Conservation status and impact of trade on the oriental rat snake *Ptyas mucosa* in Java, Indonesia

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Cover: Oriental Rat Snake in a paddy field (Sragen, Central Java)

Photograph credit: Mark Auliya/TRAFFIC Southeast Asia

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Freshly delivered Oriental Rat Snakes at a collector's premises in Klaten district, Central Java

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EXECUTIVE SUMMARY

The Oriental Rat Snake *Ptyas mucosa* has been used in the international skin trade since the early 20th century. Concern over the effects of trade, notably in Indonesia, and a distinct decline in export volumes at the end of the 1980s, led to the listing of the Oriental Rat Snake in Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) in January 1990.

Following the Appendix-II listing of Oriental Rat Snake, the annual export quota was decreased to 250 000 in 1990 and further to 200 000 in 1992 and 1993. The CITES Animals Committee noted in 1993 that the trade volume in this species reported as originating from Indonesia by importing countries exceeded the volume of exports reported by Indonesia. The Secretariat suspended international trade in the species as a result of this discrepancy.

After 12 years, the ban was lifted in 2005, following fieldwork conducted by the Indonesian Scientific Authority (LIPI) on the biology of the species and the impact of trade. Reports suggest that 50 000 to 100 000 skins and gall bladders, along with 30 to 60 tonnes of meat, were exported annually during the 1993–2005 trade suspension. Despite a lack of substantive population information, the measures formulated by Indonesia for sustainable use of the species were accepted and an annual harvest quota of 100 000 specimens was established. The CITES Secretariat strongly recommended several additional measures to ensure that trade would be conducted in a non-detrimental manner (Article IV).

Subsequently the present study related to the non-detriment finding (NDF) process was conducted by TRAFFIC Southeast Asia. Seventeen Oriental Rat Snake traders were visited (15 in Central Java, two in East Java). Morphometric and reproductive data were gathered, and attempts were made to clarify trade structure and routes, to collate views on population status, and to assess management practice.

Anecdotal evidence from a number of experienced collectors and traders suggests that the species has become less abundant because of excess collection, and that the trade volume over recent years has been maintained by increased collection effort. A trend for slightly decreasing mean snout-vent length in samples of male snakes collected during four periods between 1994 and 2007 is consistent with this. Not all traders interviewed reported declining abundance, and information on variation in population status and distribution pattern still lacks substantial data.

It became evident that none of the management proposals put forward by the Indonesian government to regulate trade in Oriental Rat Snakes were fully operational. For example, although a quota of 100 000 was set for 2007, the majority of traders interviewed (14 out of 17) were unaware of its existence. No marking of skins has taken place and it is consequently impossible to track skins through the trade chain to point of export.

The 12-year suspension of trade in skins of the Oriental Rat Snake appears to have triggered a large, and now well established illegal trade in meat and gall bladders of the species. Three ports in Java currently ship consignments of frozen rat snake meat to China and Taiwan. If this trade, which clearly has the potential to use by-products of the skin industry, is to continue, it is essential that it is regulated and brought within the same management system proposed for the skin trade.

A first NDF workshop on the Oriental Rat Snake was held in August 2007, in Bogor (West Java, Indonesia). Participants from the Scientific Authority of LIPI, the CITES Management Authority and the Director of the Forestry Department (PHKA); the BKSDA, IRATA, stakeholders and NGOs attended. The NDF study indicated strongly that international trade is likely to be unsustainable. Seventeen of the 26 criteria defined in the basic NDF model were considered to be of particular significance. These criteria relate to four major subject areas: legislation and enforcement capacity, distribution and local abundance, reproductive biology, and demography.

A more focused NDF process has been developed that considers:

- the biology and ecology of the species,
- the management of the harvest, and
- monitoring the impact of harvest.

It is likely that due to its biology and ecology the species has a fairly high resilience to harvesting. This study has shown that monitoring (field and harvest) would be crucial in adaptively managing the species's harvest and in allowing a determination that harvest was not detrimental. Much information has come from collectors and traders and a strong collaboration with them should help facilitate monitoring as could collaboration with universities. Further it is of importance to raise awareness among traders and farmers of the species's potential role as a pest controller and thus to recognize the benefit of the Oriental Rat Snake.

The proposed method of making an NDF for the Oriental Rat Snake has focused on Java, the main, or possibly only, exporting island of Indonesia, however the species is found on other islands, including Sumatra.

INTRODUCTION

The Oriental Rat Snake *Ptyas mucosa* is a medium-sized, active, diurnal snake associated with open habitats including agricultural systems; much of the diet consists of amphibians and commensal rodents. The species has a wide distribution through much of Asia, from Iran to China and Southeast Asia, and has been commercially harvested for the international skin trade since the early 20th century (CITES, 2005) (Figure 1). The species is also used in the illegal meat trade to China (CITES, 2005; Saputra, *in litt*., 2008). Under Indonesian legislation, only the harvest of live specimens and skins of the Oriental Rat Snake is permitted – the trade in meat of this species is therefore illegal (cf. below).

The Indian population has been listed in Appendix III of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) since 1984. During the 1980s most specimens in trade originated from Java (Indonesia) and Thailand. The latter banned harvest of the species in 1985, and the distinct decline in export volumes after 1986 from Indonesia was the result of a decreased market demand rather than any negative impact on populations of the Oriental Rat Snake (CITES, 2005). Despite concerns about the level of trade volumes, the Oriental Rat Snake was listed in CITES Appendix II in January 1990 throughout its range for "look-alike" reasons (CITES, 2009b).

All photos by Mark Auliya/TRAFFIC Southeast Asia

Figure 1 a - d: Skinning Oriental Rat Snakes in Central and East Java.

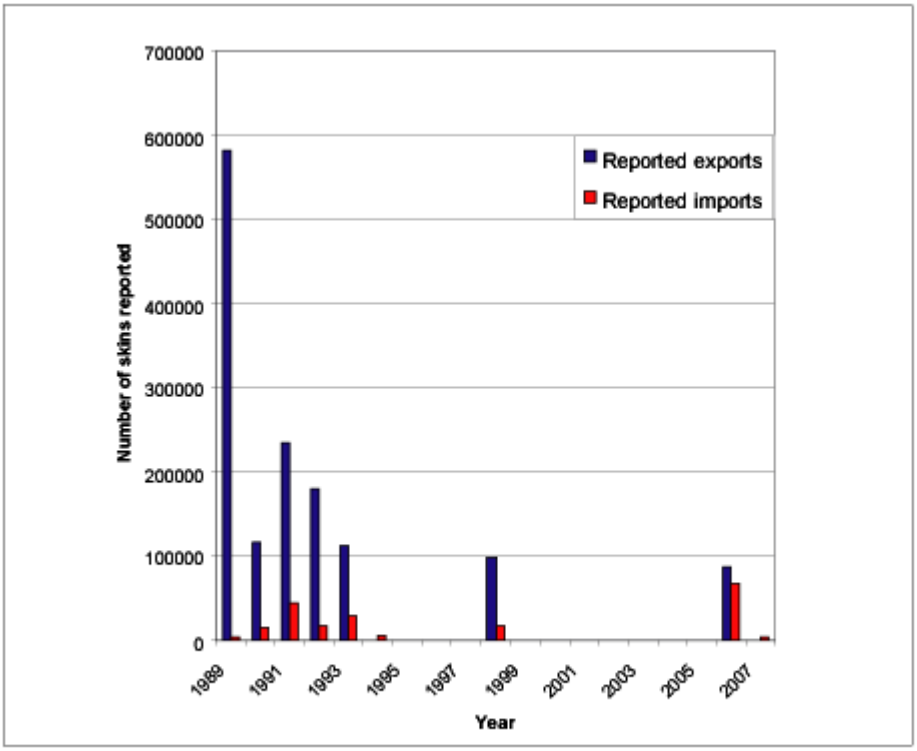
Because of continuing concern the species was among those examined during the CITES Animals Committee's Review of Significant Trade in the early 1990s. As a result it was recommended that the Directorate General of Forest Protection and Nature Conservation (PHKA), the Indonesian CITES Management Authority, should "advise the CITES Secretariat of the scientific basis for its harvest quotas and should introduce a system to ensure that the number of skins permitted for export does not exceed those quotas." In 1993, the CITES Animals Committee indicated that reported imports of the Oriental Rat Snake from Indonesia still exceeded exports reported by Indonesia. Information provided by PHKA to the CITES Secretariat proved insufficient and in 1993 the CITES Standing Committee recommended that imports of the Oriental Rat Snake from Indonesia be suspended. By decision of the Standing Committee an exception was made for 102 289 marked stockpiled skins that were apparently obtained before 30 September 1993, prior to the trade suspension.

In the years following the trade suspension the Indonesian CITES Scientific Authority, the Indonesian Institute of Sciences (LIPI), conducted field studies on the Oriental Rat Snake in an effort to prove that previous trade levels were not detrimental to the survival of the species (i.e. Boeadi *et al.,* 1998; Sugardjito *et al.,* 1998). The trade suspension remained in place until 2005. In May of that year, prior to the 53rd meeting of the Standing Committee, PHKA presented an extensive report seeking to lift the 12-year old trade suspension (CITES, 2005). With the support of the Indonesian Reptile and Amphibian Trade Association (IRATA), PHKA argued that resumption of legal trade would create transparency alongside opportunities for population monitoring, research and adaptive management (CITES, 2005). In 2005 the suspension of imports from Indonesia was withdrawn at the Fifty-third meeting of the Standing Committee after the Secretariat and Standing Committee were satisfied with the control measures proposed by the CITES Management Authority (CITES, 2005). As recommended by the CITES Secretariat, a cautious annual quota was established for 100 000 specimens. Further stipulations included (a) marking of skins, (b) monitoring programmes (based on catch per unit effort (CPUE), size sex ratio, etc.) to enable effective management, (c) field surveys, (d) trade controls through a permit system along a chain of custody, (e) awareness raising activities for relevant official agencies, commercial sector and other stakeholders, and (f) efforts to build broad consensus to support PHKA. The annual harvest quota of 99 500 skins and skin pieces and 500 live specimens was maintained for 2007 (CITES species database, 2007) but reduced to 89 500 skins and 450 live specimens for 2008 (CITES species database). Of the entire harvest quota the export quota is 90% of the harvest with the remainder for domestic use (CITES, 2005).

