Commercial wildlife farms in Vietnam: A problem or solution for conservation?

Technical report
March 2008

Wildlife Conservation Society and Vietnam Forest Protection Department

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Citation:
WCS/FPD. (2008). Commercial wildlife farms in Vietnam: A problem or solution for conservation? Wildlife Conservation Society and Vietnam Forest Protection Department. Hanoi, Vietnam

Vietnamese and English language copies available from:
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Also available:
Two-page brief - Commercial wildlife farms in Vietnam: A problem or solution for conservation? (English and Vietnamese)

Commercial wildlife farms in Vietnam:
A problem or solution for conservation?

1. Introduction

Across the world, species are experiencing population declines, range-restrictions and extirpations at a local and global scale. It is widely acknowledged that we are currently facing an extinction event occurring at rates comparable to the five major extinction events known from the fossil record (Pimm *et al.* 1995; Novacek & Cleland 2001).

The loss of wild species will not only have a major impact on reducing ecosystem integrity and services; it also poses a threat to the livelihoods of rural communities. Wildlife remains an important source of protein and means of income, where alternatives are not accessible, and often has important cultural values for many communities living near tropical forests and grasslands (Robinson & Bennett 2000; Davies 2002; Rao & McGowan 2002; Fa *et al*. 2003; Milner-Gulland *et al*. 2003; de Merode *et al*. 2004; Robinson & Bennett 2004; Bennett *et al*. 2007).

Unsustainable levels of hunting linked with the trade in wildlife is playing a major role in the extinction crisis, and is considered to be possibly the greatest threat to wildlife across the tropics (Robinson & Bennett 2000; Bennett *et al.* 2002; Milner-Gulland *et al*. 2003). The trade of wildlife is mainly for meat, skins, furs, traditional medicine, pets and souvenirs. Despite significant national and international policy controls and interventions, the wildlife trade operates in a largely uncontrolled and unsustainable manner and is driven by a growing demand for wildlife products. In addition, the low risk of detection and high profits offered by the wildlife trade has recently seen a proliferation of organised criminal gangs into this global industry (Zimmerman 2003).

Commercial wildlife farms, where wildlife is bred and raised in captivity with the intention of harvesting the animal or a product from the animal for commercial profit, have been developed to varying scales in many countries worldwide yet the practice is spreading rapidly in Asia. Proponents of wildlife farms often cite them as not only a tool for improving food security of local communities but also as a means of alleviating poverty in rural areas (Cicogna 1992; Revol 1995, Ntiamoa-Baidu 1997). More recently they

have been proposed as beneficial to conservation, not only as a market mechanism that would substitute supply from wild populations with farmed stock (e.g. Revol 1995; IUCN 2001; Lapointe *et al*. 2007); but also as a direct source of stock for supplementing or reintroducing wild populations. One example of this is from wildlife farms in Vietnam where the release stock for a Siamese crocodile (*Crocodylus siamensis*) reintroduction project in Cat Tien National Park was donated from wildlife farms in the country (Murphy *et al*. 2004). Thus, for many countries, commercial wildlife farms offer an attractive option; seen as furthering economic development, alleviating poverty and assisting conservation efforts.

However, the development and operation of wildlife farms is hotly debated amongst conservationists and development experts as many fear that they are not the solution to conservation, with some basic indications that the underlying assumptions are flawed. For example, in China more than 350,000 sika deer (*Cervus nippon*) can be found in wildlife farms, yet the population in the wild is currently under serious threat from hunting with less than 1000 remaining (Parry-Jones 2001). Similarly, the Siamese crocodile is farmed for its skin in Vietnam, Cambodia and Thailand and whilst there are tens of thousands in farms, wild populations have been all but extirpated and they are now considered to be Critically Endangered (IUCN 2007). Also, despite over 10,000 bears in bile farms in China and Vietnam there are frequent confiscations of bear gall bladders indicating a trade in wild parts still flourishes.

There are also more serious concerns with commercial wildlife farms that would not only make them ineffective as a conservation tool but in some cases become a direct threat to wild populations (Parry-Jones 2001; IUCN 2001; WCS/TRAFFIC 2004; Bulte & Damania 2005; Mockrin *et al*. 2005; Haitao *et al.* 2007). These include:

- Illegally-caught animals might readily be laundered through wildlife farms;
- By making wildlife more available, consumer demand could increase which, if not met by the supply from farms, may be sourced from wild populations;
- Founder stock for some farms is reported to be sourced from the wild and, for many farms, populations are not self-sustaining or the animals will not even breed in captivity, meaning that wild animals are regularly brought into captivity. This may be unsustainable;

- Some dealers and consumers believe that products from captive-bred animals are lower quality than wild caught ones, and that the consumer demand is for wild not farmed animals, therefore substitution is a myth;
- The farming of some species is thought to not be economically viable, especially for species whose reproductive or social behaviour limit the efficiency with which they can be kept and bred in captivity. The economic feasibility of commercial wildlife farms will always be limited as long as the product can be obtained at a lower price from the wild. This economic in-balance between wild and captive bred animals also increases the likelihood of laundering wild animals through farms;
- Escaped animals may pose a risk to wild populations through disease contamination, genetic pollution and if they become invasive species;
- Farms holding a range of species have a high risk of diseases with species being exposed to diseases and parasites which they have no resistance; additionally these conditions are considered ideal breeding grounds for emerging zoonotic diseases (e.g. SARS coronavirus);
- The development of commercial breeding farms can reduce incentives and divert attention and resources from the conservation of wild populations.

Commercial wildlife farms are regulated under various national policy instruments. At an international trade level, they fall within the scope of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which also guides a large proportion of national legislations to regulate international wildlife trade. CITES states that ‘specimens of an animal species included in Appendix I bred in captivity for commercial purposes shall be deemed to be specimens of species included in Appendix II’. This permits and encourages the farming of Appendix I species for international trade as Appendix II species are subject to less strict trade controls and, unlike Appendix I species, can be sold commercially, with the correct permits and, where specified, quotas. The topic of wildlife farming has been the source of a range of difficulties in interpretation, monitoring and regulation of the convention leading to a number of decisions (e.g. Dec. 12.78, 13.68, 14.69), resolutions (e.g. Conf. 10.16 Conf. 13.9) and working groups aimed at improving definitions, guidelines and procedures relating to wildlife farms.

Wildlife farms have been in existence for many years in Southeast Asia. In Cambodia, crocodile farming is reported to have been practiced during the Angkor era in the 10th Century (Thompson in prep.), whilst deer farming in China dates back to the 17th Century (Drew *et al*. 1989). Thailand is reported to have begun farming crocodiles in the 1940's (Thompson in prep.) and the first of China's musk deer farms were established in 1958 (Green 1989). However, the rapid expansion and development of wildlife farms only started in the 1980's. In that decade, reports indicate the proliferation of bear farming in Korea and China, the establishment of China's infamous tiger farms (Green *et al*. 2006) and the start of Vietnam's python farming network (Nguyen Van Nghia pers. comm.).

Over the past two decades, commercial wildlife farms have been developed in many countries in East and Southeast Asia. Their rate of development appears to have increased with improved regional trade and market-oriented economic policies since the 1990's. Malaysia and Indonesia have many wildlife farms for reptiles and birds, and are starting to develop farms for wild meat species (C. Shepherd, pers. comm.). China is reported currently to have more than 1000 freshwater turtle farms (Haitao *et al.* 2007), as well as farms for numerous other species, and in the last few years, Lao PDR has been reported to be developing wildlife farms. Across the region, a wide variety of taxa are in farms, as Thompson (in prep.) stated '*if a species has a market value, the chances are high that someone, somewhere, is trying to breed it in captivity*'.

Vietnam is a key country within the Southeast Asian wildlife trade network, sourcing wildlife throughout the region as well as from Vietnam's remaining forests, to supply a growing domestic and international demand for wildlife (Compton & Le Hai Quang 1998; Nooren & Claridge 2001; Bell *et al*. 2004; Lin 2005). The main domestic uses of wildlife in Vietnam include traditional medicine, pets, decoration, and souvenirs (Compton & Le Hai Quang 1998; Nguyen Van Song 2003; Bell *et al.* 2004), yet perhaps the main demand is from urban wild meat restaurants associated with increasingly affluent populations, found in urban centres throughout the country (Roberton & Bell in prep.).

Although wildlife farms are reported to have occurred in Vietnam since the late 1800's, only in the last 20 years have they rapidly expanded in numbers, species and scale (Do Kim Chung 2003). Vietnamese wildlife farms produce animals for both domestic consumers and international markets. For example, in the period 1995-2005 Vietnam

exported captive-bred wildlife for commercial purposes to Europe (including the United Kingdom, Switzerland, Sweden, Spain, Italy, Germany, Belgium, Netherlands, Hungary, France and Czech Republic), Asia (including mainland China, Taiwan, Hong Kong, Japan, Singapore, Russia, Malaysia, and South Korea), the United States of America, Canada, and Australia (WCMC/CITES Trade Database 2007).

Research or monitoring of wildlife farms in Vietnam has been limited, with the exception of input by TRAFFIC to the registration and monitoring of python and crocodile farms (Jenkins 2002a, b). A thematic research group report on economics in support of the National Action Plan on Strengthening Wildlife Trade Controls in Vietnam (Do Kim Chung 2003) reported that the main taxa in wildlife farms in Vietnam at that time were crocodile, python, soft-shell turtle, bear, macaque, porcupine, deer and cobra. Although the data in that report remain unsubstantiated, the authors cite that almost 5000 households in Vietnam were involved in wildlife farming. Data from the CITES/WCMC database on the commercial and biomedical trade of captive-bred specimens from Vietnam in the period 2000-2005 highlight the scale of the industry, with average annual trade quantities of more than 150,000 pythons (both live and skins), 7,000 Siamese crocodiles, 5,500 long-tailed macaques and 750,000 Indian bullfrogs (Table 1).

Table 1: The mean annual export quantity of a number of CITES-listed, captive-bred species from Vietnam exported for commercial trade or biomedical research in the period 2000-2005 (WCMC/CITES trade database 2007).

