened usually yellow-green in colour with white sheaths • Leaves: number 2 to 3 towards the apex of the pseudobulb acute shaped • Inflorescence: from apex of pseudobulb	
Dendrobium falconerii Hook	Ueang Sai Wisut	• Pseudobulbs: long thin pendant branching and knotting with branching habit and the clear swellings • Leaves: small narrow linear dark green flexible	"Could not be mistaken for anything else" (Seidenfaden 1985)
Dendrobium findlayanum Par. & Rchb. f.	Ueang Phuang Yok; Wai Pom	• Pseudobulbs: bilaterally compressed green to yellow <50-70cm long 1cm wide erect or pendulus swelling at the nodes and constrictions at the internodes <7 nodes	

Dendrobium jenkinsii	Ueang Phung Noi	• Pesudobulbs: 3(-5)cm long sheathes dark coloured but covered in white sheathes, often heavily apressed to substrate • Leaves: 1 at apex of pseudobulb very leathery oblong dark gree	Not unlike *D. lindleyi* but much smaller and single-flowered
Dendrobium lindleyi Steud.	Ueang Phung	• Pseudobulbs: obvoid-cylindric and narrows at apex and laterally compressed, <10cm long, heavily clustered, covered in white sheathes • Leaves: 1 leaf at apex very leathery oblong and obtuse, usually dark green, often leathery when dry • Inflorescence: subterminal and multi-flowered	Similar to *D. jenkinsii* but larger and multi-flowered
Dendrobium pachyphyllum (Kze.) Bakh. f.	Ueang Song Bai	• Pasudobulbs: small with a single very swollen globular upper internode very crowded growth habit apically swollen • Leaves: 2 succulent oblong yellow green often with red tips • Vegetatively quite regular but a few exceptions with stems 7-8cm (Sedienfaden 1985)	
Dendrobium parishii Rchb. f.	Uang Krang Sai San Uang Sai Nam Khrang	• Psuedobulbs: held very closely together often with white persistent sheathes often purple spotting on mature canes but new shoots are tender and light green. • Most common forms in dry forest have more or less erect or bending stems often compressed to the supporting trunk. In shady humid places can become pendant.	
Dendrobium pulchellum Roxb. Ex Lindl.	Ueang Chang Nao Ueang Kham Ta Khwai	• Pseudobulbs: distinctive purple striping on the internodes (Seidenfaden 1985).It is the argest and largest-flowered representative of the Section *Dendrobium* although there are small forms	
Dendrobium secundum Lindl.	Pleng Si Fun	• Pseudobulbs: usually semi-pendulous tapering at both ends sulcate young canes yellow green but old canes usually covered in white sheathes • Leaves: oblong unequally bilobed semi deciduous and absent from old canes	
Dendrobium senile Par. & Rchb. f.	Ueang Chani	• Pseudobulbs:relatively short for the genus hirsute • Leaves: hirsute ovate-lanceolate alternate semi-deciduous leaves	
Dendrobium sulcatum Lindl.	Ueang Champa Nan	• Psuedobulbs: only *Dendrobium* in the mainland with heavily flattened very light green when young then yellowish brown and glossy when dry, narrowed at base, grooved and unbranched but with several nodes, longitudinal stripes,	
Phalaenopsis pulcherrima	Ma Wing	• Leaves: typical *Phalaenopsis* structure obtuse to subacute	Not likely confused with other

(and varieties) (Lindl). JJ. Smith	Daeng Ubon Ma Bin	• Inflorescence: long and errect • Habit: lythophytic or terrestrial	*Phalaenopsis*in the region.
Gramatophyllum Speciosum Blume	Wan Phetchahung	• Roots: distinctive bundles of upright roots • Pseudobulbs: cylindric very large (up to 2.5m)	
Rhynchostylis gigantea (Lindl.) Ridl.	Chang Kra Chang Daeng (red) Chang Phueak (white)	• Stem: monopodial stout and woody • Leaves: consistent light striping linearunequally bilobed relatively wide deeply channeled thick and waxy less v-shaped than other species.	
Rhynchostylis retusa (L.) Blume	Ayalet	• Stem: monopodial and short • Leaves: heavily v-shappd and curved fleshy consistent light striping	Singificnatly thinner and less rigid leaves than *R. gigantea* and less recurved than *R. coelestis*
Paphiopedilum concolor		• Leaves: all tessellated above, sometimes purple-marked beneath but less than other species, characteristic mottled pattern, relatively short, rounded tips, not waxy	Other species in Section Brachypetalum
Phalaenopsis cornucervi (Breda) Blume & Rchb.f.	Khao Kwang On	• Leaves: relatively narrow often light green. • Inflorescence: with distinctive bracts	None of the other common species is similar.*P. thalebanii* has similar vegetative characters but is only known from 1 collection.
Pholidota articulata Lindl.	Uang Langtaw, Uang Kohtaw	• Pseudobulbs: new pseudobulbs arrive from apex of previous year's mature pseudobulb forming a stem-like structure, subcylindric (2-12cm long), sometimes branching and with a short rhizome between, few roots • Leaves: 2 at apex of new pseudobulbb, linear-lanceolate, glossy, prominent veins • Inflorescence: short, drooping and thin	*Otochilus*
Hygrochilus parishii (Rchb.) Schltr.	Uang Nang Rung	• Stem: monopodial short (<20cm), sheathed • Leaves: leathery elliptic-oblong 11-23cm in two ranks, unequally bilobed • Inflorescence: longer than leaves	*Vanda, Vandopsis*
Habenaria carnea Weathers	Wan Ya Nokwe Linmankorn Bai Jut	• Leaves: several basal olivegreen with pale spots arrangement is more flat rather than upwards • Habit: terrestrial with corms	Recommended by H. Kurtzweil as vegetatively distinguishable

Appendix 3. Notes on taxonomic approach

There remains considerable taxonomic debate within Orchidaceae. In this study we generally relied on existing nomenclature, following the observations of Schuiteman et al. (2008b) that recent nomenclatural or phylogenetic studies have resulted in both many necessary changes (e.g. to Vandae [Gardiner 2012] and to a number of other taxa [Pridgeon et al. 2005]), but also to many uncecessary changes. The ensuing shifts are often burdensome, in part because the required combinations for naming are not all yet available and because existing references become obsolete. Moreover, the classification of several large taxa (e.g. *Coelogyne, Liparis, Eria, Malaxis*) remains unstable (Schuiteman et al. 2008b).

Following Schuitman et al. (2009) we did not follow proposed changes to *Eria* (Pridgeon et al. 2005) and relied on old names *sensu* Seidenfaden.

Appendiculata and *Podochilus* were treated as a morphogenus.

The Subtribe Bulbophyllinae which includes >100 genera were all treated at the level of Subfamily Bulbophyllinae with the exceptions of individuals identified to the species-level in the genera *Bulbophyllum, Sunipia, Trias* and *Drymoda.*

The large genus *Dendrobium* was broadly approached to include *Flickingeria* as a Section (following Schuiteman 2011). However due to this borad treatment of the genus, some identification of specimen as *Dendrobium* Section Dendrobium probably also includes some individuals from Section Pedilonum and possibly S. Breviflores, as these can be vegetatively very similar (although see accuracy assessment in Chapter 2).

Staurochilus and its allies including *Arachnis, Esmeralda, Dimorphorchi,s Arnodorum* were treated as a morphogenus although it remains stornlgy suspected that most specimen encountered were in fact *Staurochilus.*

The species *Dendrobium crepidatum* and *D. primulinum* have been merged into *D. polyanthum* (see Schuiteman et al. 2008), which was followed here. However, following extensive observations across its range, this seems questionable and needs to be further explored.

We retained *D. virgineum sensu* Seidenf. due to lack of clarity with *D. kontumense*.

Appendix 4. Interview instruments

Interview questions for wild orchid traders at border markets

The following introduction should be given to each prospective respondent. In addition a Participant Information Sheet should be presented.

INTERVIEWER: "Excuse me we are students with a research project from the University of Singapore studying wild orchids at markets across Thailand. We study the orchid plants themselves but would also like to learn more their trade and about the livelihoods of people who trade orchids. I was hoping that it would be OK if we asked you some questions about the plants you are selling. This is only for research purposes and we will not record or reveal your identify to anyone for any reason. In addition should there be any questions you are not comfortable responding to you can let us know. You may also terminate the interview at any point should you not wish to proceed. Would you be willing to speak with us now or can we arrange for a more convenient time when we can speak with you?

Do I have your permission to ask these questions?"

TRADER: "Yes" or "No"

INTERVIEWER: If yes: "Thank you. Please answer our questions as honestly as possible and let us know if there are any questions that you do not understand are not comfortable answering or to which you do not know the answer.

Proceed with interview. If possible attempt to conduct interview in private. If more than one trader works at the same stall they may contribute to responses about broader issues, but only one person should be interviewed from each stall .Take note of responses using the codes. Code responses of "I do not know" as 77 and code refusals as 99. In addition record additional anecdotal comments observations and quotes of interest.

Interview information (*not asked*)
Interview number: _______________
Market site: _______________
Date: _______________
Respondent reference: ____
Interviewer: _______________
Language of interview: _______________

Demographic Information

1. *Trader gender (*not asked*)
   0=Female
   1=Male
   2=Transgender
2. *Trader category (*not asked*)
   0=bulk wild plant trader
   1=small-scale wild plant trader
   2=resale of wild plants but potted/mounted
   3=specialization in wild blooming plants
3. *Relative size of stall (*not asked*)
   0=small
   1=medium
   2=large
4. *Where are you from/born? ________________________________
5. *How old are you? ______
6. *Ethnic group__________________________
7. *What is your highest level of education?
   ____
   _

How many members are there in your household?

Category	Number of individuals in household
8. Working-age	
9. Children in school	

10. Retired or unable to work	

Background

11. How long have you been trading orchids? __________
12. Do you trade orchids all year round or only seasonally?
    1=year round
    2=seasonally
13. *If seasonally:* What months of the year do you usually sell orchids?
14. How many days per week do you usually work with orchids?
15. Is orchid trading your primary source of income or a supplementary source of income?
    1=primary
    2=supplementary
16. Do you also participate in any other kinds of work?
    0=No
    1=Yes
17. *If yes:* What type of work?
18. *If no:* Aside from selling orchids what other kinds of work opportunities or skills do you have?
19. What is the main reason that you chose to work with orchids?
    0=better income
    1=interest in plants
    2=lack of other opportunities
    3=family links / family needs help
    4=less demanding or easier than alternatives
    5=extra income
    6=other:
20. What orchid species do you trade most often? (*Free list*)
21. Does your household depend on the income from plant trade:
    0=Not at all
    1=A little
    2=A lot
22. *If "a lot/a little":*Do you use the money you make trading orchids to financially support any other family members from outside your household?
    0=No
    1=Yes

Who else works with you to sell orchids at this stall or do you work on your own?

Category	Number
23. Work alone	
24. Spouse	
25. Adult (>18 years) family members	
26. Children (<18 years) family members	
27. Friends	
28. Hired workers (non-family)	
29. Other/notes:	

Plant Origins

*What country do most of your orchids come from? Please rank the countries from most to least. (*Using cards that respondents organize; code 6 as the most important 1 as the least or 0 if none; 77 for "don't know"*)

Country	Rank	*For top 3 countries:* What provinces in (*country name*) do most of your plants come from? *If relevant:* Through what border or city do the plants from (*country*) usually enter Thailand?
30. Burma		31.
32. Lao		33.
34. Malaysia		35.

36. Thailand		37.
38. Vietnam		39.
40. Other		41.

42. How and where do you usually get your orchids? (*examples: collected myself through family contacts from middlemen from other traders at this market by visiting other markets from the collectors themselves)*

43. *If trader buys from other people:* How many different people do you **usually** buy orchids from?

44. a. How often do you (*buy order or collect*) new orchids in the high season?

44. b. How often do you (*buy order or collect*) new orchids in the low season?

45. How do you usually decide what orchids to buy order or collect or is it based on whatever is available?

46. a. About how many days will it take you to sell all of the orchids you have on sale here during the high season?

46. b. About how many days will it take you to sell all of the orchids you have on sale here during the low season?

47. Now please tell us about the people who buy orchids from you.In general are the people who usually buy from you:
    1=Female
    2=Male
    3=Both

48. In general are the people who usually buy from you:
    1=School-age (<18)
    2=Young working adult (19-35)
    3=Middle-aged (36-59)
    4=Retired (older than 60)
    77=Don't know

49. In general where do the people who usually buy from you come from?
    1=Local or from a nearby region
    2=Bangkok
    3=Other parts of Thailand

What kinds of people usually buy the greatest number of your orchids? List from most to least common. (*Using cards that respondents organize; code 6 as highest ranking 1 as lowest; 77 as "don't know*)

Type of buyer	**Ranking**
50. Middlemen who buy orchids to resell to other vendors	
51. Orchid traders who sell at **other** markets	
52. Other orchid traders at **this** market	
53. Omitted number (skip this number)	--------------
54. Orchid experts or hobbyists who already know about orchids	
55. Regular people who don't know very much about orchids	
56. Other:	

<u>Market Rules</u>

57. At this market are there rules against selling wild orchids?
    0=no
    1=yes but not heavily enforced
    2=yes heavily enforced
    77=don't know

58. What kinds of government officials visit the orchid stalls in this market and what do they usually do when they visit? About how often does this happen?

<u>Paphiopedilum Trade</u> *(Data collected but ultimately not used)*

*We would like to know about the *Paphiopedilum* species that are most common trade.

59. Do you trade *Paphiopedilum* plants?
    0=no*If "no" skip this section*
    1=yes

For key informants refer to key informant section on Paphiopedilum trade.

Using the following photographs please helps us to identify the *Paphiopedilum* species that you have traded in the last year. (*Use photographs to identify plants*).
For each selected: In the last year about how many pieces of this orchid have you sold?
0=not traded

Thai Name	*Paphiopedilum* species.	Distribution	Volume traded
60. Fa Hoi	*P. bellatulum*	N. Thailand N. Lao N. Burma	
61. Lueang Prachin	*P. concolor*	Regional	
62. Khao Satul	*P. niveum*	S. Thailand	
63. Si Cream	*P. godefroyae*	S. Thailand	
64. Doi tung	*P. charlesworthii*	N. Burma N. Thailand	
65.	*P. armeniacum*	China	
66.	*P. fairrieanum*	Bhutan India	

For the following pair of closely related species ask respondents which they have traded.If they have traded any confirm that they trade plants from the given region (see below for each species). If the geographic information provided by the trader does not match or if the trader is uncertain of origin and identification but one of the species in this group was definitely traded mark question 75 only.

Thai Name	*Paphiopedilum* species.	Distribution	Trade Frequency
67. Chiang Dao	*P. dianthum*	N. Lao N. Vietnam	
68. Mueang Kan Nuat Reusi	*P. parishii*	Thailand Burma	
69.	Uncertain one or more of the species in this group		

For the following pair of closely related species ask respondents which they have traded.If they have traded any confirm that they trade plants from the given region (see below for each species). If the geographic information provided by the trader does not match or if the trader is uncertain of origin and identification but one of the species in this group was definitely traded mark question 168 only.

Thai Name	*Paphiopedilum* species.	Distribution	Trade Frequency
70. Pbeak Maleng Pbaw Sukakun	*P. sukhakulii*	N. Thailand	
71.	*P. wardii*	N. Burma	
72.	Uncertain one or more of the species in this group		

For the following pair of closely related species ask respondents which they have traded.If they have traded any confirm that they trade plants from the given region (see below for each species). If the geographic information provided by the trader does not match or if the trader is uncertain of origin and identification but one of the species in this group was definitely traded mark question 171 only.

Thai Name	*Paphiopedilum* species.	Distribution	Trade Frequency
73. Muang Songkla	*P. barbatum*	S. Thailand Malaysia	
74. Khang Kop	*P. callosum*	Thailand Laos Cambodia Vietnam Burma	
75.	Uncertain one or more of the species in this group		

For the following pair of closely related species ask respondents which they have traded.If they have traded any confirm that they trade plants from the given region (see below for each species). If the geographic information provided by the trader does not match or if the trader is uncertain of origin and identification but one of the species in this group was definitely traded mark question 175 only.

Thai Name	*Paphiopedilum* species.	Distribution	Trade Frequency
76. Khang Kob Kho Daeng	*P. appletonianum*	E. Thailand Cambodia Lao Vietnam	
77. Lueang Loei	*P. hirsutissiumum*	N. Thailand Laos N. Vietnam N. Burma	
78.	*P. tigrinum*	N. Burma	
79.	Uncertain one or more of the species in this group		

For the following pair of closely related species ask respondents which they have traded.If they have traded any confirm that they trade plants from the given region (see below for each species). If the geographic information provided by the trader does not match or if the trader is uncertain of origin and identification but one of the species in this group was definitely traded mark question 182 only.

Thai Name	*Paphiopedilum* species.	Distribution	Trade Frequency
80. Insigne	*P. insigne*	India Nepal	
81. Intanon	*P. villosum*	N. Thailand Vietnam Laos N. Burma	
82. Intanon Lao	*P. gratixianum*	N. Laos N. Vietnam	
83. Doi Tung Kan	*P. barbigerum*	N. Vietnam S. China	
84. Luang Krabi	*P. exul*	S. Thailand	
85.	*P. spicerianum*	N. Burma India	
86.	Uncertain one or more of the species in this group		

Do you sell *Paphiopedilum* from Vietnam?*If yes:* Which species and how often are these traded? (*Selection from photos; frequency based on previous codes*)

Thai Name	*Paphiopedilum* species.	Trade Frequency
87.	*P. delenatii*	
88.	*P. vietnamese*	
89.	*P. malipoense*	
90.	*P. micranthum*	
91.	*P. hangianum*	
92.	*P. emersonii*	
93.	*P. helenae*	
94.	*P. tranlienianum*	
95.	*P. henryanum*	
96.	*P. purpuratum*	

Income

We would like to ask you some questions about your income from trading orchids. If there are any questions you prefer not to answer please let us know.

97. *Do you usually keep some type of track or account of your approximate expenses and profit from orchid trading?
    0=no
    1=yes

*Average monthly income:

How does your income vary	What months are covered	Sales from stall: Gross	Sales from stall:	Sales by order from	Sales by order: Net	Frequency of sales

throughout the year?What are the differentseasons with which income varies?	by this period	Income	Net Income	other traders: Gross Income per sale	income per sale	by order
High sale period	98.	99.	100.	101.	102.	103.
Low sale period	104.	105.	106.	107.	108.	109.
Other sale category	110.	111.	112.	113.	114.	115.
Other sale category	116.	117.	118.	119.	120.	121.

If respondents reported participating in other employment: You mentioned earlier participating in other types of work.Please tell us a little bit more about those.

Activity	What is your approximate income from this activity? (*Note whether monthly season annual)*
122.	123.
124.	125.
126.	127.
128.	129.
130.	131.

In the past year what have been your household's (people who live in your house with you) most important sources of income?For example from salaries commerce pensions remittances or agriculture.

Activity	What is their approximate income from this activity? (*Note whether monthly season annual)*
132.	133.
134.	135.
136.	137.
138.	139.
140.	141.

Assorted Species Trade *(Data collected but ultimately not used)*
Based on these pictures please help us to identify the species that you are certain you have traded in the last year?(*Selection using photographs*)
For each selected: In the last year approximately how many pieces of this species have you traded? If possible provide trade volume in kilograms.