Figure 2 shows the export and import volume, as reported by CITES Parties, of Oriental Rat Snake skins originating from Indonesia. The large export of skins permitted by PHKA within the period of trade suspension was composed of 99 058 stockpiled skins. According to IRATA in 1999 export permits for 102 285 specimens were issued. The 99 058 skins were exported in 1999, while the remainder was exported in the first quarter of 2000. If Indonesian CITES exports permits are issued end of December, the latest shipment date is the end of the first quarter in the coming year, end of March. (Saputra, *in litt.,* 2008, 2009). Figure 2 as well excludes transactions reported in terms of "belts", "pairs of shoes", "leather items" and "leather products", although the majority of trade reported from Indonesia is in skins. Also excluded are lower numbers of live snakes reported as imports to China, comprising some 3000 individuals plus shipments reported in terms of weight (11 500 kg, estimated to equate to 13 000 individuals).

In 2003, the CITES Secretariat, with the assistance of TRAFFIC Southeast Asia, conducted two regional workshops for CITES authorities in Southeast Asia under its "CITES and Science" capacity-building programme. During these workshops, it became clear that there were very few, if any, examples in the

Figure 2
CITES-reported imports and exports of Oriental Rat Snake skins from Indonesia (1989–2007). Leather products and small numbers of live individuals have been omitted from this graph. Reports for 2007 were not complete at the time this graph was produced. ***[Note: Two transactions were omitted in this database, where the import unit was defined as 42 and 131 square meters. The transaction of 1999 refers to the stockpiled specimens (cf. text). Legal trade was suspended in the period 1993 to 2005.]***



region of effective management for sustainable trade in species in CITES Appendix II (although a relatively recent study of the trade in the New Guinea Freshwater Crocodile *Crocodylus novaeguineae* in Papua province, Indonesia, suggests that despite extensive harvests, populations may be stable (Kurniati and Manolis, 2004)). Countries in the region have often been subject to recommendations with regard to potentially unsustainable levels of export identified during the Review of Significant Trade in Appendix II species. Article IV of the Convention specifies that, in addition to verifying the legal provenance of CITES specimens, the impact of trade on wild populations must be evaluated to ensure exports are sustainable. Investigations enabling a 'non-detriment finding' (NDF) must be conducted prior to the granting of export permits for international trade. As yet there is no single standard NDF process, however, baseline population assessment, monitoring mechanisms capable of detecting the impact of harvesting, and presence of responsive management tools are implicit elements. The information document (CITES, 2005) prepared by PHKA includes a "Proposed NDF Assessment Process", which is based on four main components: management, monitoring, biology status and protection.

Information gathered for the NDF process can subsequently be employed to help set an annual level of harvest and trade (quotas) and to enable adaptive management responses to control the source-to-market (or point of export) chain of custody. This task is the technical responsibility of the CITES Scientific Authority in each country, which should then advise the CITES Management Authority on the appropriate levels of trade that can be permitted.

Objectives

Attempts to manage the large trade in Oriental Rat Snake skins exemplify many of the challenges involved in the NDF process when focused on biologically poorly known species in developing countries. This study aims to clarify some of the key issues and suggest steps forward that can improve trade management and have potential wider applicability.

In collaboration with the IUCN Species Programme, TRAFFIC aimed to test and help refine the NDF methodology proposed by the Indonesian Scientific Authority in their assessment of the Oriental Rat Snake, in particular to evaluate the proposed NDF process in the light of new findings obtained by this study. It is hoped that new information gathered will contribute to a robust trade management programme designed to allow Indonesia to continue international trade in the Oriental Rat Snake without detriment to the species and its habitat.

More specifically, this study aimed to:

1. Provide current views on the taxonomic status and nomenclature of the species
2. Identify the distribution pattern and abundance of the species on the island of Java
3. Outline the reproductive biology of the species
4. Gain an understanding of general ecological aspects of the species
5. Assess the harvest and trade impact in selected locations
6. Gain information on current trade dynamics, e.g. price fluctuations, trends and trade routes
7. Understand monitoring and law enforcement systems along the source-to-market chain
8. Assess the extent and impact of the illegal harvest and export.

On the basis of information gathered, and in close cooperation with LIPI, management tools are recommended for the design and implementation of an NDF method for the Oriental Rat Snake.

MATERIALS AND METHODS

Individuals with different roles and at different levels in the Oriental Rat Snake trade chain were questioned on various topics, including: business data, staff numbers, snake habitat use or reproductive traits. Responses helped to establish the level of experience and expertise at the different premises.

Based on information from previous studies (Boeadi *et al.*, 1998; Sugardjito *et al*., 1998) and provided by IRATA and LIPI staff, data collection for this study was conducted in Central Java during the dry season in May and June 2007. In addition, the premises of two collectors in East Java were visited during November 2006.

Fifteen traders in Central Java were interviewed using a standardized questionnaire while the two collectors interviewed in East Java were presented with a slightly different questionnaire. A further interview was conducted with the chair of IRATA at the time of writing. Where possible, staff of the local Natural Resources Conservation Agency (Balai Konservasi Sumber Daya Alam, BKSDA), and former staff of LIPI accompanied the TRAFFIC researcher. Prior to these visits, the project was introduced at the BKSDA offices in Surabaya, Yogjakarta and Semarang to request further official (travel) documents and to collect additional advice on the current status of active traders in the region.

At premises with live Oriental Rat Snakes in stock, body sizes of 60 specimens (40 live, 20 dead) were measured for total length (TOL), snout-vent length (SVL), tail length (TL) and body mass. Twenty of these at one collector's facility were scored for sex and reproductive condition.

The following categories of personnel involved in the trade were recognised: (1) harvesters, those who capture snakes, (2) collectors, including small-scale collectors who gather the snakes from the harvesters and the large-scale collectors supplied by the former, (3) exporters, who receive the snakes from the large-scale collectors and supply the international market with snake skins. The term "traders" is used in this report to refer to any of those involved in the trade at any level in this hierarchy.

Further information was derived from the following existing data sources:

1. Trade data derived from the CITES Trade Database (CITES, 2009a)
2. Tabulations on morphometrics and reproductive activity of both sexes of Oriental Rat Snake (Boeadi, *et al*., 1998)
3. Snake traders (only secondary data) monitoring report of Gunung Kidul region provided by the BKSDA Yogjakarta, with information on the Oriental Rat Snake
4. Reptile trader list provided by LIPI (Bogor)
5. Literature on the Oriental Rat Snake and other relevant species

As was indicated, field data were collected at different locations in Java during the dry and onset of the wet season. Therefore the information collected presents an indication of the current trade situation of the study species but also reveals a highly complex trade pattern. Capture localities of specimens analysed at traders' premises are difficult to specify, hence morphometrical and biological data may refer to more distant populations than those occurring in the hinterland of one trader. Aside from that, the information provided through the interviews was contradictory in many ways, and thus explains the difficulty in analysing these data-sets. However, the information collated does provide a good guideline for more in-depth follow-up field studies.

RESULTS AND DISCUSSION

Biology of the Oriental Rat Snake

The next sections summarize published information. In subsequent discussion of morphometry, biology and ecology of the Oriental Rat Snake, published material is typically extended with new information from fieldwork in the present study. Important work has already been carried out on the biology of the study species in Central Java (Boeadi, *et al*., 1998) and this is drawn on for the development of a method to assess whether the impact of trade is detrimental to this species.

