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The conservation impact of commercial wildlife farming of porcupines in Vietnam

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ABSTRACT

Commercial farming of wildlife, particularly in Southeast Asia, is currently the subject of much debate and to date, its conservation impact has been largely unexplored. This study used semi-structured interviews to build a detailed understanding of the dynamics of the commercial farming of Southeast Asian porcupine (*Hystrix brachyura*) in the northwest Vietnamese province of Son La. Although farm owners are obliged by law to propagate stock solely from farm-bred animals, 58% of farm owners admitted purchasing wild founder stock, with at least 19% continuing to buy wild individuals. Despite the number of farms, the primary demand on them is to supply other farms, and wild meat restaurants were still sourcing their meat from wild populations. Lower cost was a major factor driving the trade in wild animals, with wild adult porcupines being bought for half the price of farm-bred adults. With high demand from farms and restaurants, increased targeted hunting may be the cause of a dramatic decline in the wild population of porcupines across the region.

1. Introduction

Throughout the world, wildlife products are an essential source of food and income (Chardonnet et al., 2002). Whilst humans have been hunting wildlife for more than 100,000 years, today many species are threatened by the scale of hunting and the situation has been exacerbated by the increase in human populations (Bennett and Robinson, 2000; Milner-Gulland and Bennett, 2003). Unsustainable wildlife trading is one of the most devastating underlying causes of biodiversity loss (Bennett, 2002; Broad et al., 2003) and the wild meat trade alone has now surpassed habitat loss as the greatest threat to wildlife in the humid tropics (Milner-Gulland and Bennett, 2003; Redmond et al., 2006). To date much of the research has focused on Africa (Bell et al., 2004; Redmond et al., 2006; Swift et al., 2007), but the rapid, recent acceleration of hunting most likely first occurred in Southeast Asia (Milner-Gulland and Bennett, 2003), and has grown considerably in the last few decades.

Hunting has expanded into a multi-million dollar commercial trade where wildlife is exploited for consumption, alleged medicinal properties, ornaments, clothing, pets and zoo exhibits (Broad et al., 2003; Bell et al., 2004). In most regions the levels of biodiversity loss due to hunting are largely unexplored and can vary considerably (Fa et al., 2002). The highest levels of wildlife hunting are for meat. Whilst in Africa, meat from wild animals is an important source of protein for many, across much of Southeast Asia it is consumed as a speciality food (IUCN, 2001; Roberton, 2007), at a scale that is having a devastating effect on wild populations (Whitfield, 2003).

Commercial wildlife farming has been advocated as a possible solution to meeting a growing demand for wildlife products, particularly wild meat (Cooper, 1995). Although it has been proposed as a means of providing food security since the 1950s, it is not in widespread use across the tropics (Mockrin et al., 2005). However, over the past decade, there has been a substantial increase in the number of wildlife farms appearing across much of Southeast Asia, including Vietnam (WCS, 2008). Wildlife farms are seen as a way of providing food security to local communities, as well as a possible means of poverty alleviation and economic development in rural areas (Cicogna 1992; Hardouin 1995; Revol 1995). It also has been suggested that they may promote biodiversity conservation by reducing hunting pressure on wild populations (Jori et al., 1995; Parry-Jones, 2001; Lapointe et al., 2007). It has been argued that wildlife farms provide a cheaper, acceptable alternative to wild animals (Bulte and Damania, 2005; Lapointe et al., 2007) and as such, commercial wildlife farming is being actively encouraged by governments across much of Southeast Asia (Parry-Jones, 2001; WCS and TRAFFIC, 2004).

Arguments against wildlife farming include concerns that increased availability may increase consumer demand and pressure on wild populations for founder stock, and that farms will be used for laundering illegally-caught animals (Bulte and Damania, 2005; WCS, 2008; Cooper, 1995; Mockrin et al., 2005). To date, farms have been poorly monitored and their impacts are largely unknown.

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The Vietnamese wildlife trade, including farming, is mainly regulated by Decree 32/2006/ND-CP and Decree 159/2007/ND-CP. The task of monitoring and enforcing these laws falls upon the government's Forest Protection Department (FPD). Legislation states that all wildlife farms should be registered with the relevant provincial FPD and farms maintain accurate stock records and proof of the legal origin of their stock. Violation of these laws should result in confiscation of the animals, a fine equivalent to the value of the animals up to US$1850, and the possibility of having their farm registration certificate revoked (Decree 159/2007/ND-CP). The main taxa reported in these Vietnamese wildlife farms are crocodile (*Crocodylus siamensis*), python (*Python molurus* and *Python reticulates*), cobra (*Naja naja* and *Ophiophagus hannah*), soft-shelled turtle (*Pelodiscus sinensis*), bear (*Ursus thibetanus* and *Ursus malayanus*), macaque (*Macaca fascicularus*), deer (*Cervus unicolor*) and porcupine (*Hystrix brachyura*) (WCS, 2008).

