Green python *Morelia viridis*

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Background and summary

Green pythons (*Morelia viridis*) are one of the CITES-listed species of snakes most heavily traded for pets. Indonesia is presently the only range state that allows international trade in green pythons, but only captive-bred individuals can be exported because the species is protected under Indonesian domestic legislation. Despite this, large numbers of green pythons are still collected from the wild in Indonesia and exported with a CITES "C" source code. Harvesting for trade is, therefore, a potential threat to wild populations of this species and data are provided herein to quantify the impacts of the pet trade on the survival of this species and provide recommendations for future management.

Species overview

Distribution

The green python is restricted to tropical rainforests in Cape York Peninsula, Australia, and the island of New Guinea, which is divided politically between the independent nations of Papua New Guinea (PNG) (eastern half of New Guinea) and Indonesia (western half of New Guinea, represented by the provinces of West Papua and Papua) (Natusch and Natusch 2011; O'Shea 1996; Fig. 1).

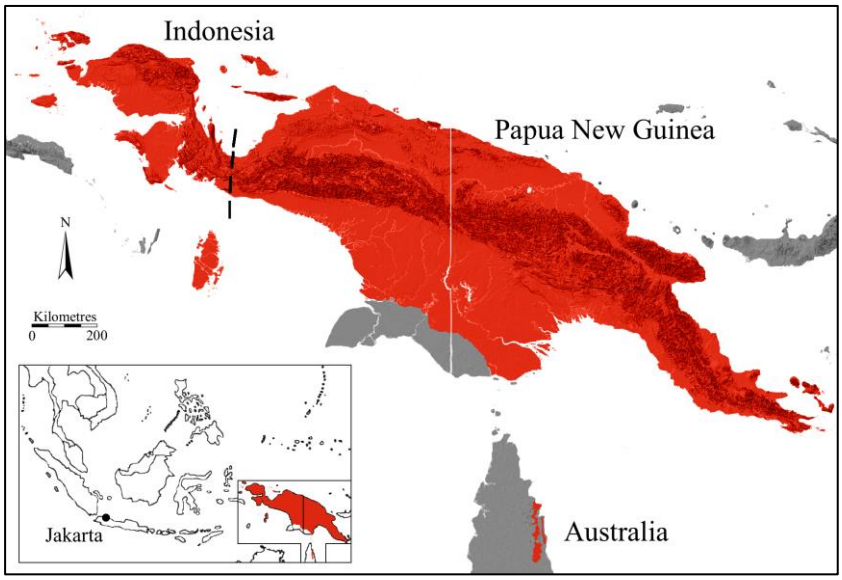

Fig. 1. The distribution of green pythons (*Morelia viridis*) (in red). The dashed line represents the approximate border between the Indonesian provinces of West Papua (left) and Papua (right). It should be noted that green pythons are apparently absent from the higher mountainous areas within New Guinea's central cordillera.

The green python is also found in the Aru Islands, which is bio-geographically part of the island of New Guinea, although it is politically part of Maluku province, Indonesia (Allison 2007). On the island of New Guinea, green pythons are found in lowland and montane rainforests up to 2000 m above sea level, as well as in secondary re-growth areas (O'Shea 1996). In Australia, they are most frequently recorded in evergreen to semi-deciduous

notophyll vine forest, and have not been located in woodlands, swamp, heath or grasslands (Natusch and Natusch 2011). The juvenile yellow morph is present throughout the green python's range, while the juvenile red morph is only found north of the central Cordillera in New Guinea (Natusch and Lyons 2012a).

Basic biology

Green pythons are small (<2 m) arboreal snakes that typically hunt in ambush close to the ground (<1 m above ground level) at night. They are relatively generalist in their diet and display an ontogenetic shift in prey, with juveniles preying on small lizards and adults on small mammals (Natusch and Lyons 2012a). Little is known about the reproductive frequency of green pythons in the wild, though in captivity adult females produce an average of one clutch of eggs each year (Maxwell 2005). Clutch size for green pythons in captivity varies from 10-30 eggs, while the average clutch size of wild individuals is 14 eggs (Natusch unpubl. data). Green pythons are highly recognisable due to their distinctive colouration and pattern, with juveniles born either a 'lemon' yellow or 'maraschino' red colour, later changing to 'lime' green at approximately 65 cm in length (Wilson et al. 2007; Natusch and Lyons 2012a). This phenomenon is known as ontogenetic colour change and can occur over a period as short as four days or as long as several years (Barker and Barker 1994).

There is strong evidence (both morphological and molecular) that green pythons include two distinct species, which are separated by New Guinea's central mountain range (Rawlings and Donnellan 2003; Natusch unpubl. data). The two species are difficult to differentiate and interbreeding is known to occur. In addition to this, green pythons exhibit a number of colour variations depending on their distribution or locality. These forms have been coined "locality types", and are coveted by collectors within the pet keeping community (Natusch and Lyons, 2014).