Nomenclature

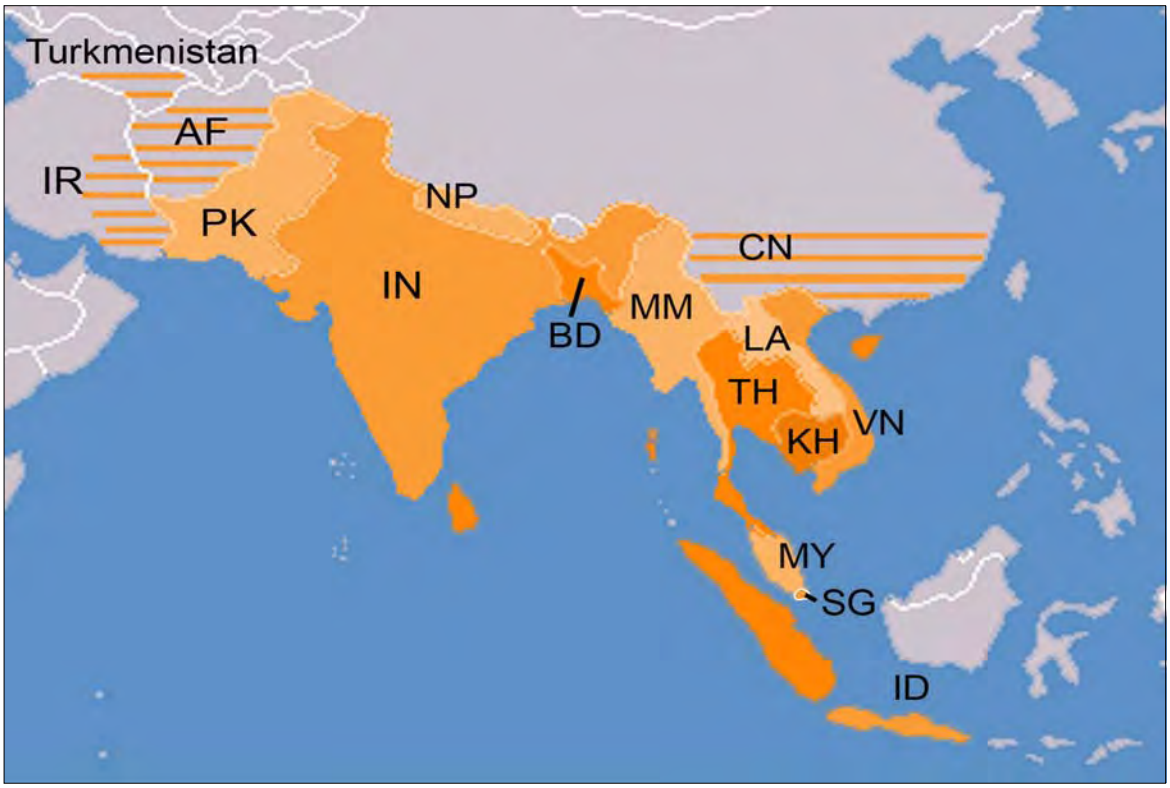
David and Das (2004) noted that the gender of the genus *Ptyas* is feminine while the then accepted specific epithet *mucosus* is masculine. In accordance with the International Code of Zoological Nomenclature (ICZN), the species name has been amended to *Ptyas mucosa*. Prior to this change the synonyms *Zaocys mucosus, Coluber mucosus* and *Ptyas mucosus* have been applied at different periods during the 20th century. However, the Appendices of CITES still use *Ptyas mucosus* (CITES, 2009c).

The related and similar species *Ptyas korros* is present in much of the geographic range of *Ptyas mucosa*, including on Java. Following Hodges (1993), the more widespread *Ptyas mucosa* is assigned the English name "Oriental Rat Snake", while *Ptyas korros* is named "Indo-Chinese Rat Snake".

Geographic distribution

The Oriental Rat Snake has an extensive geographical distribution in Asia. From west to east, it occurs in Iran, Turkmenistan, Afghanistan, Pakistan, India (incl. Andaman Isl.), Sri Lanka, Nepal, Bangladesh, Myanmar, China (incl. Hainan and Hong Kong), Thailand, Lao PDR, Cambodia, Viet Nam, Malaysia, Singapore and Indonesia (Manthey and Grossmann, 1997) (see Figure 3). All range States except Turkmenistan are Parties to CITES.

Figure 3
Geographical distribution of the Oriental Rat Snake.



In Indonesia, the species has been recorded in Sumatra, Bali, Bangka Island and Java (de Haas, 1950; David and Vogel, 1996; Iskandar and Colijn, 2001) and may occur in Kalimantan. Within the country, the Oriental Rat Snake appears most common on Java (Hodges, 1993), particularly in seasonally dry habitats of the centre and east. The climate of this part of Java is strongly influenced by the dry southeast monsoon winds originating from Australia; as a result much of this sector is seasonally dry and receives less than 100 mm rainfall/month over a period of five to eight months. The annual dry season here also tends to be highly variable between years, lasting between one and nine months, and may produce severe drought. Lowland areas in West Java receive distinctly more rainfall (Whitten *et al*., 1996).

Regional capture quotas for Oriental Rat Snake are lowest in West Java and highest in Central Java and East Java (Saputra, *in litt*., 2008) (cf. Table 5), however, the status of populations in West Java requires investigation because traders are well established in the province (Mumpuni, *in litt.*, 2007). In western Bali, the Oriental Rat Snake is reported in areas up to 100 m altitude (McKay, 2006). Distribution records are provided by Boeadi *et al*. (1998) and Sugardjito *et al.* (1998).

Morphology and Growth

Several authors have reported on morphometry, colour pattern and scalation characteristics of the Oriental Rat Snake (Cazaly, 1914; Biswas and Sanyal, 1980; Manthey and Grossmann, 1997; Lim and Lee, 1989). Characteristics are summarized below.

Colour pattern. — In general the dorsum of the Oriental Rat Snake is described as yellowish, greyish, olive to brown, posteriorly with black bands (Figure 4). The labial scales, chin and throat are whitish and framed black (Figure 5a). The belly is whitish to yellowish or greenish. The posterior ventrals and subcaudals are edged black or show a black fleck resulting in a dotted row along the ventrals. In juveniles, the anterior body shows light pigmented bands or cross-bars on an overall faintly olive coloured body. Juveniles in at least parts of the range show a distinct, bright green colour.

All photos by Mark Auliya/TRAFFIC Southeast Asia

Figure 4: Left: Two colour morphs of the Oriental Rat Snake. Right: A skin of the Oriental Rat Snake showing the darker bands across the body with the yellow belly scales on both sides.

Body size. — A maximum TOL of 4 m has been reported; however, generally the largest wild specimens measure 2–2.5 m. TL is ± 1/5 to 1/3 of the total. Mean body mass of 60 specimens (both sexes) was 877 g. Hatchlings measure ± 37–47 cm in TOL, and body mass is ± 15.5 g.

Head and scales. — The large eye and golden iris is distinctive. The head scales are characterized by one preocular (two in populations from India and Myanmar), one small subocular; two postoculars; three loreals, eight to nine supralabials of which the 4th and 5th enter the orbit, and 10 infralabials.

Mark Auliya/TRAFFIC Southeast Asia

Figure 5a: Head profile of the Oriental Rat Snake. Characteristic are the dark pigmented lip scales (labials)

Mark Auliya/TRAFFIC Southeast Asia

Figure 5b: Head profile of the Indo-Chinese Rat Snake. Lip scales (labials) are uniformly coloured lacking dark pigmentation

Body scales. — 17 midbody scales (posterior dorsal scales are keeled), 187–213 ventrals (196–208 in populations from India and Myanmar), 95–146 subcaudals (108–134 in populations from India and Myanmar) in two rows and paired anal scales. A specimen from the Andaman Islands had 198 ventrals and 117 subcaudals.

In Java, both the Oriental Rat Snake and the Indo-Chinese Rat Snake are harvested. The two species are similar in appearance and traders are believed to export the Oriental Rat Snake as the Indo-Chinese Rat Snake, not listed by CITES (Saputra, *in litt*., 2008). Key characters of the two species were listed by van Hoesel (1959) (see Table 1 and Figure 5a,b).

In the present study, morphometric data on 60 specimens were obtained (20 dead, 40 live) (Figure 6). Sex identification and data on reproductive status were obtained from dead specimens; body measurements were taken from both living and dead specimens. Results showed:

Table 1
Distinguishing characteristics of the Indo-Chinese Rat Snake and the Oriental Rat Snake (modified after van Hoesel, 1959)

	Ptyas korros	***Ptyas mucosa***
Head	• labials not black-edged	• labials black edged
Dorsally	• predominantly olive-brown, no blackish transverse bands on posterior body	• predominantly brown to blackish
	• back is not ridged	• blackish transverse bands on posterior body and tail
		• distinct vertebral ridge
Chin and belly	• yellowish white	• scales edged with black
Juveniles	• transverse rows with whitish spots	• light transverse bands on anterior body
Average total length	• 150 cm	• 250 cm

1. The total length (TOL) of the 40 living specimens ranged from 150–239 cm. The snout-vent length (SVL) ranged from 110–180 cm (mean = 145.2 cm; SD = 16.6 cm), and TL ranged from 28–59 cm (mean = 48.3 cm; SD = 5.4 cm).
2. Of the 20 dead specimens, four were identified as females and 16 as males, however as illustrated in Figure 7 due to the small sample size a sexually dimorphic trend in length can not be established.
3. The SVL of the 16 male specimens ranged from 118–157 cm (mean = 133.9 cm; SD = 10.9 cm), and TL ranged from 42–54 cm (mean = 47.4 cm; SD = 3.8 cm).
4. The SVL of four female specimens ranged from 110–145 cm (mean = 131.2 cm; SD = 14.9 cm), and TL ranged from 42–54 cm (mean = 46.7 cm; SD = 6.3 cm).