The Southeast Asian porcupine (*H. brachyura)* is one of the 11 species of Old World Porcupines (Family: Hystricidae). It is currently classified as Least Concern by the IUCN Red List (Lunde et al., 2008), with overhunting cited as its greatest threat, and a reported decline in total population size of at least 20% in the 1990s (Nowak, 1999). Farming of porcupines in Vietnam is becoming progressively more popular, and there has been a notably rapid increase in the number of porcupine farms in Son La province since 2000.

In the present study, we set out to conduct an evidence-based case study quantifying the direct impact of commercial farming on the local wild population using the Southeast Asian porcupine as a model species. This was investigated by determining the scale of porcupine farming in Son La province, the incentives for continued purchase of wild animals, and the effectiveness of the FPD in enforcing the wildlife farming regulations. Commercial wildlife farming can only be advocated if failings in the trade can be identified and dealt with, to minimise negative impacts on wild populations of species.

2. Methods

2.1. Study site

Son La province is located within the Hoang Lien Mountains, in northwest Vietnam, on the Lao PDR border (Fig. 1). Although considerable deforestation has occurred in recent decades to make way for agriculture, 41% of the province remains forested (Anon, 2006). In 2007, the construction of a section of road linking southern Son La to Lao PDR was completed.

2.2. Household interviews

Face-to-face interviews were conducted with 67 porcupine farm owners in April and May 2008. In this context, anyone breeding porcupines was considered to be a farm owner, and the terms "farm owner" and "farmer" are used interchangeably. Interviewees were identified by snowball sampling, using recommendations from respondents to establish contact with others (Bryman, 2004). Although this could provide a bias towards older and more established farms, it would be impossible to select a random sample of farms in this instance, as despite current laws, not all farms are registered.

Semi-structured interviews were carried out by a team of two researchers, one British and one Vietnamese. Questions and reported answers were translated into English by the Vietnamese member of the team. Trading in wild animals is illegal, and so to minimise response biases a role-play approach was used, positing that data were being collected in order to assess porcupine farming as a means of poverty alleviation for households in the central highlands of Vietnam. Respondents were found to be very willing to talk openly in detail about their farms, most probably aided by the presence and interest of the foreign interviewer.

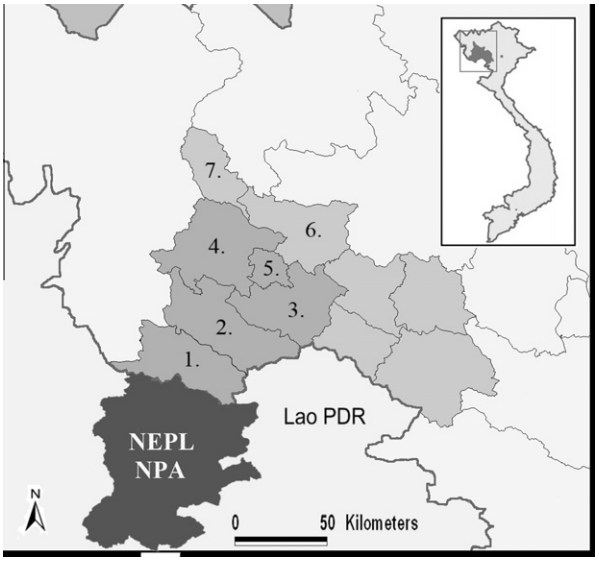

Fig. 1. Districts of Son La Province, Vietnam. 1. Sop Cop, 2. Song Ma. 3. Mai Son, 4. Thuan Chau, 5. Son La town, 6. Muong La and 7. Quynh Nhai. Districts in darker shading (1–5) were sampled during study, due to their proximity to the Lao PDR border.

The interviews followed topics set out in an interview guide, but remained flexible in nature to allow the respondents to discuss issues at their own pace, and to allow the interviewer to follow up on any key topics (Bryman, 2004). Data were collected on the size and history of the farm, animal husbandry practises, prices of products and basic expenses, the origin and quality of founder stock (male/female pairs), and perceived views on wild stock. All answers (including uncertain responses) were recorded in a notebook during the interview.