Thai name	Species	Trade Volume
142.Kulap Lueang Korat	*Aerides houlettiana*	
143.Kulap Airawan	*Aerides rosea*	
144.Khem Muang	*Ascocentrum ampullaceum*	
145.Singto Kam Pu Daeng	*Bulbophyllum patens*	
146.Singto sukhakulii	*Bulbophyllum sukhakulii*	
147.	*Calanthe pulchra*	
148.Ka Re Ka Ron Doi	*Cymbidium lowianum*	
149.Uang Pha Wiang	*Dendrobium albosanguineum*	
150.Ueang Sai Man Phra In Uang Sai Luat	*Dendrobium devonianum*	
151. Ueang Sai Wisut	*Dendrobium falconeri*	
152.Ueang Phung Noi	*Dendrobium jenkinsii*	
153.Nang Lom	*Dendrobium peguanum*	
154.Ayalet	*Rhyncostylis retusa*	
155.Ueang Ma Lai	*Kingidium minus*	
156.Nang Ua Sakhrik	*Pecteilis hawkessiana*	
157.Ueang Pi Seua Chompu	*Phalaenopsis lowii*	
158.Pi Seua Noi	*Phalaenopsis parishii*	
159.Khao Kwang On	*Phalaenopsis cornucervi*	
160.Chang Khra	*Rhyncostylis gigantea*	
161.Sam Poi Khun Tan Sam Poi Luang	*Vanda denisoniana*	
162.Salaeng	*Vanda pumila*	

163.Sam Poi Chomphu	*Vanda bensonii*	
164.Fa Mui	*Vanda coerulea*	

Social Network Analysis*(Not that SNA was not successful but did provide insights into regional trade patterns).*

Please tell us about the three people who you most often buy your orchids from.We are asking this in order to figure out where the plants are coming from and so that we can eventually visit the forests where they were collected.We will not share contacts or personal information with anyone else.

99=Refusal

Name	Where do they usually sell from?	Why do you choose to trade with this person most often?
165.	166.	167.
168.	169.	170.
171.	172.	173.

If respondents report selling to others traders resellers or middlemen: Please tell us about the three resellers or traders that you sell to most often?

99=Refusal

Name	Where do they usually sell from?
174.	175.
176.	177.
178.	179.

Key Informant – Additional open Ended Interview Survey questions

1. Why are many plants imported from Laos and Burma instead of being collected from within Thailand?
2. Are there any particular orchid species that were once fairly common in trade that have become hard to find in recent years?
3. Are there any orchid species that considers want but that have become hard to find in recent years?

Species	Purchase Price	Sale Price

4. Have *Paphiopedilum* populations changed over time?If so for which species and how?

Species	Notes

5. Who owns this market space?
6. Please tell us about the history of orchid trade at this market.
7. How has the orchid trade at this market changed over time?Has it grown or gotten smaller?
8. What are the official rules for selling at this market?
9. What are the barriers for people who want to start a business trading orchids? (*examples: restrictive startup costs lack of trade contacts lack of access to credit saturated market lack of orchid knowledge legality)*
10. Please tell us about the money borrowing practices of orchid traders who you know including who people usually borrow from.
11. Do traders usually order specific orchids or do you sell whatever is available from the middlemen/collectors?

Survey Instrument for Orchid Collectors

<u>Demographic Information</u>

1. Trader gender (*not asked*)

   0=Female
   1=Male
   2=Transgender

1. Where are you from/born?

2. How old are you?
3. Ethnic group
4. What is your highest level of education?

How many members are there in your household?

Category	Number of individuals in household
5. Working-age	
6. Children in school	
7. Retired or unable to work	

Background

8. How long have you been collecting orchids? ___________
9. How did you get involved in collecting orchids?
10. Do you collect orchids all year round or only seasonally?
    1=year round
    2=seasonally
11. *If seasonally:* What months of the year do you usually collect orchids?
12. How many days per week do you usually collect orchids?
13. Does anyone else in your family work with orchids? In what capacity?
14. What are the main reasons that you chose to work with orchids?
    0=better income
    1=interest in plants
    2=lack of other opportunities
    3=family links / family needs help with existing orchid business
    4=less demanding or easier than alternatives
    5=extra income
    6=other:

Income

15. Is orchid collecting your primary source of income or a supplementary source of income?
    1=primary
    2=supplementary

What are the differentseasons with which income varies?

	What months are covered by this period	Gross Income	Net Income/ Profit
High sale period	16.	17.	18.
Low sale period	19.	20.	21.
Other:	22.	23.	24.
Other:	25.	26.	27.

28. Do you also participate in any other kinds of work?
    0=No
    1=Yes

If yes: What types of work? And what is your approximate income/profit from these activities? (*Note whether monthly seasonal annual)*

Activity	Income
29.	30.
31.	32.
33.	34.
35.	36.
37.	38.

Aside from selling orchids what other kinds of work opportunities or skills do you have? What is the approximate income/profit you could make from this activity?

Activity	Potential income (*Note whether monthly season annual)*
39.	40.
41.	42.
43.	44.
45.	46.

47. Does your household depend on the income from plant trade:

0=Not at all
1=A little
2=A lot

Plant Origins / Harvest Practises

48. Please describe your usual methods for collecting orchids?
49. How do you decide which species to collect? (*for example whatever is ordered highest prices collect all)*
50. Do you usually collect all of the orchids you find or only some plants? *If targeted:* Which plants do you collect? (*such as those that are mature largest or in bloom*)
51. Do you usually collect from all of the trees in a certain area or only from some of the trees? *If targeted:* Which trees do you usually target?
52. What orchid species do you collect most often? (*Free list*)

Who do you usually collect with or do you collect on your own?

Category	Number
53. Work alone	
54. Spouse	
55. Adult (>18) family members	
56. Children (<18) family members	
57. Friends	
58. Hired workers (non-family)	
59. Other/notes:	

60. How many other people do you know who are collecting orchids for sale at least once per month?
61. In the last year where have you collected orchids? (*e.g. name of province district particular forest etc*.)What is the tenure/ownership of the land where you collect (*e.g. private protected area government*)?Across how large an area did you collect at that site?

Name	Tenure	Size of area
62.	63.	64.
65.	66.	67.
68.	69.	70.
71.	72.	73.
74.	75.	76.

77. Once you collect in a certain area do you usually return to collect there again at a later date?
78. How do you usually transport the orchids?
79. Do you usually collect other plants or animals while you are collecting orchids?*If yes:* Which species?
80. a. Are there any orchid species that were once common but are now difficult to find or that were rare and are now more common? Are there places where you used to collect orchids but they are now difficult to find?
    b. *If so:* Which species and areas and how has abundance changed?

Rules and Enforcement

81. Are there rules against collecting and selling wild orchids?
    0=no
    1=yes but not heavily enforced
    2=yes heavily enforced
    77=don't know
82. *If yes:* What are the official rules regarding collecting wild plants and orchids?
83. Do you ever encounter officials or enforcement such as from the forest department?If so how do you manage this?
84. Do you ever have to pay officials in order to collect plants or avoid problems?

Social Network Analysis

Please tell us about the three people that you sell to most often?
99=Refusal

Name	Where do they usually sell from?
85.	86.
87.	88.

Appendix 5. Market species lists (Number of individuals and percent of individuals in market)

Family	Genus	Section	species	Chedi Sam Ong	Dansingkorn	Jatujak	Mukdahan	All Markets
Orchidaceae				5899 (70.34)	16566 (88.87)	48435 (88.09)	11279 (92.01)	82179 (87.17)
	Acampe			2 (0.02)	12 (0.06)	222 (0.4)	22 (0.18)	258 (0.27)
			papilosa	0	0	2 (0)	0	2 (0)
			praemorsa	0	0	6 (0.01)	0	6 (0.01)
			sp.	2 (0.02)	12 (0.06)	214 (0.39)	22 (0.18)	250 (0.27)
	Acanthephippium		*striatum*	0	0	4 (0.01)	0	4 (0)
	Acriopsis			8 (0.1)	9 (0.05)	32 (0.06)	0	49 (0.05)
			liliifolia	3 (0.04)	3 (0.02)	0	0	6 (0.01)
			sp.	5 (0.06)	6 (0.03)	32 (0.06)	0	43 (0.05)
	Adenoncos		*parviflora*	0	0	4 (0.01)	0	4 (0)
	Aerides			205 (2.44)	1841 (9.88)	3034 (5.52)	1663 (13.57)	6743 (7.15)
			crassifolia	0	0	2 (0)	5 (0.04)	7 (0.01)
			falcata	0	10 (0.05)	106 (0.19)	0	116 (0.12)
			flabellata	0	0	8 (0.01)	0	8 (0.01)
			houlettiana	0	46 (0.25)	158 (0.29)	0	204 (0.22)
			multiflora	0	4 (0.02)	213 (0.39)	0	217 (0.23)
			odorata	29 (0.35)	23 (0.12)	49 (0.09)	0	101 (0.11)
			retusa	0	0	2 (0)	0	2 (0)
			rosea	2 (0.02)	29 (0.16)	69 (0.13)	0	100 (0.11)
			sp.	174 (2.07)	1729 (9.28)	2427 (4.41)	1658 (13.53)	5988 (6.35)
	Agrostophyllum		*sp.*	38 (0.45)	45 (0.24)	2 (0)	6 (0.05)	91 (0.1)
	Anoectochilus		*sp.*	0	0	301 (0.55)	0	301 (0.32)
	Apostasia		*sp.*	0	0	6 (0.01)	0	6 (0.01)

Appendicula / Podochilus§		*sp.*	35 (0.42)	0	50 (0.09)	0	85 (0.09)
Arachnis		*labrosa*	0	0	1 (0)	0	1 (0)
Arundina		*graminifolia*	0	10 (0.05)	25 (0.05)	150 (1.22)	185 (0.2)
Ascocentrum			248 (2.96)	225 (1.21)	1629 (2.96)	144 (1.17)	2246 (2.38)
		ampullaceum	36 (0.43)	1 (0.01)	75 (0.14)	0	112 (0.12)
		curvifolium	212 (2.53)	211 (1.13)	319 (0.58)	10 (0.08)	752 (0.8)
		garayi	0	13 (0.07)	891 (1.62)	134 (1.09)	1038 (1.1)
		pusillum	0	0	256 (0.47)	0	256 (0.27)
		sp.	0	0	88 (0.16)	0	88 (0.09)
Brachycorythis			0	0	55 (0.1)	0	55 (0.06)
		acuta	0	0	7 (0.01)	0	7 (0.01)
		neglecta	0	0	28 (0.05)	0	28 (0.03)
		sp.	0	0	20 (0.04)	0	20 (0.02)
Brachypeza		*laotica*	0	0	1 (0)	0	1 (0)
Bromheadia			0	4 (0.02)	111 (0.2)	3 (0.02)	118 (0.13)
		aporoides	0	0	0	3 (0.02)	3 (0)
		sp.	0	4 (0.02)	111 (0.2)	0	115 (0.12)
Bulbophyllinae§			54 (0.64)	1182 (6.34)	2943 (5.35)	281 (2.29)	4460 (4.73)
Bulbophyllum			343 (4.09)	320 (1.72)	2715 (4.94)	196 (1.6)	3574 (3.79)
	Not placed	*sukhakulii*	0	1 (0.01)	0	0	1 (0)
	Aeschynanthoides	*sp.*	0	0	7 (0.01)	0	7 (0.01)
	Cirrhopetalum		0	0	153 (0.28)	0	153 (0.16)
		annandalei	0	0	1 (0)	0	1 (0)
		auratum	0	0	22 (0.04)	0	22 (0.02)
		bciolor	0	0	1 (0)	0	1 (0)

	cf. pulchellum	0	0	1 (0)	0	1 (0)
	corolliferum	0	0	5 (0.03)	0	5 (0)
	flabellum-veneris	0	0	8 (0.01)	0	8 (0.01)
	gracillimum	0	0	1 (0)	0	1 (0)
	lasiochilum	0	0	24 (0.04)	0	24 (0.03)
	longissimum	0	0	13 (0.02)	0	13 (0.01)
	picturatum	0	0	6 (0.01)	0	6 (0.01)
	pulchellum	0	0	2 (0)	0	2 (0)
	retusiusculum	0	0	1 (0)	0	1 (0)
	wendlandianum	0	0	10 (0.02)	0	10 (0.01)
	sp.	0	0	58 (0.11)	0	58 (0.06)
Desmosanthes		0	16 (0.09)	100 (0.18)	0	116 (0.12)
	odoratissimum	0	0	27 (0.05)	0	27 (0.03)
	planibulbe	0	16 (0.09)	71 (0.13)	0	87 (0.09)
	sutepense	0	0	2 (0)	0	2 (0)
Globiceps	*repens*	0	0	22 (0.04)	0	22 (0.02)
Hyalosema	*grandiflorum*	0	0	48 (0.09)	0	48 (0.05)
Leopardinae		0	0	251 (0.46)	0	251 (0.27)
	dayanum	0	0	103 (0.19)	0	103 (0.11)
	psittacoglossum	0	0	148 (0.27)	0	148 (0.16)
Mastigion	*appendiculatum*	0	2 (0.01)	0	0	2 (0)
Monilibulbus	*subtenellum*	0	0	1 (0)	0	1 (0)
Oxysepala	*clandestinum*	0	0	58 (0.11)	0	58 (0.0)
Pleiophyllus		0	0	17 (0.03)	0	17 (0.02)
	comosum	0	0	2 (0)	0	2 (0)
	hirtum	0	0	3 (0.01)	0	3 (0)

	lemniscatoides	0	0	6 (0.01)	0	6 (0.01)
	muscarirubrum	0	0	5 (0.01)	0	5 (0.01)
	n. sp.	0	0	1 (0)	0	1 (0)
Racemosae		2 (0.02)	7 (0.04)	130 (0.24)	0	139 (0.15)
	aff. limbatum	0	0	1 (0)	0	1 (0)
	sicyobulbon	0	3 (0.02	0	0	3 (0)
	cf. peninsulare	0	1 (0)	0	0	1 (0)
	dissitiflorum	0	0	5 (0.01)	0	5 (0.01)
	microtepalum	2 (0.02)	0	0	0	2 (0)
	lindleyanum	0	0	56 (0.1)	0	56 (0.06)
	n. sp.	0	0	2 (0)	0	2 (0)
	crassipes	0	0	17 (0.03)	0	17 (0.02)
	tricorne	0	0	25 (0.05)	0	25 (0.03)
	sp.	0	4 (0.02)	23 (0.04)	0	27 (0.03)
Sestochilus		0	0	13 (0.02)	0	13 (0.01)
	affine	0	0	1 (0)	0	1 (0)
	capillipes	0	0	7 (0.01)	0	7 (0.01)
	lobbii	0	0	1 (0)	0	1 (0)
	orectopetalum	0	0	3 (0.01)	0	3 (0)
	smitinandii	0	0	1 (0)	0	1 (0)
Stachyanthes	*apodum*	0	0	5 (0.01)	0	5 (0.01)
Stenochilus		0	8 (0.04)	1 (0)	0	9 (0.01)
	macranthum	0	8 (0.04)	0	0	8 (0.01)
	patens	0	0	1 (0)	0	1 (0)
Tripudianthes		148 (1.76)	106 (0.57)	246 (0.45)	77 (0.63)	577 (0.61)
	blepharistes	148 (1.76)	106 (0.57)	169 (0.31)	77 (0.63)	500 (0.53)
	refractum	0	0	75 (0.14)	0	75 (0.08)

		wallichii	0	0	2 (0)	0	2 (0)
	Sect. unidentified	*sp.*	193 (2.3)	180 (0.97)	1663 (3.02)	119 (0.97)	2155 (2.29)
Calanthe			441 (5.26)	26 (0.14)	146 (0.27)	0	613 (0.65)
		rubens	0	0	20 (0.04)	0	20 (0.02)
		vestita	0	20 (0.11)	1 (0)	0	21 (0.02)
		sp.	441 (5.26)	6 (0.03)	125 (0.23)	0	572 (0.61)
Chamaeanthus		*brachystachys*	0	1 (0)	0	0	1 (0)
Ceratostylis			0	4 (0.02)	1 (0)	0	5 (0.01)
	Desmosanthes	*pleurothallis*	0	4 (0.02)	0	0	4 (0)
	Sect. unidentified	*sp.*	0	0	1 (0)	0	1 (0)
Cheirostylis			300 (3.58)	0	6 (0.01)	0	306 (0.32)
		yunnanensis	300 (3.58)	0	0	0	300 (0.32)
		sp.	0	0	6 (0.01)	0	6 (0.01)
Chiloschista			140 (1.67)	112 (0.6)	471 (0.86)	17 (0.14)	740 (0.78)
		lunifera	0	0	2 (0)	0	2 (0)
		parishii	120 (1.43)	51 (0.27)	8 (0.01)	0	186 (0.2)
		usneoides	0	7 (0.04)	0	0	7 (0.01)
		ramifera	0	3 (0.02)	0	0	3 (0)
		viridiflava	0	0	38 (0.07)	0	38 (0.04)
		sp.	20 (0.24)	51 (0.27)	423 (0.77)	17 (0.14)	511 (0.54)
Cleisomeria			0	0	21 (0.04)	0	21 (0.02)
		pilosulum	0	0	5 (0.01)	0	5 (0.01)
		sp.	0	0	16 (0.03)	0	16 (0.02)
Cleisostoma			134 (1.6)	310 (1.66)	1125 (2.05)	252 (2.06)	1821 (1.93)
	Cleisostoma		1 (0.01)	1 (0.01)	110 (0.2)	0	112 (0.12)
		crochetii	0	0	95 (0.17)	0	95 (0.1)
		kerrii	0	1 (0.01)	0	0	1 (0)

		racemiferum	1 (0.01)	0	15 (0.03)	0	16 (0.02)
	Complicatum		1 (0.01)	0	13 (0.02)	0	14 (0.01)
		chantaburiense	0	0	1 (0)	0	1 (0)
		complicatum	1 (0.01)	0	0	0	1 (0)
		simondii	0	0	12 (0.02)	0	12 (0.01)
	Mitriformes		1 (0.01)	145 (0.78)	319 (0.58)	120 (0.98)	585 (0.62)
		arietinum	0	145 (0.78)	317 (0.58)	120 (0.98)	582 (0.62)
		williamsonii	1 (0.01)	0	2 (0)	0	3 (0)
	Pilearia		0	60 (0.32)	5 (0.01)	8 (0.07)	73 (0.08)
		filiforme	0	0	1 (0)	0	1 (0)
		fuerstenberianum	0	0	2 (0)	8 (0.07)	10 (0.01)
		rolfeanum	0	60 (0.32)	0	0	60 (0.06)
		sp.	0	0	2 (0)	0	2 (0)
	Subulatum	*subulatum*	0	1 (0.01)	0	0	1 (0)
	Sect. unidentified	*sp.*	131 (1.56)	103 (0.55)	678 (1.23)	124 (1.01)	1036 (1.1)
Coelogyne			125 (1.49)	153 (0.82)	762 (1.39)	107 (0.87)	1147 (1.22)
	Carinatae		0	0	5 (0.01)	0	5 (0.01)
		lacteata	0	0	1 (0)	0	1 (0)
		trinervis	0	0	4 (0.01)	0	4 (0)
	Coelogyne	*cumingii*	0	0	1 (0)	0	1 (0)
	Elatae	*calcicola*	0	0	120 (0.22)	0	120 (0.13)
	Flaccidae	*viscosa*	0	0	2 (0)	0	2 (0)
	Fulginosae		0	0	31 (0.06)	0	31 (0.03)
		fimbriata	0	0	23 (0.04)	0	23 (0.02)
		ovalis	0	0	8 (0.01)	0	8 (0.01)
	Fuscescentes	*fuscecens*	0	0	50 (0.09)	0	50 (0.05)