Figure 6
Relationship of tail length (TL) and snout vent length (SVL) of the Oriental Rat Snake (n = 60). Specimens were examined at five traders' premises. Blue dots indicate males, red dots females. Black dots indicate live, unsexed specimens. (Arrow indicates a specimen with a blunt tail). Date: May 2007

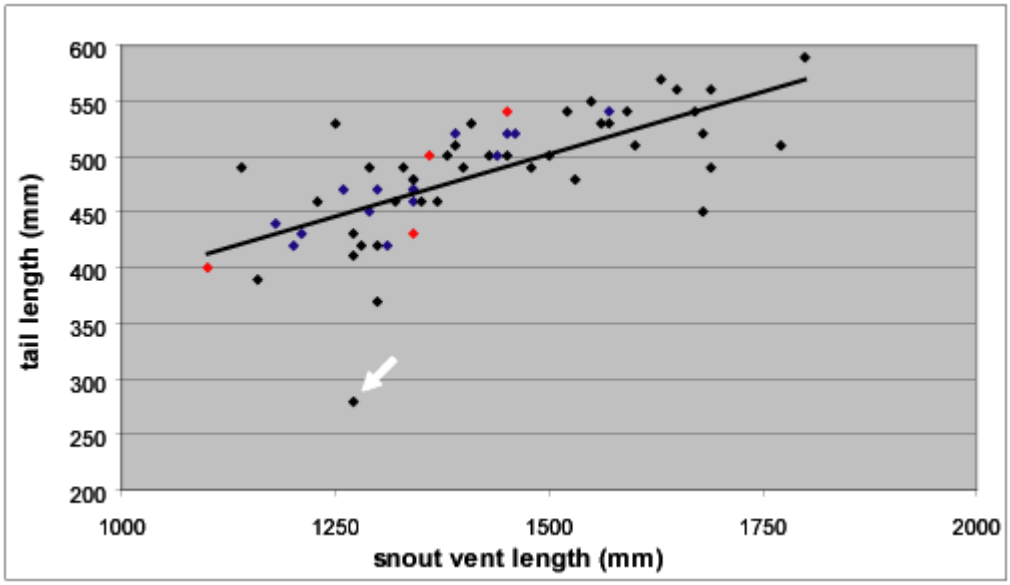
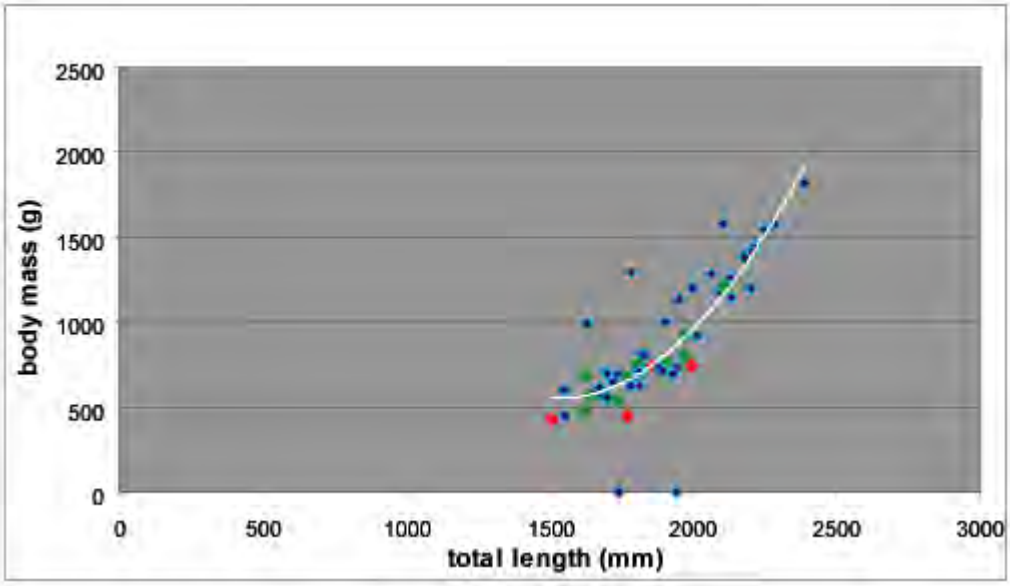


Figure 7 demonstrates the strong correlation between body mass and TOL. The low sample size does not reveal any strong sexual dimorphism. Mean body mass was 877 g; SD = 375 g.

Figure 7
Relationship of total length (TOL) and body mass of the Oriental Rat Snake (n = 60). Green dots indicate dead males and red dots dead females. Blue dots indicate specimens measured alive



For comparison, additional morphometric data relating to populations in Central Java are provided (Table 2). These derive from field studies conducted by LIPI between 1994–1998 (Boeadi, *in litt*., 2007). All measurements were obtained at the premises of traders.

Table 2
Size relationships of female and male Oriental Rat Snakes over a 13-year period. Measurements in cm. SVL = snout-vent length; SD = Standard deviation. SE = standard error. Data were gathered from wild-captured specimens at the premises of traders (Boeadi, *in litt.*, 2007)

PERIOD	Dec 94 - Jan 95	Dec 94 - Jan 95	Oct 96 - Nov. 96	Oct 96 - Oct 96	Jun-98	Jun-98	May-Jun 07	May - Jun 07	May - Jun 07
Sex	♀	♂	♀	♂	♀	♂	♀	♂	♀ and ♂
Sample size	n=42	n=49	n=32	n=53	n=102	n=113	n=4	n=16	n = 40
SVL (mean)	135.8	144	125.8	139	137.7	136.7	131.2	133.8	145.2
SVL (SD)	9.4	16.6	14.4	18.1	9.8	15.1	14.9	10.5	17.3
SE	1.45	2.38	2.54	2.49	0.97	1.42	7.45	2.63	2.74
TL (mean)	47.3	50.7	44.6	48.2	45.7	48.2	46.7	47.4	48.8
TL (SD)	3.3	6	8.1	8.1	4.2	5.3	9.6	3.7	11.6

Sample sizes were not consistent over the 13 year period represented, neither were the sampling periods (Table 2). The data as plotted in Figure 8 show some evidence of a declining trend in the mean SVL of males during the period.

Figure 8
Mean SVL and SE of female and male Oriental Rat Snakes over a 13-year study period (also cf. Table 2)

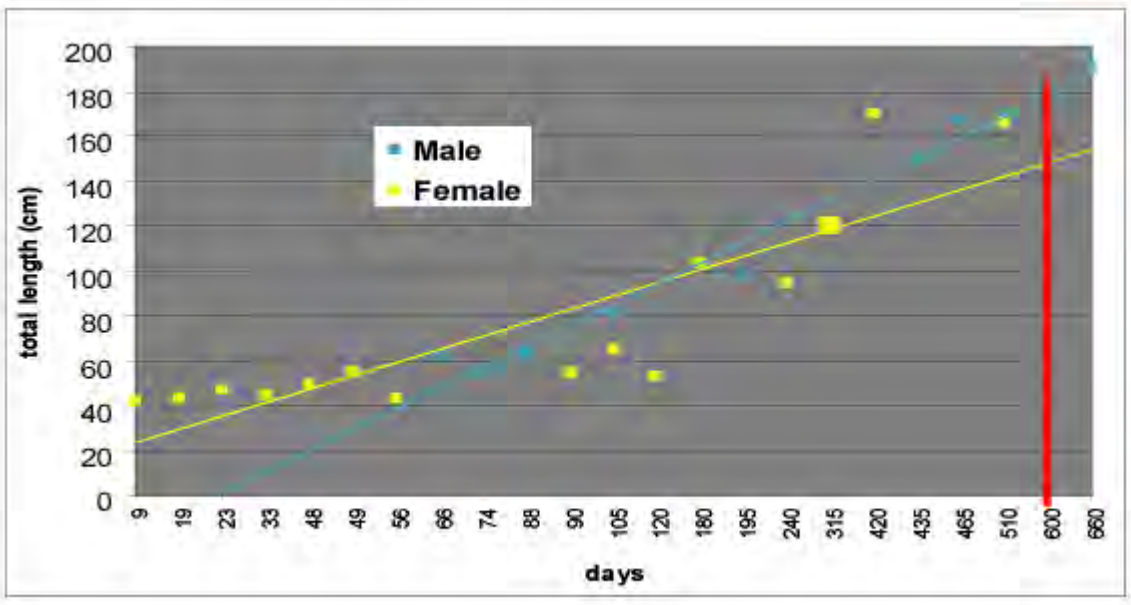
Sexual dimorphism. — Males tend to have larger heads, a longer body and a larger body mass than females (Boeadi *et al.*, 1998). The ability among traders to identify the sex of specimens is of interest in relation to collection pressure and the potential impact on population structure if collection bias exists. Seven traders were unable to indicate morphological sex differences of the Oriental Rat Snake, whilst the remaining 10 collectors appeared aware of key differences (Table 3).

Table 3
Sexual dimorphism in the Oriental Rat Snake as reported by traders

	Females	Males
Tail	• Thin	• Thick
	• shorter tail	• wider tail base
		• longer tail
Body	• more fat	• thinner more elongate
	• distinct transition from body to tail	• evenly elongate and no distinct transition from body to tail

Growth. — Kopstein (1938) provided growth data on captive raised specimens (Figure 9). Hatchlings measured between 39 and 47 cm. Three and a half months after hatching a male specimen measured 80.5 cm, and two females 65 and 65.3 cm. By 10.5 months a female measured 120 cm. By 17 months, two males measured 168 and 172.5 cm and a female 166 cm. In Figure 9, the yellow regression line reflects the growth data for females and the blue regression line that for males. The enlarged yellow square reflects the female size at maturity according to information of most traders (cf. text below). The red line indicates size in both sexes at 20 months, approximately the age of maturity in captivity according to Kopstein (1938). This discrepancy may be because growth conditions in captivity inevitably differ in many respects from wild conditions. Currently the preferred skin length in trade is 140 cm (see below); this might be attained three to six months after maturity, using traders information (with males growing more rapidly than females), or a similar period before maturity, using Kopstein's data.

Figure 9
Growth data for female and male Oriental Rat Snakes. Source: Kopstein (1938). The red line indicates size in both sexes at 20 months, approximately the age of maturity in captivity according to Kopstein (1938)



Reproduction

Information on the reproductive biology of the Oriental Rat Snake is required in order to assess the potential reproductive rate of the species, e.g. in relation to harvest levels. Clutch size ranges from six to 18 eggs. The incubation period is between 60 (Lim and Lee, 1989) and 92 days (Kopstein, 1938). According to Kopstein (1938), 55% of eggs in nine clutches hatched. Of 36 specimens hatched in captivity, there were 13 males and 23 females (1:1.7). Of 60 specimens captured in the wild, there were 25 males and 35 females (1:1.4). In captivity, both sexes mature at around 20 months (Kopstein, 1938) (see Figure 9).