2.3. Data analysis

Response frequencies are presented as percentages. Due to the open nature of interviews, the number of respondents varies between questions, and thus frequencies also are shown as fractions of the total number of interviewees that were asked that question. When considering questions that required a numerical response, if interviewees gave a range, statistics were calculated from the midpoint of the range.

A Pearson's correlation was used to evaluate the price trend of juvenile founder stock over time. Prices were converted to US Dollars at the currency exchange rate for the relevant year (OANDA, 2008), and adjusted for inflation to the 2008 rate (BLS, 2008). Profits and expenses of farming and trading were calculated using mean values gathered from the interviews. The prices of wild meat versus farmed meat equivalent were compared with a one-way ANOVA, and a Tukey's post hoc examination. The farmed meat equivalent was calculated by dividing the mean price of farmed breeding-age founder stock pairs by the mean reported maximum weight of an adult porcupine, and then halved to account for only one individual.

2.4. Forest Protection Department interview

A semi-structured face-to-face interview was conducted with the Deputy Director of the Son La FPD. Topics covered included

the laws and regulations governing porcupine farming in Son La, monitoring effort, punishments and rate of prosecutions, and staff numbers and training. Data were provided on the number and size of registered porcupine farms in the province of Son La at a district level, as well as the number of convictions for possession of porcupines of unknown origin in 2007.

2.5. Restaurant interviews

A small survey was conducted with restaurant owners in the greater Hanoi region. Of 35 suspected wild meat restaurants approached, only nine restaurant owners admitted selling porcupine meat, and were willing to participate. Short semi-structured interviews were conducted, with data collected on aspects of the price, trade and consumer preferences of porcupine meat in restaurants.

3. Results

3.1. Porcupine farming and husbandry practises

In total, 449 porcupine farms were registered with the FPD in the province of Son La, although the FPD admits that this is an underestimate of the true number. In mid-2008 Son La provincial FPD reported a little over 8000 porcupines in successful breeding programs in farms to National FPD. A total of 67 porcupine farm owners were interviewed in five districts of Son La province. All were current farm owners except for one, who had sold all of his porcupines within the last year, but intended to start farming porcupines again as soon as possible.

3.2. Trade dynamics

Fifty-eight per cent (39/67) of farm owners reported that their original founder stock of porcupines was of wild origin; of these, 31% (12/39) continued to buy porcupines of wild origin on some scale. Sixty-seven per cent (18/27) claimed that wild porcupines could no longer be found locally, with another 30% (8/27) saying there were very few. Only one respondent (1/27) thought that wild porcupines could still be readily found locally. Fifty-three per cent (28/53) of respondents reported that wild-caught porcupines originated from Lao PDR. Although 36% (19/53) of farmers reported wild-caught porcupines originated from Song Ma or Sop Cop districts, nearest the Laotian border, 100% (11/11) of respondents in these areas reported that there were no, or very few, wild porcupines to be found in the area.

All farm owners reported that they sold porcupines to other farms for founder stock (67/67). The sale destinations of the founder stock included much of northern Vietnam, with sale to some provinces further south coinciding with large urban centres. One farm owner (1/67) also reported selling to China. Only two out of 67 farmers reported also selling porcupines to restaurants for meat, though both said that this was only occasional, and as a result of accidental death, or if they had a surplus of old males. Six farm owners volunteered the information that the supply of porcupines from farms was not large enough to meet the demand for meat, so porcupines of wild origin supplied restaurants.

3.3. Scale of porcupine trade

3.3.1. Growth of farming

The number of porcupine farms has increased significantly in the last decade (Fig. 2), with 55% of respondents having established their farms in the past 3 years. The number of founder stock purchased to start the farm ranged from 2 to 39, with a mean ± SE of 8.77 ± 0.94 (n = 66). There was a slight trend for increased numbers of founder stock to be purchased in the more recently established farms (Fig. 3), however this was not found to be statistically significant (τ = 0.15, n = 66, p = 0.06). Only 8% (5/61) of respondents had no wish to expand their farm further.

There has been no significant decline in the proportion of farms buying wild founder stock over time (r = −0.1, n = 13, p > 0.05). Whilst the majority of farmers who bought porcupines of wild origin claimed to buy them for founder stock for their own farm, there was also evidence of farm owners trading in wild porcupines directly. Six per cent (4/67) of the farm owners were reported as, or admitted to, trading wild animals directly, accounting for a total of 910 wild porcupine individuals traded onto other farms from those four farms alone. One respondent also worked in the border army on the main road to Lao PDR and claimed that 20 pairs of wild-caught porcupines were brought across the border every night. Without verification, reliable conclusions cannot be drawn here, but if this estimate is accurate it would amount to over 14,000 wild porcupines being brought from Lao PDR per annum, and pose a serious threat to wild populations in Lao PDR that requires immediate attention.