Trade product	Mean annual export amount (individual animals)
Live Indian bullfrogs	766,554
Burmese python skins	90,209
Reticulated python skins	35,913
Live Burmese pythons	19,163
Live Siamese crocodiles	7,166
Live long-tailed macaques	5,694
Live reticulated pythons	1,549

In each province of Vietnam, the Provincial Forest Protection Department (FPD) is responsible for managing and confirming the production capabilities of wildlife farms of terrestrial animal species, with the provincial Department of Fisheries responsible for aquatic species. Lists of registered farms are then reported up to the National FPD and National Department of Fisheries.

All wildlife farms are legally required to be registered with the appropriate government agency. The Vietnam CITES Management Authority in Hanoi reviews all applications for registration of farms for species listed in Appendix I of CITES, and the legislation states this must include a review of the documentation for each farm by the CITES secretariat. Five wildlife farms for Appendix I species are registered in this way in Vietnam, all for the Siamese crocodile (*Crocodylus siamensis*), and all were registered in 2003 after inspections in 2002. The relevant Provincial FPD reviews applications for registration of farms for species listed in CITES Appendices II and III and those species protected in Vietnam under Decree 32/2006/ND-CP[1] but not listed in CITES Appendices.

In addition to general information on the farm's operations, applications for farm registration must include documents proving legal origin of the farm stock, individual identification marking methods, veterinary capability and farm stock records. Furthermore, wildlife farms for species listed in the CITES appendices are required to have suitable enclosures for the farmed species and ensure hygiene and safety standards are met; no details are provided on how this is assessed (Decree No. 82/2006/ND-CP). The final condition required for registration of a farm for CITES species is for the Vietnam CITES Scientific Agency (The Institute of Ecology and Biological Resources and the Center for Research and Environmental Resources) to assess and confirm that: (i) the farmed species has the ability to breed in a controlled environment; and (ii) this wildlife farm is not detrimental to the species' conservation in the wild.

In terms of international export from registered wildlife farms, for specimens listed in CITES Appendix I or Group IB of Decree 32/2006/ND-CP, only F2 generation and onwards that are individually marked under CITES Vietnam guidance can be sold. For species listed in CITES Appendix II/III or Group IIB of Decree 32/2006/ND-CP, only specimens from F1 generations onwards can be exported (Decree No. 82/2006/ND-CP).

Farms are permitted to source non-protected species from the wild for breeding purposes following state regulations. The exploitation of protected species (i.e. those under Decree 32/2006/ND-CP) for farm stock is also permitted as long as it is

[1] Decree 32/2006/ND-CP is the species protection legislation in Vietnam. This decree provides two levels of protection to animals: Group IB species, for which exploitation and use for commercial purposes are prohibited; and Group IIB species, for which exploitation and use for commercial purposes are restricted.

determined not to have negative impacts upon conservation of the species in the wild. Permits are issued at the appropriate level according to Decree 32/2006/ND-CP.

Violating these regulations on wildlife farming is punishable by law. In Vietnam, violations involving Decree 32, Group 1B species or Group IIB species over the value of US$1850 in local market value are prosecuted under the penal code of Vietnam (Decree 159/2007/ND-TTg); yet an exception is made for 'raising/rearing' of Group IB species where the maximum fine is set to US$1850

Punishment for violations relating to common species of wildlife involves fines ranging from US$6- US$1,850 calculated from the local market value of the animals involved in the violation. Punishment for violations relating to species of wildlife protected under Group IIB of Decree 32/2006/ND-CP involves fines ranging from US$125- US$1,850 also based upon the value of the animals concerned. Under the law, violators are also liable to have their wildlife farm registration certificate revoked (Decree 159/2007/ND-TTg).

Despite these legislative controls, the regulation and monitoring of wildlife farms in Vietnam is poor and enforcement weak. Many FPD rangers lack knowledge on the laws and species identification, and have low understanding of Vietnamese wildlife farms, the global demand for wildlife or techniques to manage farms. In response to this concern, all Provincial FPDs were recently instructed to complete the registration of all wildlife farms within their jurisdiction and report the results back to the National FPD by March 31st 2007 (No. 3270/BNN-KL). These data have not yet been made available.

We lack reliable data to assess under which circumstances wildlife farms might be an option for conservation, when they are neutral in terms of their conservation role, and when they are a threat to wild populations. The Vietnamese government recognises this, and the National Action Plan to Strengthen Wildlife Trade Controls calls for a review of the impacts of wildlife farming on wild species to recommend sound models for application, and standard operational guidelines for these models (1021/2004/QD-TTg).

This study aims to increase data on commercial wildlife farms, with the aim of evaluating their possible conservation role and the impact they have on conserving wild populations

of those species (either positive, neutral or negative), and determining how this can be assessed in future. The aim is to help guide policy on commercial wildlife farms in Vietnam.

2. Methods

For the purpose of this study, a commercial wildlife breeding farm was defined as a facility or household breeding, or attempting to breed, a wild animal species with the intention of harvesting the animal or a product from the animal for commercial profit. This excluded households or companies holding wildlife as pets, 'living trophies', and solely for tourism purposes.

Setting an appropriate sample size, and selecting areas and species to survey was complex due to the lack of existing reliable and accurate knowledge on wildlife farms in Vietnam. Wildlife farms reported in the print media from 2002-2006 were extracted from: (i) the Education for Nature-Vietnam environmental news database, which contains all environmental news stories published in 11 national newspapers; and (ii) a national list of wildlife farms from National FPD; although this list to be incomplete since registration of farms with FPD, as required by law, has been poorly implemented) and communicated to the central level. These two sources identified more than 800 farms distributed in 38 provinces throughout the country, with the highest densities being in the Mekong Delta and South-eastern regions of the country.

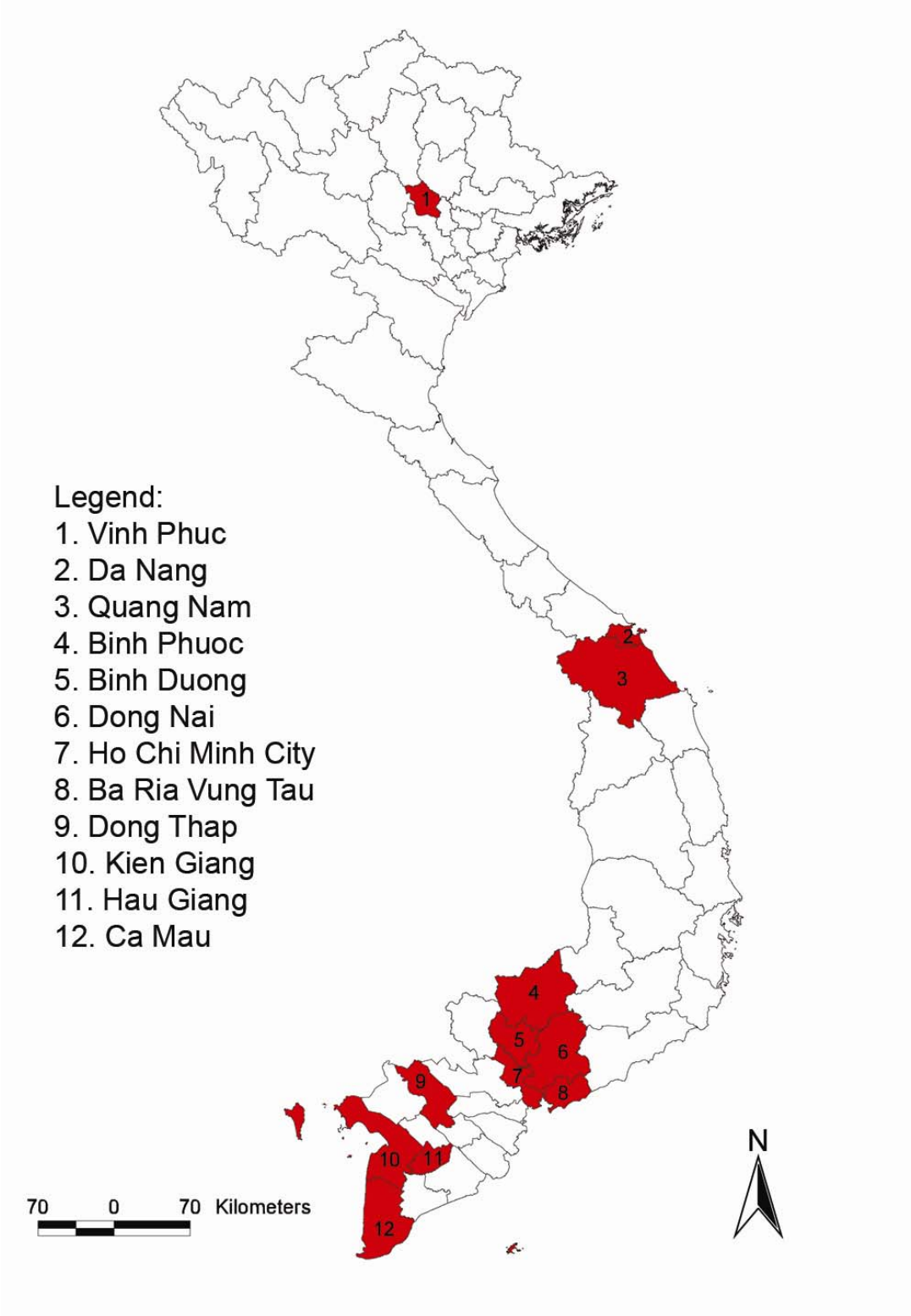
Data on species in farms were much generalised in both the National FPD list and the media database. Only four taxa were listed to species level (sambar deer *Cervus unicolor*, sika deer *Cervus nippon*, wild pig *Sus scrofa*, and Bocourt's water snake *Enhydris bocourti*), with a further 15 general taxon groups recorded (soft-shelled turtle, turtle, snake, python, lizard, tokay gecko, porcupine, macaque, bear, frog, crocodile, monitor lizard, scorpion, and sea horse). The majority of these taxa fell within the Mammalia and Reptilia taxonomic classes. We wished to sample a set of taxa that would provide a range of life-history traits, animal husbandry techniques and trade dynamics for analysis. As our sources of information on farmed species did not always provide species-level data, we selected at the generic level for most taxa. The following 10 taxa were selected due to their recorded presence in farms and their variance in the above factors: scorpion, python, cobra, crocodile, soft-shell turtle, tokay lizard *Gecko gecko*, monitor lizard, macaque, porcupine, and sambar deer. Five farms were set as a minimum sample size for each taxon. If a farm holding additional species of conservation concern or with a unique life-history trait or trade dynamic was encountered beyond the primary target species, then it was also included in the sample. These species provided

us with a sample of wide ranging individual weights from 0.05kg (scorpions) to 300kg (crocodiles), and with species of high reproductive capacity and short generation time (e.g. scorpions and soft-shell turtles), as well as those with relatively low reproductive capacity and long generation times (e.g. macaque, sambar and crocodile).