On Zhoushan and associated islands of China, with a sub-tropical monsoonal climate regime, the egg-laying period is in mid to late July, during the hot and humid season (Helin *et al*., 1988). According to Kopstein (1938) and Saint Girons and Pfeffer (1971) the Oriental Rat Snake on Java is reproductive all year round. The males are sexually active from the beginning of June until approximately November.

Twenty out of 42 females (48%) examined in Central Java were reproductively active during the period Dec. 1994 to Jan. 1995. Nine females were found to have oviductal eggs. In the period Oct to Nov. 1996, 17 of 32 (53%) of the females collected were reproductively active with seven carrying oviductal eggs. Clutch size ranged from seven to 25 eggs (averaged at 13.0; SD = 4.0) according to the number of oviductal eggs or vitellogenic ovarian follicles in 37 reproductive females. Clutch size was not significantly correlated with female total length (Boeadi *et al.,* 1998).

Kopstein (1938) reported that one female laid one clutch of eggs on 13 October and a second clutch on 11 December, nine eggs on both occasions (captive conditions). The period of internal gestation has been reported to last 59 days (Kopstein, 1938).

The reproductive pattern of the Oriental Rat Snake appears to be distinctly variable across the range as a whole (Saint Girons and Pfeffer, 1971). Further information on geographical variation in reproductive cycles could help implement regional harvest quotas.

The following material is based on the results of the present study. These findings are compared to published information.

Maturation. — Most traders claimed knowledge of the size of individuals at maturation. According to one collector; the smallest females containing eggs measured ± 110 cm TOL. Six traders independently reported that females mature at ± 120 cm TOL whilst three others stated that females mature at 115 and 125 cm TOL. One exporter reported that females mature between 130 and 140 cm TOL. The most detailed information was provided by a collector and snake charmer with over 30 years of experience collecting Oriental Rat Snakes and other reptiles. He stated that both sexes of the study species mature at ± nine months, at ±120 cm TOL, however he did note that on occasion immature females at 125 cm can be observed, and that females usually mature earlier than males.

In summary, according to traders female body length at maturation is in the range 110–140 cm (average around 120 cm). Maturation in females may be reached in nine months. However, according to Kopstein (1938) one captive raised immature female reportedly measured 120 cm after 10.5 months, but in captivity would not be expected to attain maturity for another 9.5 months, as the author stated (cf. above).

It is not clear whether maturity is typically attained later in captivity, or whether there is geographical or temporal variation. In this context it may be mentioned that studies on the long-term impact of trade on Nile Monitors *Varanus niloticus* in northern Africa showed that populations under constant pressure began to attain sexual maturity at an earlier age and smaller size (de Buffrénil and Hémery, 2002). Similar adaptations to a regular trade impact in other squamates particularly in euryecious species may be expected.

General reproduction activities. — Not all traders were able to provide information on the breeding cycle of the species. In general the reproductive season was reported to be in January/February, July and August. However, three collectors reported that the species reproduces twice a year, during the dry season (approximately between April and August) and wet season (approximately between November and February). One collector stated that there is no distinct reproductive season and another mentioned that gravid females can be recorded within a three month period (this would in fact mean that eggs can be laid four times a year), while another collector stated that the breeding season commences by the end of the wet season. This information and that available through previous studies together with published material, was collated in an attempt to illustrate the annual pattern of reproductive behaviour (Figure 10). As all these results refer to various populations in Central and East Java associated to different climate regimes, the varying cycles are extended over a longer period throughout the year.

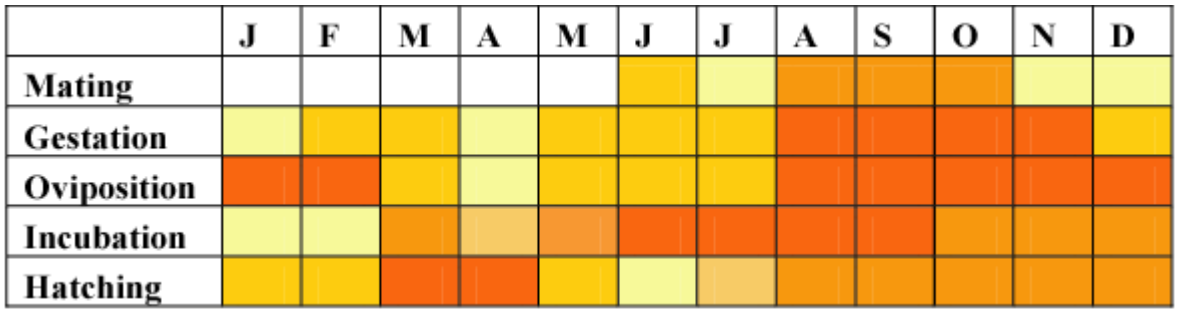
Reproductive cycle. — The mating period was reported by some to be in January, April and May and August to October. The oviposition period was reported to be in January and February and the snake charmer reported that the hatching period occurs in March and April, the gestation period lasts two and a half months and the average incubation period is about 35 days. Published information on captive raised specimens (see above) indicates that the gestation period is two months and the incubation period two to three months.

Some traders provided information on the period of egg deposition, but in some cases the same individuals gave information that was not consistent with views already given on the breeding season. Eight traders mentioned a marked annual oviposition period between September/October and February, during the wet season. One stated that there are two oviposition periods, one during the wet season in November/December and another at the end of the wet season in February/March (cf. Figure 11). Another collector also reported that possibly there are two annual egg laying seasons. According to two traders, the oviposition period lies in the dry season March to June and one harvester in East Java reported that the Oriental Rat Snakes lay their eggs in June. Four of the collectors commented that the study species does not have a distinct oviposition period but may lay eggs all year round. Kopstein (1938) found that nine gravid specimens from Central Java laid their eggs from June to February, with a distinct peak (six females) laying their eggs between October and December during the wet season.

Oviposition sites. — Five traders could not provide any data, but the majority reported that eggs are usualy found usually in rodent burrows. Other similar cavities are also selected for egg laying, e.g., cracks in soil, inside rotten logs, haystacks, piles of organic waste, in bamboo root systems or around rice fields.

Clutch size. — Out of 17 traders questioned, only two (large-scale collectors in East Java) were unable to provide any data regarding clutch size. The remainder either provided range sizes, approximate values or one distinct value of the amount of eggs detected in one clutch. Reported clutch sizes range between seven and 30 eggs (mean = 15.47; SD = 6.3).

Figure 10
Reproduction cycle of the Oriental Rat Snake in Central and East Java. The emphasis of the single reproductive behavioural traits is marked where each colour is brightest. For comments on variations of this cycle see above



Overall, information derived from traders was somewhat inconsistent but tends to suggest that reproductive activities are associated with the seasons, and given the greater humidity and lesser seasonality in the west compared with the remainder of Java, significant differences in breeding activity may be expected. According to Fitch (1982) a short and discrete annual breeding season is typical for tropical snakes in sharply seasonal climates, with one or more dry seasons in the annual cycle. Some information from traders on Java is consistent with this; however, a shift towards the wet season may occur. Reproductive activity may also be promoted by regular food intake; hence one female may reproduce twice a year under suitable environmental conditions. It seems there may be more than one breeding season among Oriental Rat Snake populations on Java, and this intraspecific geographic variation in reproductive cycles may be as variable as the climatic microgeography of the island. Zug *et al.* (1979) pointed out the potential diversity in reproductive cycles at a single site and the potential of a species for modifying this pattern at different locations.

All photos by Mark Auliya/TRAFFIC Southeast Asia

Figure 11: Eggs of the Oriental Rat Snake found on 23 November 2006 in a bag with several captured specimens (right photo) at traders' premises in East Java

Ecology

Diet. — Rodents are reportedly the favoured prey but a recent study showed that amphibians (Bufonidae and Ranidae) were the predominant prey of Oriental Rat Snake populations surveyed in Central Java (Sidik, 2006). The same study revealed that in addition to amphibians and rodents, lizards, birds and even insects were also consumed. Of the 85 specimens examined, 65 contained prey items. In another study 71% of alimentary tracts contained the remains of frogs, and 14% mammalian fur, presumed to be that of rats (Boeadi *et al.,* 1998). Juveniles prey on frogs and smaller reptiles, and shift to mammalian prey as they grow larger (Lim and Lee, 1989). Local abundance and therefore an increased encounter rate may also be distinct for either adults or juveniles in the dry or wet season (Brown *et al*., 2002). The annual peak abundance of the Oriental Rat Snake's major prey, frogs and rats, also triggers an increased local abundance of the species.

Habitat use. — The diurnal Oriental Rat Snake is predominantly terrestrial and occurs in a variety of agro-ecosystems (Manthey and Grossmann, 1997) (Figure 12). In general, the species is found in open terrain adjacent to forested areas. Arboreal behaviour is believed to be largely associated with resting during the night.

Parts of the range of the Oriental Rat Snake overlap with the Indo-Chinese Rat Snake and where they overlap both species may share the same habitat (syntopic). Both species search paddy fields for prey and find shelter beneath dense vegetation along river banks (van Hoesel, 1959). However, the Indo-Chinese Rat Snake is more closely associated with habitats along water courses than the Oriental Rat Snake (Herklots, 1934).