Table 1. Variables that influence a species' resilience to use and the attributes of green pythons.

Variable	Use resilience key[1]		Resilience of green pythons
	High	**Low**	
Distribution	Broad	Narrow	Broad
Habitat specificity	Broad	Narrow	Medium
Dietary specificity	Generalist	Specialist	Generalist
Reproductive output	High	Low	High
Growth rate	High	Low	High
Reproductive rate	High	Low	Medium
Time until maturation	Short	Long	Short
Population size	High	Low	High
Population density	High	Low	High (in areas studied)
Population connectivity	High	Low	High
Dispersal ability	Good	Poor	Medium
Genetic variability	High	Low	High

[1]For example, if a species' reproductive output is high then it is more likely to have a high resilience to use than a species that has a low reproductive output.

Status and threats

Status

In 2009, the green python was evaluated by the IUCN for the Red List of Threatened Species and classified as a Least Concern species. This status was justified on the basis of its large distribution (Auliya et al. 2009). Indonesia is currently the only country that permits the commercial export of green pythons, but they must be captive-bred, meaning that individuals must be produced using techniques that are demonstrably capable of producing offspring of second generation (F2) (CITES source code 'C'; see CITES 1992). The green python is fully protected under Government Regulation No. 7/1999 (Dilindungi Peraturan Pemerintah Nomor 7 Tahun 1999), meaning no utilisation of protected species in any form is permitted without prior permission. Persons found smuggling and/or mis-declaring trade that is not in accordance with the provision of Government Regulation No. 7/1999 are liable to imprisonment.

Threats

Green pythons are subject to a number of threats, such as habitat degradation and loss, but often the direct impacts of these threatening processes are unknown. Despite wild populations being fully protected, one of the main threats to green pythons is the continued harvest of wild individuals to supply the international pet trade. The main threat posed by this trade appears to be on some island populations, where a combination of small land area, improved accessibility and habitat degradation may be impacting local populations.

Trade characteristics

How trade operates

Based on CITES import data[1] global trade of green pythons totals approximately four thousand individuals annually, with all specimens exported by Indonesia with a captive-bred source code (Fig. 2). However, circumvention of relevant laws within Indonesia results in a great proportion of these individuals being sourced from the wild. A number of green pythons exported are indeed captive-bred, however, the additional costs of breeding can reduce overall profits and the capacity and willingness to breed this species in captivity at a bigger scale is unknown.

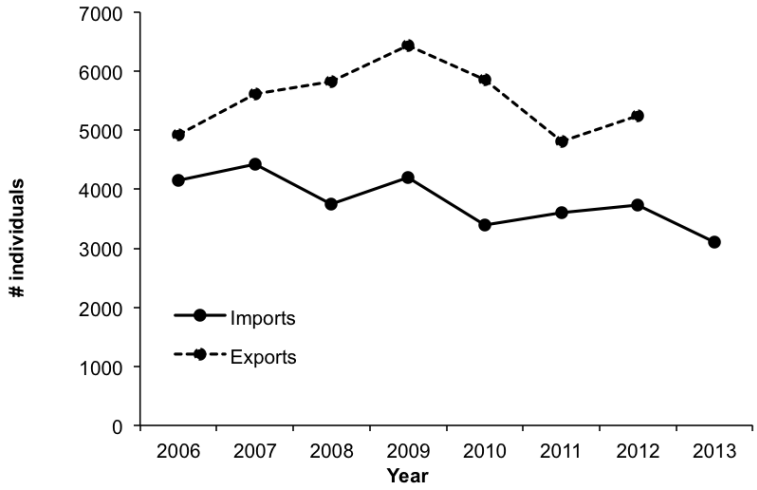

Fig. 2. Gross trade statistics for green pythons between 2006 and 2013. All exports are from Indonesia with a C source code (UNEP-WCMC CITES Trade Database 2015).

[1] Higher export figures are likely due to reported export quotas that have not been realized.

All wild green pythons entering trade originate from the island of New Guinea, with the vast majority coming from the Indonesian provinces of Maluku, West Papua and Papua. Trade operates via a complex trade chain. Depending on the ease of access, green pythons are sold either directly to a provincial trader situated in a major centre in New Guinea, or via a local collector.

Lyons and Natusch (2011) visited wildlife traders in Indonesian New Guinea and recorded the number of wild green pythons collected. These data were combined with estimates provided by traders themselves to give an indication of the number of green pythons harvested annually from each site (Table 2).

Table 2. Trade data for green pythons collected from five localities in Indonesia between August 2009 and April 2011.