Both the Asian black bear (*Ursus thibetanus*) and the sun bear (*Ursus malayanus*) are held in large numbers in 'bile farms' throughout Vietnam. Poor husbandry and inadequate enclosures have severely restricted captive breeding and there have been no reports on bears being imported from Chinese farms, suggesting that towards 100% of the animals are likely wild sourced (J. Robinson pers. comm.). In recent years, the management and control of bear bile farms has received the attention of the CITES Secretariat, National FPD and international NGOs, resulting in specific legislation (e.g. Directive 127/2003/KL-BTTN, Decision 2/2005/QD-BNN, Decision 47/2006/QN-BNN) and projects formulated to improve the management and enforcement of these farms. These two species were omitted from this study because: (i) the impact on wild populations is clear as the sole production system is captive-rearing (i.e. raising animals taken from the wild with very few exceptions (only one farm to S. Roberton's knowledge); and (ii) unlike all other species, they have received significant attention specifically aimed at controlling the farms (e.g. A project to implant microchips for individual ID by World Society for the Protection of Animals and Wildlife At Risk, and awareness campaigns by Education for Nature-Vietnam and TRAFFIC/WWF).

Provinces were then ranked by the total number of farms of the target taxa reported in the media database and the FPD list, and were then grouped into geographic regions. This resulted in the identification of four survey regions: Mekong Delta (Dong Thap, Ca Mau, Hau Giang, and Kien Giang provinces); South-east (Ba Ria Vung Tau, Binh Phuoc, Dong Nai and Binh Duong provinces and Ho Chi Minh City); South-central (Quang Nam province and Da Nang City); and the Red River Delta (Vinh Phuc province) (Map 1).

A total of 64 survey days effort was carried out across the 12 provinces. Survey teams were provided with a list of the farms in each province as a minimum target and tasked with locating further farms in the province using a snowball survey method (Bryman 2001) where farm owners and staff were used to establish contact with other wildlife farms.



Map 1: Map showing the provinces sampled in Vietnam during the wildlife farm survey.

Two survey teams were deployed for data collection. The first comprised WCS staff and the second comprised one National level and one provincial FPD ranger as a guide. Pre-survey training was carried out and regular communication and briefings between the teams to ensure comparable methods. Due to the often illegal nature of the wildlife trade and the potential that farm stock were illegally sourced, survey teams adopted a role-play approach to data collection and did not openly declare their affiliation to WCS or FPD. Teams found this approach successful and farm owners were very willing to discuss their business with teams.

Semi-structured interviews were carried out with the owners of the targeted wildlife farms from August to October 2006. If the farm owners were not available for an interview, the animal keepers were interviewed, and this was noted instead. Interviews were initiated through a combination of introductory telephone calls (where numbers were available), 'cold-calling' in person at farms, and through introductions by other farm owners and traders. The semi-structured interviews collected data on six main areas relating to the farm's species and core business: General information on the farm including the species present, their life-history, animal husbandry, financial expenditures and income, trade details and dynamics, and relationship to wild populations. The specific data collected in each of the areas are presented in more detail in the following section:

- General information

Species farmed, current population size, start-up year, location of farm, reported source of founder stock (i.e. breeding farm, FPD auction of confiscated animals, wild origin, or a combination of these), if the farm forms a household activity or is a registered company and if the sale of wildlife is reported to be the sole income source of the household. Breeding production systems were defined as follows: Closed-cycle breeding (i.e. no addition of specimens from the wild); ranching (i.e. removing specimens from a wild, whilst conserving a free-ranging, breeding population). These wild-caught specimens are then held in a controlled environment awaiting sale); contained propagation (i.e. maintaining a captive population with continuing input of stock from wild); and captive-rearing (i.e. removal of pregnant animals from the wild and rearing their offspring in a controlled environment).

- Species life-history

Reported litters/clutches per year, litter/clutch size, age to maturity, gender composition, saleable age, and the estimated mortality rate from laying/birth to that saleable age.

- Animal husbandry

Enclosure size (m^2/individual), adult groupings (individuals, pairs, single or mixed sex groups), breeding techniques (e.g. assisted reproduction methods, artificial incubation, population management), anti-escape protocols, individual identification/marking techniques, and veterinary health management (including reports of fatal disease/infection, and treatment, and if it is a multi-species farm).

- Financial expenditures and income

Staff (total monthly cost), annual and founder stock procurement (USD/individual), animal food (USD/month), enclosure construction and maintenance costs, land purchase cost, veterinary treatment costs, gross annual revenue (calculated from trade quantities and selling prices from 2005) for their primary sale products and other secondary sale products reported.

- Trade details and dynamics

Primary sale product and consumer market, the size/age to sale, main trade destinations, the perceived demand (i.e. increasing, decreasing or stable), reported consumer preferences (i.e. for wild or captive stock).

- Relationship to wild populations

Indication of the presence of animals sourced from the wild (i.e. through an owner/staff admission, from an FPD auction receipt, life stages and associated facilities not observed at the farm, and observation of hunting wounds), differences between wild and farmed stock (i.e. morphology, behaviour, health), and other illegal wildlife trade activities observed or reported (i.e. illegal trade, storage, transport of wildlife or economic corruption of enforcement agencies reported or observed).

The reliability of data on finances, trade dynamics, illegal activities and impacts on wild populations is potentially limited as these are sensitive areas, and we relied upon reports and not primary data. Although those wildlife farms registered as companies are likely to

maintain financial records on their business, they are unlikely to allow outsiders to see their books. As primary data on finances, trade dynamics, and illegal activities were not readily available, we therefore used reports from owners and staff. If the survey teams felt that the interviewee was providing false or inaccurate information, it was noted and that data omitted from analysis. This was ascertained from the interviewee's behaviour, and from repeat and cross-questioning. Direct observations were also made during visits of farm stock and conditions to identify animals that have come from the wild (e.g. trap wounds), presence of different life stages (eggs, pregnant animals, neonates, juveniles, breeding adults), and husbandry methods. Additional data on species (including generation length, adult weight, and growth rate) were sourced from existing available literature (Molur *et al.* 2003; Nowak 2005); personal communication with species experts from the IUCN/SSC specialist groups, and from websites focussing on exotic pet husbandry (http://www.pondturtle.com ; http://www.ub.ntnu.no/scorpion-files/faq.php).

During survey periods, teams also arranged meetings with Provincial FPDs in Kien Giang, Dong Nai, and Ba Ria-Vung Tau provinces to discuss the management of wildlife farms and enforcement of regulations.

Data were standardised and analysed using SPSS Ver 14.0. A Spearman's rank correlation was used to test the relationship between the enclosure size and: (i) sale weight; and (ii) minimum body mass. Pearson's Chi Square was used to examine differences between the number of farms using open production systems (i.e. with input of wild stock) with those using closed production systems and: (i) taxonomic class; (ii) taxonomic order; (iii) species; (iv) protection status (i.e. CITES and Decree 32/2006/ND-CP); and (v) conservation status (i.e. IUCN Red List and Vietnam Red Book). Mann-Whitney U tests were used to identify significant differences between closed and open production systems in terms of the following characteristics of the farmed species: Body mass, generation length, annual reproductive capacity, sale age, and monthly feeding costs. In addition, this test was used to examine the differences between closed and open production systems in terms of the annual farm revenue.

3. Results

3.1 General farm information

Data were collected from a total of 78 wildlife farms during the survey period. The majority were in the south of Vietnam with 34 (43.6%) from the Mekong Delta region and 32 (41.0%) from the Southeast. Only five (6.4%) were from the northern Red River Delta region and seven (9.0%) from the South-central region. We believe this sample reflected national farm distribution relatively well although the Red river delta area was slightly under-sampled.

The sample was distributed relatively evenly between wildlife farms registered as a company (n=35, 45%) and those as a household activity (n=33, 42%); with these data on registration status unavailable from the remaining ten farms. Wildlife farming was reported to be the sole occupation of 12/33 (36%) of the household-activity wildlife farms visited.

Twenty-nine farms reported the year they started, ranging from the earliest in 1980 to the most recent in 2005. Our data show that over the last 25 years there has been a increase in the number of wildlife farms established each year in Vietnam with significant growth since 1990 (Figure 1).

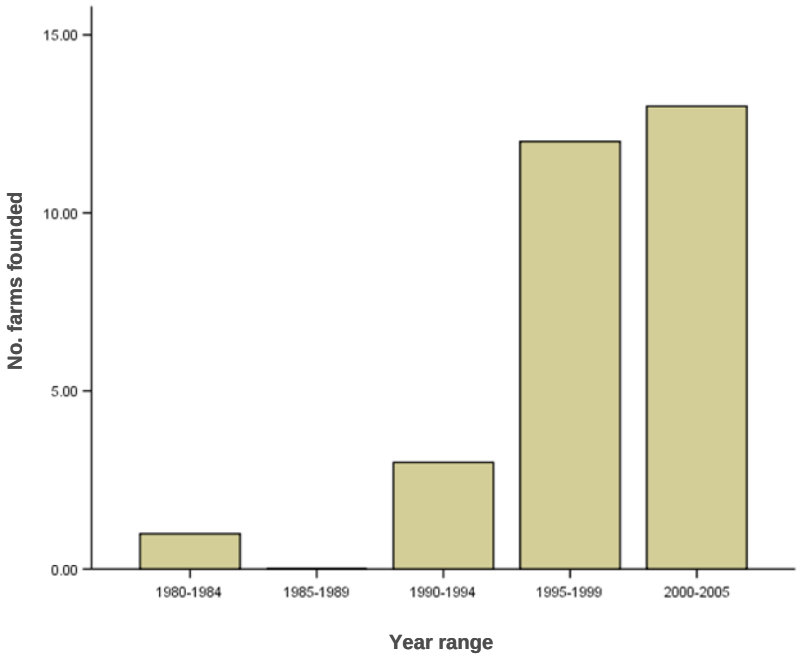


Figure 1: The number of wildlife farms founded annually in 5 year periods in Vietnam from a survey of 29 farms in Aug-Oct 2006.