	Lawrenceanae		0	0	16 (0.03)	0	16 (0.02)
		eberhardtii	0	0	1 (0)	0	1 (0)
		lawrenceana	0	0	15 (0.03)	0	15 (0.02)
	Ocellatae	*nitida*	0	0	36 (0.07)	0	36 (0.04)
	Tomentosae		0	0	5 (0.01)	0	5 (0.01)
		pulverula	0	0	4 (0.01)	0	4 (0)
		rochussenii	0	0	1 (0)	0	1 (0)
	Sect. unidentified	*sp.*	125 (1.49)	153 (0.82)	496 (0.9)	107 (0.87)	881 (0.93)
Crepidium[§]			0	0	23 (0.04)	0	23 (0.02)
		calophylla	0	0	10 (0.02)	0	10 (0.01)
		mackinnonii	0	0	3 (0.01)	0	3 (0)
		sp.	0	0	10 (0.02)	0	10 (0.01)
Cymbidium			195 (2.33)	301 (1.61)	541 (0.98)	179 (1.46)	1216 (1.29)
	Jensoa	*ensifolium*	0	0	15 (0.03)	0	15 (0.02)
	Cymbidium		0	83 (0.45)	0	11 (0.09)	94 (0.1)
		aloifolium	0	25 (0.13)	0	11 (0.09)	36 (0.04)
		findlaysonianum	0	58 (0.31)	0	0	58 (0.06)
	Cyperorchis		0	0	15 (0.03)	0	15 (0.02)
		lowianum	0	0	9 (0.02)	0	9 (0.01)
		mastersii	0	0	4 (0.01)	0	4 (0)
		tracyanum	0	0	2 (0)	0	2 (0)
	Himantophyllum	*dayanum*	0	2 (0.01)	0	0	2 (0)
	Sect. unidentified	*sp.*	195 (2.33)	216 (1.16)	511 (0.93)	168 (1.37)	1090 (1.16)
Dendrobium			1618 (19.29)	4366 (23.42)	16430 (29.88)	4346 (35.45)	26760 (28.39)
	Aporum		44 (0.52)	331 (1.78)	528 (0.96)	4 (0.03)	907 (0.96)
		indivisum	0	0	87 (0.16)	0	87 (0.09)

	keithii	1 (0.01)	19 (0.1)	3 (0.01)	0	23 (0.02)
	leonis	0	0	2 (0)	0	2 (0)
	nathanielis	0	0	7 (0.01)	0	7 (0.01)
	terminale	0	0	1 (0)	0	1 (0)
	sp.	43 (0.51)	312 (1.67)	428 (0.78)	4 (0.03)	787 (0.83)
Bilobidium		0	35 (0.19)	200 (0.36)	0	235 (0.25)
	hymenanthum	0	1 (0.01)	0	0	1 (0)
	pachyphyllum	0	34 (0.18)	200 (0.36)	0	234 (0.25)
Breviflores		0	0	351 (0.64)	0	351 (0.37)
	aduncum	0	0	2 (0)	0	2 (0)
	cf. aduncum	0	0	2 (0)	0	2 (0)
	hercoglossum	0	0	10 (0.02)	0	10 (0.01)
	linguella	0	0	2 (0)	0	2 (0)
	secundum	0	0	72 (0.13)	0	72 (0.08)
	stuposum	0	0	80 (0.15)	0	80 (0.08)
	umbonatum	0	0	1 (0)	0	1 (0)
	sp.	0	0	182 (0.33)	0	182 (0.19)
Callista		522 (6.22)	1023 (5.49)	5581 (10.15)	1391 (11.35)	8517 (9.03)
	brymerianum	0	0	20 (0.04)	0	20 (0.02)
	chrysotoxum	317 (3.78)	438 (2.35)	2270 (4.13)	699 (5.7)	3724 (3.95)
	farmeri	8 (0.1)	3 (0.02)	7 (0.01)	0	18 (0.02)
	griffithianum	2 (0.02)	0	7 (0.01)	0	9 (0.01)
	jenkinsii	0	155 (0.83)	11 (0.02)	34 (0.28)	200 (0.21)
	lindleyi	151 (1.8)	240 (1.29)	2468 (4.49)	540 (4.41)	3399 (3.61)
	palpebrae	3 (0.04)	1 (0.01)	8 (0.01)	0	12 (0.01)
	sulcatum	0	24 (0.13)	31 (0.06)	0	55 (0.06)
	thyrsiflorum	0	0	7 (0.01)	15 (0.12)	22 (0.02)

	sp.	41 (0.49)	162 (0.87)	752 (1.37)	103 (0.84)	1058 (1.12)
Conostalix		20 (0.24)	25 (0.13)	27 (0.05)	0	72 (0.08)
	pachyglossum	20 (0.24)	25 (0.13)	0	0	45 (0.05)
	sp.	0	0	27 (0.05)	0	27 (0.03)
Dendrobium		855 (10.19)	1847 (9.91)	5065 (9.21)	1747 (14.25)	9514 (10.09)
	friedericksianum	0	0	1 (0)	0	1 (0)
	albosanguineum	17 (0.2)	4 (0.02)	180 (0.33)	0	201 (0.21)
	anosmum	0	19 (0.1)	49 (0.09)	73 (0.6)	141 (0.15)
	aphyllum	0	14 (0.08)	12 (0.02)	0	26 (0.03)
	brymerianum	0	30 (0.16)	51 (0.09)	0	81 (0.09)
	capillipes	0	21 (0.11)	577 (1.05)	9 (0.07)	607 (0.64)
	chittimae	0	3 (0.02)	2 (0)	0	5 (0.01)
	chrysanthum	0	0	2 (0)	0	2 (0)
	crepidatum	0	38 (0.2)	2 (0)	65 (0.53)	105 (0.11)
	crystallinum	0	0	5 (0.01)	7 (0.06)	12 (0.01)
	devonianum	0	10 (0.05)	5 (0.01)	0	15 (0.02)
	falconeri	0	52 (0.28)	184 (0.33)	139 (1.13)	375 (0.4)
	findlayanum	0	58 (0.31)	664 (1.21)	55 (0.45)	777 (0.82)
	friedericksianum	0	0	9 (0.02)	0	9 (0.01)
	gibsonii	0	0	1 (0)	0	1 (0)
	gratiosissimum	0	81 (0.43)	67 (0.12)	1 (0.01)	149 (0.16)
	heterocarpum	0	0	32 (0.06)	0	32 (0.03)
	lamyaiae	0	0	22 (0.04)	0	22 (0.02)
	lituiflorum	0	3 (0.02)	10 (0.02)	0	13 (0.01)
	moschatum	0	8 (0.04)	2 (0)	0	10 (0.01)
	nobile	0	12 (0.06)	77 (0.14)	5 (0.04)	94 (0.1)

	ochreatum	0	0	15 (0.03)	0	15 (0.02)
	parishii	0	85 (0.46)	181 (0.33)	25 (0.2)	291 (0.31)
	pendulum	0	0	14 (0.03)	83 (0.68)	97 (0.1)
	polyanthum	3 (0.04)	28 (0.15)	35 (0.06)	50 (0.41)	116 (0.12)
	pulchellum	18 (0.21)	2 (0.01)	135 (0.25)	139 (1.13)	294 (0.31)
	schildhaueri	0	0	26 (0.05)	0	26 (0.03)
	senile	0	46 (0.25)	30 (0.05)	0	76 (0.08)
	signatum	0	0	20 (0.04)	6 (0.05)	26 (0.03)
	tortile	363 (4.33)	118 (0.63)	49 (0.09)	30 (0.24)	560 (0.59)
	unicum	0	28 (0.15)	85 (0.15)	0	113 (0.12)
	wardianum	0	0	0	34 (0.28)	34 (0.04)
	sp.	454 (5.41)	1187 (6.37)	2521 (4.58)	1026 (8.37)	5188 (5.5)
Distichophyllum		0	25 (0.13)	43 (0.08)	0	68 (0.07)
	cf. ellipsophyllum	0	0	1 (0)	0	1 (0)
	connatum	0	0	10 (0.02)	0	10 (0.01)
	ellipsophyllum	0	0	6 (0.01)	0	6 (0.01)
	oligophyllum	0	0	18 (0.03)	0	18 (0.02)
	trinervium	0	18 (0.1)	0	0	18 (0.02)
	sp.	0	7 (0.04)	8 (0.01)	0	15 (0.02)
Flickingeria	*sp.*	93 (1.11)	31 (0.17)	19 (0.03)	0	143 (0.15)
Formosae		16 (0.19)	493 (2.64)	2639 (4.8)	545 (4.45)	3693 (3.92)
	bellatulum	0	0	290 (0.53)	0	290 (0.31)
	cariniferum	0	1 (0.01)	91 (0.17)	28 (0.23)	120 (0.13)
	christyanum	0	23 (0.12)	119 (0.22)	110 (0.9)	252 (0.27)
	draconis	0	0	242 (0.44)	32 (0.26)	274 (0.29)
	formosum	14 (0.17)	94 (0.5)	102 (0.19)	0	210 (0.22)

	infundibulum	0	11 (0.06)	0	0	11 (0.01)
	scabrilingue	0	0	56 (0.1)	0	56 (0.06)
	schildhaueri	0	8 (0.04)	12 (0.02)	0	20 (0.02)
	schrautii	0	30 (0.16)	38 (0.07)	0	68 (0.07)
	trigonopus	0	0	49 (0.09)	0	49 (0.05)
	virgineum	0	0	8 (0.01)	0	8 (0.01)
	sp.	2 (0.02)	326 (1.75)	1632 (2.97)	375 (3.06)	2335 (2.48)
Gastridium		0	3 (0.02)	3 (0.01)	1 (0.01)	7 (0.01)
	salaccense	0	2 (0.01)	0	0	2 (0)
	sp.	0	1 (0.01)	3 (0.01)	1 (0.01)	5 (0.01)
Oxystophyllum		1 (0.01)	0	25 (0.05)	0	26 (0.03)
	carnosum	0	0	1 (0)	0	1 (0)
	sp.	1 (0.01)	0	24 (0.04)	0	25 (0.03)
Pedilonum		23 (0.27)	106 (0.57)	487 (0.89)	302 (2.46)	918 (0.97)
	calicopsis	1 (0.01)	0	1 (0)	0	2 (0)
	cumulatum	0	0	8 (0.01)	0	8 (0.01)
	lampongense	0	0	4 (0.01)	0	4 (0)
	parcum	0	0	15 (0.03)	0	15 (0.02)
	secundum	22 (0.26)	104 (0.56)	459 (0.83)	282 (2.3)	867 (0.92)
	sp.	0	2 (0.01)	0	20 (0.16)	22 (0.02)
Rhopalanthe		40 (0.48)	375 (2.01)	168 (0.31)	0	583 (0.62)
	aciculare	0	0	15 (0.03)	0	15 (0.02)
	angulatum	3 (0.04)	6 (0.03)	1 (0)	0	10 (0.01)
	blumeii	0	2 (0.01)	22 (0.04)	0	24 (0.03)
	crumentaum	0	3 (0.02)	1 (0)	0	4 (0)
	sp.	37 (0.44)	364 (1.95)	129 (0.23)	0	530 (0.56)
Stachyobium		2 (0.02)	17 (0.09)	1018 (1.85)	328 (2.68)	1365 (1.45)

		cf. incurvum	0	0	2 (0)	0	2 (0)
		cuspidatum	0	0	2 (0)	0	2 (0)
		delacourii	0	0	252 (0.46)	14 (0.11)	266 (0.28)
		eliotianum	2 (0.02)	0	20 (0.04)	0	22 (0.02)
		penguanum	0	0	345 (0.63)	0	345 (0.37)
		venustum	0	1 (0.01)	285 (0.52)	47 (0.38)	333 (0.35)
		sp.	0	16 (0.09)	112 (0.2)	267 (2.18)	395 (0.42)
	Strongyle		0	29 (0.16)	247 (0.45)	0	276 (0.29)
		acerosum	0	6 (0.03)	2 (0)	0	8 (0.01)
		parciflorum	0	0	27 (0.05)	0	27 (0.03)
		sp.	0	23 (0.12)	218 (0.4)	0	241 (0.26)
	Sect. unidentified	*sp.*	2 (0.02)	26 (0.14)	29 (0.05)	28 (0.23)	85 (0.09)
Dendrochilum		*sp.*	0	0	50 (0.09)	0	50 (0.05)
Dienia		*ophrydis*	0	0	6 (0.01)	0	6 (0.01)
Dipodium		*paludosum*	0	0	1 (0)	0	1 (0)
Drymoda			0	0	166 (0.3)	0	166 (0.18)
		siamensis	0	0	16 (0.03)	0	16 (0.02)
		sp.	0	0	150 (0.27)	0	150 (0.16)
Eclecticus		*chungii*	0	0	5 (0.01)	0	5 (0.01)
Eparmatostigma		*dives*	0	0	7 (0.01)	0	7 (0.01)
Eria			299 (3.57)	1496 (8.03)	629 (1.14)	168 (1.37)	2592 (2.75)
	Callostylis	*mucronata*	0	0	4 (0.01)	0	4 (0)
	Dendrolirium		56 (0.67)	35 (0.19)	114 (0.21)	0	205 (0.22)
		laniceps	50 (0.6)	0	0	0	50 (0.05)
		lasiopetala	1 (0.01)	10 (0.05)	30 (0.05)	0	41 (0.04)
		ornata	0	0	40 (0.07)	0	40 (0.04)
		tomentosa	5 (0.06)	0	41 (0.07)	0	46 (0.05)

		sp.	0	25 (0.13)	3 (0.01)	0	28 (0.03)
	Eria	*javanica*	11 (0.13)	7 (0.04)	1 (0)	0	19 (0.02)
	Hymenaria		2 (0.02)	5 (0.03)	6 (0.01)	0	13 (0.01)
		amica	0	0	1 (0)	0	1 (0)
		bractescens	0	2 (0.01)	0	0	2 (0)
		concolor	0	3 (0.02)	2 (0)	0	5 (0.01)
		obesa	2 (0.02)	0	0	0	2 (0)
		sp.	0	0	3 (0.01)	0	3 (0)
	Mycaranthes	*paniculata*	0	0	1 (0)	0	1 (0)
	Strongyleria	*pannea*	0	0	8 (0.01)	0	8 (0.01)
	Urostachya	*densa*	8 (0.1)	33 (0.18)	0	0	41 (0.04)
	Sect. unidentified	*sp.*	222 (2.65)	1416 (7.6)	495 (0.9)	168 (1.37)	2301 (2.44)
Eulophia			0	402 (2.16)	163 (0.3)	192 (1.57)	757 (0.8)
		graminea	0	72 (0.39)	80 (0.15)	0	152 (0.16)
		macrobulbon	0	0	9 (0.02)	20 (0.16)	29 (0.03)
		spectabilis	0	0	30 (0.05)	0	30 (0.03)
		sp.	0	330 (1.77)	44 (0.08)	172 (1.4)	546 (0.58)
Gastrochilus			0	0	111 (0.2)	3 (0.02)	114 (0.12)
		bellinus	0	0	43 (0.08)	0	43 (0.05)
		obliquus	0		1 (0)	0	1 (0)
		sp.	0	0	67 (0.12)	3 (0.02)	70 (0.07)
Geodorum			93 (1.11)	177 (0.95)	297 (0.54)	352 (2.87)	919 (0.97)
		recurvum	18 (0.21)	0	0	180 (1.47)	198 (0.21)
		terrestre	0	170 (0.59)	42 (0.08)	0	212 (0.22)
		densiflorum	0	60 (0.32)	0	0	60
		sp.	75 (0.89)	7 (0.04)	255 (0.46)	172 (1.4)	509 (0.54)
Grammatophyllu		*speciosum*	0	91 (0.49)	37 (0.07)	0	128 (0.14)

m

Grosourdya			0	7 (0.04)	25 (0.05)	0	32 (0.03)
		appendiculata	0	0	3 (0.01)	0	3 (0)
		sp.	0	7 (0.04)	22 (0.04)	0	29 (0.03)
Habenaria			16 (0.19)	83 (0.45)	787 (1.43)	259 (2.11)	1145 (1.21)
		carnea	0	0	39 (0.07)	0	39 (0.04)
		dentata	0	0	2 (0)	0	2 (0)
		hosseusii	5 (0.06)	0	0	0	5 (0.01)
		humistrata	0	0	13 (0.02)	0	13 (0.01)
		lindleyana	0	0	10 (0.02)	0	10 (0.01)
		myriotricha	0	20 (0.11)	107 (0.19)	0	127 (0.13)
		rhodocheila	0	0	209 (0.38)	164 (1.34)	373 (0.4)
		rostellifera	0	0	7 (0.01)	0	7 (0.01)
		vidua	11 (0.13)	0	0	0	11 (0.01)
		sp.	0	63 (0.34)	400 (0.73)	95 (0.78)	558 (0.59)
Holcoglossum		*sp.*	0	0	29 (0.05)	0	29 (0.03)
Hygrochilus		*parishii*	0	7 (0.04)	172 (0.31)	0	179 (0.19)
Liparis			7 (0.08)	15 (0.08)	106 (0.19)	0	128 (0.14)
	Cestichis	*lacerata*	0	0	15 (0.03)	0	15 (0.02)
	Coriifoliae	*aurita*	0	1 (0.01)	0	0	1 (0)
	Liparis		0	0	60 (0.11)	0	60 (0.06)
		jovispluvii	0	0	15 (0.03)	0	15 (0.02)
		odorata	0	0	5 (0.01)	0	5 (0.01)
		siamensis	0	0	5 (0.01)	0	5 (0.01)
		tschangii	0	0	35 (0.06)	0	35 (0.04)
	Sect. unidentified	*sp.*	7 (0.08)	14 (0.08)	31 (0.06)	0	52 (0.06)
Ludisia		*discolor*	0	0	26 (0.05)	0	26 (0.03)

Luisia			7 (0.08)	115 (0.62)	52 (0.09)	135 (1.1)	309 (0.33)
		brachystachys	0	1 (0.01)	0	0	1 (0)
		curtisii	0	0	0	2 (0.02)	2 (0)
		primulina	0	0	30 (0.05)	0	30 (0.03)
		psyche	0	0	2 (0)	0	2 (0)
		thailandica	0	0	5 (0.01)	0	5 (0.01)
		sp.	7 (0.08)	114 (0.61)	15 (0.03)	133 (1.09)	269 (0.29)
Macodes		*petola*	0	0	8 (0.01)	0	8 (0.01)
Micropera			3 (0.04)	99 (0.53)	15 (0.03)	13 (0.11)	130 (0.14)
		pallida	3 (0.04)	2 (0.01)	0	0	5 (0.01)
		thailandica	0	0	2 (0)	0	2 (0)
		sp.	0	97 (0.52)	13 (0.02)	13 (0.11)	123 (0.13)
Microsaccus		*grifithii*	0	0	5 (0.01)	0	5 (0.01)
Nervilia			0	0	358 (0.65)	58 (0.47)	416 (0.44)
	Nervilia	*aragoana*	0	0	0	23 (0.19)	23 (0.02)
	Sect. unidentified	*sp.*	0	0	358 (0.65)	35 (0.29)	393 (0.42)
Oberonia			17 (0.2)	15 (0.08)	96 (0.17)	0	128 (0.14)
		delacourii	0	3 (0.02)	1 (0)	0	4 (0)
		sp.	17 (0.2)	12 (0.06)	95 (0.17)	0	124 (0.13)
Ornithochilus		*difformis*	10 (0.12)	9 (0.05)	25 (0.05)	0	44 (0.05)
Otochilus		*sp.*	0	0	17 (0.03)	0	17 (0.02)
Panisea			1 (0.01)	11 (0.06)	14 (0.03)	0	26 (0.03)
		uniflora	0	11 (0.06)	14 (0.03)	0	25 (0.03)
		sp.	1 (0.01)	0	0	0	1 (0)
Paphiopedilum			129 (1.54)	582 (3.12)	3494 (6.35)	732 (5.97)	4937 (5.24)
	Subgen.		129 (1.54)	352 (1.89)	2357 (4.29)	42 (0.34)	2880 (3.06)

	Brachypetalum						
		bellatulum	0	0	276 (0.5)	0	276 (0.29)
		concolor	90 (1.07)	74 (0.4)	595 (1.08)	7 (0.06)	766 (0.81)
		godefroyae	0	0	68 (0.12)	0	68 (0.07)
		niveum	0	26 (0.14)	145 (0.26)	0	171 (0.18)
		sp.	39 (0.47)	252 (1.35)	1273 (2.32)	35 (0.29)	1599 (1.7)
	Subgen. Paphiopedilum Sect. Barbata		0	99 (0.53)	504 (0.92)	50 (0.41)	653 (0.69)
		callosum	0	6 (0.03)	31 (0.06)	0	37 (0.04)
		sukhakulii	0	0	12 (0.02)	0	12 (0.01)
		sp.	0	93 (0.5)	461 (0.84)	50 (0.41)	604 (0.64)
	Subgen.Paphiopedilum Sect. Paphiopedilum		0	124 (0.67)	435 (0.79)	640 (5.22)	1199 (1.27)
		exul	0	0	92 (0.17)	0	92 (0.1)
		hirsutissimum	0	0	0	26 (0.21)	26 (0.03)
		sp.	0	124 (0.67)	343 (0.62)	614 (5.01)	1081 (1.15)
	Subgen. Paphiopedilum Pardalopetalum		0	7 (0.04)	198 (0.36)	0	205 (0.22)
		dianthum	0	0	133 (0.24)	0	133 (0.14)
		parishii	0	0	21 (0.04)	0	21 (0.02)
		sp.	0	7 (0.04)	44 (0.08)	0	51 (0.05)
Papilionanthe		*sp.*	346 (4.13)	252 (1.35)	290 (0.53)	12 (0.1)	900 (0.95)
Pecteilis			0	40 (0.21)	83 (0.15)	7 (0.06)	130 (0.14)
		hawkessiana	0	40 (0.21)	0	0	40 (0.04)
		susannae	0	0	13 (0.02)	7 (0.06)	20 (0.02)
		sp.	0	0	70 (0.13)	0	70 (0.07)