Traders reported that the Oriental Rat Snake is not strongly associated with wetland habitats. In the wet season, the species shifts to drier areas that do not flood. Traders in the southern part of Central Java stated that the species utilises dry rocky and shrubby habitat in open landscapes. Traders from northern Central Java reported that the species is found in stony and shrubby habitat systems (with black soil), and according to other traders it occurs in dry rice fields, plantations and bamboo.

Harvest of and trade in Oriental Rat Snake and the effect on wild populations

Trade Structure and Dynamics

Harvesting

Two collectors said that the majority of Oriental Rat Snakes were captured in rice fields, orchards and bamboo stands. Collectors typically also hold other snake species harvested for commercial purposes, which are sympatric (occur in the same area) with the Oriental Rat Snake and may in some cases occur in the same habitats (e.g. Reticulated Python *Python reticulatus*, Southern Indonesian Spitting Cobra *Naja sputatrix*, Radiated Rat Snake *Coelognathus radiatus*, Rainbow Water Snake *Enhydris enhydris*, Copper Rat Snake *Coelognathus flavolineata*, Indo-Chinese Rat Snake, Sunbeam Snake *Xenopeltis unicolor* and Masked Water Snake *Homalopsis buccata* (Figure 13a,b).

The Oriental Rat Snake is mainly captured during the day. Some collectors stated that the most suitable time to hunt the species is during their highest activity levels from 9am to midday and 3 to 7pm. Capture

All photos by Mark Auliya/TRAFFIC Southeast Asia

Figure 12: Various habitats the Oriental Rat snake utilises. Top left and right: A typical open agro-ecosystem with maize and sugar cane fields framed with shrubby vegetation along the slopes of embankments and bunds in East Java. Below left: Paddy fields bordered by plantations and forests, right: rocky and open terrain in southern Central Java

during the night is very rare, but occurs in shrubs and trees where the snakes rest. Reportedly the species is active in the late afternoon during the dry season.

The sparse data available suggest a slight preponderance of females over males at hatching (above). Among more knowledgeable traders, nine could provide no information on the sex ratio of harvest but three (one collector established in East Java and two collectors in Central Java) stated that more females are captured throughout the whole year. This view contrasts with the greater occurrence of males in collections from some sample periods (Table 2). According to another collector, males are more active in January to March and females more active from March to June. During the wet season both sexes are more or less equally active with capture rates of each sex approximately the same.

Reported harvest seasons

The Oriental Rat Snake is most commonly encountered during the wet season and capture rates are highest during this period. According to several traders, activity levels increase with the onset of the wet season (the first heavy rains after the dry season). In East Java the wet season typically occurs between December and April and in Central Java between October and December and February to April, depending on the geographical location. One trader remarked that in recent times the onset of both the wet and dry season has been impossible to predict. Other traders also reported that the study species is common in the transition from the wet to the dry season (May and June). However, according to one trader in Central Java, the species is common throughout the year. Higher activity levels were reported either when rainy days change to bright days or on cloudy days after several bright and hot days.

Mark Auliya/TRAFFIC Southeast Asia

Figure 13a: A collection of colubrids harvested for the skin trade. Oriental Rat Snake, Radiated Rat Snake, Rainbow Water Snake, Copper Rat Snake, Masked Water Snake and Sunbeam Snake

Mark Auliya/TRAFFIC Southeast Asia

Figure 13b: Left: Skins of the Rainbow Water Snake, Radiated Rat Snake, Southern Indonesian Spitting Cobra and the Oriental Rat Snake in East Java (left to right).

Only two traders were unable to suggest when during the year the Oriental Rat Snake is less common. Ten traders pointed out that during the dry season (May to August) the species is extremely scarce, and another collector estimated that the capture of the Oriental Rat Snake decreases to 50–60% in the dry season. However this may be in part because during the dry season people work in the rice fields (although such farming activities result in a lesser income than the capture of the Oriental Rat Snake) and therefore less manpower is available to capture snakes during the rice harvest, leading to the conclusion that the study species is less common in trade during the dry season. Another collector said that the Oriental Rat Snake was less common in the wet season and they are not captured owing to the unfavourable conditions.

Mark Auliya/TRAFFIC Southeast Asia

Figure 13c: Indo-Chinese Rat Snake is rolled up and dried in ovens for the TCM trade.

Catch per unit effort (CPUE)

Most harvesters and collectors were able to provide estimates of CPUE. These estimates are indicative only, because numerous extraneous factors potentially affect capture rates. Table 4 collates a number of such estimates. Central Java is subdivided because the abundance of Oriental Rat Snakes varies, e.g. in southern Central Java, abundance is lower than in northern districts of the province.

An assessment of harvest levels of Oriental Rat Snake was published by Sugardjito *et al*. (1998). The results were obtained during two weeks in 1996 and are based on nine sites in Central Java. Estimated harvest levels per hunter and per day were extrapolated to a regional level and annual harvest levels were estimated at 24 671 to 117 551 specimens.

Table 4
Number of Oriental Rat Snakes captured per day and per week by a single harvester (exceptions noted) in Central Java. Actual time in the field is not known

	No. of specimens captured per day	No of specimens captured per week
Provinsi Yogja	-	two to three/five
Provinsi Yogja	-	one to two
Provinsi Yogja	-	two to three or five
Provinsi Yogja	-	four
Provinsi Yogja	-	20 (from more people)
Provinsi Yogja	-	four to five
Southern Central Java	-	five (in 1980–90s), now two
Southern Central Java	occasionally one to three	minimum four
Central/eastern Central Java	one to 10	
Central/eastern Central Java	minimum three	±21
Central/eastern Central Java	one to two	seven
Central Central Java	five (Magellang);	
Northern Central Java	12 (Purwodadi)	
Northern Central Java	two to three	
Northern Central Java		perhaps none in a week

Harvesters

For some individuals, snake catching is their main source of income, and they rely on a number of species in addition to Oriental Rat Snake. One farmer (around 55 years old) reported that he had been snake catching for most of his life and identified at least 10 other farmers in his district who also supplement their income in this way (cf. Figure 12).

Some professional harvesters target snakes during the day and frogs at night. One interviewee noted a decrease in the number of professional snake harvesters, however this may be a temporary consequence of the number of local people otherwise occupied rebuilding after the Yogjakarta earthquake in 2006. Another reported that professional harvesters are only active outside the rice harvest season, implying that commercial harvest represents a seasonal income source. Six harvesters commented that farmers opportunistically harvest snakes, and one said that harvesters tended to be individuals with no land of their own.

Legal trade

Commercial harvesting of the Oriental Rat Snake began in the late 1970s. In 1993 the CITES Standing Committee recommended that imports of the Oriental Rat Snake from Indonesia be suspended which was withdrawn in 2005 at the 53rd CITES Standing Committee.

A small proportion of the Oriental Rat Snakes harvested is used locally. Rural communities occasionally consume snake meat as purported treatment for skin irritations and diseases. One trader reported that the snake meat is only consumed by non-religious people, and a number of traders reported that snake consumption only occurs in urban areas. Small tanneries occasionally buy rejected poor quality skins and produce small leather products for domestic trade.

Reported legal trade according to the CITES trade database is summarised in Figure 2. Most trade from Indonesia has been in skins. According to Indonesian regulations skins must be tanned before export.

One trader claimed that live specimens are not exported and five reported that the skin is exported to Hong Kong and Korea. A collector reported that the majority of specimens are exported, but did not know in what form (skins, live or meat). None of the traders interviewed indicated that the Oriental Rat Snake is captured for the pet trade.

Illegal Trade

Southeast Asian snake species are commonly found in Chinese food markets, and the cross-border trade of wildlife in general is currently on a dramatic scale (Lee *et al.,* 2004). During winters the level of snake meat consumption in China increases as many consumers believe it to have a warming effect. The demand in China for snake meat exceeds local supply during the cold season, and so additional sources of snakes, including Oriental Rat Snakes are required. Indonesia is one of the major sources supplying the demand from China for Oriental Rat Snakes and other species (Saputra, *in litt*., 2008).

According to Saputra (*in litt.,* 2008), the 12-year suspension of imports from Indonesian populations of the Oriental Rat Snake triggered the illegal export of meat with some other traders claiming that during this

time skins were stockpiled. He estimated that 50 000 to 100 000 snakes were exported annually, the equivalent of 30 to 60 tonnes of meat per year and about 50 000 to 100 000 gall bladders (Figure 14). According to traders interviewed, illegal export of meat and gall bladders has continued since the ban on trade was lifted. Export is only permitted in products for which quotas are set, currently skin and live specimens therefore making trade in meat and gall bladders illegal. Many collectors, including those directly involved, stated that the illegal meat trade was very large and some declared that they were not aware that the meat trade was illegal, claiming that they had not been informed and had never seen evidence of any enforcement activities.

All photos by Mark Auliya/TRAFFIC Southeast Asia

Figure 14: Gall bladders of the Oriental Rat Snake (left) and the Southern Indonesian Spitting Cobra (right)

In general snake meat is exported by sea in freezer containers with the volume of the cargo rather than the weight being recorded. There are three ports in Java from which the meat of the Oriental Rat Snake is exported, Jakarta, Semarang and Surabaya either via Haiphong (Viet Nam) to Guangxi (South China) or via Hong Kong to nearby Guangzhou (see Figure 17). At least eleven well established collectors said that they supplied snake meat to one exporter in Semarang. It is believed that those involved in the meat trade may declare smaller specimens of the Oriental Rat Snake as the Indo-Chinese Rat Snake, a species not listed under CITES (Saputra, *in litt.,* 2008); the frozen, coiled-up, skinned or whole specimens cannot be easily identified by the local authorities (see Figure 13c). As it is reported that some export of snakes is of whole (un-skinned specimens), the estimated annual volume of these illegal exports suggests that this is not solely a spin-off from the skin trade, but is a distinct branch of trade, which could have a significant impact on wild populations. Saputra (*in litt*., 2007) stated that whole frozen snakes are sometimes declared as frozen fish.