3.3.2. Economics of farming

The high level of income gained was the reason given for farming porcupines by 78% (46/59) of respondents, followed by 54% (32/59) citing low maintenance requirements, and 44% (26/59) of

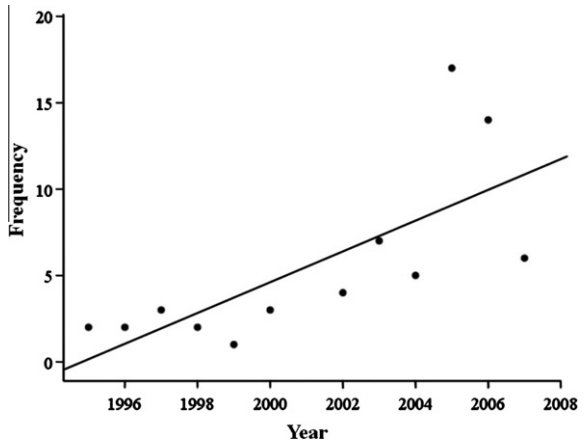

Fig. 2. Frequency of reported start-up dates of 67 porcupine farms in Son La province, Vietnam (r = 0.72, n = 12, p < 0.004).

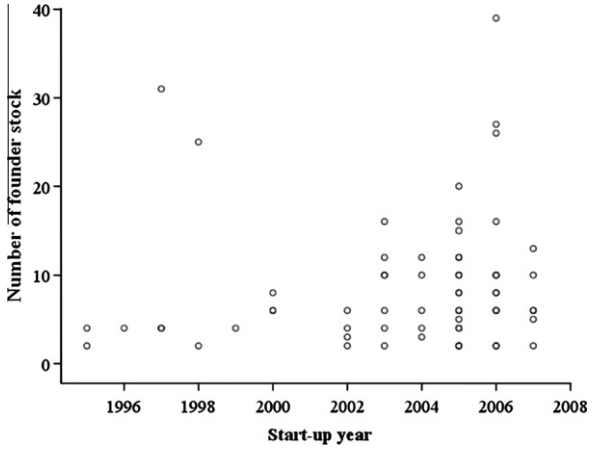

Fig. 3. Number of porcupine founder stock purchased against year of establishment of 65 farms in Son La province, Vietnam.

respondents stating that they farmed porcupines because unlike some livestock, porcupines are disease-free. Four farm owners stated that porcupines brought the highest profit of any animal. There has been a significant increase in the value of porcupines in the past seven years (Fig. 4).

Twenty-five per cent (17/67) of farm owners were retired. Of the remaining 75%, none reported profit from breeding porcupines as their only source of income, though 73% (41/56) of respondents reported porcupine farming as their main source of income. The alternative sectors of employment of the farm owners are government, retail and agricultural. Thirteen farmers (13/29) swapped from farming another species to porcupine farming, with 46% (6/13) of these citing the increase in profits as the reason for the swap, 23% (3/13) reporting the lack of diseases in porcupines as the reason, 15% (2/13) commenting on the lower maintenance effort of farming porcupines in relation to other species, and 8% (1/13) reporting the smaller amount of land required as the reason for the swap. Many farm owners favourably compared farming porcupines with other species in terms of income and ease of work, with six stating that porcupine farming brought in at least ten times the income of pig farming.

Based on mean figures of the main expenses incurred by porcupine farmers, an average profit of US$1000/breeding pair each year can be made through the sale of juvenile captive-bred offspring. Assuming a population of ten breeding pairs (the average per farm found in this study), a farmer could expect to make a profit of US$10,000 pa. Each of the three farm owners who admitted trading wild individuals directly, made a profit of $61.19 (1 million VND) per pair sold. Even excluding any food or maintenance costs that may be incurred (dependent on how long they held the animals), a farm owner would have to trade 164 pairs of wild porcupines to make the same amount of profit as from ten pairs of farmed stock. None of the four respondents who were trading wild porcupines directly reported porcupines as their main source of income.

3.4. Threats to wild populations

3.4.1. Demand

Ninety-nine per cent (66/67) of farm owners believed that demand for porcupines was increasing, and the remaining farm owner had no perception if demand was increasing or not. All (58/58) of the respondents reported that demand was higher than supply, with one respondent estimating that current supply was only 10% of demand. All respondents (47/47) reported that there was no competition between farmers, and porcupines were easy (5/19) or very easy (14/19) to sell due to the high demand.