Pelatantheria		64 (0.34)	153 (0.28)	69 (0.56)	286 (0.3)	
	ctenoglossum	0	10 (0.05)	44 (0.08)	0	54 (0.06)
	insectifera	0	0	9 (0.02)	0	9 (0.01)
	woonchengii	0	6 (0.03)	1 (0)	0	7 (0.01)
	sp.	0	48 (0.26)	99 (0.18)	69 (0.56)	216 (0.23)
Peristylus	*goodyeriodes*	0	0	55 (0.1)	0	55 (0.06)
Phaius		0	0	296 (0.54)	0	296 (0.31)
	tankervilliae	0	0	12 (0.02)	0	12 (0.01)
	sp.	0	0	284 (0.52)	0	284 (0.3)
Phalaenopsis		23 (0.27)	183 (0.98)	1282 (2.33)	141 (1.15)	1629 (1.73)
	bellina	0	0	4 (0.01)	0	4 (0)
	cornucervi	6 (0.07)	173 (0.93)	170 (0.31)	10 (0.08)	359 (0.38)
	deliciosa	2 (0.02)	5 (0.03)	38 (0.07)	0	45 (0.05)
	finleyi	0	0	105 (0.19)	0	105 (0.11)
	hieroglyphica	0	0	1 (0)	0	1 (0)
	lowii	0	0	2 (0)	0	2 (0)
	parishii	0	0	10 (0.02)	0	10 (0.01)
	pulcherrima	0	5 (0.03)	922 (1.68)	131 (1.07)	1058 (1.12)
	stuartiana	0	0	1 (0)	0	1 (0)
	sumatrana	0	0	14 (0.03)	0	14 (0.01)
	violacea	0	0	3 (0.01)	0	3 (0)
	sp.	15 (0.18)	0	12 (0.02)	0	27 (0.03)
Philodota		269 (3.21)	1596 (8.56)	374 (0.68)	64 (0.52)	2303 (2.44)
	articulata	102 (1.22)	1070 (5.74)	212 (0.39)	0	1384 (1.47)
	chinensis	0	0	25 (0.05)	0	25 (0.03)
	convallariae	0	0	5 (0.01)	0	5 (0.01)
	imbricata	0	157 (0.84)	13 (0.02)	0	170 (0.18)

	sp.	167 (1.99)	369 (1.98)	119 (0.22)	64 (0.52)	719 (0.76)
Phreatia	*sp.*	0	10 (0.05)	0	0	10 (0.01)
Pleione	*sp.*	0	0	35 (0.06)	260 (2.12)	295 (0.31)
Polystachya						
	concreta	0	0	16 (0.03)	0	16 (0.02)
	sp.	0	0	3 (0.01)	0	3 (0)
Pomatocalpa		0	0	19 (0.03)	0	19 (0.02)
	angustifolium	0	0	5 (0.01)	0	5 (0.01)
	diffusum	0	0	1 (0)	0	1 (0)
	spicatum	0	5 (0.03)	2 (0)	0	7 (0.01)
	sp.	45 (0.54)	70 (0.38)	118 (0.21)	1 (0.01)	234 (0.25)
Porpax		0	0	38 (0.07)	0	38 (0.04)
	elwesii	0	0	32 (0.06)	0	32 (0.03)
	lanii	0	0	6 (0.01)	0	6 (0.01)
Pteroceras	*sp.*	0	0	12 (0.02)	0	12 (0.01)
Renanthera	*sp.*	4 (0.05)	30 (0.16)	0	4 (0.03)	38 (0.04)
Rhynchostylis		522 (6.22)	1475 (7.91)	3499 (6.36)	679 (5.54)	6175 (6.55)
	coelestis	0	47 (0.25)	518 (0.94)	406 (3.31)	971 (1.03)
	gigantea	2 (0.02)	264 (1.42)	1246 (2.27)	228 (1.86)	1740 (1.85)
	retusa	520 (6.2)	1164 (6.24)	1735 (3.16)	45 (0.37)	3464 (3.67)
Robiquetia		10 (0.12)	160 (0.86)	16 (0.03)	0	186 (0.2)
	spathulata	4 (0.05)	133 (0.71)	5 (0.01)	0	142 (0.15)
	succisa	1 (0.01)	0	1 (0)	0	2 (0)
	sp.	5 (0.06)	27 (0.14)	10 (0.02)	0	42 (0.04)
Sarcoglyphis	*mirabilis*	0	12 (0.06)	8 (0.01)	0	20 (0.02)
Schoenorchis		0	60 (0.32)	506 (0.92)	0	566 (0.6)
	fragrans	0	60 (0.32)	235 (0.43)	0	295 (0.31)

	sp.	0	0	271 (0.49)	0	271 (0.29)
Seidenfadenia	*mitra*	0	72 (0.39)	576(1.04)	40 (0.33)	688 (0.73)
Smitinandia		6 (0.07)	1 (0.01)	76 (0.14)	23 (0.19)	106 (0.11)
	helferii	0	0	3 (0.01)	0	3 (0)
	micrantha	0	1 (0.01)	0	10 (0.08)	11 (0.01)
	sp.	6 (0.07)	0	73 (0.13)	13 (0.11)	92 (0.1)
Spathoglottis		0	0	291 (0.53)	0	291 (0.31)
	affinis	0	0	259 (0.47)	0	259 (0.27)
	sp.	0	0	32 (0.06)	0	32 (0.03)
Staurochilus and allies[§]		37 (0.37)	2 (0.01)	181 (0.32)	57 (0.47)	271 (0.29)
	dawsonianus	13 (0.16)	0	1 (0)	0	14 (0.01)
	faciatus	0	0	7 (0.01)	0	7 (0.01)
	fasciatus	0	0	166 (0.3)	0	166 (0.18)
	sp.	18 (0.21)	2 (0.01)	7 (0.01)	57 (0.47)	84 (0.09)
Stereochilus	*erinaceus*	6 (0.07)	0	3 (0.01)	0	9 (0.01)
Sunipia	*grandiflora*	0	25 (0.13)	0	0	25 (0.03)
Taeniophyllum	*sp.*	0	2 (0.01)	0	0	2 (0)
Tainia	*sp.*	0	0	319 (0.58)	0	319 (0.34)
Thecostele	*alata*	0	5 (0.03)	3 (0.01)	0	8 (0.01)
Thelasis		0	1 (0.01)	3 (0.01)	0	4 (0)
	micrantha	0	0	1 (0)	0	1 (0)
	pygmea	0	1 (0.01)	0	0	1 (0)
	sp.	0	0	2 (0)	0	2 (0)
Thrixspermum		0	10 (0.05)	177 (0.32)	0	187 (0.2)
Dendrocolla		0	3 (0.02)	2 (0)	0	5 (0.01)

		merguense	0	0	2 (0)	0	2 (0)
		trichoglottis	0	3 (0.02)	0	0	3 (0)
	Thrixspermum		0	0	24 (0.04)	0	24 (0.03)
		centipeda	0	0	5 (0.01)	0	5 (0.01)
		leucarachne	0	0	1 (0)	0	1 (0)
		n. sp.	0	0	18 (0.03)	0	18 (0.02)
	Sect. unidentified	*sp.*	0	6 (0.03)	151 (0.27)	0	157 (0.17)
Thunia			3 (0.04)	114 (0.61)	27 (0.05)	0	144 (0.15)
		alata	0	15 (0.08)	9 (0.02)	0	24 (0.03)
		sp.	3 (0.04)	99 (0.53)	18 (0.03)	0	120 (0.13)
Trias			0	32 (0.17)	375 (0.68)	6 (0.05)	413 (0.44)
		cambodiana	0	0	1 (0)	0	1 (0)
		disciflora	0	0	5 (0.01)	0	5 (0.01)
		intermedia	0	0	15 (0.03)	0	15 (0.02)
		nasuta	0	0	1 (0)	0	1 (0)
		oblonga	0	0	1 (0)	0	1 (0)
		picta	0	0	12 (0.02)	0	12 (0.01)
		sp.	0	32 (0.17)	340 (0.62)	6 (0.05)	378 (0.4)
Trichoglottis			0	1 (0.01)	55 (0.1)	5 (0.04)	61 (0.06)
		cirrhifera	0	0	12 (0.02)	0	12 (0.01)
		triflora	0	0	4 (0.01)	0	4 (0)
		sp.	0	1 (0.01)	39 (0.07)	5 (0.04)	45 (0.05)
Trichotosia			0	118 (0.63)	48 (0.09)	0	166 (0.18)
		dasyphylla	0	0	2 (0)	0	2 (0)
		velutina	0	46 (0.25)	0	0	46 (0.05)
		sp.	0	72 (0.39)	46 (0.08)	0	118 (0.13)
Uncifera		*thailandica*	0	0	48 (0.09)	0	48 (0.05)

	Vanda		0	12 (0.06)	1606 (2.92)	477 (3.89)	2095 (2.22)
		bensonii	0	0	23 (0.04)	0	23 (0.02)
		brunnea	0	0	58 (0.11)	0	58 (0.06)
		coerulea	0	0	61 (0.11)	0	61 (0.06)
		coerulescens	0	0	1 (0)	0	1 (0)
		lilacina	0	7 (0.04)	19 (0.03)	0	26 (0.03)
		lilicina	0	0	5 (0.01)	0	5 (0.01)
		liouvillei	0	0	0	9 (0.07)	9 (0.01)
		testacea	0	0	1 (0)	0	1 (0)
		sp.	0	5 (0.03)	1438 (2.62)	468 (3.82)	1911 (2.03)
	Vandopsis		0	55 (0.3)	75 (0.14)	8 (0.07)	138 (0.15)
		gigantea	0	18 (0.1)	0	0	18 (0.02)
		sp.	0	37 (0.2)	75 (0.14)	8 (0.07)	120 (0.13)
	Vanilla		0	0	15 (0.03)	5 (0.04)	20 (0.02)
		aphylla	0	0	0	5 (0.04)	5 (0.01)
		sp.	0	0	15 (0.03)	0	15 (0.02)
	Ventricularia	*tenuicaulis*	0	0	4 (0.01)	0	4 (0)
	Genus unidentified		166 (1.98)	130 (0.70)	399 (0.73)	143 (1.17)	838 (0.89)
Fern / Fern Allies			715 (8.53)	1533 (8.22)	3691 (6.71)	242 (1.97)	6181 (6.56)
Aspleniaceae	*Asplenium*	*sp.*	0	30 (0.16)	16 (0.03)	25 (0.2)	71 (0.08)
Lycopodiaceae	*Huperzia*		10 (0.12)	319 (1.71)	956 (1.74)	0	1285 (1.36)
		goebellii	0	16 (0.09)	0	0	16 (0.02)
		serratum	0	6 (0.03)	0	0	6 (0.01)
		squarrosum	0	47 (0.25)	0	0	47 (0.05)
		sp. unidentified	10 (0.12)	250 (1.34)	956 (1.74)	0	1216 (1.29)
	Lycopodiella	*sp. unidentified*	0	0	11 (0.02)	0	11 (0.01)

	Lycopodium		2 (0.02)	41 (0.22)	93 (0.17)	12 (0.1)	148 (0.16)
		nummularifolium	0	41 (0.22)	54 (0.1)	0	95 (0.1)
		sp.	2 (0.02)	0	39 (0.07)	12 (0.1)	53 (0.06)
Polypodiaceae	*Platycerium*		702 (8.37)	913 (4.9)	977 (1.78)	38 (0.31)	2630 (2.79)
		coronarium	0	0	113 (0.21)	0	113 (0.12)
		holttumii	0	0	11 (0.02)	0	11 (0.01)
		ridleyi	0	184 (0.99)	60 (0.11)	0	244 (0.26)
		wallichii	0	0	70 (0.13)	0	70 (0.07)
		sp.	702 (8.37)	729 (3.91)	723 (1.31)	38 (0.31)	2192 (2.33)
Pteridaceae	*Adiantum*	*sp.*	0	0	4 (0.01)	0	4 (0)
Family unidentified			1 (0.01)	230 (1.23)	1634 (2.97)	167 (1.36)	2032 (2.16)
Other ornamental taxa			1773 (21.14)	541 (2.9)	2860 (5.2)	737 (6.01)	5911 (6.27)
Aeraceae			0	0	31 (0.06)	0	31 (0.03)
Amaryllidaceae	*Crinum*	*sp.*	27 (0.32)	0	0	123 (1)	150 (0.16)
Apocynaceae	*Hoya*	*sp.*	0	27 (0.14)	57 (0.1)	98 (0.8)	182 (0.19)
Araceae			0	1 (0.01)	57 (0.1)	0	58 (0.06)
	Amorphophallus	*sp.*	0	0	34 (0.06)		34 (0.04)
	Genus unidentified	*sp.*	0	1 (0.01)	57 (0.1)	0	58 (0.06)
Asclepiadaceae	*Dischidia*	*sp.*	0	0	39 (0.07)	43 (0.35)	82 (0.09)
Aspargaceae	*Cordyline*	*sp.*	8 (0.1)	48 (0.26)	234 (0.43)	0	290 (0.31)
Asteraceae			0	0	5 (0.01)	0	5 (0.01)
Balanophoracea e	*Balanophora*	*sp.*	0	3 (0.02)	0	0	3 (0)
Balsaminaceae	*Impatiens*	*sp*	0	0	173 (0.31)	0	173 (0.18)
Begoniaceae	*Begonia*	*sp*	0	3 (0.02)	25 (0.05)	0	28 (0.03)

Cycadaceae	*Cycas*	*sp.*	31 (0.37)	18 (0.1)	179 (0.33)	197 (1.61)	425 (0.45)
Discoreaceae	*Tacca*	*sp.*	1336 (15.93)	3 (0.02)	15 (0.03)	89 (0.73)	1443 (1.53)
Gesneriaceae							
	Aeschynanthus	*sp.*	0	4 (0.02)	3 (0.01)	0	7 (0.01)
	Gesneria	*sp.*	5 (0.06)	20 (0.11)	96 (0.17)	0	121 (0.13)
Moraceae	*Ficus*	*sp.*	0	1 (0.01)	0	0	1 (0)
Musaceae	*Musa*	*sp.*	59 (0.7)	0	0	0	59 (0.06)
Nepenthaceae	*Nepenthes*	*sp.*	0	0	46 (0.08)	8 (0.07)	54 (0.06)
Palmaceae			9 (0.11)	2 (0.01)	8 (0.01)	0	19 (0.02)
Rubiaceae	*Hydnophytum or Myrmecodia*	*sp.*	0	68 (0.36)	396 (0.72)	0	464 (0.49)
Xyridaceae	*Xyris*	*Missing*	0	0	280 (0.51)	0	280 (0.3)
Zingiberaceae							
	Boesenbergia	*sp.*	0	0	25 (0.05)	0	25 (0.03)
	Curcuma		67 (0.8)	28 (0.15)	257 (0.47)	74 (0.6)	426 (0.45)
		latifolia	0	0	0	74 (0.6)	74 (0.08)
		parviflora	0	15 (0.08)	10 (0.02)	0	25 (0.03)
		roscoeana	51 (0.61)	0	0	0	51 (0.05)
		sp.	16 (0.19)	13 (0.07)	247 (0.45)	0	276 (0.29)
	Gagnepainia	*godefroyi*	0	0	25 (0.05)	34 (0.28)	59 (0.06)
	Globba		8 (0.1)	0	33 (0.06)	0	41 (0.04)
		winitii	0	0	30 (0.05)	0	30 (0.03)
		sp.	8 (0.1)	0	3 (0.01)	0	11 (0.01)
	Hedychium	*coronarium*	3 (0.04)	24 (0.13)	0	0	27 (0.03)
	Kaempteria	*sp.*	0	0	331 (0.6)	0	331 (0.35)
	Genus unidentified		0	0	211 (0.38)	0	211 (0.22)

Family unidentified	220 (2.62)	291 (1.56)	300 (0.55)	71 (0.58)	882 (0.93)
Total	8487	18640	53769	12258	88928

* Observed count is based on the number of plant bundles (potentially including multiple individuals) plus the number of individuals (potentially divisions of larger plants) both recorded as single counts. This is conservative relative to traditional customs recording but not necessarily representative of the number of genetically distinct individuals.

§ Taxonomic notes:Appendiculata and Podochilus treated as a morphogenus. Subtribe Bulbophyllinae which incldues >100 genera treated together with the exceptions of individuals identified to the species-level in the genus *Bulbophyllum Sunipia Trias* and *Drymoda.Staurochilus*includes its allies *Arachnis Esmeralda Dimorphorchis Arnodorum.*See Appendix 3 for notes on taxonomic approach.

Appendix 6. Spirit vouchers deposited at Bangkok Forest Herbarium (All collected and labeled J.Phelps and under verification by the Herbarium)

Voucher	Col. date	Market col.	Genus	species	Authority	Trader reported country and locality	
4	20 April 2011	Jatujak	*Hygrochilus*	*parishii*	(Rachb. f.) Schltr.	Thailand	Chiang Mai
8	20 April 2011	Jatujak	*Dendrobium*	*cariniferum*	Rchb.f.	Thailand	Northern region
9	20 April 2011	Jatujak	*Dendrobium*	*draconis*	Rchb.f.	Thailand	
19	20 April 2011	Jatujak	*Dendrobium*	*ochreatum*	Lindl.	Thailand	Chiang Mai
26	20 April 2011	Jatujak	*Aerides*	*rosea*	Lodd. ex Lindl. & Paxt.	Thailand	
27	20 April 2011	Jatujak	*Cymbidum*	*aloifolium*	(L.) Sw.	Thailand	Issan region
28	20 April 2011	Jatujak	*Aerides*	*odorata*	Laur.	Thailand	
36	20 April 2011	Jatujak	*Geodorum*	*recurvum*	(Roxb.) Alston	Thailand	Sakon Nakhon
50	20 April 2011	Jatujak	*Dendrobium*	*trigonopus*	Rchb.f.	Lao PDR	Vang Vieng; into Thialand via Nong Khai
53	20 April 2011	Jatujak	*Dendrobium*	*cariniferum*	Rchb.f.	Lao PDR	
60	20 April 2011	Jatujak	*Dendrobium*	*delacourii*	Guill.	Thailand	Sakon Nakhon
91	20 April 2011	Jatujak	*Staurochilus*	*fasciatus*	(Rchb.f.) Ridl.	Lao PDR	
93	20 April 2011	Jatujak	*Dendrobium*	*mannii*	Ridl.	Lao PDR	
122	20 April 2011	Jatujak	*Dendrobium*	*sutepense*	Rolfe ex Downie		
123	20 April 2011	Jatujak	*Vanda*	*bensonii*	Batem.	Thailand	Lampang
254	07 May 2011	Mukdahan	*Nervilia*	*cf. concolor*	(Blume) Schltr.	Thailand	
255	07 May 2011	Mukdahan	*Nervilia*	*cf. concolor*	(Blume) Schltr.	Thailand	
256	07 May 2011	Mukdahan	*Gagnepainia*	*godefroyi*	(Baill.) K.Schum	Lao PDR	
257	07 May 2011	Mukdahan	*Dendoribum*	*delacourii*	Guill.	Lao PDR	
289	07 May 2011	Mukdahan	*Smitinandia*	*micrantha*	(Lindl.) Holtt.	Thailand	Mukdahan
290	07 May 2011	Mukdahan	*Dendrobium*	*crystallinum*	Rchb.f.	Lao PDR	
304	07 May 2011	Mukdahan	*Dendrobium*	*christyanum*	Rchb.f.	Lao PDR	
307	07 May 2011	Mukdahan	*Dendrobium*	*thyrsiflorum*	B.S.Williams	Lao PDR	
319	07 May 2011	Mukdahan	*Luisia*	*cf. curtisii*	Seidenf.	Lao PDR	