Species

Data were collected on 22 different species in the farms (excluding four farms where species identification was limited to the genus level): Field cricket (*Gryllus* sp.), scorpion (*Heterometrus laoticus*), Bengal monitor lizard (*Varanus bengalensis*), water monitor (*Varanus salvator*), tokay gecko (*Gecko gecko*), Indochinese water dragon (*Physignathus cocincinus*), Bocourt's water snake (*Enhydris bocourti*), Burmese python (*Python molorus*), reticulated python (*P. reticularis*) , Chinese cobra (*Naja naja*), king cobra (*Ophiophagus hannah*), Chinese soft-shell turtle (*Pelodiscus sinensis*), wattle-necked soft-shell turtle (*Palea steindachneri*), Cuban crocodile (*Crocodylus rhombifer*), saltwater crocodile (*C. porosus*), Siamese crocodile (*C. siamensis*), long-tailed macaque (*Macaca fascicularus*), Southeast Asian porcupine (*Hystrix brachyura*), Indochinese tiger (*Panthera tigris*), leopard (*Panthera pardus*), wild pig (*Sus scrofa*), and sambar deer (*Cervus unicolor*). These represented five taxonomic classes (Arachnida, Insecta, Reptilia, Sauropsida and Mammalia) and nine orders (Scorpiones, Orthoptera, Squamata, Crocodilia, Testudines, Arctiodactyla, Carnivora, Primate, and Rodentia).

Across all species, the number of individuals per species per farm surveyed ranged from five (Leopards) to 400,000 (Field Crickets), totalling 534,939 individuals with a mean of 7038.67 per wildlife farm.

Conservation and protection status

Six of the species sampled are globally-threatened; five are in the lower risk category of the IUCN Red List (IUCN 2007); and twelve are nationally-threatened species in the Vietnam Red Book (MONRE 2002). Of the species sampled incidentally during the surveys (i.e. Field cricket, Indochinese water dragon, Bocourt's water snake, Indochinese tiger, leopard, and wild pig) only one of these was globally-threatened (tiger), with three considered nationally-threatened (tiger, leopard, Indochinese water dragon).

Eleven of the species are protected under national legislation, including five listed in Group IB prohibiting all commercial trade (Decree 32/2006/ND-CP). In terms of international trade regulations, eleven species are listed on the CITES appendices (CITES 2007) (Table 2 and Appendix 1).

Table 2: The conservation and protection status of the farmed species sampled

Protection status	No. species sampled	Conservation status	No. species sampled
CITES		**IUCN Red list**	
App I	5	Critically Endangered	1
App II	6	Endangered	3
App III	1	Vulnerable	2
Not listed	9	Low Risk/near-threatened	2
		Low Risk/least concern	3
Decree 32/2006/ND-CP		Not listed	9
Group IB	5		
Group IIB	6	**Vietnam Red Book**	
Not listed	11	Endangered	5
		Vulnerable	5
		Threatened	2
		Not listed	10

Production systems

Accurately identifying different production systems was difficult in many cases. For 16 of the 78 farms visited (20.5%), we felt that the production system could not be reliably established (Table 3). The most frequently encountered production system was closed-cycle breeding comprising 32.1% (25/78) of the farms sampled. A total of 18 farms (23.1%) used production systems that relied upon a continued input of wild populations, i.e. comprised propagation, captive-rearing and a combination of the two. At 19 (24%) farms, no production had occurred, or the establishment was a satellite farm raising offspring of a breeding farm (See Box 1).

Table 3: Production systems encountered in sampled wildlife farms in Vietnam

Production system	n	%
Closed cycle breeding	25	32%
Contained propagation	12	15%
No production (inc. satellite farms)	19	24%
Unclear	16	20%
Captive rearing	4	5%
Contained propagation + captive rearing	2	3%

Source of farm founder stock

The source of farm founder stock was a sensitive topic in many interviews, and 25 farms (32%) were either unclear or would not report the source of their original stock. Twenty-five of the 53 farms (47.2%) that did report the source of their founder stock stated that it came from another breeding farm; 19 (35.9%) reported that their founder stock was of

Box 1: Satellite farm systems

A satellite farm is a farm that does not produce any offspring, only raises stock from hatchling/infant to the sale age they purchase from core producing farms. Many raise them to the sale age and then sell them back to the core farm. The majority of these satellite farms are contracted to core farms that focus on the production of hatchling/infant stock. This reduces the costs of land and staff to the core farm, who control sale prices of both hatchlings and stock at a sale age.

A soft-shell turtle farm owner in Ho Chi Minh City explained that this model allowed him to significantly increase revenue whilst controlling costs. He sells hatchling turtles at roughly $0.35/individual then buys them back 12 months later at a weight of 1-1.2kg for $12.50/kg, before selling onto domestic and international markets for $15.50-$20.50/kg. Both farms make profit from this system (although the satellite farm has increased risks as infants have with higher reported mortality) yet, the satellite farm's profit is limited by space and restricted market access.

One crocodile farm owner explained that this model is very popular and core farms are in fierce competition to recruit satellite farms. This farm owner established an incentive system to satellite farms that he would meet 100% of their costs (i.e. food, vet care, cage repair and animal procurement) in the first year, and each following year the proportion they give increases each year until they are covering 100%.

wild origin and a further seven (13.2%) reported a combination of farm and wild sourced founders. One farm was presented 13 Cuban Crocodiles (*Crocodylus rhombifer*) by the Cuban government. We found a significant difference between the source of founder stock and the different taxonomic orders ($X^2_7=23.6$; $P<0.005$) (Table 4). All farms holding Artiodactyla, Carnivora, Orthoptera and Scorpiones sourced founders from the wild, with 14/17 (82%) of Crocodilian farms sourcing founders from other farms. Farms for Squamata (lizards and snakes) were split roughly half and half between wild and farm sources.

Table 4: The source of founder stock reported in a survey of wildlife farms in Vietnam

Order	Wild origin	Breeding farm	Wild origin & farms	Other
Arctiodactyla	5			
Carnivora	3			
Crocodilia	1	14	1	1
Orthoptera	1			
Primate				1
Rodentia		1		
Scorpiones	2			
Squamata	6	5	5	
Testudines	1	5	1	
TOTAL	**19**	**25**	**7**	**2**

Analyses were carried out to identify any significant life-history differences between the species sourced from the wild to those sourced from other farms. These analyses gave misleading results highlighting a significant relationship that larger and longer generation species are more likely to be sourced from farms and not from the wild. This result is likely to be due to the high number of Siamese crocodile farms sourcing founders from farms, as a direct result of their near extirpation from the wild; and also with small, short generation species such as scorpions and field crickets having a wild founder source.

3.2 Animal husbandry

Enclosure size

Enclosure size (m^2/individual) ranged from 0.002 m^2 (soft-shell turtle) to 118 m^2 (wild pig). There was a positive relationship between enclosure size and (i) sale weight (Spearman's correlation coefficient = 0.61; $p<0.005$) and (ii) maximum body mass (Spearman's correlation coefficient = 0.71; $p<0.005$) of the farmed species.

Social groupings

Data on social groupings of adult animals (i.e. groups, pairs, individual) were collected from 68 of the wildlife farms visited. Thirty-seven (54.4%) of these farms held animals in mixed-sex groups, followed by farms housing animals individually (n=14, 20.6%). A smaller proportion of farms held animals in a combination of ways, in pairs or in single sex groups (Table 5).

Table 5: Social groupings encountered in a survey of wildlife farms in Vietnam

Order	Mixed sex group	Individual	Individual, breeding pair	Individuals, single sex group	Pairs	Single sex groups
Arctiodactyla	3	1	2			
Carnivora						
Crocodilia	13		1	4		
Orthoptera	1					
Primate	2					
Rodentia	2		3		2	
Scorpiones	2					
Squamata	5	13	2	1		1
Testudines	10					
TOTAL	**37**	**14**	**8**	**6**	**2**	**1**

Presence of different life-stages

A number of national and international guidelines on evaluating wildlife farms use the presence of four main life stages (i.e. pregnant female/eggs, hatchlings/infants, juveniles/sub-adult, breeding adult) of the farmed species as an indicator that the farm does not rely upon wild stock (i.e. an assumption that if the farm is breeding then they do not need wild stock). We carried out a coarse analysis to test this assumption by recording the number of life stages present for a species in each farm and presenting this as a proportion of the four main stages. We then compared the proportion of life stages observed for a species at each farm visited to the production system that the farm used, specifically, if that system included the input of wild stock.

The mean proportion of life stages present in farms using closed systems was 69% (±3%) whilst for those with wild stock the mean was 62% (±6%) (Figure 2). We found no significant difference in the proportion of life stages present between farms using a system with input of wild stock and closed systems.