During the survey for this study at least three traders recommended a temporary ban on the trade in this species. This position is not unexpected, because another temporary trade suspension would probably again trigger the illegal trade of live specimens and products other than skin, resulting in much higher prices. Legal traders fear that an ongoing illegal trade may lead to another ban.

Trade network and activity

The network of traders involved in the commercial trade of the Oriental Rat Snake in Java is very complex.

Snakes are either captured by an experienced person or opportunistically by seasonal rice farmers; however, probably in no case does harvest of this species provide full time annual employment. In very rare cases, Oriental Rat Snakes are killed for local consumption, or simply out of fear.

Harvested snakes may be taken directly to a large-scale collector, or may be captured by small-scale collectors who also skin the snakes and subsequently sell them to other better established collectors. Snakes are also sold live through animal markets to a variety of collectors and exporters. Local animal markets are widespread in the region and are held regularly; market traders are rarely themselves snake catchers. One trader knew 20 collectors selling snakes in a local market. Some large-scale collectors slaughter the snakes themselves, whilst others supply snakes to other large collectors or exporters. However, most of these larger operators slaughter the snakes themselves since they can then profit from selling the skin as well as from the meat separately.

While some traders claimed to know the exact number of collectors active in the region, others provided either rough estimates or no information. The trade has a hierarchical organisation. The small-scale collectors sell their snakes on to the higher level collectors. While some small-scale collectors said they were aware of 50 to 200 snake collectors (who also collect other species of snakes), the large-scale collectors, operating at higher levels in the trade, spoke of five to 10 such collectors. It appears that more collectors were established in the region in the past.

From the information collected at interview, it was evident that the number of people involved in the Oriental Rat Snake trade increases during the peak collecting season (generally in the wet season). However the main determinant of the number of collectors active in the region is the price paid for their services. In Central Java a collector's harvesting area varies according to status; it may be within a 10-km radius from his facility or may even extend to East Java. The biggest collector and exporter of Oriental Rat Snakes in Central Java is located in Semarang.

The majority of raw skins are usually sent to Jakarta where, if entering the legal trade, they are measured and tanned. The smaller specimens are tanned by local craftsmen in Central Java, e.g. in the area of Borobodur, and destined only for domestic use. There are at least five registered exporters of Oriental Rat Snakes in Indonesia, two in Jakarta (Java), one in Makassar (Sulawesi), one in Samarinda (East Kalimantan) and one in Medan (North Sumatra) (see Figure 17).

All 17 traders (harvesters, smaller and larger collectors, and exporters) questioned commenced their business between the 1970s and 2000. The traders interviewed had been active on average for around the past 23 years and nine of the 17 were already active 30 years ago. None of the traders focused solely on the study species, but also traded in e.g., Tokay Gecko *Gekko gecko,* other snake species (see above) and the Sunda Pangolin *Manis javanica* (Figures 15, 16). One purchased whatever snakes were available at animal markets, whilst another reported that his major income was derived from the manufacture of bird cages.

Mark Auliya/TRAFFIC Southeast Asia

Figure 15: The illegal medicinal trade in the Tokay *Gekko gecko* at the premises of Oriental Rat Snake traders in Central and East Java

Mark Auliya/TRAFFIC Southeast Asia

Figure 16: A skin of the Sunda Pangolin *Manis javanica* observed at a trader of Oriental Rat Snakes and Tokay's in Central Java

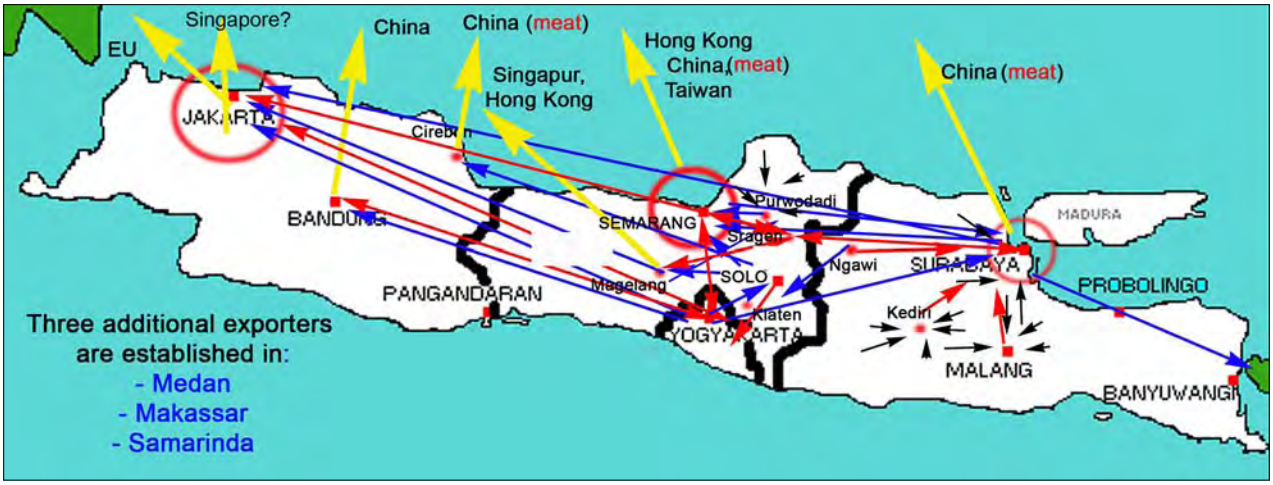
The number of staff employed by the different traders involved in this trade varied significantly and largely depended on the status of each trader. Accordingly, a harvester and small-scale collectors would employ no staff (but may be occasionally assisted by relatives) while the large-scale and well established collectors employed up to 20 staff. On average traders were assisted by five employed staff.

Reported trade routes

Collectors send either live snakes or processed snake skins to localities within Java, both nearby and further afield. Small-scale collectors sometimes take the snakes to the larger traders for sale (Jakarta, Cirebon, Bandung, Surabaya, Semarang, Magelang, Solo, and Bali); however these larger traders may also send agents to both small-scale and large-scale collectors. Some collectors send the skins to Jakarta and Bali, the meat to Semarang and the gall bladders to Bali. One collector sends live specimens only to Semarang, but dispatches skins to Magelang. Semarang is the main domestic destination for skins and also functions as the major port for export of snake meat. Figure 17 illustrates the complex trade routes in Java.

Only one exporter ships skins to Europe, the remainder all ship either skinned snakes or frozen specimens with skins via Singapore (a transit country) and then onwards to China (including Hong Kong). One exporter in Semarang (Java) stated that he does export directly to Taiwan although they probably play a limited role as importers of snake meat because their food quarantine regulations are very strict.

Figure 17: Trade routes of commercially harvested live Oriental Rat Snakes and products thereof on the island of Java, Indonesia. The three major export ports are circled. Arrow size increases from small-scale to large-scale traders



Economic value of the Oriental Rat Snake

Live snakes are usually sold by harvesters to collectors for prices between IDR15 000 and 22 000 (USD1.65 and 2.42) and are sold on by the collectors for IDR17 000 to 24 000 (USD1.87–2.64). The prices for skins only range between IDR13 000 to 20 000 (USD1.41–2.20), hence the range is slightly lower than that of live snakes. Some collectors sell live specimens at higher prices to traders established in Jakarta. In 2002 during the trade ban, Oriental Rat Snake prices were considerably lower; one trader reported he bought live specimens for IDR5000 each (USD0.55) and sold them for IDR7000 (USD0.77).

The exporters in Jakarta stipulate the quality standards such as size or weight of live specimens and skins. Live specimens are categorized into three different weight classes, <600 g, up to 800 g, and >800 g. One trader pays IDR11 000 (USD1.20) for a 500 g snake and sells for IDR12 000 (USD1.31), or pays IDR17 000 (USD1.86) for a >600 g snake and sells for IDR19 000 (USD2.06), and buys >800 g rat snakes for IDR24 000–25 000 (USD2.60–2.71), and sells it for IDR26 000–27 000 (USD2.85–2.96). At the time of writing, the demand in Jakarta is for large individuals with skins at an ideal length of 140 cm long and 11 cm wide. A skin with these dimensions may be sold for IDR18 000 (USD1.95).

Small-scale collectors reported selling one kilogramme meat for IDR5000–6000 (USD0.54–0.65). One well established large-scale collector, who also traded several other reptile species for varying purposes (including the medicinal trade), sells 800 g meat for IDR10 000 (USD1.08), whereas the largest exporter in Semarang buys one kilogramme of meat for IDR10 000 (USD1.08) and sells it for IDR15 000 (USD1.65).

Price fluctuations

Trends in fashion affect demand and price. Currently there is little demand for reptile skin products in the European fashion industry and the price is low. With regard to the meat trade the demand and consumption for snake meat decreases markedly during the hot and humid season in China (April to August). During this time the low demand can be met by local supplies within China and this leads to a distinct drop in prices for Oriental Rat Snake from Indonesia. During the colder period in China (September to March), the reverse is true, and within this period the demand and therefore the price are both high.