345	14 May 2011	Chedi Sam Ong	*Cleisostoma*	*complicatum*	(Seidenf.) Garay	Myanmar	
352	14 May 2011	Chedi Sam Ong	*Staurochilus*	*dawsonianus*	Myanmar		
388	14 May 2011	Chedi Sam Ong	*Cleisostoma*	*williamsonii*	(Rchb.f.) Garay	Myanmar	
389	14 May 2011	Chedi Sam Ong	*Robiquetia*	*spathulata*	(Blume) J.J.Sm.	Myanmar	
397	14 May 2011	Chedi Sam Ong	*Cleisostoma*	*racemiferum*	(Lindl.) Garay	Myanmar	
398	14 May 2011	Chedi Sam Ong	*Eria*	*tomentosa*	(J.Koenig) Hook.f.	Myanmar	
430	14 May 2011	Chedi Sam Ong	*Dendrobium*	*formosum*	Roxb. ex Lindl.	Myanmar	
431	14 May 2011	Chedi Sam Ong	*Acriopsis*	*lilifolia*	(J.Koenig) Siedenf.	Myanmar	
432	14 May 2011	Chedi Sam Ong	*Chiloschista*	*cf. parishii*	Seidenf.	Myanmar	
435	14 May 2011	Chedi Sam Ong	*Luisia*	*cf. trichorrhiza*	(Hook.) Bloome	Myanmar	
436	14 May 2011	Chedi Sam Ong	*Micropera*	*pallida*	(Roxb.) Lindl.	Myanmar	
444	14 May 2011	Chedi Sam Ong	*Dendrobium*	*pachyglossum*	Par. & Rchb. f.	Myanmar	
472	14 May 2011	Chedi Sam Ong	*Stereochilus*	*erinaceus*	(Rchb.f.) Garay	Myanmar	
510	22 May 2011	Peng Charn	*Dendrobium*	*chryseum*	Rolfe	Lao PDR	
529	28 May 2011	Dan Singkorn	*Panisea*	*uniflora*	Lindl.	Myanmar	
530	28 May 2011	Dan Singkorn	*Pholidota*	*imbricata*	(Roxb.) Lindl.	Myanmar	
531	28 May 2011	Dan Singkorn	*Cleisostoma*	*kerrii*	Siedenf.	Myanmar	
589	28 May 2011	Dan Singkorn	*Robiquetia*	*spathulata*	(Blume) J.J.Sm.	Myanmar	
657	28 May 2011	Dan Singkorn	*Trichotosia*	*velutina*	(Lodd. ex Lindl.) Kraentzl.	Myanmar	
658	28 May 2011	Dan Singkorn	*Thunia*	*alba*	(Lindl.) Rchb.f.	Myanmar	
754	28 May 2011	Dan Singkorn	*Geodorum*	*terrestre*	(L.) Garay	Myanmar	
781	28 May 2011	Dan Singkorn	*Geodorum*	*terrestre*	(L.) Garay	Myanmar	
811	28 May 2011	Dan Singkorn	*Dendrobium*	*trinervium*	Ridl.	Myanmar	
812	28 May 2011	Dan Singkorn	*Chiloschista*	*cf. parishii*	Seidenf.	Myanmar	
876	29 May 2011	Dan Singkorn	*Thelasis*	*pygmaea*	(Griff.) Lindl.	Myanmar	
948	29 May 2011	Dan Singkorn	*Bulbophyllum*	*macranthum*	Lindl.	Myanmar	
972	29 May 2011	Dan Singkorn	*Schoenorchis*	*fragrans*	(Par. & Rchb.f.) Seidenf. & Smitinand	Thailand	Sangkhlaburi

1020	29 May 2011	Dan Singkorn	*Cleisostoma*	*rolfeanum*	(King & Pantling) Garay	Myanmar	
1125	29 May 2011	Dan Singkorn	*Dendrobium*	*acerosum*	Lindl.	Myanmar	
1127	29 May 2011	Dan Singkorn	*Panisea*	*uniflora*	(Lindl.) Lindl.	Myanmar	
1166	01 June 2011	Jatujak	*Dendrobium*	*draconis*	Rchb.f.	Thailand	Issan region
1175	01 June 2011	Jatujak	*Aerides*	*multiflora*	Roxb.	Thailand	Issan
1180	01 June 2011	Jatujak	*Dendrobium*	*indivisum* var. *pallidum*	Siedenf.	Myanmar	into Thialand via Dan Singkorn Market
1207	01 June 2011	Jatujak	*Cleisomeria*	*pilosulum*	(Gangep.) Seidenf. & Garay	Thailand	Ubon Ratchathani
1218	01 June 2011	Jatujak	*Dendrobium*	*unicum*	Seidenf.	Lao PDR	
1305	01 June 2011	Jatujak	*Peristylus*	*goodyeriodes*	(D. Don) Lindl.	Thailand	Chiang Mai
1313	01 June 2011	Jatujak	*Phalaenopsis*	*finleyi*	Christenson	Thailand	Chiang RaiPa Yao
1365	01 June 2011	Jatujak	*Bulbophyllum*	*odoratissimum*	(Sm.) Lindl.ex Wall.	Lao PDR	
1366	01 June 2011	Jatujak	*Bulbophyllum*	*clandestinum*	Lindl.	Lao PDR	
1367	01 June 2011	Jatujak	*Bulbophyllum*	*affine*	Wall. ex Lindl.	Lao PDR	
1368	01 June 2011	Jatujak	*Aerides*	*houllettiana*	Rachb.f.		
1369	01 June 2011	Jatujak	*Bulbophyllum*	*hymenanthum*	Hook.f.	Lao PDR	
1406	15 June 2011	Jatujak	*Pholidota*	*chinensis*	Lindl.	Lao PDR	Southern; into Thialand via Chong Mek
1407	15 June 2011	Jatujak	*Liparis*	*lacerata*	Ridl.	Thailand	Khura BuriPhang Nga
1408	15 June 2011	Jatujak	*Grosourdya*	*appendiculata*	(Blume) Rchb.f.	Thailand	Phan Nga
1409	15 June 2011	Jatujak	*Bulbophyllum*	*corolliferum*	J.J. Sm.	Thailand	Satoon
1411	15 June 2011	Jatujak	*Dendrobium*	*ellipsophyllum*	Tang & F.T. Wang	Lao PDR	
1412	15 June 2011	Jatujak	*Liparis*	*odorata*	(Willd.) Lindl.	Thailand	TakMae Sot
1413	15 June 2011	Jatujak	*Liparis*	*jovispluvii*	Par. & Rchb.f.	Thailand	TakMae Sot
1414	15 June 2011	Jatujak	*Crepidium*	*mackinnonii*	(Duthi) Szlach.	Thailand	TakMae Sot
1415	15 June 2011	Jatujak	*Liparis*	*tschangii*	Schltr.	Thailand	TakMae Sot
1419	15 June 2011	Jatujak	*Adenoncos*	*parviflora*	Ridl.	Thailand	Ranong
1421	15 June 2011	Jatujak	*Coelogyne*	*calcicola*	Kerr.	Lao PDR	

1422	15 June 2011	Jatujak	*Dendrobium*	*stuposum*	Lindl.	Lao PDR	
1438	06 July 2011	Jatujak	*Porpax*	*lanii*	Seidenf.	Thailand	Mae Hong Son
1440	06 July 2011	Jatujak	*Pelatantheria*	*ctenoglossum*	Ridl.	Thailand	Chiang Mai
1444	06 July 2011	Jatujak	*Dendrobium*	*kentrophyllum*	Hook.f.	Thailand	Krabi
1453	06 July 2011	Jatujak	*Dendrobium*	*linguella*	Rchb.f.	Thailand	Issan region
1485	06 July 2011	Jatujak	*Porpax*	*elwesii*	(Rchb.f.) Rolfe	Thailand	
1492	06 July 2011	Jatujak	*Appendicula*	*sp.*	Bulme	Thailand	
1536	06 July 2011	Jatujak	*Dendrobium*	*oligophyllum*	Gagnep.	Thailand	Petchaburi
1542	06 July 2011	Jatujak	*Habenaria*	*rostellifera*	Rchb.f.	Thailand	Petchaburi
1546	06 July 2011	Jatujak	*Liparis*	*odorata*	(Willd.) Lindl.	Thailand	Issan region
1616	006 July 2011	Jatujak	*Trias*	*disciflora*	(Rolfe) Rolfe		
1712	06 July 2011	Jatujak	*Microsaccus*	*griffithii*	(Parish & Rchb.f.)Seidenf.		
1713	03 Aug. 2011	Jatujak	*Dendrobium*	*terminale*	Par. & Rchb.f.	Thailand	
1718	03 Aug. 2011	Jatujak	*Thecostele*	*alata*	(Roxb.) Par. & Rchb.f.	Thailand	
1721	03 Aug. 2011	Jatujak	*Dendrobium*	*cuspidatum*	Lindl.	Thailand	
1722	03 Aug. 2011	Jatujak	*Thrixspermum*	*leucarachne*	Ridl.	Thailand	Issan region
1726	03 Aug. 2011	Jatujak	*Eria*	*ornata*	(Blume) Lindl.	Thailand	
1756	03 Aug. 2011	Jatujak	*Eria*	*ornata*	(Blume) Lindl.	Thailand	
1764	03 Aug. 2011	Jatujak	*Dendrobium*	*lamyaiae*	Seidenf.	Lao PDR	Southern; into Thialand via Chong Mek
1771	03 Aug. 2011	Jatujak	*Oberonia*	*nitida*	Seidenf.	Thailand	Phang Nga
1803	03 Aug. 2011	Jatujak	*Gesneria*	*sp.*			
1940	14 Aug. 2011	Chedi Sam Ong	*Eria*	*javanica*	(Sw.) Blume	Myanmar	
2011	14 Aug. 2011	Chedi Sam Ong	*Dendrobium*	*acerosum*	Lindl.	Myanmar	
2094	14 Aug. 2011	Chedi Sam Ong	*Dendrobium*	*griffithianum*	Lindl.	Myanmar	
3017	14 Aug. 2011	Chedi Sam Ong	*Phalaenopsis*	*deliciosa*	Rchb.f.	Myanmar	
3018	14 Aug. 2011	Chedi Sam Ong	*Dendrobium*	*calicopis*	Ridl.	Myanmar	

3019	14 Aug. 2011	Chedi Sam Ong	*Eria*	*densa*	Ridl.	Myanmar	
3026	14 Aug. 2011	Chedi Sam Ong	*Habenaria*	*vidua*	Parish & Rchb f.	Myanmar	
3042	14 Aug. 2011	Chedi Sam Ong	*Robiquetia*	*succisa*	(Lindl.) Siedf. & Garay	Myanmar	
3045	14 Aug. 2011	Chedi Sam Ong	*Habenaria*	*hosseusii*	Schltr.	Myanmar	
3065	17 Aug. 2011	Jatujak	*Dendrobium*	*kontumense*	Gangep.	Thailand	Loei
3068	17 Aug. 2011	Jatujak	*Thrixspermum*	*centipeda*	Lour.	Thailand	Issan region
3069	17 Aug. 2011	Jatujak	*Cleisostoma*	*crochetii*	(Guillaum.) Garay	Thailand	Nakhon Phanom
3071	17 Aug. 2011	Jatujak	*Polystachya*	*concreta*	(Jacq) Garay & H.R.Sweet	Thailand	Prachinburi
3072	17 Aug. 2011	Jatujak	*Bulbophyllum*	*tricorne*	Seidenf. & Smitinand	Thailand	Prachinburi
3073	17 Aug. 2011	Jatujak	*Dendrobium*	*brymerianum*	Rachb.f.	Thailand	Northern region
3076	17 Aug. 2011	Jatujak	*Coelogyne*	*trinervis*	Lindl.	Thailand	Chantaburi
3077	17 Aug. 2011	Jatujak	*Habenaria*	*humistrata*	Rolfe ex Downie	Thailand	Chiang Mai
3078	17 Aug. 2011	Jatujak	*Habenaria*	*sp.*		Thailand	Tak
3079	17 Aug. 2011	Jatujak	*Spathoglottis*	*affinis*	de Vriese	Thailand	Chiang Rai
3081	17 Aug. 2011	Jatujak	*Smitinandia*	*helferi*	(Hook.f.) Garay	Thailand	Nakhon Si Thammarat
3082	17 Aug. 2011	Jatujak	*Ventricularia*	*tenuicaulis*	(Hook.f.) Garay	Thailand	Nakhon Si Thammarat
3083	17 Aug. 2011	Jatujak	*Pomatocalpa*	*diffusum*	Breda	Thailand	Nakhon Si Thammarat
3084	17 Aug. 2011	Jatujak	*Eclecticus*	*chungii*	P.O'Byrne	Thailand	Loei
3348	20 Aug. 2011	Mukdahan	*Vanilla*	*aphylla*	Bl.	Lao PDR	
3476	27 Aug. 2011	Dan Singkorn	*Habenaria*	*myriotricha*	Gagnep.	Lao PDR	
3477	27 Aug. 2011	Dan Singkorn	*Pecteilis*	*hawkesiana*	(King & Pantl.) C.S.Kumar	Lao PDR	
3481	27 Aug. 2011	Dan Singkorn	*Sarcoglyphis*	*mirabilis*	(Rachb.f.) Garay	Lao PDR	
3495	27 Aug. 2011	Dan Singkorn	*Liparis*	*aurita*	Ridl.	Myanmar	
3622	27 Aug. 2011	Dan Singkorn	*Pelatantheria*	*woonchengii*	O'Byrne	Myanmar	
3649	27 Aug. 2011	Dan Singkorn	*Dendrobium*	*trinervium*	Ridl.	Myanmar	
3652	27 Aug. 2011	Dan Singkorn	*Thrixspermum*	*sp.*		Myanmar	
3807	27 Aug. 2011	Dan Singkorn	*Eria*	*concolor*	Par. & Rchb.f.	Myanmar	

3846	27 Aug. 2011	Dan Singkorn	*Cleisostoma*	*subulatum*	Bl.	Myanmar	
3904	07 Sept. 2011	Jatujak	*Dendrobium*	*ellipsophyllum*	Tang & F.T.Wang	Lao PDR	
3912	07 Sept. 2011	Jatujak	*Cleisostoma*	*crochetii*	(Guillaum.) Garay	Thailand	Sakon Nakhon
3945	07 Sept. 2011	Jatujak	*Bulbophyllum*	*cf. pulchellum*	J.J. Sm.	Thailand	
3987	07 Sept. 2011	Jatujak	*Cleisostoma*	*simondii*	Gagnep.		
3995	07 Sept. 2011	Jatujak	*Cleistostoma*	*crochettii*	(Guill.) Garay	Thailand	Sakon Nakhon
4029	07 Sept. 2011	Jatujak	*Bulbophyllum*	*sp.*		Thailand	Prachinburi
4135	07 Sept. 2011	Jatujak	*Thrixpermum*	*merguense*	(Hk.f.) Kze.	Lao PDR	
4138	07 Sept. 2011	Jatujak	*Uncifera*	*thailandica*	Seidenf. & Smitihand	Lao PDR	
4161	07 Sept. 2011	Jatujak	*Eulophia*	*sp.*			
4176	15 Sept. 2011	Mukdahan	*Cleisostoma*	*fuerstenbergianum*	Krzl.	Vietnam	
4177	15 Sept. 2011	Mukdahan	*Habenaria*	*sp.*		Lao PDR	
4178	15 Sept. 2011	Mukdahan	*Pecteilis*	*susannae*	(L.) Raf.	Lao PDR	
4207	05 Oct. 2011	Jatujak	*Dendrobium*	*aciculare*	Lindl.	Vietnam	
4209	05 Oct. 2011	Jatujak	*Dendrobium*	*cf. incurvum*	Lindl.	Vietnam	
4257	05 Oct. 2011	Jatujak	*Coelogyne*	*ovalis*	Lindl.		
4329	05 Oct. 2011	Jatujak	*Dendrobium*	*acerosum*	Lindl.		
4376	05 Oct. 2011	Jatujak	*Cleisostoma*	*crochetii*	(Guill.) Garay	Thailand	Mukdahan
4444	10 Oct. 2011	Jatujak	*Trias*	*nasuta*	(Rchb.f.) Stapf.	Lao PDR	
4497	14 Dec. 2011	Jatujak	*Gastrochilus*	*obliquus*	(Lindl.) Kze.	Thailand	Chantaburi
4499	14 Dec. 2011	Jatujak	*Pomatocalpa*	*angustifolium*	Seidenf.		
4502	14 Dec. 2011	Jatujak	*Acampe*	*praemorsa*	(Roxb.) Blatt &McCann	Thailand	
4514	14 Dec. 2011	Jatujak	*Dendrobium*	*peguanum*	Lindl.	Myanmar	into Thailand via Mae Sot
4886	14 Dec. 2011	Jatujak	*Coelogyne*	*cf. fimbriata*	Lindl.	Thailand	Chiang Rai
4888	14 Dec. 2011	Jatujak	*Gastrochilus*	*bellinus*	(Rchb.f.) Kze.	Myanmar	into Thialand via Mae Sai
4914	14 Dec. 2011	Jatujak	*Dendrobium*	*elliotianum*	P.O'Byrne	Thailand	Kanchanaburi
4923	14 Dec. 2011	Jatujak	*Bulbophyllum*	*repens*	Griff.		

4924	14 Dec. 2011	Jatujak	*Bulbophyllum*	*cf. dissitiflorum*	Seidenf.	Thailand	Southern region
4990	05 Oct. 2011	Jatujak	*Coelogyne*	*fuscescens*	Lindl.	Lao PDR	
4991	05 Oct. 2011	Jatujak	*Habenaria*	*dentata*	(Sw.) Schltr.	Thailand	Ubon Ratchathani
5022	04 Jan. 2012	Jatujak	*Bulbuphyllum*	*cf. peninsulare*	Seidenf.	Thailand	Ubon Ratchathani
5028	04 Jan. 2012	Jatujak	*Dendrobium*	*scabrilingue*	Lindl.	Thailand	Chiang Mai
5065	04 Jan. 2012	Jatujak	*Dendrobium*	*heterocarpum*	Lindl.	Thailand	Issan region
5100	04 Jan. 2012	Jatujak	*Dendrobium*	*draconis*	Rchb.f.		
5112	04 Jan. 2012	Jatujak	*Trichoglottis*	*cirrhifera*	Teijsm. & Binnend.	Thailand	Loei
5126	04 Jan. 2012	Jatujak	*Ascocentrum*	*pusillum*	Aver.	Lao PDR	
5134	04 Jan. 2012	Jatujak	*Bulbophyllum*	*repens*	Griff.	Lao PDR	
5291	14 Jan. 2012	Dan Singkorn	*Dendrobium*	*chittimae*	Seidenf.	Thailand	Ubon Ratchathani
5292	14 Jan. 2012	Dan Singkorn	*Dendrobium*	*polyanthum*	Wall. ex Lindl.	Myanmar	
5297	14 Jan. 2012	Dan Singkorn	*Vandopsis*	*gigantea*	(Lindl.) Pfitz.	Myanmar	
5298	14 Jan. 2012	Dan Singkorn	*Pomatocalpa*	*spicatum*	Breda.	Myanmar	
5299	14 Jan. 2012	Dan Singkorn	*Bulbophyllum*	*sukhakulii*	Seidenf.	Myanmar	
5302	14 Jan. 2012	Dan Singkorn	*Eria*	*bractescens*	Lindl.	Myanmar	
5303	14 Jan. 2012	Dan Singkorn	*Eulophia*	*graminea*	Lindl.	Myanmar	
5304	14 Jan. 2012	Dan Singkorn	*Eria*	*bractescens*	Lindl.	Myanmar	
5306	18 Jan. 2012	Jatujak	*Dendrobium*	*parcum*	Rchb.f.		
5310	28 Jan. 2012	Chedi Sam Ong	*Eria*	*obesa*	Lindl.	Myanmar	
5315	28 Jan. 2012	Chedi Sam Ong	*Dendrobium*	*angulatum*	Lindl.	Myanmar	
5316	28 Jan. 2012	Chedi Sam Ong	*Dendrobium*	*tortile*	Lindl.	Myanmar	
5317	28 Jan. 2012	Chedi Sam Ong	*Cheirostylis*	*yunnanensis*	Rolfe	Myanmar	
5319	28 Jan. 2012	Chedi Sam Ong	*Eria*	*laniceps*	Rchb.f.	Myanmar	
5340	28 Jan. 2012	Chedi Sam Ong	*Dendrobium*	*albosanguineum*	Lindl. & Paxton	Myanmar	
5341	28 Jan. 2012	Chedi Sam Ong	*Dendrobium*	*keithii*	Ridl.	Myanmar	
5342	28 Jan. 2012	Chedi Sam Ong	*Eria*	*lasiopetala*	Rchb.f.	Myanmar	
5350	28 Jan. 2012	Chedi Sam Ong	*Dendrobium*	*albosanguidium*	Lindl. & Paxt.		