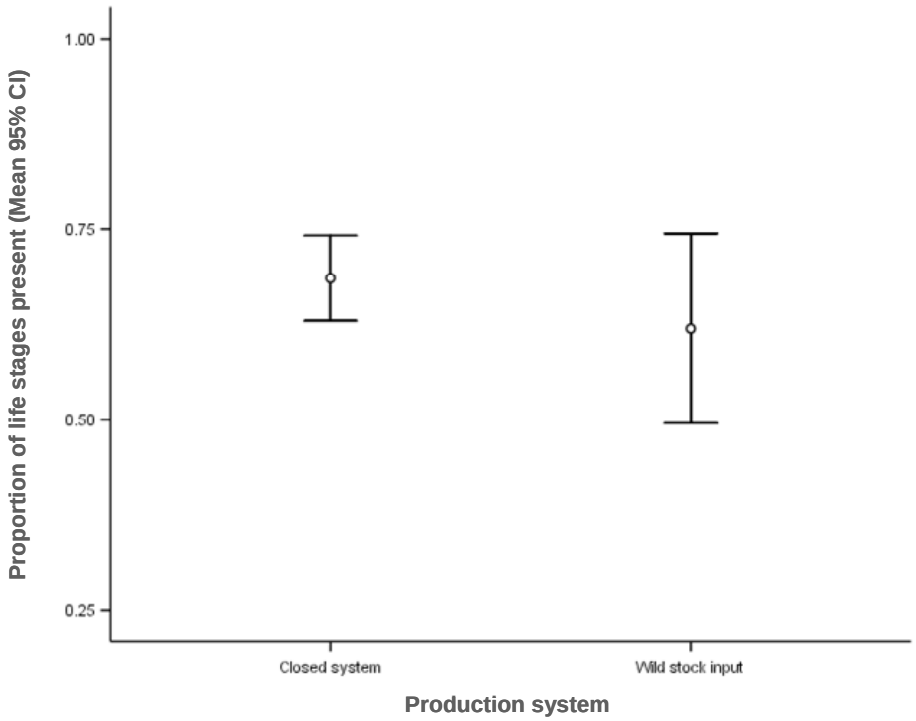


Figure 2: The proportion of life stages observed between closed production systems and open systems (i.e. include wild stock input) encountered in a survey of wildlife farms in Vietnam

Breeding techniques

Twenty-five of the 78 farms surveyed had either not yet bred animals or did not report a breeding technique. Of the 53 farms remaining it is fair to say that reproductive techniques used are very basic. No assisted reproduction methods were encountered and only one farm reported a population management system. Thirty-one farms reported the use of artificial egg incubation techniques (including semi-artificial for pythons, where the eggs are removed from the mother in the later stages) yet the only other techniques were simply to house the animals in a group and leave them to it or house individually and then introduce the male to the female stock (Table 6).

Table 6: Breeding techniques encountered in a survey of wildlife farms in Vietnam

Breeding technique	No.	%
Artificial egg incubation	20	37.7%
Leave them to it	16	30.2%
Introduce male & semi-artificial egg incubation	10	18.9%
Introduce male	5	9.4%
Introduce male & artificial egg incubation	1	1.9%
Introduce male, hand-rearing	1	1.9%

Animal escapes

Over 20% of the farms surveyed (16/78) reported that animals have escaped in the past and most of those farms have since repaired enclosures to prevent further escapes. Species that have escaped included Indochinese water dragon, Tokay gecko, Southeast Asian porcupine, wild pig, and field cricket in addition to ones outside of their natural distribution range (e.g. Chinese soft-shell turtle), hybrids (e.g. Soft-shell turtle) and those posing a threat to humans (e.g. Burmese python, King cobra, Chinese cobra and Siamese crocodile).

Individual identification

Only three of the 78 wildlife farms surveyed (5%) used any form of individual identification marking techniques. These included identification tags on wild pig and Siamese crocodile and identification collars on long-tailed macaque.

Veterinary health care

Veterinary care in wildlife farms is weak to non-existent; and only one of the 78 farms reported to employ (and/or consult) veterinarians. The minimum reported mortality rate of farm stock (from birth to sale age, rounded to the nearest 5%) ranged from 0%-100%

with a mean (±SE) of 23.2% (±2.8). Mortality rate reported by taxonomic order where enough farm reports were available are presented in Table 7.

Table 7: The minimum reported mortality rates (from birth to sale age, rounded to the nearest 5%) by taxonomic order from a survey of wildlife farms in Vietnam.

Order	N	Mean (%)	Std. Error	Minimum (%)	Maximum (%)
Squamata	16	21.88	3.41	10	50
Crocodilia	9	33.89	9.27	10	100
Testudines	9	33.44	5.76	15	58
Arctiodactyla	7	19.29	7.11	0	50
Rodentia	4	0.00	0.00	0	0

It is also important to note that at least 44/78 (78.6%) of the farms are multi-species farms (data from 22 farms were unclear). Forty-nine farms reported the type of veterinary care they provided their animals with 30/49 (61%) stating they did not carry out any veterinary treatments, 13/49 (27%) used human medicines, whilst three used veterinary drugs and two used traditional Vietnamese and Chinese medicines.

Fifteen farms including those for water snake, python, soft-shell turtle, crocodile and macaque reported the occurrence of fatal diseases affecting their populations. Nine of these stated they used no veterinary drugs; one used traditional herbal remedies whilst the remaining five used human medicine of varying types and quantities.

3.3 Financial expenditures and income

Monthly expenditures

Data on costs of enclosure maintenance and veterinary care were omitted from the analysis as we found that farm owners did not provide accurate or reliable information on these.

Reliable figures for the cost of animal food (USD/indv/month) were collected from 44/78 wildlife farms surveyed. It ranged from $0.06 - $461.18 (Mean ±SE: $39.70 ±16.9) (Table 8). The four carnivore farms (specifically tiger and leopard) shared the highest monthly food costs ranging from $195.65-$461.18 per individual. There were 12 farms with monthly food costs per individual lower than $1.00. These included 11 Reptile farms (crocodile, soft-shell turtle, monitor lizard, water dragon, water snake, tokay gecko and cobra) and one scorpion farm.

Table 8: Monthly animal feeding costs (US$/indv) reported for the different taxonomic orders encountered in wildlife farms in Vietnam

Order	n	Mean	Std. Error	Min	Max
Crocodilia	12	5.34	1.92	0.10	24.22
Squamata	12	3.85	1.16	0.09	9.32
Arctiodactyla	5	16.31	7.52	1.86	37.27
Carnivora	4	374.42	62.13	195.65	461.18
Rodentia	4	3.50	0.80	1.86	5.59
Testudines	4	2.45	2.29	0.06	9.32
Primate	2	.	.	3.26	30.00
Scorpiones	1	0.10	.	0.10	0.10
Total	**44**	**39.70**	**16.93**	**0.06**	**461.18**

Total monthly staff salaries were collected from 45 wildlife farms. 23 of these reported zero costs, relying upon family members for the farm work. Staff costs ranged from $0.00 - $745.34 (Mean ±SE: $91.65 ±24.69). Costs of annual stock procurement (USD/individual) were collected from 46 wildlife farms. Seventeen farms reported they do not buy additional stock and individual costs ranged from $0.00 to $4,968 (for tigers) with a mean (±SE) $181.18 (±110.41).

Set-up costs

Data on the set-up costs of wildlife farms were limited as many farm owners did not remember and/or were not comfortable sharing this information. The cost of enclosure construction was collected from 29 farms and ranged from $18.63 (plastic bowls for Bocourt's water snake) to $62,111.80 (Siamese Crocodile) at a mean (±SE) of $6,788.13 (±3,129.13). There was variation between the different taxonomic orders encountered (Table 9). Only one wildlife farm reported buying land to establish their farm, and 21 of the 22 that reported this data stated zero land costs, using land they currently owned. Only nine farm owners provided information on the costs of founder stock procurement which ranged from $155.28 (Soft-shell turtle) to $2298.14 (Sambar deer) at a mean (±SE) of 681.85 (±273.70).

Gross annual revenue

Reliable data on both trade quantities and selling prices for 2005 were collected from 40 wildlife farms. No wildlife farms reported a difference in selling price of wild stock to captive bred stock. The gross annual revenue ranged from $0 (for five farms that chose

not to sell in that year) to $1,863,354 (a soft-shell turtle farm that exports for meat internationally) with a mean (±SE) of $56,452.60 (±46,408.40).

Table 9: Enclosure construction costs (US$) reported for the different taxonomic orders encountered in wildlife farms in Vietnam

Order	N	Mean	Std. Error	Minimum	Maximum
Squamata	11	1577.64	692.36	18.63	8074.53
Crocodilia	9	8999.31	6676.32	372.67	62111.80
Carnivora	2	.	.	9316.77	62111.80
Rodentia	2	.	.	86.96	186.34
Testudines	2	.	.	186.34	621.12
Arctiodactyla	1	.	.	12422.36	12422.36
Total	**27**	**6788.13**	**3129.13**	**18.63**	**62111.80**

Omitting the farms that did not make any sales and the international exporting soft-shell turtles farm which could be considered a special case gives a gross minimum annual revenue range of $272 (Bocourt's water snake meat) to $94,410 (Chinese Cobra individuals) with a mean (±SE) of $11,610.30 (±3079.30) (Table 10).

A total of 15 farms reported an additional secondary income sale product providing a minimum gross annual revenue ranging from $298 to $7764 (both from Burmese python hatchlings) with a mean (±SE) of $3104.33 (825.09).

Table 10: Annual revenue of commercial wildlife farms for different species reported in Vietnam

Species	n	Mean (US$)	Std. Error	Minimum (US$)	Maximum (US$)
Siamese crocodile	11	8,565.5	3,048.8	726.7	36,956.5
Burmese & Reticulated python	4	15,987.6	7,884.8	3,950.3	37,267.1
Southeast Asian porcupine	4	1,118.0	357.7	310.6	1,863.4
Burmese python	3	5,104.6	2,210.0	717.4	7,764.0
Chinese cobra	3	36,604.5	28,903.0	7,453.4	94,409.9
Wild pig	3	2,463.8	1,268.0	869.6	4,968.9
Bocourt's water snake	1			271.7	271.7
Chinese soft-shell turtle	1			14,906.8	14,906.8
Field cricket	1			37,267.1	37,267.1
Hybrid soft-shell turtle	1			8,385.1	8,385.1
Saltwater & Siamese crocodiles	1			16,397.5	16,397.5
Sambar	1			22,360.2	22,360.2
Total	**34**	**11,610.3**	**3,079.3**	**271.7**	**94,409.9**

3.4 Trade details and dynamics

Sale products

The majority of farms practised a destructive harvest comprising 82.1% (64/78) where the sale product was the whole animal, with only two (2.6%) harvesting an animal product without needing to kill the animal (Sambar antlers). The remaining 12 farms had not yet sold any products but eight of these were planning on selling the whole animal, with the four farms for tiger/leopard stating they will not sell anything but this could not be confirmed.

No farms were producing meat for their own consumption or selling locally. All farms were providing products to urban-based markets. Fifty-four of the 78 wildlife farms surveyed (69.2%) sold their product into the wild meat trade and 19 (24.4%) sold into the skin trade. Other trades represented, though at far smaller proportions, were the pet trade, bio-medical research trade, traditional medicine trade and those that exported to an unknown final use. Twenty farms also reported they sold into a combination of trades (e.g. both meat and skin trade, traditional medicine and meat trade).