3.4.2. Price

Only 13% (8/63) of farm owners regularly sold their stock at breeding-age, while 87% (55/63) sold founder stock pairs whilst still juvenile, with the mean ± SE age of sale being 3.1 ± 0.19 months (n = 55). There was a significant difference between the price of captive-bred juvenile founder stock pairs, captive-bred adult founder stock pairs, and founder stock pairs of wild origin (Fig. 5). A Tukey's post hoc analysis showed that farm-bred founder stock pairs sold at juvenile-age were significantly cheaper than those sold as adults ($p < 0.001$). Founder stock pairs of wild origin were significantly cheaper than farmed adults ($p < 0.001$), but not than those sold whilst still juvenile ($p = 0.16$). Ninety-three per cent (13/14) also reported that wild origin founder stock was cheaper than farm-bred porcupines.

3.5. Enforcement

Son La FPD reported that regulations governing the monitoring of porcupine farms in Son La started in 2004 in the districts of Sop Cop and Song Ma, due to the availability of good quality wild founder stock from Lao PDR. Since 2005, the same regulations have applied across the entire province. All farms should register with the FPD, whereupon a certificate and notebook for monitoring the population will be issued. The FPD should be informed of the numbers of births on the farm, which will be confirmed by a visit from an FPD ranger. The FPD must also be informed if buying or selling of stock occurs, when the population numbers will again be checked and the legal origin of the animals verified. All FPD staff receive basic training, including identification of characteristics of wild animals.

Only three respondents (3/67) admitted to not being registered with the FPD, although it could only be confirmed with the FPD records that 43% (29/67) of those interviewed were legally registered. This number is likely to underestimate the number of farm owners registered because of multiple ownership of properties, and that a farmer may hold animals at two locations and only register one of these. Although 100% of farmers, when asked, reported that FPD "did a good job", or monitored farms closely (29/29), the FPD only made three convictions for unlawful possession of porcupines in 2007. Whilst farm owners were consistently correct in describing monitoring procedures of porcupine farms by the FPD,

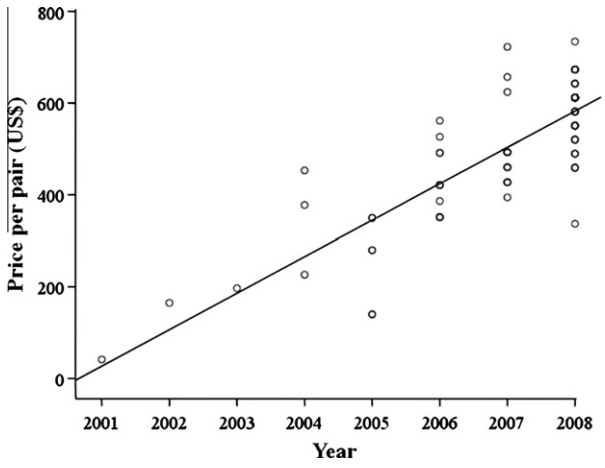

Fig. 4. Price trend for commercial sales of founder stock pairs of juvenile porcupines in Son La province, Vietnam ($\tau = 0.62$, $n = 96$, $p < 0.001$). Values adjusted to 2008 prices to account for inflation rates.

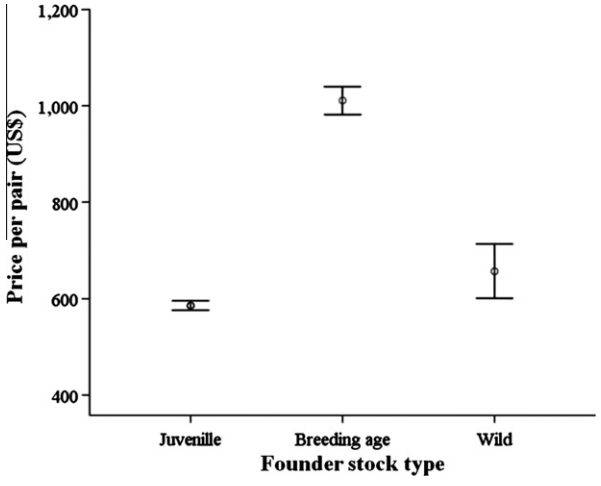

Fig. 5. Mean (±SE) sale price of founder stock porcupine pair (US$) sold in Son La province, Vietnam, as juveniles or breeding-age of farmed stock, or of wild origin ($F_{2,79} = 136.05$, $p < 0.001$).

65% (11/17) failed to mention that a fine (as well as confiscation of porcupines) was part of the punishment for unregistered porcupines. Although registering porcupines with the FPD is free of charge, 89% (8/9) of farm owners reported some sort of fee associated with registering or selling porcupines.