5350	28 Jan. 2012	Chedi Sam Ong	*Dendrobium*	*albosanguineum*	Lindl. & Paxt.		
5402	28 Jan. 2012	Chedi Sam Ong	*Bulbophyllum*	*elassonotum*	Summerh.		
5564	01 Feb. 2012	Jatujak	*Coelogyne*	*ovalis*	Lindl.	Thailand	
5569	01 Feb. 2012	Jatujak	*Bulbophyllum*	*retusiusculum*	Rchb.f.	PDR Laos	
5573	01 Feb. 2012	Jatujak	*Bulbophyllum*	*muscarirubrum*	Siedenf.	PDR Laos	
5579	01 Feb. 2012	Jatujak	*Dendrobium*	*keithii*	Ridl.	Thailand	Krabi
5612	01 Feb. 2012	Jatujak	*Dendrobium*	*capillipes*	Rchb.f.	Thailand	Northern region
5617	01 Feb. 2012	Jatujak	*Trias*	*intermedia*	Seidenf. & Smitinand	Thailand	Sakun Nakhon
5649	01 Feb. 2012	Jatujak	*Coelogyne*	*viscosa*	Rchb.f.	Thailand	
5649	01 Feb. 2012	Jatujak	*Coelogyne*	*viscosa*	Rchb.f.	Thailand	
5665	01 Feb. 2012	Jatujak	*Bulbophyllum*	*refractum*	Rchb.f.	PDR Laos	Southern
5686	01 Feb. 2012	Jatujak	*Calanthe*	*rubens*	Ridl.		
5690	01 Feb. 2012	Jatujak	*Vanda*	*lilacina*	Teijsm. & Binn.	Thailand	Ubon Ratchathani
5704	01 Feb. 2012	Jatujak	*Eria*	*rigida*	Lindl.		
5750	01 Feb. 2012	Jatujak	*Coelogyne*	*fimbriata*	Lindl.		
5805	10 Feb. 2012	Dan Singkorn	*Dendrobium*	*crumentaum*	Sw.	Myanmar	
5806	10 Feb. 2012	Dan Singkorn	*Dendrobium*	*lituiflorum*	Lindl.	Lao PDR	
5808	10 Feb. 2012	Dan Singkorn	*Dendrobium*	*capillipes*	Rchb.f.	Lao PDR	into Thialand via Nong Khai
5814	10 Feb. 2012	Dan Singkorn	*Dendrobium*	*gratiosissimum*	Rchb.f.	Lao PDR	Southern; into Thailand
5815	10 Feb. 2012	Dan Singkorn	*Dendrobium*	*gratiosissimum*	Rchb.f.	Lao PDR	into Thailand via Nong Khai
5888	10 Feb. 2012	Dan Singkorn	*Oberonia*	*nitida*	Seidenf.		
5889	10 Feb. 2012	Dan Singkorn	*Thrixspermum*	*trichoglottis*	(Hk.f.) Kze.	Myanmar	
5893	10 Feb. 2012	Dan Singkorn	*Dendrobium*	*blumeii*	Lindl.		
5959	10 Feb. 2012	Dan Singkorn	*Eria*	*lasiopetala*	(Willd.) Ormerod	Myanmar	
6056	10 Feb. 2012	Dan Singkorn	*Rhynchostylis*	*gigantea*	(Lindl.) Ridl.		
6151	11 Feb. 2012	Dan Singkorn	*Dendrobium*	*polyanthum*	Wall. ex Lindl.	Myanmar	
6324	11 Feb. 2012	Dan Singkorn	*Luisia*	*brachystachys*	(Lindl.) Blume	Myanmar	
6325	11 Feb. 2012	Dan Singkorn	*Dendrobium*	*hymenanthum*	Rchb.f.	Myanmar	
6480	11 Feb. 2012	Dan Singkorn	*Trichotosia*	*dasyphylla*	(Par. & Rachb.f.) Krzl.	Myanmar	
6491	11 Feb. 2012	Dan Singkorn	*Bulbophyllum*	*cf. peninsulare*	Seidenf.		
6552	15 Feb. 2012	Jatujak	*Vanda*	*brunnea*	Rchb.f.	Thailand	Isaan region
6553	15 Feb. 2012	Jatujak	*Dendrobium*	*trigonopus*	Rchb.f.	PDR Laos	
6558	15 Feb. 2012	Jatujak	*Dendrobium*	*ochreatum*	Lindl.	Myanmar	

6560	15 Feb. 2012	Jatujak	*Coelogyne*	*lacteata*	Rchb.f.	Thailand	Chiang Rai
6584	15 Feb. 2012	Jatujak	*Eria*	*lasiopetala*	(Willd.) Omerod	PDR Laos	
6590	15 Feb. 2012	Jatujak	*Gastrochilus*	*obliquus*	(Lindl.) Kuntze		
6600	29 Feb. 2012	Jatujak	*Dendrobium*	*cariniferum*	Rchb.f.	Thailand	Ubon Ratchathani
6611	29 Feb. 2012	Jatujak	*Dendrobium*	*gratiosissimum*	Rchb.f.	Thailand	Northern region
6632	29 Feb. 2012	Jatujak	*Dendrobium*	*signatum*	Rchb.f.	Thailand	Ubon Ratchathani
6674	29 Feb. 2012	Jatujak	*Cleisostoma*	*williamsonii*	(Rchb.f.) Garay		
6687	29 Feb. 2012	Jatujak	*Dendrobium*	*cariniferum*	Rchb.f.	PDR Laos	into Thailand via Issan
6692	29 Feb. 2012	Jatujak	*Eria*	*tomentosa*	(Koen.) Hk. f.	Lao PDR	
6701	29 Feb. 2012	Jatujak	*Dendrobium*	*gratiosissimum*	Rchb.f.	PDR Laos	
6708	29 Feb. 2012	Jatujak	*Dendrobium*	*cariniferum*	Rchb.f.	Myanmar	via Chiang Mai
6809	29 Feb. 2012	Jatujak	*Bulbophyllum*	Synonimization of *B. dhaninivatii* and *B. tripaleum*		Thailand	Mae Hong Son
6856	29 Feb. 2012	Jatujak	*Aerides*	*crassifolia*	Parish & Rachb.f.	Thailand	Isaan region
6925	17 Mar. 2012	Mukdahan	*Eulophia*	*macrobulbon*	(Par. & Rchb.f.) Hk. f.	Lao PDR	
7136	17 Mar. 2012	Mukdahan	*Vanda*	*liouvillei*	Finet.	Lao PDR	
7197	21 Mar. 2012	Jatujak	*Dendrobium*	*connatum*	(Bl.) Lindl.	Thailand	Yala
7199	21 Mar. 2012	Jatujak	*Trias*	*cambodiana*	Christenson	Lao PDR	into Thailand via Chong Mek
7206	21 Mar. 2012	Jatujak	*Pholidota*	*convallariae*	(Parish & Rchb.f.) Hk.f.	Lao PDR	
7209	21 Mar. 2012	Jatujak	*Thrixspermum*	*sp.*		Lao PDR	into Thailand via Chong Mek
7262	04 April 2012	Jatujak	*Dendrobium*	*unicum*	Seidenf.	PDR Laos	
7315	04 April 2012	Jatujak	*Eulophia*	*macrobulbon*	(Parish & Rchb.f.) Hk.f.	PDR Laos	
7577	04 April 2012	Jatujak	*Dendrobium*	*cf. signatum*	PDR Laos		
7602	04 April 2012	Jatujak	*Dendrobium*	*tortile*	Lindl.	Lindl.	
7628	04 April 2012	Jatujak	*Eparmatostigma*	*dives*	(Rachb. f.) Garay	Thailand	Isaarn region
7679	18 April 2012	Jatujak	*Chilochilsta*	*parishii*	Seidenf.	Thailand	Nakon Phanom
7680	18 April 2012	Jatujak	*Micropera*	*thailandica*	(Seidenf. & Smitin.) Garay	Thailand	Prachinburi
7681	07 May 2011	Mukdahan	*Bromheadia*	*aporoides*	Rchb.f.	Thailand	Nakhon Phanom
7687	17 Jan. 2012	Dan Singkorn	*Cleisostoma*	*sp.*		Lao PDR	

7711	04 April 2012	Jatujak	*Eulophia*	*spectabilis*	(Dennst.) Suresh		
7756	02 May 2012	Jatujak	*Acanthephippium*	*striatum*	Lindl.	PDR Laos	
8078	04 July 2012	Jatujak	*Bublophyllum*	*sp. nova. ?*		Thailand	Mae Hong Son

Annex 7. Reported price per wild orchid plant by genus and species at four markets in Thailand

Market	Genus [a]	species	Reported price (Thai Baht) [b]			
			Median	Minimum	Maximum	N [c]
Chedi Sam Ong	*Aerides*	-	40	30	50	3
	Aerides	*rosea*	30	30	30	1
	Aerides	*odorata*	45	40	50	2
	Ascocentrum	-	40	20	300	15
	Ascocentrum	*ampullaceum*	40	20	50	3
	Ascocentrum	*curvifolium*	45	20	300	12
	Bulbophyllum	*blepharistes*	75	30	300	8
	Cheirostylis	*yunnanensis*	30	30	30	1
	Chiloschista	*parishii*	25	25	25	1
	Cleisostoma	*complicatum*	170	170	170	1
	Dendrobium	-	60	20	300	35
	Dendrobium	*albosanguineum*	150	150	150	1
	Dendrobium	*angulatum*	100	100	100	1
	Dendrobium	*calicopsis*	50	50	50	1
	Dendrobium	*chrysotoxum*	62.5	40	120	4
	Dendrobium	*eliotianum*	20	20	20	1
	Dendrobium	*farmeri*	135	70	200	2
	Dendrobium	*formosum*	80	80	80	1
	Dendrobium	*keithii*	40	40	40	1
	Dendrobium	*lindleyi*	50	30	250	7
	Dendrobium	*pachyglossum*	50	50	50	1
	Dendrobium	*palpebrae*	80	80	80	1
	Dendrobium	*polyanthum*	100	100	100	1
	Dendrobium	*pulchellum*	40	20	50	3
	Dendrobium	*secundum*	80	80	80	1
	Dendrobium	*tortile*	75	20	300	9
	Eria	-	150	50	170	3
	Eria	*javanica*	50	50	50	1
	Eria	*obesa*	150	150	150	1
	Eria	*tomentosa*	170	170	170	1
	Habenaria	*hosseusii*	20	20	20	1
	Habenaria	*vidua*	10	10	10	1
	Micropera	*pallida*	300	300	300	1
	Paphiopedilum	-	60	60	60	1
	Paphiopedilum	*concolor*	60	60	60	1
	Phalaenopsis	*cornucervi*	50	30	250	3
	Phalaenopsis	*deliciosa*	40	40	40	1
	Philodota	*articulata*	30	20	200	7
	Rhynchostylis	*retusa*	40	10	340	9
	Staurochilus	*dawsonianus*	180	180	180	1
	Stereochilus	*erinaceus*	40	40	40	1
Dan Singkorn	*Aerides*		50	50	50	2

Aerides	*houlettiana*	50	50	50	1
Aerides	*multiflora*	50	50	50	1
Arundina	*graminifolia*	20	20	20	1
Ascocentrum	-	50	10	200	5
Ascocentrum	*curvifolium*	20	10	200	3
Ascocentrum	*garayi*	75	50	100	2
Bulbophyllum	-	50	10	100	8
Bulbophyllum	*blepharistes*	20	10	100	5
Bulbophyllum	*macranthum*	50	50	50	1
Bulbophyllum	*sicybulbon*	50	50	50	1
Bulbophyllum	*sukhakulii*	80	80	80	1
Chamaeanthus	*brachystachys*	5	5	5	1
Chiloschista	-	20	10	30	2
Chiloschista	*parishii*	10	10	10	1
Chiloschista	*ramifera*	30	30	30	1
Cleisostoma	-	80	20	200	7
Cleisostoma	*arietinum*	80	30	200	6
Cleisostoma	*kerrii*	20	20	20	1
Cymbidium	*findlaysonianum*	900	900	900	1
Dendrobium	-	80	10	450	82
Dendrobium	*albosanguineum*	80	80	80	1
Dendrobium	*angulatum*	40	40	40	1
Dendrobium	*anosmum*	80	80	80	1
Dendrobium	*aphyllum*	50	30	180	3
Dendrobium	*blumeii*	60	60	60	1
Dendrobium	*brymerianum*	35	20	50	2
Dendrobium	*capillipes*	40	40	40	1
Dendrobium	*cariniferum*	250	250	250	1
Dendrobium	*chittimae*	100	100	100	1
Dendrobium	*christyanum*	20	20	20	1
Dendrobium	*chrysotoxum*	125	30	450	12
Dendrobium	*crepidatum*	100	100	100	1
Dendrobium	*devonianum*	80	80	80	1
Dendrobium	*falconeri*	100	80	150	3
Dendrobium	*farmeri*	350	350	350	1
Dendrobium	*findlayanum*	115	40	300	6
Dendrobium	*formosum*	185	20	350	2
Dendrobium	*gratiosissimum*	100	100	100	1
Dendrobium	*hymenanthum*	10	10	10	1
Dendrobium	*jenkinsii*	35	20	50	2
Dendrobium	*lindleyi*	55	10	150	8
Dendrobium	*lituiflorum*	180	180	180	1
Dendrobium	*moschatum*	150	150	150	1
Dendrobium	*pachyglossum*	30	30	30	1
Dendrobium	*pachyphyllum*	20	20	20	1
Dendrobium	*parishii*	80	10	300	5

Dendrobium	*polyanthum*	50	10	150	3
Dendrobium	*salaccense*	100	100	100	1
Dendrobium	*schildhaueri*	30	30	30	1
Dendrobium	*schrautii*	30	30	30	1
Dendrobium	*secundum*	100	20	180	6
Dendrobium	*senile*	50	20	80	2
Dendrobium	*sulcatum*	40	40	40	1
Dendrobium	*tortile*	100	20	400	5
Dendrobium	*trinervium*	25	10	40	2
Eria	-	75	50	100	2
Eria	*concolor*	50	50	50	1
Eria	*densa*	100	100	100	1
Eulophia	*graminea*	15	10	20	2
Geodorum	-	10	10	100	3
Geodorum	*densiflorum*	10	10	10	1
Geodorum	*terrestre*	55	10	100	2
Grammatophyllum	*speciosum*	350	120	8000	7
Habenaria	*myriotricha*	20	20	20	1
Hygrochilus	*parishii*	100	100	100	1
Liparis	*aurita*	10	10	10	1
Luisia	*brachystachys*	10	10	10	1
Paphiopedilum	-	50	20	200	6
Paphiopedilum	*callosum*	80	80	80	1
Paphiopedilum	*concolor*	41.5	20	50	4
Paphiopedilum	*niveum*	200	200	200	1
Pecteilis	*hawkessiana*	20	20	20	1
Pelatantheria	*ctenoglossum*	50	50	50	1
Pelatantheria	*woonchengii*	30	30	30	1
Phalaenopsis	*cornucervi*	85	20	300	10
Phalaenopsis	*pulcherrima*	100	100	100	1
Philodota	-	45	10	300	14
Philodota	*articulata*	40	10	300	11
Philodota	*imbricata*	100	10	250	3
Pomatocalpa	*spicatum*	10	10	10	1
Rhynchostylis	-	100	10	3000	25
Rhynchostylis	*coelestis*	200	120	250	3
Rhynchostylis	*gigantea*	200	30	3000	9
Rhynchostylis	*retusa*	50	10	200	13
Robiquetia	*spathulata*	80	80	80	2
Sarcoglyphis	*mirabilis*	30	30	30	1
Schoenorchis	*fragrans*	50	50	50	1
Smitinandia	*micrantha*	80	80	80	1
Thecostele	*alata*	50	50	50	1
Thrixspermum	*trichoglottis*	50	50	50	1
Trichotosia	*velutina*	50	50	50	1
Vanda	*lilacina*	100	100	100	1

	Vandopsis	*gigantea*	1350	200	2500	2
Mukdahan	*Aerides*	-	100	100	100	1
	Aerides	*crassifolia*	100	100	100	1
	Arundina	*graminifolia*	200	200	200	1
	Ascocentrum	-	60	20	250	4
	Ascocentrum	*curvifolium*	60	20	100	2
	Ascocentrum	*garayi*	135	20	250	2
	Bromheadia	*aporoides*	20	20	20	1
	Bulbophyllum	*blepharistes*	27.5	20	35	2
	Cleisostoma	-	20	4	200	6
	Cleisostoma	*arietinum*	20	4	200	5
	Cleisostoma	*fuerstenberianum*	20	20	20	1
	Dendrobium	-	50	14	2000	45
	Dendrobium	*anosmum*	300	250	350	2
	Dendrobium	*cariniferum*	33	33	33	1
	Dendrobium	*christyanum*	110	20	200	2
	Dendrobium	*chrysotoxum*	33	20	250	5
	Dendrobium	*crystallinum*	100	100	100	2
	Dendrobium	*delacourii*	110	20	200	2
	Dendrobium	*draconis*	30	30	30	1
	Dendrobium	*falconeri*	25	20	350	5
	Dendrobium	*findlayanum*	50	50	50	1
	Dendrobium	*jenkinsii*	26.5	20	33	2
	Dendrobium	*lindleyi*	33	20	2000	5
	Dendrobium	*nobile*	200	200	200	1
	Dendrobium	*parishii*	180	50	250	3
	Dendrobium	*pendulum*	50	20	80	2
	Dendrobium	*pulchellum*	33	20	100	3
	Dendrobium	*secundum*	20	14	2000	3
	Dendrobium	*signatum*	250	150	350	2
	Dendrobium	*thyrsiflorum*	150	150	150	1
	Dendrobium	*tortile*	35	35	35	1
	Dendrobium	*venustum*	80	80	80	1
	Gagnepainia	*godefroyi*	17	17	17	1
	Geodorum	*recurvum*	20	20	20	1
	Habenaria	*rhodocheila*	20	20	20	1
	Luisia	*curtisii*	20	20	20	1
	Nervilia	*aragoana*	17	17	17	1
	Paphiopedilum	-	37.5	25	50	2
	Paphiopedilum	*concolor*	50	50	50	1
	Paphiopedilum	*hirsutissimum*	25	25	25	1
	Phalaenopsis	-	32.5	20	2000	4
	Phalaenopsis	*cornucervi*	35	35	35	1
	Phalaenopsis	*pulcherrima*	30	20	2000	3
	Rhynchostylis		33	11	500	11
	Rhynchostylis	*coelestis*	29	20	200	6