Selling destinations and scale

Data on the selling destinations, and thus trading scale, were collected from 59 of the 78 farms. Trading at a national scale (defined as trade out of the province) was the most frequently reported with 34 out of 59 farms (64.4%) followed by trade within the province with 19 farms (32.2%) and finally an international trade with only 8 farms (13.56%). Percentages totalled over 100% as two farms reported selling at both the national and international level.

The two most reported international selling destinations, with four of the eight farms trading to these countries, were North America and China, followed by Japan and Singapore (three farms). England, Spain, France, Holland, Germany, Italy, South Korea, Taiwan and Europe were reported by one farm each. The most frequently reported national selling destination was Ho Chi Minh City (24 farms) followed in order by An Giang (six farms); Dong Nai and Mong Cai Town (Quang Ninh) (four farms each); Ba Ria Vung Tau, Binh Duong and Ca Mau (three farms each); Da Nang, Dong Thap, Kien Giang, Hanoi, Long An (two farms each); and Binh Thuan, Hau Giang, Can Tho, Vinh Phuc, Ninh Thuan (one farm each). It is worth noting that Mong Cai Town in Quang Ninh is close to the Chinese border and known to be a hotspot for illegal cross-border traders.

Perceptions on demand

Only 29 of the 78 farms would comment on their perception of the trend in demand for their product. Ninety-seven percent of respondents considered consumer demand to be increasing with only one farm, representing 3%, that thought demand was stable.

One wildlife farm owner who held a range of species (including long-tailed macaques, Southeast Asian porcupine, Chinese cobra, king cobra, Bengal monitor lizards, Chinese soft-shell turtle, Asian soft-shell turtle, and Siamese crocodile) provided reliable and extensive information on wildlife farming. He reported the presence of two consumer markets for his products in the wild meat trade: (1) an emerging group who were consuming wild meat because it was something new and different and they had no preference to wild or farmed stock. He reported that they were the main consumers of his Chinese soft-shell turtles which breed prolifically in farms; (2) people with a preference for wild meat and would not accept farmed stock. He stated that these consumers selected species they knew were difficult to breed in captivity and were the main consumers of species such as the Asian soft-shell turtle which has extremely limited breeding success in captivity. He gave no indication to the relative proportions of these consumer groups, and further research is warranted here. This preference for wild-sourced meat was also expressed in an interview with a restaurant owner in Dong Nai province. The owner stated that in his area, despite farmed wild pig, porcupine, and soft-shell turtle being locally-available, legal and cheaper he would still buy wild-sourced as he believes it to be of higher quality and what his customers want.

One company with offices based in Ho Chi Minh City, that serves as a core farm for a number of species and is developing farms for other taxa (e.g. lesser oriental chevrotain) explained that restaurant owners must even lie to consumers about the source of the stock as people want wild not farmed.

Age at sale

The age at which farm stock was sold ranged from 0.25 months (i.e. one week) for Burmese python hatchlings to 36 months for Soft-shell turtle, Chinese cobra, Sambar, Scorpion and Siamese Crocodile with a mean (±SE) of 16.11 (±1.65). The size (kg) at which farm stock was sold ranged from 0.6 kg (Bocourt's water snake) to 200 kg (Sambar) with a mean (±SE) of 16.21 (±5.24).

Differences between farmed and wild stock

Twenty-nine wildlife farm owners/staff reported they could tell the difference between a wild individual and a captive-bred individual of their particular species. Twelve of the 29 (41.4%) reported they compared behaviours citing wild individuals were either more aggressive or more active than captive-bred. Other characteristics reported to differ between the two were strength, wild stock being stronger than captive-bred (reported by 5/29, 17.2%); morphology (reported by 4/29, 13.8%); colour (reported by 3/29, 10.3%) and metabolism (by one farm). Four farm owners (13.8%) reported it was impossible to reliably tell wild stock from captive-bred stock apart, particularly if the wild stock have been in captive conditions for a period of time.

Other illegal activities

During a number of semi-structured interviews with wildlife farm owners other illegal wildlife trade activities were observed or reported. Nine farms, representing 11.5% of all farms, reported selling to, or working with, traders near the Chinese border to illegally export their sale product. Seven farms (9%) reported illegal hunting whilst others reported economic bribes to enforcement agencies, illegal transport, illegal imports and illegal possession of wildlife.

3.4 Characteristics of wildlife farms using production systems relying on the input of wild-sourced stock

A key issue concerning conservationists relates to the risk of over-harvest from wildlife populations when farms use production systems that involve the continued input from wild populations.

We found that there was a significant difference in the number of farms using open systems which involves the input of wild stock and those operating closed systems between the different farmed species in terms of their taxonomic class (Pearson's $X^2_4=13.12$; $P<0.05$), order (Pearson's $X^2_8=21.36$; $P<0.05$) (Table 11) and species (Pearson's $X^2_{21}=36.84$; $P<0.05$).

Table 11: The number of wildlife farms for different taxonomic order found using closed production systems and open production systems (i.e. involves the input of wild stock) in Vietnam

Taxonomic order	Closed system (i.e. no input of wild stock)	Input of wild stock	TOTAL
Arctiodactyla	3	3	6
Carnivora	0	1	1
Crocodilia	5	0	5
Orthoptera	1	0	1
Primate	0	2	2
Rodentia	5	0	5
Scorpiones	2	0	2
Squamata	4	11	15
Testudines	5	1	6
TOTAL	25	18	43

We investigated whether this was related to certain life-history characteristics of the farmed species (Table 12). However, we found no significant difference between farms using systems relying on the input of wild stock and farms with closed production systems and (i) the minimum adult mass (kg) of the farmed species, (ii) the estimated generation length (years) of the farmed species (iii) the selling age of farm stock and (iv) reported annual reproductive capacity (i.e. number of offspring produced annually).

Table 12: The difference in life-history characteristics between wildlife farms using closed production systems and open production systems (i.e. involves the input of wild stock) in Vietnam

Life history trait	Production system	N	Mean	±SE	Min	Max
Minimum Adult Mass (kg)	Closed-system	25	74.68	23.02	0.01	300
	Input of wild stock	16	32.38	9.30	1	90
Estimated Generation length (years)	Closed-system	24	10.80	1.62	0.25	25
	Input of wild stock	12	11.58	1.22	5	15
Annual reproductive capacity (indv/year)	Closed-system	22	61.77	20.62	1	400
	Input of wild stock	11	14.45	3.09	1	30
Sale age (months)	Closed-system	18	14.75	2.99	1	36
	Input of wild stock	9	7.67	2.47	1	24

Secondly, we considered if this difference could be explained by the conservation and protection status of the farmed species. In terms of a farmed species protection status, we found the majority of farms using closed-cycle systems were for species not listed in CITES appendices (16/21, 76.2%) or Decree 32 protected groups (17/23, 73.9%), whilst farms using systems relying upon the input of wild stock were found to be mainly for species in CITES App II (9/18, 50%) and in Group IIB of decree 32 (10/18, 55.5%).

We found a significant difference between farms using systems relying on the input of wild stock and farms with closed production systems and the listing of their farm species

within CITES appendices (Pearson's X^2_3=13.15; P<0.005). In terms of national protection status, we also found a significant difference between farms using systems relying on the input of wild stock and farms with closed production systems and the listing of their farm species within the species protection law of Vietnam (Decree 32/2006/ND-CP) (Pearson's X^2_2= 13.02; P<0.005) (Table 13). These results indicate that legally-protected species were more likely to be in systems relying on the input of wild stock.

Table 13: The number of wildlife farms found using closed production systems and open production systems (i.e. involves the input of wild stock) for protected species in Vietnam

Protection status	Closed system	Wild input	TOTAL
CITES			
App 1	4	3	7
App 2	1	9	10
App 3	0	1	1
Not listed	16	5	21
Decree 32/2006/ND-CP			
Group IB	4	2	6
Group IIB	2	10	12
Not listed	17	6	23

In terms of conservation status, 11 of the 13 wildlife farms (84.6%) for globally-threatened species reported closed production systems, with eight of the 18 (44.4%) wildlife farms for nationally-threatened species reporting closed production systems (Table 14). The numbers of farms using systems relying on the input of wild stock and farms with a closed production system did not differ significantly between the different IUCN Red list categories or the Vietnam Red book categories. It is worth noting that two farms of species considered Endangered in the IUCN Red list reported production systems relying upon the input of wild stock, and a further two for species considered nationally endangered by the Vietnam Red Book.

Table 14: The number of wildlife farms found using closed production systems and open production systems (i.e. involves the input of wild stock) in terms of the farmed species conservation status in Vietnam

Conservation status	Closed system	Wild input	TOTAL
IUCN Red list			
Critically Endangered	3	0	3
Endangered	1	2	3
Vulnerable	7	0	7
Low Risk/near-threatened	1	5	6
Low Risk/least concern	3	3	6
Not listed	6	8	14
Vietnam Red Book			
Endangered	4	2	6
Vulnerable	2	6	8
Threatened	2	2	4
Not listed	14	8	22

Finally, we investigated if there were financial differences in farms using systems relying on the input of wild stock and farms with closed production systems. Despite the mean minimum annual gross revenue for farms using closed production systems being far greater than that for farms with wild stock input ($163,773 compared to $4,171), we found no significant difference in this pattern. Similarly, although it appears that the monthly feeding costs per individual are greater for farms using systems depending on input of wild stock we found no significant difference in monthly individual feeding costs between wildlife farms using the two different systems (Table 15).

Table 15: The difference in annual revenue (US$) and monthly individual feeding costs between wildlife farms using closed production systems and open production systems (i.e. involves the input of wild stock) in Vietnam

Financial item	System	N	Mean	±SE	Min	Max
Minimum gross annual revenue (US$)	Closed-system	12	163,773.29	154,544.33	0	1863354.04
	Wild stock input	6	4,171.07	1,591.62	271.74	7950.31
Monthly feeding costs/indv (US$)	Closed-system	14	3.11	0.79	0.06	9.32
	Wild stock input	10	54.55	44.85	0.17	456.52

4. Discussion

This study aimed to improve the understanding of the conservation implications of commercial wildlife farms for a range of species in Vietnam. We have documented the increase in farms over the last two decades and highlighted their use of wild populations, with a minimum of 36% having wild founder stock and at least 23% using systems with continued input of wild stock (noting 20% where it was unclear). We found no evidence supporting the notion that farms are more likely to require the input of wild-stock if the species is large and slow-growing. However, we found that farms for protected species were more likely to use systems relying on the input of wild stock than those for non-protected species. We encountered a range of enclosure standards from very poor to quite advanced, basic breeding techniques, limited abilities to reliably identify individual animals, extremely poor veterinary health care (despite high mortality and diseases), and animal escapes of both hybrid individuals and those outside their natural range. We found wildlife farms selling globally-threatened species, many protected under national and international law to an increasing demand in both domestic and international urban markets with individual gross annual revenues reaching over US$1 million.