Locality	Traders	Times visited	Green pythons recorded	Collected per month	Estimated annual collection
Aru Islands	1	2	123	67	804
Biak Island	1	25	3831	250	2841
Jayapura	3	15	70	40	480
Merauke	2	21	29	9	108
Vogelkop and Raja Ampat	6	31	176	92	1104
Total	13	94	4229	458	5337

Harvest characteristics

The vast majority of green pythons harvested from the wild for the pet trade are collected opportunistically. Local people entering the forest for other activities serendipitously happen across green pythons, which are collected for trade. On rare occasions, during certain times of the year, local people may undertake dedicated trips to collect reptiles, including green pythons, however these are rare. Green pythons are not trapped and there is no known method to collect large numbers in a small space of time or reliably locate individuals within a given area.

Management

Currently there is no management plan for wild green pythons in Indonesia as technically all green pythons exported are “captive-bred”. In Australia and Papua New Guinea green python populations are currently not managed.

Impacts of harvest on wild populations

Methodologies

Lyons and Natusch (2011) visited wildlife traders in the Indonesian provinces of Maluku, West Papua and Papua and recorded the attributes of green pythons harvested from the wild. All snakes collected from the wild were sexed and measured to determine the ratio of males to females and the life stage of each individual. Trips were carried out in 2009 and then again in 2011, allowing elucidation of any changes in the total number of snakes or their attributes among years.

Effects of trade

In total, 4229 green pythons were recorded between August 2009 and April 2011. Most were collected from Biak Island with a smaller number being collected from the four other localities (Table 2). Collection was not biased towards one sex and absolute numbers of green pythons collected over the survey period did not change.

However, the following differences were noted, and may be indicative of a harvest effect:

- On Biak Island, where the largest number of green pythons are collected, the ratio of juveniles to adults collected was very different to that found for other localities (Fig. 3)

- Between 2009 and 2011 the harvest was skewed even further towards juvenile individuals, dropping from 37% adults in 2009 to 21% in 2011 (Fig. 4).

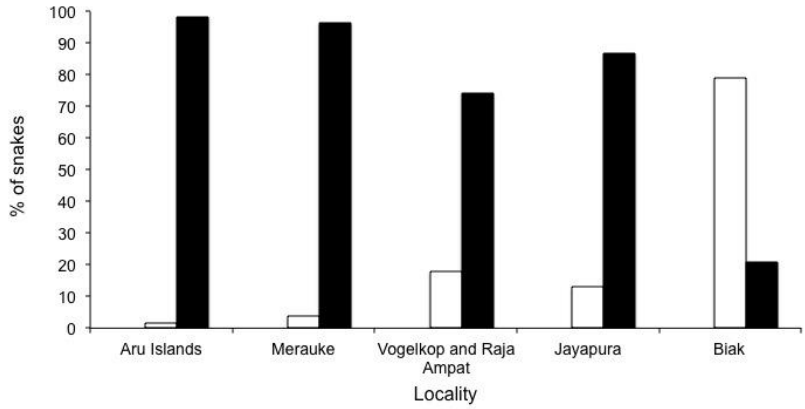

Fig. 3. Proportion of juvenile (white columns) to adult (black columns) green pythons at each site surveyed.

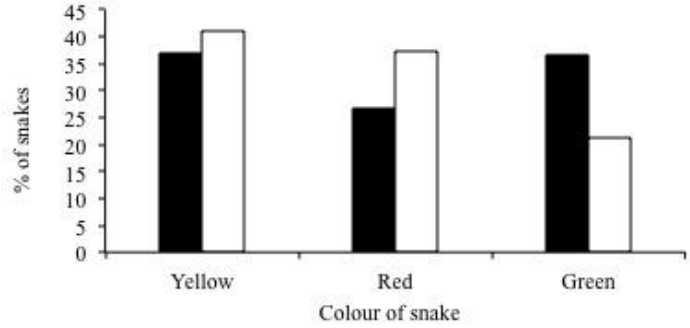

Fig. 4. The percentage of green pythons that were yellow, red and green, collected from Biak in 2009 (black columns) and 2011 (white columns). Yellow and red are juveniles while green snakes are adults.

The trader from Biak indicated that during the 10 years green pythons had been collected, they had become less abundant. Similarly, collectors on another small island in New Guinea, but for which no data were collected, reported that trade has resulted in severe declines in the green python population on that island.

Conclusions

Evaluating the extent to which harvesting threatens wild populations is important for designing adequate regulatory and management strategies. There is little argument that harvesting causes declines in the absolute numbers of individuals in a population. However,

determining whether those declines, and their associated effects (e.g., demographic shifts), affect the sustainability of the harvest or viability of the population is difficult.