	Rhynchostylis	*gigantea*	300	11	500	5
	Smitinandia	*micrantha*	200	200	200	1
	Vanda	*liouvillei*	20	20	20	1
	Vanilla	*aphylla*	20	20	20	1
Jatujak	*Acanthephippium*	*striatum*	100	100	100	1
	Aerides	-	45	20	800	10
	Aerides	*falcata*	350	350	350	1
	Aerides	*houlettiana*	35	30	40	2
	Aerides	*multiflora*	36.5	20	50	4
	Aerides	*odorata*	800	800	800	1
	Aerides	*retusa*	70	70	70	1
	Aerides	*rosea*	800	800	800	1
	Arundina	*graminifolia*	80	50	180	3
	Ascocentrum	-	50	10	300	22
	Ascocentrum	*ampullaceum*	75	50	300	4
	Ascocentrum	*curvifolium*	60	40	180	6
	Ascocentrum	*garayi*	33	10	100	7
	Ascocentrum	*pusillum*	35	20	80	5
	Brachycorythis	-	40	30	50	2
	Brachycorythis	*acuta*	50	50	50	1
	Brachycorythis	*neglecta*	30	30	30	1
	Bulbophyllum	-	80	20	600	27
	Bulbophyllum	*auratum*	200	200	200	1
	Bulbophyllum	*bciolor*	150	150	150	1
	Bulbophyllum	*blepharistes*	33	20	100	5
	Bulbophyllum	*capillipes*	80	80	80	1
	Bulbophyllum	*crassipes*	33	33	33	1
	Bulbophyllum	*dayanum*	80	33	100	3
	Bulbophyllum	*lobbii*	100	100	100	1
	Bulbophyllum	*muscarirubrum*	80	80	80	1
	Bulbophyllum	*n. sp.*	500	500	500	1
	Bulbophyllum	*peninsulare*	200	200	200	1
	Bulbophyllum	*picturatum*	150	150	150	1
	Bulbophyllum	*planibulbe*	45	20	80	4
	Bulbophyllum	*psittacoglossum*	60	50	70	2
	Bulbophyllum	*refractum*	100	100	100	1
	Bulbophyllum	*retusiusculum*	80	80	80	1
	Bulbophyllum	*smitinandii*	600	600	600	1
	Bulbophyllum	*tricorne*	40	40	40	1
	Calanthe	*vestita*	100	100	100	1
	Chiloschista	*usneoides*	150	150	150	1
	Cleisomeria	*pilosulum*	40	40	40	1
	Cleisostoma	-	33	20	100	11
	Cleisostoma	*arietinum*	30	20	100	6
	Cleisostoma	*crochetii*	40	30	50	2
	Cleisostoma	*simondii*	41.5	33	50	2

Cleisostoma	*williamsonii*	35	35	35	1
Coelogyne	-	100	30	400	5
Coelogyne	*calcicola*	30	30	30	1
Coelogyne	*fuscecens*	100	100	100	1
Coelogyne	*lacteata*	50	50	50	1
Coelogyne	*pulverula*	400	400	400	1
Coelogyne	*viscosa*	100	100	100	1
Crepidium	*mackinnonii*	30	30	30	1
Cymbidium	*ensifolium*	300	300	300	1
Cymbidium	*lowianum*	150	150	150	1
Cymbidium	*tracyanum*	25	25	25	1
Dendrobium	*acerosum*	80	80	80	1
Dendrobium	*aciculare*	33	33	33	1
Dendrobium	*albosanguineum*	50	50	50	1
Dendrobium	*anosmum*	150	100	200	2
Dendrobium	*bellatulum*	25	25	25	1
Dendrobium	*blumeii*	33	33	33	1
Dendrobium	*brymerianum*	100	100	100	1
Dendrobium	*capillipes*	36.5	33	40	2
Dendrobium	*cariniferum*	50	20	100	3
Dendrobium	*cf. incurvum*	30	30	30	1
Dendrobium	*christyanum*	40	33	100	3
Dendrobium	*chrysanthum*	200	200	200	1
Dendrobium	*chrysotoxum*	110	33	200	8
Dendrobium	*crumentaum*	100	100	100	1
Dendrobium	*cuspidatum*	100	100	100	1
Dendrobium	*delacourii*	33	20	40	3
Dendrobium	*draconis*	45	33	100	4
Dendrobium	*ellipsophyllum*	100	100	100	1
Dendrobium	*falconeri*	75	33	150	4
Dendrobium	*farmeri*	200	200	200	1
Dendrobium	*findlayanum*	36.5	25	100	6
Dendrobium	*formosum*	275	150	400	2
Dendrobium	*friedericksianum*	300	300	300	1
Dendrobium	*gibsonii*	250	250	250	1
Dendrobium	*gratiosissimum*	116.5	33	200	2
Dendrobium	*heterocarpum*	100	100	100	1
Dendrobium	*indivisum*	30	30	30	1
Dendrobium	*jenkinsii*	75	50	100	2
Dendrobium	*lamyaiae*	41.5	33	50	2
Dendrobium	*lindleyi*	50	20	150	7
Dendrobium	*lituiflorum*	200	200	200	1
Dendrobium	*nobile*	150	150	150	1
Dendrobium	*oligophyllum*	40	40	40	1
Dendrobium	*pachyphyllum*	30	20	40	5
Dendrobium	*parishii*	300	150	800	6

Dendrobium	*pendulum*	50	50	50	1
Dendrobium	*penguanum*	10	10	10	1
Dendrobium	*polyanthum*	175	150	200	2
Dendrobium	*pulchellum*	150	40	250	3
Dendrobium	*scabrilingue*	40	30	50	3
Dendrobium	*schrautii*	66.5	33	100	2
Dendrobium	*secundum*	125	33	550	8
Dendrobium	*senile*	100	80	150	3
Dendrobium	*signatum*	250	250	250	1
Dendrobium	*stuposum*	30	30	30	1
Dendrobium	*sulcatum*	325	300	350	2
Dendrobium	*terminale*	250	250	250	1
Dendrobium	*tortile*	80	80	80	1
Dendrobium	*trigonopus*	30	30	30	1
Dendrobium	*unicum*	150	50	250	2
Dendrobium	*venustum*	32.5	25	40	2
Dienia	*ophrydis*	800	800	800	1
Eparmatostigma	*dives*	33	33	33	1
Eria	-	100	50	300	3
Eria	*ornata*	100	100	100	1
Eria	*paniculata*	300	300	300	1
Eria	*tomentosa*	50	50	50	1
Gastrochilus	*bellinus*	50	33	150	3
Geodorum	*terrestre*	33	33	33	1
Grammatophyllum	*speciosum*	2000	1200	3000	3
Habenaria	-	20	15	50	5
Habenaria	*dentata*	20	20	20	1
Habenaria	*rhodocheila*	20	15	50	3
Habenaria	*rostellifera*	50	50	50	1
Hygrochilus	*parishii*	80	33	200	5
Liparis	-	30	20	30	3
Liparis	*jovispluvii*	30	30	30	1
Liparis	*siamensis*	20	20	20	1
Liparis	*tschangii*	30	30	30	1
Luisia	-	85	20	150	2
Luisia	*primulina*	150	150	150	1
Luisia	*thailandica*	20	20	20	1
Microsaccus	*grifithii*	60	60	60	1
Oberonia	*delacourii*	20	20	20	1
Ornithochilus	*difformis*	100	100	100	1
Panisea	*uniflora*	450	450	450	1
Paphiopedilum	-	90	20	1100	22
Paphiopedilum	*bellatulum*	60	50	150	4
Paphiopedilum	*callosum*	40	40	40	1
Paphiopedilum	*concolor*	80	33	150	6
Paphiopedilum	*exul*	275	50	1100	4

Paphiopedilum	*godefroyae*	300	100	500	2
Paphiopedilum	*niveum*	20	20	20	1
Paphiopedilum	*parishii*	150	50	300	3
Paphiopedilum	*sukhakulii*	150	150	150	1
Peristylus	*goodyeriodes*	20	20	20	1
Phaius	*tankervilliae*	120	120	120	1
Phalaenopsis	-	100	20	600	24
Phalaenopsis	*bellina*	200	200	200	1
Phalaenopsis	*cornucervi*	150	30	600	8
Phalaenopsis	*deliciosa*	62.5	25	100	2
Phalaenopsis	*finleyi*	140	80	200	2
Phalaenopsis	*hieroglyphica*	300	300	300	1
Phalaenopsis	*parishii*	175	150	200	2
Phalaenopsis	*pulcherrima*	50	20	150	7
Phalaenopsis	*stuartiana*	600	600	600	1
Philodota	*articulata*	40	20	200	5
Philodota	*chinensis*	40	40	40	1
Porpax	*elwesii*	42.5	5	80	2
Rhynchostylis	-	100	25	800	26
Rhynchostylis	*coelestis*	40	33	350	5
Rhynchostylis	*gigantea*	125	30	800	12
Rhynchostylis	*retusa*	100	25	200	9
Seidenfadenia	*mitra*	175	50	300	2
Spathoglottis	*affinis*	40	40	40	1
Staurochilus	*faciatus*	33	25	50	3
Thecostele	*alata*	500	500	500	1
Thrixspermum	-	65	30	100	2
Thrixspermum	*leucarachne*	100	100	100	1
Thrixspermum	n.sp. *(?)*	30	30	30	1
Trias	-	56.5	33	80	2
Trias	*cambodiana*	80	80	80	1
Trias	*intermedia*	33	33	33	1
Trichoglottis	-	140	80	200	2
Trichoglottis	*cirrhifera*	200	200	200	1
Trichoglottis	*triflora*	80	80	80	1
Uncifera	*thailandica*	80	80	80	1
Vanda	-	65	20	150	8
Vanda	*bensonii*	100	100	100	1
Vanda	*brunnea*	30	20	40	2
Vanda	*coerulea*	80	50	150	3
Vanda	*lilacina*	65	30	100	2

[a] Range of prices given for each genus were based on the species-level identifications (in each genus) at that market
[b] Prices are per piece/bundle and do not include prices per kilogram or prices for planted pieces (in pots or tied to wood)
[c] Number of encounters at that market

Appendix 8. Threat Analysis of orchid species in trade.

Compilation on available data on species distribution, global and national-level conservation assessments, matched with trade data from market surveys.

	From the literature and conservation assessments			Survey data	
Taxa	Extent of Occurrence [a]	Global conservation status [b]	National conservation status [b]	Reported origin	Observed in trade [c]
*Aerides houlettiana**	Widespread: Lao PDR, Cambodia, Vietnam Thailand (Pooma et al. 2005)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Thailand	20
				Myanmar	32
				Unknown	152
Aerides odorata	Widespread: India, Nepal, Bhutan, Myanmar, Andaman Is., Thailand, Vietnam, Peninsular Malaysia, Sumatra, Java, Borneo, Sulawesi, Moluccas, Philippines. Lao PDR (Pooma et al. 2005; Schuteman et al. 2008)	Not threatened (UNEP-WCMC 2010)	Unknown	Thailand	22
				Myanmar	33
				Unknown	46
Aerides rosea	Widespread: Bhutan, India (NE), Myanmar, S. China, Lao PDR, Vietnam, N Thialand (Pooma et al. 2005)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Thailand	2
				Myanmar	31
				Unknon	67
*Ascocentrum ampullaceum**	Widespread: Nepal, Sikkim, Bhutan, India (NE, NW), Myanmar, China (S), Andaman Is., Lao PDR, Thailand (Pooma et al. 2005; Schuiteman et al. 2008)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Thailand	28
				Myanmar	77
				Unknown	7
Brachypeza laotica	Regional: Lao PDR, Vietnam, Thailand (Pooma et al. 2005; Schuiteman et al. 2008)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Unknown	1
Bulbophyllum clandestinum (syn. *sessile)*	Widespread: Thailand, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, Sulawesi, Moluccas, New Guinea, Philippines, Solomon Is., Fiji. Lao PDR (Schuiteman et al. 2008)	Not threatened (UNEP-WCMC 2010)	Unknown	Lao PDR	15
				Unknown	43
Bulbophyllum lobbii	Widespread: India (NE), Myanmar, Thailand, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, lesser Sunda Is., Philippines, Lao PDR (Schuiteman et al. 2008)	Not threatened (UNEP-WCMC 2010)	Unknown	Thailand	1
Bulbophyllum macranthum	Widespread: Assam, Cambodia, Myanmar, Thailand, Vietnam, Borneo, Java, Malaysia, Phlippines, Sulawesi, Sumatra, Solomon Is. (Grovaerts 2013)	Not threatened (UNEP-WCMC 2010)	Unknown	Myanmar	8
Bulbophyllum	Endemic: Thailand (Seidenfaden 1979)	Unknown	Unknown	Lao PDR	3

muscarirubrum				(new record)	
				Unknown	2
Bulbophyllum patens	Pen. Thailand, Vietnam, Borneo, Malaysia, Sumatra (Grovaerts 2013)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Thailand	1
Bulbophyllum pulchellum	Widespread: India (NE), Myanmar, Nepal, Thailand, Peninsular Malaysia, Singapore, Vietnam. Lao PDR (Schuiteman et al. 2008)	Vulnerable (UNEP-WCMC 2010)	Unknown	Unknown	2
Bulbophyllum refractum	Widespread: Vietnam, Peninsular Malaysia, Sumatra, Java, Thailand, Lao PDR (Schuiteman et al. 2008)	Not threatened (UNEP-WCMC 2010)	Unknown	Lao PDR	25
				Unknown	50
Bulbophyllum sukhakulii	Endemic: Thailand (Kanchanaburi) (Santisuk et al. 2006)	Unknown	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006)	Myanmar	1
Chiloschista lunifera	Widespread: Himalayas to Indo-China, Java (Gorvaerts 2013)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Thailand	2
Chiloschista virdiflava	Narrow: Thailand (Chiang Mai), Lao PDR (Vientiane) (Santisuk et al. 2006, Schuiteman et al. 2008)	Threatened (Pooma et al. 2005) Endangered (Santisuk et al. 2006)	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006)	Thailand	13
				Unknown	25
Chiloschista ramifera	Endemic: Thailand (Seidenfaden 1988; Pooma et al. 2005)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Myanmar	3
Cleisostoma williamsonii	Widespread: Bhutan to S. China to Malaysia (Grovaerts 2013)	Unknown	Thailand: Rare (Seidenfaden 1975)	Myanmar	1
				Unknown	2
Cleisostoma kerrii	Endemic: Thailand (Yala) (Santisuk et al. 2006)	Threatened (Pooma et al. 2005) Endangered (Santisuk et al. 2006)	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006)	Myanmar (new record)	1
Coelogyne nitida	Widespread: India (NE), Nepal, Bhutan, Myanmar, Thailand, China (Yunnan), Vietnam. Lao PDR (Schuiteman et al. 2008)	Rare (UNEP-WCMC 2010)	Unknown	Thailand	34
				Unknown	2
Coelogyne rochussenii	Regional: Peninsular Thailand to Malaysia (Grovaerts 2013)	Not threatened (UNEP-WCMC 2010)	Malaysia: Not threatened (UNEP-WCMC 2010)	Malaysia	1

Coelogyne trinervis	Widespread: Assam to W. and C. Malaysia (Grovaerts 2013)	Not threatened (UNEP-WCMC 2010)	Unknown	Unknown	4
Cymbidium aloifolium	Widespread: Himalaya to W. Malaysia (Grovaerts 2013)	Not threatened (UNEP-WCMC 2010)	Unknown	Thailand	25
				Unknown	11
Cymbidium dayanum	Widespread: India (NE), Myanmar, China, Taiwan, Japan, Thailand, Cambodia, Vietnam, Peninsular Malaysia, Sumatra, Borneo, Philippines. Lao PDR (Schuiteman et al. 2008)	Not threatened (UNEP-WCMC 2010)	Unknown	Lao PDR	2
Cymbidium ensifolium	Widespread: Sri Lanka, India, China, Taiwan, Ryukyu Arch., Japan, Thailand, Cambodia, Vietnam, Peninsular Malaysia, Sumatra, Java, Borneo, Philippines. Lao PDR (Schuiteman et al. 2008)	Not threatened (UNEP-WCMC 2010)	Unknown	Thailand	15
Cymbidium lowianum	Widespread: Himalaya, Thailand (Chiang Mai), Myanmar, China (Yunnan), Vietnam. Lao PDR (Pooma et al. 2005; Schuiteman et al. 2008)	Unknown	Thailand: Threatened (Pooma et al. 2005) Thailand: Rare (Santisuk et al. 2006)	Lao PDR	5
				Myanmar	4
Cymbidium mastersii	Widespread: East Himalaya to China (W. Yunnan), Myanmar, Thailand, Vietnam (Grovaerts 2013)	Unknown	Thailand: Threatened (Pooma et al. 2005) Thailand: Vulnerable (Santisuk et al. 2006)	Malaysia	4
Cymbidium tracyanum	Narrow: Myanmar, Thailand (Chiang Mai, Loei) (Pooma et al. 2005)	Unknown	Thailand: Threatened (Pooma et al. 2005) Thailand: Vulnerable (Santisuk et al. 2006)	Myanmar	2
Dendrobium indivisum	Widespread: Myanmar, Thailand, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, Moluccas, Philippines. Lao PDR (Schuiteman et al. 2008)	Not threatened (UNEP-WCMC 2010)	Unknown	Myanmar	25
				Thailand	30
				Unknown	32
Dendrobium secundum	Widespread: India, Myanmar, Thailand, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, Sulawesi, lesser Sunda Is., New Guinea,	Not threatened (UNEP-WCMC 2010)	Unknown	Lao PDR	196

	Philippines. Lao PDR (Schuiteman et al. 2008)			Myanmar	130
				Thailand	319
				Unknown	294
Dendrobium crumenatum	Widespread: Seychelles, India, Bangladesh, Nepal, Bhutan, Myanmar, China, Taiwan, Thailand, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, Sulawesi, Lesser Sunda Is., Moluccas, Philippines, Australia. Lao PDR (Schuiteman et al. 2008)	Not threatened (UNEP-WCMC 2010)	Unknown	Lao PDR	1
				Myanmar	3
*Dendrobium gratiosissimum**	Widespread: India (NE), Myanmar, China, Thailand, Vietnam. Lao PDR (Schuiteman et al. 2008)	Unknown	Thailand: Rare (Seidenfaden 1985)	Lao	104
				Thailand	36
				Unknown	9
Dendrobium aphyllum	Widespread: India, Nepal, Bhutan, Myanmar, China, Thailand, Cambodia, Vietnam, Peninsular Malaysia. Lao PDR (Schuiteman et al. 2008)	Not threatened (UNEP-WCMC 2010)	Thailand: Locally threatened (Schuiteman 2013)	Myanmar	20
				Unknown	6
Dendrobium formosum	Widespread: C. Himalayas to Indo-China (Grovaerts 2013)	Unknown	Thailand: Rare (Seidenfaden 1985)	Myanmar	207
				Unknown	2
Dendrobium trinervium	Regional: Indo-China to Pen. Malaysia (Grovaerts 2013)	Unknown	Thailand: Rare (Seidenfaden 1985)	Myanmar	18
Dendrobium draconis	Widespread: India (NE), Myanmar, Thailand, Cambodia, Vietnam. Lao PDR (Schuiteman et al. 2008)	Unknown	Thailand: Common (Seidenfaden 1985)	Lao PDR	17
				Myanmar	18
				Thailand	48
				Unknown	197
*Dendrobium albosanguineum**	Narrow: Myanmar, Thailand (Chiang Mai, Tak) (Pooma et al. 2005)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Myanmar	16
				Thailand	105
				Unknown	80
Dendrobium chrysanthum	Widespread: India, Nepal, Bhutan, Myanmar, China, Thailand, Vietnam, Lao PDR (Pooma et al. 2005)	Unknown	Thailand: Threatened (Pooma et al. 2005) Thailand: Rare (Santisuk et al. 2006)	Myanmar	2
*Dendrobium falconeri**	Widespread: Bhutan, India, Myanmar, China (Yunan), N. Thailand (Pooma et al. 2005)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Myanmar	62
				Lao PDR	200

			Thailand: Rare (Santisuk et al. 2006)	Thailand	56
				Unknown	57
*Dendrobium lamyaiae**	Endemic: Lao PDR (Brikhanchai, Vientiane) (Schuiteman et al. 2008)	Unknown	Unknown	Lao PDR	22
Dendrobium sulcatum	Widespread: India (NE), Myanmar, China, Thailand. Lao PDR (Schuiteman et al. 2008)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Lao PDR	45
				Thailand	2
				Unknown	8
Dendrobium umbonatum	Endemic: Thailand (Trat) (Pooma et al. 2005)	Threatened (Pooma et al. 2005) Endangered (Santisuk et al. 2006)	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006)	Unknown	1
Dendrobium wardianum	Widespread: E Himalayas to China (Yunan), N. Indo-China (Grovaerts 2013)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Lao PDR	34
*Dendrobium friedericksianum **	Narrow: Thailand (Chachoengsao, Chanthaburi, Trat), Lao PDR (Khammouan) (Satisuk et al. 2006; Schuiteman et al. 2008)	Threatened (Pooma et al. 2005) Vulnerable (Santisuk et al. 2006)	Thailand: Threatened (Pooma et al. 2005) Thailand: Vulnerable (Santisuk et al. 2006)	Thailand	4
				Unknown	5
Dendrobium thyrsiflorum	Widespread: India (NE), Myanmar, China, Thailand, Vietnam. Lao PDR (Schuiteman et al. 2008)	Unknown	Lao PDR: Very common (Schuiteman et al. 2008)	Lao PDR	15
				Thailand	4
				Unknown	3
Dendrobium crumentatum	Widespread: Seychelles, India, Bangladesh, Nepal, Bhutan, Myanmar, China, Taiwan, Thailand, Cambodia, Vietnam, Pen. Malaysia, Singapore, Sumatra, Java, Borneo, Sulawesi, Lesser Sunda Is., Moluccas, Philippines, Australia. Lao PDR (Schuiteman et al. 2008)	Unknown	Thailand: Very common (Seidenfaden 1985)	Lao PDR	1
				Myanmar	3
Dendrobium jenkinsii	Widespread: Sikkim, Buhutan, NE India, Yunnan, Myanmar, Lao PDR, N Thailand (Pooma et al. 2005)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Lao PDR	190
				Thailand	4
				Unknown	6
Dendrobium lampongense	Narrow: Thailand, West Malaysia (Grovaerts 2013)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Thailand	1
				Unknown	3