3.6. Further threats to wild populations

Six farm owners volunteered the information that porcupine meat was supplied exclusively from the wild. Fourteen farm owners declared that wild founder stock often carry injuries, from which the porcupines often do not recover. Eleven also said that as a result of the high mortality rate when capturing wild animals, there is a constant supply of injured and/or deceased porcupines for the meat market. When asked if there was a difference in the quality of the meat, 37% (17/46) responded that wild meat was preferable to farm-bred meat and only 2% (1/46) responded that farmed meat was of higher quality. Fifty per cent (23/46) thought that there was no difference between meats of different origins, though many added that there was a perceived difference by consumers.

In a sample of wild meat restaurants, all nine that admitted selling porcupine meat reported that the animals were sourced from the wild, with 2/9 saying they had also tried selling farm-bred meat. All (9/9) reported that there was a perceived difference between wild and farm-bred meat, and that customers preferred wild meat. Fifty-seven per cent (4/7) added that despite this, they did not believe that customers would be able to tell the difference between the two sources of meat.

The two most common reasons given for sourcing porcupine meat from wild rather than farmed populations were availability and price (both given by 50% (3/6) of restaurant owners). Thirty-three per cent (2/6) sourced wild porcupine meat because of customer preference, and 17% (1/6) because of the assumed higher quality of wild meat. There was a significant difference between the price of: (a) wild meat reported by the farm owners in Son La province, (b) wild meat reported by the restaurant owners, and (c) the price of farmed meat (Fig. 6). A Tukey's post hoc analysis found no significant difference between the wild meat prices reported by the farm owners and the restaurant owners ($p = 0.22$), but farmed meat was significantly more expensive than the wild meat prices reported by both farm owners ($p < 0.001$) and restaurant owners ($p < 0.001$).

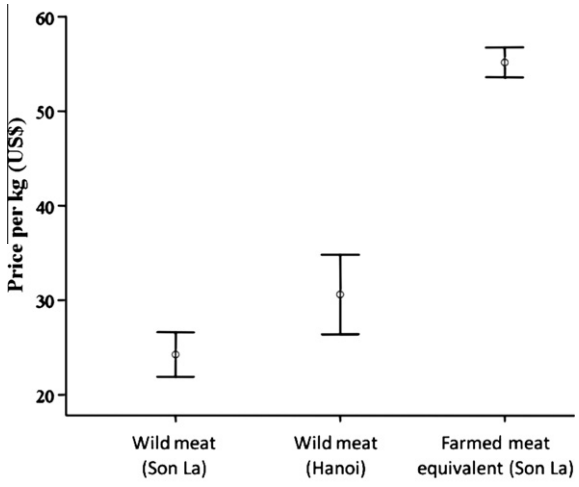

Fig. 6. Mean (±SE) price (US$) of meat per kg ($F_{2,33} = 53.12$, $p < 0.001$). Reported wild meat prices were collected from farm owners in Son La province, and restaurant owners in Hanoi. Equivalent farmed meat prices are from porcupine farms in Son La.

4. Discussion

This study provides valuable data to help understand the conservation impact of commercial farming. At least 58% of the 67 farms in this study had purchased wild founder stock, and at least 19% are continuing to buy wild animals. The scale of commercial porcupine farming has increased dramatically in recent years alongside an increase in selling price of porcupines from farms. The results here highlight that under current management, commercial farming could potentially cause local extirpations of even relatively common and fast-breeding species like porcupines.

4.1. A large and rapidly growing industry

Whilst there are 449 porcupine farms registered with the FPD in Son La province, the department admits that this is an underestimation of the true number. Indeed, only half of those interviewed were verified as registered farms. Accounts volunteered from interviewed farm owners suggest there may be as many as 600 farms in Son La and Song Ma towns alone, with many more unregistered farms across the province where FPD reports there are none (e.g. in the districts of Muong La and Quynh Nhai, shown in Fig. 1). We recorded a rapid growth in porcupine farming in recent years, with more than half of farm owners interviewed stating they started in the last three years. The snowball sampling method used to identify farms would be expected to result in a right-skewed bias towards older and more established farms (i.e. better known to people than newer ones) so it is unlikely that this increase is due to sampling bias.

The vast majority of farms were household enterprises, and frequently enclosures were simply adaptations of existing enclosures for other domestic livestock (e.g. pigs). Resource constraints, or lack of economic viability, are often cited as reasons that wildlife farming is often unsuccessful (e.g. Mockrin et al., 2005) but the minimal husbandry requirements and the reported ease with which porcupines are bred indicate that these are not limiting factors for this species.