The results presented herein indicate that the opportunistic nature of green python collection at most sites does not result in collection biases based on sex or size. However, the large number of juveniles collected from Biak Island suggests that harvesting may have skewed the age composition of the green python population at that site. In support of this view, the single trader on Biak indicated that when harvesting first began more than 10 years ago, a substantial number of large green snakes were collected. More recently however, juveniles are most commonly encountered.

Nevertheless, this does not necessarily indicate that the harvest of green pythons from Biak Island is unsustainable. It is perfectly feasible that the population has stabilised, trade is sustainable, but harvest is now skewed towards juvenile snakes. Although the opposite may also be true, long-term data on the size demographic of the harvest and number of snakes collected are required to evaluate sustainability with any certainty.

It should be acknowledged that while the cost of exporting wild green pythons is lower than keeping and breeding captive individuals' wild collection will continue. Nevertheless, based on the evidence above (and other publications on the harvest of Indonesian reptiles) the best solution for preventing illegal harvest and mis-declaration of wild green pythons may be to allow some trade in wild specimens. Given the broadly generalist life-history traits of green pythons (Table 1), the opportunistic methods of harvest and their very large distribution within intact habitats (Fig. 1), present levels of trade are not a threat to green pythons. Because wild collection is already occurring, permitting some wild harvest will in reality have little additional impact on wild populations.

A more intractable problem than the effects on wild populations may be that captive-bred specimens are often more attractive for the hobbyist market as they are more resistant to health complications and hence easier to keep than wild-caught animals (Auliya 2003). It is thus difficult to anticipate whether consumer demand will be great enough to support a trade in green pythons known to be wild-caught. Nonetheless, because "locality specific" forms of green pythons are coveted within the reptile keeping community, it may be possible to allow the collection of specific geographic forms for premium sale to private collections. Levies from the sale of these snakes could be reinvested in the management of the resource.

Regardless of the path the trade in this species takes, harvesting has been shown to impact this species on small islands. Although not a threat to the overall population, this is of concern because of known diversity within island reptiles in Indonesia. It is therefore paramount that monitoring of the harvest demographic be undertaken on a regular basis to ensure these island populations are not depleted beyond recovery.

Recommendations

The most important recommendation of this review is for Indonesia to realise that, despite legislation preventing the export of wild specimens, harvesting is still occurring. Indonesia can then begin rectifying the problem of illegal trade and implementing positive solutions. Aid from the international community is paramount to assist Indonesia with this endeavour.

This review suggests that there are two major ways forward for improving this trade but they are, to some degree, mutually exclusive:

1) The first recommendation is for the Indonesian Government to allow a legal harvest of wild individuals for trade. While exports of green pythons from Indonesia are occurring it is unlikely that wild collection will stop. It may thus be more beneficial to allow a legal trade of wild specimens, particularly given that current trade does not appear to be negatively impacting the species.

2) The second recommendation involves maintaining the prohibition of wild collection and to instead increase monitoring and enforce current legislation. This may include increased monitoring of breeding farms and wildlife traders in source areas, together with the development of methodologies to distinguish between captive-bred and wild-caught green pythons.

Considerations for the two broad recommendations above are presented in Table 3, together with tools that may assist in the implementation of each scenario.

If mis-declaration of captive-bred specimens is addressed then non-detriment finding for exports of this species is not required.

Table 3. Considerations and tools for the implementation of the two broad recommendations aimed at improving the management and trade of green pythons.

Allowing trade in wild specimens		**Increasing enforcement**	
Positives	***Negatives***	***Positives***	***Negatives***
• Potential for levies from legal trade	• Need to repeal/amend domestic legislation		• Acknowledgement that increased enforcement is unlikely to prevent wild harvesting
• Community benefits through legal trade			• There are presently no techniques available to differentiate between W and C specimens
• Alleviate pressure from international community			• Capacity to increase monitoring and detection may be unavailable
• Knowledge of wild harvest volumes and potential to monitor trends in wild populations			
• Diversification of market through sale of both W and C specimens			
• Possible incentives for protection of green python habitat			
• Legal trade and transport will minimise the number of individuals that die during clandestine transport of illegally collected specimens			
Tools to assist each scenario			
• Allow harvest of animals between a defined (and biologically meaningful) size range, effectively limiting the number of individuals that may be harvested and exported. Size ranges can be manipulated progressively to ensure sustainable trade.		• Use of eggshells to prove that farming operations truly breed green pythons	
• Develop accompanying guide of green python morphs to allow determination of geographic source		• Development of other techniques (e.g., stable isotopes) to differentiate between W and C specimens	
		• Increased monitoring of breeding facilities, exporters and wildlife traders	
		• Provide capacity training on how to more efficiently keep and breed green pythons to reduce financial incentives to export wild specimens	

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