*Dendrobium nobile**	Widespread: India, Nepal, Bhutan, Myanmar, China, Taiwan, Thailand, Vietnam. Lao PDR (Schuiteman et al. 2008)	Unknown	Lao PDR: European Community trade suspension (CITES 2013)	Lao PDR Thailand Vietnam Unknown	17 8 53 16
Dendrobium peguanum	Widespread: C. Himalaya to Thailand (Grovaerts 2013)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Myanmar Thailand	300 45
*Drymoda siamensis**	Narrow: N Thailand, Lao (Khammouan, Vientiane) (Pooma et al. 2005; Schuiteman et al. 2008)	Unknown	Thailand: Threatened (Pooma et al. 2005) Thailand: Rare (Santisuk et al. 2006)	Unknown	16
Eparmatostigma dives	Narrow: Vietnam. Lao PDR (Bolikhamxai) (Schuiteman et al. 2008)	Unknown	Lao PDR: Rare (Schuiteman et al. 2008	Cambodia Thailand	1 6
*Grammatophyllum speciosum**	Widespread: Thailand, Myanmar, Peninsular Malaysia, Singapore, Sumatra, Java, Borneo, Sulawesi, New Guinea, Philippines, Solomon Islands. Lao PDR (Schuiteman et al. 2008)	Not threatened (UNEP-WCMC 2010)	Thailand: Endangered (UNEP-WCMC 2010)	Myanmar Thailand Unknown	51 7 70
*Habenaria carnea**	Narrow: Thailand and Peninsular Malaysia	Unknown	Thailand: Near threatened (Kurtzweil 2011)	Thailand Unknown	27 2
Habenaria dentata	Endemic: Thailand (but widespread within) (Kurtzweil 2011)	Unknown	Thailand: Least Concern (Kurtzweil 2011)	Thailand	2
Habenaria hosseusii	Endemic: N Thailand (Mae Hong Son, Chiang Mai, Lamphun,Tak, Kamphaeng Phet, Phetchabun, Sakon Nakhon, Buri Ram, Uthai Thani, Phetchaburi) (Kurtzweil 2011)	Least Concern (Kurtzweil 2011)	Thailand: Least Concern (Kurtzweil 2011)	Myanmar (new record)	5
Habenaria myriotricha	Narrow: N. Thailand, Vietnam, Lao PDR (Kurtzweil 2011)	Thailand: Vulnerable (Kurtzweil 2011) Vietnam: Very Rare but data deficient (Averyanov 2010)	Thailand: Vulnerable (Kurtzweil 2011) Vietnam: Very Rare but data deficient (Averyanov 2010)	Lao PDR Unknown	120 7
*Habenaria rhodocheila**	Widespread: China, Thailand (widespread), Cambodia, Vietnam, Peninsular Malaysia, Lao PDR (Kurtzweil 2011)	Unknown	Thailand: Least Concern (Kurtzweil 2011) Vietnam: Not rare	Lao PDR Thailand Unknown	61 208 104

			(Averyanov 2010)		
Habenaria vidua	Regional: Thailand, Myanmar (Kurtzweil 2011)	Unknown	Thailand: Least Concern (Kurtzweil 2011)	Myanmar	11
Habenaria humistrata	Endemic: Thailand (widespread) (Kurtzweil 2011)	Least Concern (Kurtzweil 2011) Threatened (Pooma et al. 2005)	Thailand: Least Concern (Kurtzweil 2011) Thailand: Threatened (Pooma et al. 2005)	Unknown	13
Habenaria linedleyana	Thailand (widespread), Lao PDR, Vietnam (Kurtzweil 2011)	Unknown	Thailand: Least Concern (Kurtzweil 2011)	Unknown	10
Nervillia aragoana	Widespread: Thailand, Vietnam, India, Nepal, Bhutan, China, Myanmar, Peninsular Malaysia, Sumatra, Java, Borneo, Sulawesi, lesser Sunda Is., Moluccas, New Guinea, Philippines, Australia, Solomon Is., Vanuatu, New Caledonia, Fiji, Samoa, Society Is. Lao PDR (Bolikhamxai, Luang Aphay, Champasak, Phongsali, Saravan, Vientiane, Xiangkhoang) (Schuiteman et al. 2008)	Not threatened (UNEP-WCMC 2010)	Unknown	Thailand	23
*Paphiopedilum concolor**	Regional: Myanmar, China (Yunnan), Thailand, Cambodia, Vietnam, Myanmar, Lao PDR (Schuiteman et al. 2008)	Not threatened (UNEP-WCMC 2010) CITES Appendix I (CITES 2013)	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006) Lao PDR: Probably threatened (Thomas et al. 2006)	Cambodia Lao PDR Myanmar Thailand Unknown	8 59 119 518 62
*Paphiopedilum exul**	Narrow: Thailand (Phangnga, Karbi), Lao PDR (Bolikhamxai, Champasak) (Schuiteman et al. 2008; Pooma et al. 2005)	Endangered (UNEP-WCMC 2010) CITES Appendix I (CITES 2013)	Thailand: Edangered (UNEP-WCMCM 2010) Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006)	Thailand Unknown [d]	64 28
*Paphiopedilum godefroyae**	Endemic: Thailand (Chumporn, Surat Thani, Karbi) (Pooma et al. 2005)	Rare (UNEP-WCMC 2010) CITES Appendix I (CITES 2013)	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006)	Thailand	68

*Paphiopedilum hirsutissimum**	Regional: China, Thailand, Vietnam. Lao PDR (Schuiteman et al. 2008; Pooma et al. 2005)	Rare (UNEP-WCMC 2010) CITES Appendix I (CITES 2013)	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006) Lao PDR: Probably threatened (Thomas et al. 2006)	Unknown [d]	26
*Paphiopedilum niveum**	Narrow: Pen. Malaysia, Thailand (Sathun) (Pooma et al. 2005)	CITES Appendix I (CITES 2013)	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006)	Myanmar Thailand Unknown	80 6 85
*Paphiopedilum bellatulum**	India (NE), Myanmar, China (Yunnan), Thailand (Chiang Mai, Doi ChiangDao, Mae Tuen, Ang Thong, Trat, Koh Change, Phangnga), Vietnam. Lao PDR (Schuiteman et al. 2008)	CITES Appendix I (CITES 2013)	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006)	Myanmar Thailand Unknown [d]	220 17 39
*Paphiopedilum parishii**	Regional: Myanmar, China (Yunnan), Thailand, N. Lao PDR (Pooma et al. 2005; Schuiteman et al. 2008)	CITES Appendix I (CITES 2013)	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006)	Myanmar Unknown [d]	6 15
*Paphiopedilum sukhakulii**	Endemic: NE Thailand (Loei) (Pooma et al. 2005)	Threatened (Pooma et al. 2005) Endangered (Santisuk et al. 2006) CITES Appendix I (CITES 2013)	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006)	Lao PDR	12
*Paphiopedilum appletonianum**	Regional: Thailand, Cambodia, Vietnam. Lao PDR (Santisuk et al. 2006; Schuiteman et al. 2008)	CITES Appendix I (CITES 2013)	Thailand: Threatened (Pooma et al. 2005) Lao PDR: Probably threatened (Thomas et al. 2006)	Uncertain [d]	-
*Paphiopedilum callosum**	Regional: Thailand (Chiang Mai, Doi Chiangdao, Mae Tuen, Ang Thong, Trat, Koh Chang, Phang Nga), Cambodia, Vietnam. Lao PDR (Schuiteman et al. 2008)	CITES Appendix I (CITES 2013)	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006) Lao PDR: Probably	Uncertain [d]	-

			threatened (Thomas et al. 2006)		
*Paphiopedilum dianthum**	Regional: China (S), Thailand, Vietnam. Lao PDR (Schuiteman et al. 2008)	CITES Appendix I (CITES 2013)	Lao PDR: Probably threatened (Thomas et al. 2006)	Lao PDR	133
*Paphiopedilum villosum**	Regional: Thailand, Vietnam. Lao PDR (Schuiteman et al. 2008)	CITES Appendix I (CITES 2013)	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006) Lao PDR: Probably threatened (Thomas et al. 2006)	Uncertain [d]	-
*Pecteilis susannae**	Widespread: India (NE), Myanmar, China, Thailand, Cambodia, Vietnam, Peninsular Malaysia, Sumatra, Java, Borneo, Sulawesi, lesser Sunda Is., Moluccas. Lao PDR (Schuiteman et al. 2008)	Unknown	Thailand: Threatened (Pooma et al. 2005) Vietnam: Endangered (Averyanov 2010)	Lao PDR Unknown	7 13
Phaius tankarvilliae	Widespread: Sri Lanka, India, Bhutan, Myanmar, China, Japan, Thailand, Cambodia, Vietnam, Peninsular Malaysia, Sumatra, Java, Borneo, Sulawesi, lesser Sunda Is., Moluccas, New Guinea, Philippines, Australia, Pacific Is. Lao PDR (Schuiteman et al. 2008)	Not threatened (UNEP-WCMC 2010)	Unknown	Thailand	12
Phalaenopsis finleyi (syn. *Kingidium minus*)*	Endemic: NE Thailand (Loei) (Pooma et al. 2005)	Threatened (Pooma et al. 2005) Endangered (Santisuk et al. 2006)	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006)	Thailand Unknown	101 4
Phalaenopsis lowii	Narrow: Myanmar (Tenasserim), Thailand (Kanchanaburi) (Seidenfaden 1996; Grovaerts 2013)	Unknown	Thailand: Threatened (Pooma et al. 2005) Thailand: Rare (Seidenfaden 1996)	Unknown	2
Phalaenopsis parishii	Widespread: E. Himalayas to Indo-China (Grovaerts 2013)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Thailand	10
*Phalaenopsis sumatrana**	Widespread: Indochina to West Malaysia and Philippines (Palawan) (Govaerts 2013)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Thailand	14
Rhynchostylis	Widespread: Sri Lanka, India, Nepal, Myanmar,	Not threatened (UNEP-	Unknown	Lao PDR	91

retusa	Thailand, Cambodia, Vietnam, Peninsular Malaysia, Sumatra, Java, Philippines, Lao PDR (Schuiteman et al. 2008)	WCMC 2010)		Myanmar	2093
				Thailand	112
				Unknown	1168
*Rhynchostylis gigantea**	Widespread: Myanmar, China (Hainan), Thailand, Cambodia, Vietnam, Peninsular Malaysia, Singapore, Borneo, Philippines. Lao PDR (Schuiteman et al. 2008)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Cambodia	201
				Lao PDR	612
				Myanmar	115
				Thailand	351
				Unknown	461
Robiquetia spathulata	Widespared: E. Himmalaya, Assam, Cambodia, Lao PDR, Myanmar, Vietnam, Bornea, Java, Malaysia, Sulawesi, Sumatra (Govaerts 2013)	Not threatened (UNEP-WCMC 2010)	Unknown	Myanmar	17
				Unknown	125
Sarcoglyphis thailandica	Endemic: Thailand (Govaerts 2013)	Unknown	Thailand: Threatened (Pooma et al. 2005)	Thailand	1
				Unknown	7
Spathoglottis affinis	Widespread: Myanmar, Thailand, Cambodia, Vietnam, Peninsular Malaysia, Java. Lao PDR (Schuiteman et al. 2008)	Not threatened (UNEP-WCMC 2010)	Unknown	Unknown	259
Stereochilus erinaceus	Narrow: Myanmar, SW Thailand (Kanchanaburi) (Santisuk et al. 2006)	Unknown	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006)	Myanmar	6
				Thailand	3
Trichoglottis cirrhifera syn.*orchidea*	Widespread: Thailand, Nicobar Is., Peninsular Malaysia, Java, Lao PDR (Schuiteman et al. 2008)	Not threatened (UNEP-WCMC 2010)	Unknown	Thailand	4
				Unknown	8
Uncifera thailandica	Regional: Yunan, N Thailand (Mae Hong Son, Phitsanulok) (Santisuk et al. 2006; Grovaerts 2013)	Rare (Seidenfaden 1988) Threatened (Pooma et al. 2005) Endangered (Santisuk et al. 2006)	Thailand: Rare (Seidenfaden 1988) Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006)	Lao PDR	47
				Unknown	1
*Vanda coerulea**	Widespread: India (NE), Myanmar, S China, N Thailand (Pooma et al. 2005)	Common (Schuiteman on Kew Website)	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006) Thailand: Not threatened	Myanmar	1
				Thailand	46
				Unknown	14

			based on CITEs Non-Detriment Finding (Sripotar 2008)		
Vanda coerulescens	Widespread: NE India, Myanmar, S China, N Thailand	Unknown	Thailand: Threatened (Pooma et al. 2005) Thailand: Endangered (Santisuk et al. 2006)	Thailand	1
*Vanda bensonii**	Widespread: Assam to N/NE Thailand	Unknown	Thailand: Threatened (Pooma et al. 2005)	Thailand	23

* Indicates possibly threatened by regional trade based on threat analysis

[a] Distribution categories as:

Widespread = Distribution extends beyond continental SE Asia (e.g., includes Himalayas, S. China, Indonesia)

Regional = Restricted to continental SE Asia;

Narrow = Restricted to 2 countries

Endemic = Restricted to 1 country

[b] Conservation status categories based on evaluation system used in each reference, not IUCN categories

[c] These only represent species-level identifications; species may have encountered additional times but only identified to the genus-level.

[d] Many *Paphiopedilum* specimens were identified than are listed here, as most were identified to sub-genus. These nevertheless represent CITES Appendix I species considered threated by trade.

Appendix 9. Income analysis from Chapter 5

Table A9.1. differences report for four target markets and harvesters in Southern Myanmar using Tukey-Kramer comparison for each pair

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
Jatujak	Dan Singkorn	0.4819764	0.1401821	0.093291	0.870662	0.0072
Jatujak	Mukdahan	0.4229711	0.1532361	-0.00191	0.8478518	0.0516
Jatujak	Harvester	0.350897	0.1543425	-0.077051	0.7788455	0.1613
Jatujak	Chedi Sam Ong	0.3095908	0.1809185	-0.192046	0.8112272	0.4313
Chedi Sam Ong	Dan Singkorn	0.1723855	0.1451693	-0.230128	0.5748993	0.7585
Harvester	Dan Singkorn	0.1310793	0.1102915	-0.174728	0.4368869	0.758
Chedi Sam Ong	Mukdahan	0.1133802	0.1578113	-0.324186	0.5509468	0.9519
Harvester	Mukdahan	0.072074	0.1264694	-0.27859	0.4227382	0.9792
Mukdahan	Dan Singkorn	0.0590053	0.1087378	-0.242494	0.3605049	0.9826
Chedi Sam Ong	Harvester	0.0413062	0.1588859	-0.39924	0.4818522	0.999

Table A9.2 Ordered differences report for comparison of the categories of trader at Dan Singkorn using Tukey-Kramer comparison for each pair

Level	- Level	Difference	Std Err Dif	Lower CL	Upper CL	p-Value
Thai	Displaced Burmese	0.4344277	0.1440712	0.084985	0.7838701	0.0116
Thai	Burmese	0.3166263	0.113608	0.041072	0.5921806	0.0209
Burmese	Displaced Burmese	0.1178014	0.1291538	-0.195459	0.4310617	0.6356

Table A9.3. Contingency table for household economic dependence in four target botanical markets

Count.Total %. Col %.Row %	None	Moderate	High
Chedi Sam Ong	00.000.000.00	00.000.000.00	1211.1126.09100.00
Dansingkorn	00.000.000.00	3229.6352.4657.14	2422.2252.1742.86
Jatujak	00.000.000.00	1110.1918.0368.75	54.6310.8731.25
Mukdahan	10.93100.004.17	1816.6729.5175.00	54.6310.8720.83

Appendix 10. Comparision of *R. gigantea* cultivated and wild plants

Comparison of cultivated vs. wild plants of *R. gigantea* by price class for seven physical characteristics

Price Class[a] (THB)	Plant Character	Cultivated			Wild			Independent samples t-tests / Mann Whitney test
		N	Mean [SE]	Mdn	N	Mean	Mdn	
≤50		85			210			
	Longest Leaf		8.5 [SD 2.1]			18.4 [SD 7.0]		t(277)=18.7 p<0.001
	Longest Root		6.3 [SD 4.0]			5.1 [SD 4.0]		t(293)=-2.38 p=0.018
	Number Leaves			5			4	U=312350 Z=-8.99p<0.001
	Number of Inflorescences			0			0	U=8172.50 Z=-1.43 p=0.152
	Flower condition						1	-
	Plant condition			6			3	U=242.50 Z=-13.44 p<0.001
	Number of additional shoots			0			0	U=8920.00 Z<0.001 p=1.00
51-100		49			91			
	Longest Leaf		17.1 [SD 4.1]			25.1 [SD 6.2]		t(131)=9.10 p<0.001
	Longest Root		40.3 [SD 24.6]			10.8 [SD 7.9]		t(53)=-8.20 p<0.001
	Number Leaves			6			5	U=1423.50 Z=-3.64 p<0.001
	Number of Inflorescences			1			0	U=337.50 Z=-9.47 p<0.001
	Flower condition			3			2	U=126.50 Z=-5.82 p<0.001
	Plant condition			6			3	U=167.00 Z=-9.36 p<0.001
	Number of additional shoots			0			0	U-229.50 Z<0.001 p=1.000
101-150		121			42			
	Longest Leaf		18.9 [SD 4.3]			26.4 [SD 6.8]		t(52)=6.74 p<0.001
	Longest Root		46.3 [SD 25.9]			13.5 [SD 11.8]		t(149)=11.04 p<0.001
	Number Leaves			6			6	U=2077.50 Z=-1.80 p=0.072
	Number of Inflorescences			1			0	U=337.50 Z=-9.03 p<0.001
	Flower condition			3			2	U=190.00 Z=-5.77 p<0.001
	Plant condition			6			3	U=178.00 z=-10.21 p>0.001
	Number of additional shoots			0			0	U=2480.50 Z=-1.70 p=0.90

151-200		92	26	
	Longest Leaf	21.7 [SD 3.4]	29.7 [SD 5.6]	t(30)=6.94 p<0.001
	Longest Root	51.0 [SD 22.5]	19.1 [SD18.2]	t(116)=-6.64 p<0.001
	Number Leaves	7	7	U=93050 Z=-1.77 p=0.077
	Number of Inflorescences	2	0	U=518.00 Z=-4.78 p<0.001
	Flower condition	3	3	U=330.00 Z=-4.63 p>0.001
	Plant condition	6	4	U=230.50 Z=-7.36 p<0.001
	Number of additional shoots	0	0	U=1150.00 Z=-1/88 p=0.060
>200		122	32	
	Longest Leaf	23.5 [SD 4.2]	30.4 [SD 6.5]	t(38)=5.72 p<0.001
	Longest Root	51.5 [SD 22.1]	18.6 [SD 12.8]	t(81)=-10.77 p<0.001
	Number Leaves	7	8	U=1658.50 Z=-1.26 p=0.208
	Number of Inflorescences	2	0	U=780.00 Z=-5.55 p<0.001
	Flower condition	3	1	U=244.00 Z=-9.82 p<0.001
	Plant condition	6	4	U=114.50 Z=-9.48 p<0.001
	Number of additional shoots	0	0	U=1489.00 Z=-4.83 p<0.001

[a] Divided into 50 Thai Baht price classes (~US$1.60)