Wildlife farms and livelihoods

Although wildlife farms have been cited as tools for improving food security of rural communities; in Vietnam, and probably most of South-east Asia, wildlife farms are providing wild products to urban markets and they are not consumed to any significant degree by rural communities. These urban communities consume wildlife as a luxury item with no relationship to food security (Bennett 2002; Siren *et al*. 2006).

Despite significant progresses in poverty reduction, 29% of Vietnam's population remains below the national poverty line, and ranks 109/177 in the Human development index with a Poverty index of 15.7% (UNDP 2006). It is undeniable that commercial wildlife farming is a profitable venture, yet its link to poverty alleviation is not established.

Job creation is relatively low with 24/45 (53%) wildlife farms, where data on staff were collected, reporting family members carried out the work. Excluding the large Vietnam-Hong Kong Joint-venture macaque farm (NafoVanny) which employs over 200 staff of Vietnamese, Chinese and Cambodian nationality; a total of 89 hired staff were reported in farms, averaging around two staff per farm. It is difficult to assess the importance of

the income from farming wildlife to the households as we did not collect data from staff livelihoods for this. However, considering that 21/33 (64%) of households considered this their main income source it is clearly an important income source to a number of households.

However, it is important to acknowledge that whilst economic growth is a necessary condition for poverty reduction, alone it is not sufficient (Anon 2004). Human development and poverty indices are measured not only on economic parameters but also on other living standards, knowledge access, and life quality measures (UNDP 2006), for which commercial wildlife farms offer no more gains than other agricultural enterprises.

In addition, market price fluctuations for wildlife, extremely limited husbandry, veterinary care and population management knowledge, and a complex and weak institutional support structure present increased vulnerabilities to achieving sustainable rural livelihoods for poor households. Furthermore, the practice of sourcing stock from wild populations and the risks associated with animal escapes present issues threatening the environment and thus commercial wildlife farms are not in harmony with the Government's goal for sustainable development (Ministry of Planning & Investment 2006). Therefore, despite potentially high profits, there are a number of factors which make wildlife farming unsuitable as a tool for improving livelihoods when compared to other available rural livelihoods.

Wildlife farms and public health

Another issue relating to human livelihoods is the potential for wildlife farms to affect public health. The links between the wildlife trade and emerging infectious diseases is well established (Bell *et al*. 2004; Karesh *et al*. 2005) and these wildlife farms present a whole suite of risks to promote transmission and emergence of zoonotic diseases. We found wildlife farms of mixed-species, with little veterinary care and dealing with taxa where very little is known on the pathogens they host. In addition, a number of farms for crocodile and python reported purchasing H5N1-infected poultry to save money, despite the risks it posed.

Considering that Vietnam continues to be affected by a range of fatally infectious diseases affecting domestic livestock, including highly pathogenic zoonotic viruses (e.g. Avian Influenza H5N1); policy that promotes the development of wildlife farms that does not address these above issues will present difficult challenges to public and animal health in the coming years.

Wildlife farms and the conservation of wild populations

There is only one example from Vietnam where wildlife farms have undeniably made a positive impact to the conservation of wild populations; in the provision of stock to the reintroduction programme for Siamese Crocodiles (Murphy *et al*. 2004). However, it is unlikely that wildlife farms present a better alternative to zoological institutions and conservation breeding centres that incorporate research, education and high quality veterinary care, population management and husbandry protocols with a conservation mission (WAZA 2005), and therefore this should be viewed as an exception rather than the rule. Furthermore, it is universally accepted that it was wildlife farms that have caused the near extirpation of this species in the wild in Vietnam and continue to deplete populations in other range countries.

Wildlife farms as a supply-side intervention

Wildlife farms are professed to be a potential tool in the supply-side approach to tackling the illegal wildlife trade; providing a cheap, acceptable alternative to wild stock (Bulte & Damania 2005; Lapointe *et al*. 2007). Accurate and reliable estimations on the total quantity of products in the wildlife trade and the proportion of farmed stock versus wild-sourced are unlikely to be calculated at present due to difficulties in accessing this sensitive, often criminal information. Therefore, to understand if farmed wildlife is effectively substituting wild stock, we must rely upon other indicators to this occurring.

A key factor in the supply-side approach model is that the farmed product provides a cheaper and acceptable substitute. These criteria are not met in Vietnam with our study finding no difference in the selling price of wild versus farmed stock and an indication from a trader and a restaurant owner that certain consumers preferred wild-sourced stock. The market for crocodile skin is said to favour captive-bred animals due in part to the better quality skin in a captive crocodile compared to a wild individual (Macgregor 2006). We found the majority of crocodile farms in Vietnam hold their animals in poor

conditions in large groups and many had low quality skins due to fighting between individuals. However, as reported by a number of farms they would simply sell the stock with good skins into the skin trade, whilst those with lower quality skins would be sold illegally to China into the meat trade and they could make profit from both end uses. A similar situation was reported in some python farms.

Bulte & Damania (2005) warn that the influx of wildlife farms to the imperfect competition model exhibited by the illegal wildlife trade risks increasing hunting pressure on wild populations, where this competition is aggressive, which could lead to the extirpation of species. Although there are arguments against applying simple economic rules to the complex wildlife trade dynamic, it is possible that this has already occurred in Vietnam. The extirpation of the Vietnamese Sika Deer and Siamese Crocodile occurred alongside the rapid development of commercial farms for these species, with a number of crocodile farm owners reporting from 1987-1993 large numbers of wild crocodiles were brought into farms. During our surveys a number of python farm owners reported they sourced pythons from Cambodia as local populations were so depleted. On a number of separate occasions we had reports that the first farm to develop a breeding technique for monitor lizards would be a millionaire, and encountered a number of farms procuring large numbers of these species in an attempt to master this. Furthermore, studies and law enforcement confiscations have shown despite being the most extensively farmed taxa in Vietnam, hunting and trade still impacts wild populations of Siamese crocodiles (Murphy *et al.* 2004), Chinese soft-shell turtle (McCormack, T. pers. comm.), Asian black bear (Nguyen Phi Truyen pers. comm.) and Burmese python (Education for Nature - Vietnam pers. comm.)

Additionally, producing a cheaper product that will substitute wild products is potentially a flawed assumption if wildlife is consumed as a status symbol by the growing affluent urban population (Mockrin *et al*. 2005). There is a need to increase our knowledge on the dynamics of the consumer markets for wildlife in Vietnam and investigate the reported emergence of a new consumer groups for farmed wildlife products and the persistence of the ‘original’ consumers of wildlife that choose to pay higher prices for wild stock.

The comparative costs of farming and hunting will remain a key argument for why alone wildlife farming will not be a solution to the illegal hunting and trade of wildlife. As long as there is an accessible supply of wild animals, and the risks from law enforcement are relatively low relative to the price of the good being traded, hunting will remain cheaper and provide quicker profits than farming (Mockrin *et al*. 2005). It was thought that this would be particularly true for large, slow-growing species which would be more expensive to raise (Bennett 2007). However, we found no such relationship and that even farms with fast-growing species of relatively high reproductive rates (e.g. python and wild pig) were still bringing in wild stock.

Box 2: Have farms caused local extirpation of Southeast Asian porcupines?

The number of Southeast Asian porcupine farms in Son La province, Northern Vietnam has grown rapidly since 2000-2007. Very little monitoring and management has taken place in these wildlife farms and it is possible they have caused significant declines in local population of porcupines in the immediate area.

Fauna and Flora International carried out a camera-trapping survey in Muong La district, northern Son La consisting 2,274 camera trap days from Oct 2005 - May 2006 and did not record the presence of Southeast Asian porcupines (Swann, S. pers. comm.). Furthermore, in Nam Et-Phou Louey NBCA in north eastern Lao PDR, which borders with Son La province, the Wildlife Conservation Society has camera-trapping data from 2003-2007. These data show a significant decline in the number of sites recording the presence of Southeast Asian porcupines over the four years. In addition, information from local communities and forest guards indicates that this species is targeted for sale to the Vietnamese wildlife farms (Johnson *et al*. in prep).

Although direct causality cannot be established in this case, it is clear that further research is urgently needed to fully understand this farming network and other activities that may be responsible for this decline of wild porcupines.

Farming and legal protection

We found that species not protected under national or international laws were over represented in farms using closed-cycle systems whilst species where trade is legally regulated or prohibited (i.e. CITES App I/II and Decree 32 Group IB/IIB) formed the

majority of farms depending on wild stock input. This result was counter-intuitive to what one might expect (i.e. that protected species would not taken from the wild). We believe that this can be explained in a situation where the legislative regulatory framework for wildlife farming and indeed wildlife protection is being dictated by the market for wildlife, running one step behind. This is also likely to be combined with the fact that enforcement effort and effectiveness remains low.

Animal escapes

Most of the species reported to have escaped were within their natural distribution range and the risks to wild populations are primarily associated with introducing pathogens and genetic traits from poorly-managed populations to the wild. However, the reports of Chinese soft-shell turtles escaping in the south of the country (including hybrids) are of potential concern as this is outside of their natural range and the fact they can breed in the Southern farms suggests they may be able to survive in the wild, which could have a potentially negative impact on other turtle species in the south, as reported from Malaysia (Mockrin *et al* 2005).

Management, monitoring and enforcement of wildlife farms

Provincial FPD's are not clear on methods to monitor wildlife farms and they do not regularly visit and make spot-checks to all the farms in their province. Dong Nai FPD reported that they are in the process of registering 78/278 (28%) wildlife farms present in the province, yet 58 of these (73%) cannot provide documentation to the legal origin of their stock and thus they are unsure of how to proceed.