Large profits are available from the breeding of porcupines, with the sale of just two pairs of porcupines far exceeding the GNI per capita of Vietnam of US$890 (World Bank, 2008a), hence the increasing interest in porcupine farming, and high demand for founder stock. The accelerated growth in the number of farms starting up each year is likely to continue, with the increased price and demand encouraging a greater level of hunting of wild populations (Redmond et al., 2006).

The current porcupine trade dynamics are encouraging growth of trading by recruiting more porcupine farmers, whilst not passing on the porcupine product of meat to the consumers. This trade structure is akin to a pyramid scheme, and is an unsustainable model.

4.2. Direct threats to wild porcupine populations

This study found however that the greatest threat to the wild populations is not from demand for founder stock, but from farms laundering wild animals, and selling them across the country. Four farms which were willing to talk openly, reported trading almost 1000 wild porcupines each year, predominantly to other farms as founder stock. At least two further farms were suspected of laundering animals, based on interview reports yet this could not be verified. Due to the illegal nature of this activity, it is more likely that farm owners would hide this information, so figures reported

should be considered a conservative estimate of the true scale of the illegal trade of porcupines through the farms.

Most farm owners are very aware their trade was resulting in the decline of wild populations. However, they were either unconcerned or ignorant of the implications of this. Several interviewees reported that porcupines used to be found locally in Son La province, but have been largely or entirely wiped out in the past 20 years through hunting. Without preventative measures, the wild porcupine populations sourcing the farms in Son La could also be facing extirpation.

4.3. Economics of porcupine trade

The viability of wildlife farming as an alternative to illegal hunting relies upon the farm producing a cheaper, acceptable product to the consumer (Brown and Layton 2001; Bulte and Damania, 2005). This model does not apply in this study where we found wild individuals to be sold for half the price of farmed individuals. In addition, the simple economic models often used to justify wildlife farming fail to incorporate the strategic responses of illegal traders, who take advantage of weak management of wildlife farms to make additional profit from illegal sales.

Although profit can be made from direct trading of wild animals, rather than breeding them, farm owners can receive a greater income through closed-cycle breeding due to the higher sale price of farm stock. Nonetheless, despite having facilities and capital for breeding, a number of farm owners still chose to trade wild porcupines. It appears that legalisation of the trade and government support relaxes law enforcement efforts, providing opportunity for illegal traders to make additional profit from wild porcupine sales. This is facilitated through continued demand for wild porcupines from restaurant owners who favour wild porcupines due to lower price and consumer preference for wild over farm-raised.

The price of porcupines has increased sharply, with the cost of juvenile founder stock doubling between 2005 and 2008, and this was regularly cited as a limitation to more people starting farms. Demand for porcupines as founder stock will likely decrease over coming years as the market is saturated and prices will ultimately fall. Whether farmed porcupines can substitute the demand for wild porcupines from restaurants is likely to decide the fate of the farms from that point onwards but results from this study indicate that is unlikely. The trade may be continued through the export of porcupines to Chinese markets rather than for sale in Vietnam. One farm owner has already exported at least once to China and received 800,000 VND (US$49) per kg, far greater than estimates for sale prices in Vietnam.

4.4. Porcupine farms are poorly managed and monitored

The monitoring and control of the wildlife trade in Vietnam (including wildlife farms) is under-resourced, weak and ineffectual (Vu, 1999; Nguyen, 2003; WCS and TRAFFIC, 2004; WCS, 2008). Current management of the porcupine farms is inadequate to prevent wild animals entering the trade. Many farms are established with porcupines of wild origin and then being registered by the FPD; whilst others bring in wild stock and register them as births. In other Vietnamese provinces farm owners reported replacing sick/injured animals or any lost with those from the wild, knowing that the authorities cannot distinguish individuals. Eighty-nine per cent of farmers reported paying FPD a fee for processing their farm registration, which given the fact this is a free process, strongly suggests corruption may play a large part in facilitating this illegal trade.

4.5. Do the porcupine farms provide a substitute for illegally-sourced wild porcupine meat?

Large amounts of porcupine meat are consumed in restaurants. In a study in the central provinces of Vietnam, Roberton (2007) found that porcupine was the second most frequently reported wild meat to be sold in restaurants after wild pig, at an average of 47.6 kg per week per restaurant.

This study found that due to the high price of farmed porcupines, restaurants source almost all their porcupine meat from illegal wild sources. Therefore, the farms are yet to address the potential positive conservation impact they hold. However, since there is a preference for wild meat, should prices of farmed animals fall, restaurant owners may continue to source meat from the wild to fulfil consumer demand, even if there is a locally-available, legal and cheaper alternative (Roberton, 2007). In addition to this, the high mortality rate of trapped animals provides a steady source of meat to restaurants.

4.6. Are porcupine farms driving the decline of porcupines in Lao PDR?

Whilst there has been a suggested link between wildlife farms and local extirpations of species populations, there have been no direct studies of farms having a resultant impact on wild populations. WCS (2008) discusses a possible connection between porcupine farms in the province of Son La, and the decline in wild populations in Nam Et-Phou Louey National Protected Area (NEPL NPA) directly across the border from Son La in Lao PDR. Preliminary analysis of camera-trap data collected in the NPA showed a significant decline in the number of sites recording the presence of Southeast Asian porcupines (*H. brachyura*) between 2003 and 2007.

Although overexploitation has caused the decline in a range of taxa in NEPL NPA in neighbouring Lao PDR (Johnson et al., 2006), the Southeast Asian porcupine has shown a greater rate of decline compared to similar species also part of the wildlife trade, such as muntjacs, *Muntiacus sp* (A. Johnson, unpublished data). As well as reports by residents and officials in the local area of NEPL NPA that live porcupines are hunted for sale to farms in Son La province (A. Johnson, pers. comm.), the confiscation from offenders of male/female pairs of porcupines provides evidence that the species is being targeted to meet the demand for founder stock. Fifty-three per cent of Son La farm owners confirmed that wild porcupines originated from populations in Lao PDR. A further 36% thought that wild porcupines were captured in the districts of Song Ma or Sop Cop, but since all respondents in these districts reported there were no, or very few, wild porcupines to be found locally, it is likely that these animals actually originated from Lao PDR, despite being sold by hunters or traders in Song Ma and Sop Cop.

Illegal wildlife trade increases as access for hunters and traders improves (Milner-Gulland and Bennett, 2003; Redmond et al., 2006). The completion of the new road joining NEPL directly with Son La will have facilitated the transfer of hunted animals. Thousands of porcupines are being removed from the NPA to supply the demand from the farms in Son La alone, and there may be a similar situation developing in the neighbouring province of Dien Bien, also joined to NEPL by road. With the increase in demand for founder stock, there is an expanding market for hunters to profit from, and with such high prices, even at source level, the incentives to continue the illegal trade are considerable. Hunters trapping porcupines in NEPL NPA were selling these to traders at US$250 per pair in 2007 (A. Johnson, pers. comm.). Whilst this is lower than the mean sale price to Son La farmers of US$657, it is still a significant source of income, and the sale of just two pairs of porcupines by hunters would meet the equivalent of the GNI per capita of Lao PDR of US$500 (World Bank, 2008b). Punishment for hunters and illegally operating farm owners alike is confisca-

tion of the animals and a fine equivalent to their retail value. For large-scale offenders, this is an inadequate disincentive when prosecution rates are so low, and the sale of just two more pairs of porcupines would cover their losses.

5. Conclusions

Advantages and disadvantages of wildlife farming cannot be applied universally. For instance, whereas in Africa wildlife farming is argued to be an alternative to wild meat, providing food security (see Mockrin et al. (2005)), this is not the case for species farmed in Vietnam. Wild meat in Vietnam supplies a luxury, urban market and as such commands a high value. It is likely that these species will continue to be hunted from the wild as long as populations do not diminish so much as to become unprofitable to the hunters (Mockrin et al., 2005).

Currently, commercial porcupine farming is driving hunting and is thought to be, at least in part, responsible for the decline of wild porcupines in NEPL NPA in adjacent Lao PDR. However well the farms are managed, as long as there is consumer demand for porcupine products, without serious disincentives for the hunters, hunting of the wild populations will continue. Contrary to the claims of proponents of wildlife farmers, the porcupine farms in Son La province are not providing a cheaper alternative, nor are they providing an adequate substitute since meat is still sourced from the wild. Monitoring and enforcement of these farms and the restaurants is inadequate and needs to be addressed to ensure the protection of wild porcupine populations.

Farming wildlife is a growing enterprise in Vietnam and across much of Southeast Asia (WCS, 2008). Wildlife farms have been linked to the decline and extirpation of once-common species such as sika deer (*Cervus nippon*) and Siamese crocodile (*Crocodylus siamenis*) in Vietnam (Polet, 2004). Southeast Asian porcupines are a relatively common species within their distribution range, yet this study highlights that commercial farming could be responsible for a rapid decline in Northern Vietnam. The gaps in current regulations and management found here and in other studies indicate the significant risks to populations of threatened species.

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