A number of limitations to the effective management of wildlife farms must be overcome to neutralise any negative impact on wild populations. Firstly, is the issue of how enforcement officers can make accurate distinctions between wild and farmed stock, a problem reported by all three provincial FPDs we met with. This is a critical problem to overcome as we found no parallel legal trade for farmed stock. Instead we found that farmed stock (specifically crocodiles and pythons) are mixed into the existing illegal network confounding difficulties in law enforcement.

Farm owners cited a number of characteristics that they reported to differ between wild and captive-bred stock including behaviour, strength, morphology, colour and

metabolism yet all these are largely subjective measures, requiring a familiarity with the animals and could vary between individuals of the same species. A number of farm owners stated that it is impossible to accurately distinguish wild from farmed individuals, particularly after a wild individual has been in captivity for a period of time.

Stock records are also used in monitoring and farm owners are required by law to maintain these and present them to FPD rangers during inspections. A number of farm owners reported that the FPD rely entirely on these records and do not actually count every individual as this would not be feasible given the large numbers in some cases (e.g. 400,000 field crickets) and also enclosures that would prevent this (e.g. ponds for soft-shell turtles and crocodiles and coconut shell-filled tanks for scorpions). One wildlife farm owner rearing King cobra explained his method of cheating the stock book. His stock book read 20 adult King cobras and so each time the FPD would visit, he would ensure he had 20 adult King cobras, with no record of the 40+ he had sold in between.

The method adopted by CITES is to provide reliable individual identity markers on all farm stock, each with accompanying documentation. Therefore if an animal is encountered at the farm or in the trade, enforcement officers have a record of its origin. At present only 5% of the wildlife farms surveyed used individual identification markers yet this has already been widely implemented for Asian black bear farms with the use of microchips. However, considering that over 80% of farms practice a destructive harvest of stock; microchips would reduce the economic viability of many wildlife farms and thus may even promote hunting of wild populations by making this method of supply more profitable. In addition, the obvious criticism of other forms of identification marking (e.g. ear tags, notching etc.) is the ability for replication and transference between animals.

An inspection and regulation guideline developed by TRAFFIC for the Vietnam CITES Management Authority (Jenkins 2002a) recommended as part of a broader inspection protocol to record the presence of life stages of the farmed species. This served as an indicator that the farm has the ability to breed and relies on an assumption that therefore they are less likely to be bringing in wild stock. However, we have shown this logic to be flawed with no relationship between farms using open or closed production systems and the proportion of life stages we saw present.

A major limitation to enforcement of wildlife farms (and indeed the illegal wildlife trade in general) is the placement of animals that would be confiscated if the law was strictly followed. Vietnam suffers from a limited rescue and captive care infrastructure (including zoos, conservation centres and rehabilitation centres); a lack of funding and human resources for genetic analysis, disease screening and post-release monitoring; and a society that does not believe euthanasia is an acceptable option. For example, the Indochinese tigers of wild origin we encountered in Binh Duong province became the focus of a heated public debate on what their fate should be. Despite the involvement of national and international conservationists, scientists, zoos, welfare organisations and enforcement agencies, the only available option was to leave the animals in their current location.

Policy directions

The co-existence of farms for globally-threatened species and healthy, viable and growing wild populations of those species is a distant vision under current enforcement capacity. We strongly recommend a policy that, rather than viewing wildlife farms as a positive development for biodiversity conservation, recognises they pose serious threats to the conservation of wild populations and applies the appropriate mitigation and enforcement measures.

It is unrealistic to propose the closure of all wildlife farms and a 180º policy change but the negative impacts to wild populations are real and present a serious threat to biodiversity conservation efforts in Vietnam. We recommend the government applies a precautionary principle[2] and adopts a policy encompassing the following values:

- Prohibits wildlife farms holding protected species listed in Group IB of Decree 32/2006/ND-CP and globally-threatened species listed in the IUCN Red List;
- Strictly punishes farm owners violating the law on wildlife protection and publicises the cases in the media;
- The burden of evidence on the source of animals being held in farms lies with the farm owner and not enforcement agencies;

[2] The IUCN defines 'precaution' – the "precautionary principle" or "precautionary approach" – as a response to uncertainty, in the face of risks to health or the environment. In general, it involves acting to avoid serious or irreversible potential harm, despite lack of scientific certainty as to the likelihood, magnitude, or causation of that harm.

- Increased investment to rescue centre infrastructure that can handle animals confiscated from farm owners.

Recommended activities

The Forest Protection Department faces a large number of existing farms of many species and therefore there is an urgent need to develop an effective and efficient system of management and enforcement. It is critical that the development of mitigation measures to reduce the negative impact of wildlife farms do not deter resources from conserving populations in the wild. Many of these monitoring activities will also improve control of the illegal wildlife trade, and that should be promoted where possible.

For the effective management and enforcement of legislation governing wildlife farms, a range of activities is required that will require significant financial and human investment:

- Monitoring techniques, including reliable and cost-effective methods for individual identification marking, and chain of custody protocols, need to be developed that eliminate the opportunity to launder individuals of wild origin. We recommend piloting techniques in 2-3 provinces before extending nation-wide.
- Clear guidelines and additional funding and resources must be developed to accompany legal documents and support the provincial FPDs in implementation.
- Forest protection departments in provinces with numerous farms will require at least one person to dedicate 100% of their time to monitoring and enforcement of wildlife farms. These staff must be competent in species identification and have good familiarity with farmed species in a captive condition.
- Husbandry techniques, veterinary care and disease screening critically need to be improved in wildlife farms and will require the assistance from the Department of Animal Health at each administrative level (i.e. commune, district, and province).
- Partnerships and/or funding for DNA testing need to be developed for high profile cases where stock of wild origin are suspected and also for those destined for reintroduction to determine relatedness of specimens.
- Hygienic slaughter houses need to be developed for safe processing of farmed wildlife reducing the public health risk.
- Funding and research into improving the viability of options for the placement of confiscated animals must be developed.

- Enforcement on wildlife farms must present a strong, effective deterrent through fines and additional punishments (e.g. removal of permission to keep wildlife) and where applicable criminal prosecutions, to farm owners violating the relevant national and international laws especially those illegally laundering wild-caught animals and selling to traders with intent to illegally export

Conclusion

Many species in Southeast Asia are facing extinction if the illegal and unsustainable wildlife trade of animals sourced from the wild is not controlled. Interventions to tackle the illegal trade and promote species conservation must be well-planned, and based on reliable data. If such data are scarce, the precautionary principle should be followed, and no steps should be taken where conservation outcome are unclear.

The positive conservation role of wildlife farming remains unclear. Without strict controls and improved understanding of market forces and consumers, the risks to and negative impacts on wild populations might vastly outweigh any gains. The rapid development of wildlife farms appears to be driven at least in part by entrepreneurs recognising low barriers to entry, and a means for improved risk management (i.e. securing supply, controlling costs), and weak governing legislation.

Breeding of animals in farms with little or no prospect of their being returned to the wild, no awareness-raising activities, no funds being directed towards the conservation of wild populations and no conservation-related research is not conservation. Animals are only truly conserved if they are playing their natural role as an integral part of functioning ecological systems. Hence, the ultimate aim of any conservation program is to enhance the conservation of animals in the wild. Well-planned and managed conservation breeding programs can do that. This study shows that the role here of commercial breeding farms is detrimental in some cases, unclear in others, and in only one case was a conservation objective present.

Wildlife farms achieve the conservation of species at the utilitarian level and we must advocate for decision-makers to focus conservation programs on how to conserve species in their natural habitat, and raise understanding not only of the ecosystem services species provide but also the cultural and spiritual role they have in society.

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Appendix 1: Table showing species sampled, their protected status under Vietnamese law, and CITES; their conservation status in the IUCN Red list and Vietnam Red Book and some life-history parameters.

English name	Latin name	CITES	IUCN Red list	Viet Nam Red Book	Decree 32/2006 /ND-CP	Adult mass (kg)	Litters/ year (months)	Min litter size	Generation length (years)
Scorpion	*Heterometrus laoticus*					0.05	2	7	3
Bush Cricket	*Gryllus sp*					0.01	1	400	0.25
Sambar	*Cervus unicolor*		LR/lc			109-260	1	1	8
Wild pig	*Sus scrofa*		LR/lc			50-350	3	4	5
Indochinese tiger	*Panthera tigris*	App I	EN	EN	IB	75-140	U/K	U/K	14
Leopard	*Panthera pardus*	App I	LC	EN	IB	45-90	U/K	U/K	13
Long-tailed macaque	*Macaca fascicularus*	App 2	LR/nt		IIB	5-7	1	1	11
Southeast Asian Porcupine	*Hystrix brachyura*		VU			10-30	2.5	2	7
Bengal monitor lizard	*Varanus bengalensis*	App I		VU	IIB	1.5-2.7	U/K	U/K	
Bocourt's water snake	*Enhydris bocourti*					1	U/K	U/K	
Burmese & Reticulated python	*Python molorus + P. reticularis*	App 2		VU	IIB	90	1	40	14
Burmese Python	*Python molurus*	App 2	LR/nt	VU	IIB	90	1	25	15
Chinese cobra	*Naja naja*	App 2		T	IIB	1.5-2.5	1	20	14
Indochinese water dragon	*Physignathus cocincinus*			VU		1	2	12	8
King Cobra	*Ophiophagus hannah*	App 2		EN	IB		U/K	U/K	
Tokay Gecko	*Gecko gecko*			T		0.15-0.3	12	12	10
Water Monitor	*Varanus salvator*	App 2		VU	IIB	10	U/K	10	
Cuban Crocodile	*Crocodylus rhombifer*	App I	EN			250	1	30	25
Saltwater & Siamese Crocodiles	*C. siamensis, C. porosus*			EN	IB	300	1	14	25
Siamese Crocodile	*Crocodylus siamensis*	App I	CR	EN	IB	300	1	U/K	25
Chinese soft-shell turtle	*Pelodiscus sinensis*		VU			1.5	12	6	7
Hybrid Soft-shell turtle	(Unknown species)					1.5	6	10	7
Soft-shell turtle	(Unknown species)					1.5	U/K	U/K	
Wattle-necked soft-shell turtle	*Palea steindachneri*	App 3	EN			5	U/K	U/K	14

NB: U/K = Unknown