Traders made varied comments about price fluctuations. Two small-scale collectors did not comment and four reported price fluctuations but did not give any explanations for these. One large collector in East Java stated that the price has increased slightly during the past few years while another collector in Central Java reported that prices have remained stable over the past three years. One large-scale collector and one exporter stated that price fluctuations correlate with different seasons in different ways: a price decrease during the hot, dry season (March to September) and price increase during the rice harvest (beginning in April and May) when part-time snake collectors are occupied. When the rice harvest is over, snake capture resumes and the price decreases. Another collector and the same exporter explained that prices fluctuate according to availability, with low prices when stocks are plentiful. However, another trader stated that the price drops only if a small number of snakes are available, which is said to reduce demand.

Price variations are also related to regulatory measures. Four collectors (who also skinned the snakes) and one exporter linked price fluctuation to permits and quota decisions made there. One of the collectors said that the price decreased if permits are not available.

Government control measures

National regulations and guidelines

The harvest or capture and distribution of wild plant and animal specimens in Indonesia can only be done under a licence, issued by Directorate General of Forest Protection and Nature Conservation (PHKA) (*Decree of Ministry of Forestry No. 447/Kpts-11/2003*, revised from *Decree of the Ministry of Forestry No.*

62/Kpts-II/1998). The legal transport of protected or non-protected species within Indonesia is permitted according to *Article 42, Chapter X of the Regulations of the Government of the Republic of Indonesia No. 8, 1999*. Harvesters and collectors must be registered by the BKSDA offices, who report the annual volumes harvested to PHKA. However, the study shows that most harvesters collect rat snakes and other reptiles as a side business and hence do not possess a licence. All exporters are registered with PHKA and must be members of IRATA, if they are to be allotted an annual quota and permission to export. No list of registered harvesters, collectors and exporters was available to the researcher at the time of the study.

Capture quotas and guidelines

Under Indonesian legislation, harvest of all nationally non-protected species native to Indonesia, whether listed by CITES or not, is regulated by a harvest quota system; national quotas are subdivided according to region (Soehartono and Mardiastuti, 2002). The 2007 annual quota for Oriental Rat Snake in Java was 500 specimens for the live animal trade, and 99 500 specimens for the skin trade, and for 2008 this was reduced to 89 500 skins and 450 live specimens. The annual quota represents the total number of animals which can be caught irrespective of whether these are exported or not (Nash, 1993). Harvest quotas are set at the levels of district and province (see Table 5) and are based on requests submitted by the BKSDA and these are divided amongst registered traders. These quotas are established each year during the quota meeting attended by LIPI, PHKA, traders, non-government organizations and other stakeholders. The basis for these quotas is not clear. The BKSDA regional offices appear to have inadequate input to allocation of the annual harvest quota. Requests for annual quotas are usually forwarded by traders to regional BKSDA offices. The export quota is allocated 90% of the harvest in order to accommodate domestic trade, although for some species, where domestic trade is considered negligible, the export quota is the same as the harvest quota (CITES, 2005). Animals are not allowed to be exported for purposes other than those stated in the annual quotas, which has only included skins and live specimens since the import suspension was removed therefore trade in meat is not permitted. Table 5 shows how the annual quota was allotted to the provinces/districts in Java in 2007. CITES (2005) states that harvesting of the Oriental Rat Snake continued during the period of suspension of imports from Indonesia but that licensed exporters had largely stopped purchasing skins. In addition, a low number snakes were still harvested for taken the manufacture of products for the domestic market (Mumpuni *et al.* 2002; CITES, 2005). It is not clear whether harvest quotas were set for domestic use only for this period.

Table 5
The regional quotas for the Oriental Rat Snake from Java implemented for 2007

	West Java (JaBar I)	West Java (JaBar II)	Central Java (JaTeng)	East Java (JaTim I)	East Java (JaTim II)
skins	5000	5000	40 500	24 000	25 000
pets	100	100	100	100	100

Fourteen of the 17 traders involved in Oriental Rat Snake trade were unable to provide information on the 2007 capture quota set by the government. One collector in East Java said the species was common during the wet season and so the quota should be increased. Two traders in Central Java believed that the 2006 quota for their region was 40 500, including 500 live specimens, but one said he alone could accumulate 10 000 specimens in one year. Another believed, mistakenly, that the 2007 capture quota for Central Java was 60 000 skins.

When the traders were asked about the relationship between their actual capture/collecting activities and what is permitted, seven traders offered no information, four purchased snakes continuously throughout the year and two reported that there is no limitation imposed on Oriental Rat Snake collection. Of these two, one stated that he could amass 2000 per year and the other simply that the annual abundance of the species fluctuates. Another commented that, depending on the price, he could collect 3000–4000 specimens per year, while another could only collect 300 per year stating that during the last two years Oriental Rat Snakes were more rarely offered to him. One of the biggest traders in Central Java reported that he could accumulate 50 000–100 000 per year, while another stated that the species is too rare in his collection area. One major trader who illegally exports frozen meat of Oriental Rat Snakes stated that LIPI gives a too low quota for many species even though Indonesia has "so many species"; such statements indicate a lack of understanding of the potential impact of trade on the species and the need to manage utilization and trade.

Overall, it seems that the quota system has proved ineffective in controlling snake collection. Information gathered during this study shows that the existence of harvest quotas is unknown to many of those operating at lower levels in the trade chain, and that harvest is opportunistic and with no regards to the annual quota system.

Population trends

Little is known about the population status of the species in Java or other Indonesian islands. No quantitative data on the change in Oriental Rat Snake populations in Java appear to be available, nor any evidence of population increase during the period of the trade suspension recommended by the CITES Standing Committee between 1993 and 2005 (see Section 2.1.1), very likely because significant collection for illegal export continued. No information exists with regards to the population levels of Oriental Rat Snake prey species and how they are impacted by the abundance of the snakes (prey-predator relationships). Studies are needed to determine if rat plagues, such as those discussed by Williams *et al.* (1980) and Stenseth *et al.* (2003) in Java are related to over-harvesting of the rat snakes.

According to CITES (2005), "Sustainability of Rat Snake (*Ptyas mucosus*) Harvests in Indonesia: A Discussion of Issues", submitted to the CITES Standing Committee by the CITES Management Authority of Indonesia for review to consider the lifting of the trade suspension, harvesting has largely been restricted to Java, and there was no evidence to suggest that its abundance has been reduced significantly, with snakes still being readily caught by villagers.

However contradictory opinions were expressed during this study; some traders considered that the species is now less common than in the recent past, some claimed that populations had decreased dramatically, whereas others claimed that the Oriental Rat Snake is just as common now as in previous years. One trader said he had been unable to purchase any Oriental Rat Snakes since the beginning of 2007, as none was available in the market due to a decline of the species in the wild. One trader in southern Central Java, who has been an active snake trader for around 30 years, stated that he could previously buy 300 specimens/day in the main harvesting area, but presently only buys about 25 specimens/day from within a 10-km radius; he attributes this decline to the increase of snake harvesters in the region. According to eight small-scale harvesters and collectors, who have been active between seven and 35 years, the local abundance of Oriental Rat Snakes, particularly in Central Java, has decreased noticeably. In contrast, five collectors reported that the species is still common in "the wild" owing to a good market price, remarking that "when the price is good, there are many snakes".

Toward a non-detriment finding

Assessing risks to the species from trade

The information presented above indicates that, despite some progress (quota setting, field surveys), management of the Oriental Rat Snake trade in Indonesia has significant weaknesses toward implementing those measures which were thought capable of ensuring a sustainable harvest of the Oriental Rat Snake as proposed in CITES (2005), specifically: marking of skins, monitoring programmes to adapt the management and levels of off-take, trade controls through a permitting system along the chain of custody, awareness raising activities for relevant official agencies, the commercial sector and other stakeholders, and efforts to build broad consensus on and support for the management regime.

IUCN developed a set of 26 key criteria, relating to biology, harvest and management, against which any given Appendix II species may be assessed in order to clarify the possible sustainability of international trade (Rosser and Haywood, 2002). The species is assigned a score of between 1 and 5 with respect to each criterion, where the higher score indicates greatest risk of unsustainability. The process is designed to assist Scientific Authorities in making an NDF where appropriate. Transparency is one major virtue of this approach; another is the focus needed to collate available information into a standardised spreadsheet. The graphic presentation of results in the form of a radar diagram is also important in facilitating rapid appraisal of the critical information. In the broadest terms, the more of the graph is filled, the less likely trade is to be sustainable.

A first NDF workshop on the Oriental Rat Snake was held in August 2007, in Bogor (West Java, Indonesia) and a draft NDF analysis representing findings of the present study was presented. In addition to participants from the Scientific Authority of LIPI, the CITES Management Authority and the Director of the Forestry Department (PHKA); the BKSDA, IRATA, stakeholders and NGOs were in attendance. Two international experts on NDFs and wildlife management also attended. However, as was discussed at the NDF workshop in Bogor, the IUCN developed approach may not be the ultimate methodology to test sustainable/unsustainable trade in species, and needs to be more practical for the Scientific Authorities.

Figure 18 depicts scores assigned for each of the 26 criteria identified in Rosser and Haywood (2002). The Oriental Rat Snake NDF study indicated strongly that international trade is likely to be unsustainable. Overall, a large proportion of the diagram is filled, meaning there are a number of important concerns. Notably, a high score of four was assigned to 17 (61%) of the 26 criteria, considerably higher than the critical = 40% threshold that the workshop had identified as signaling a high probability of unsustainability. The 17 high-scoring critical criteria are set out in Table 6.

Figure 18
Risk assessment of the Oriental Rat Snake on Java on the basis of 26 criteria

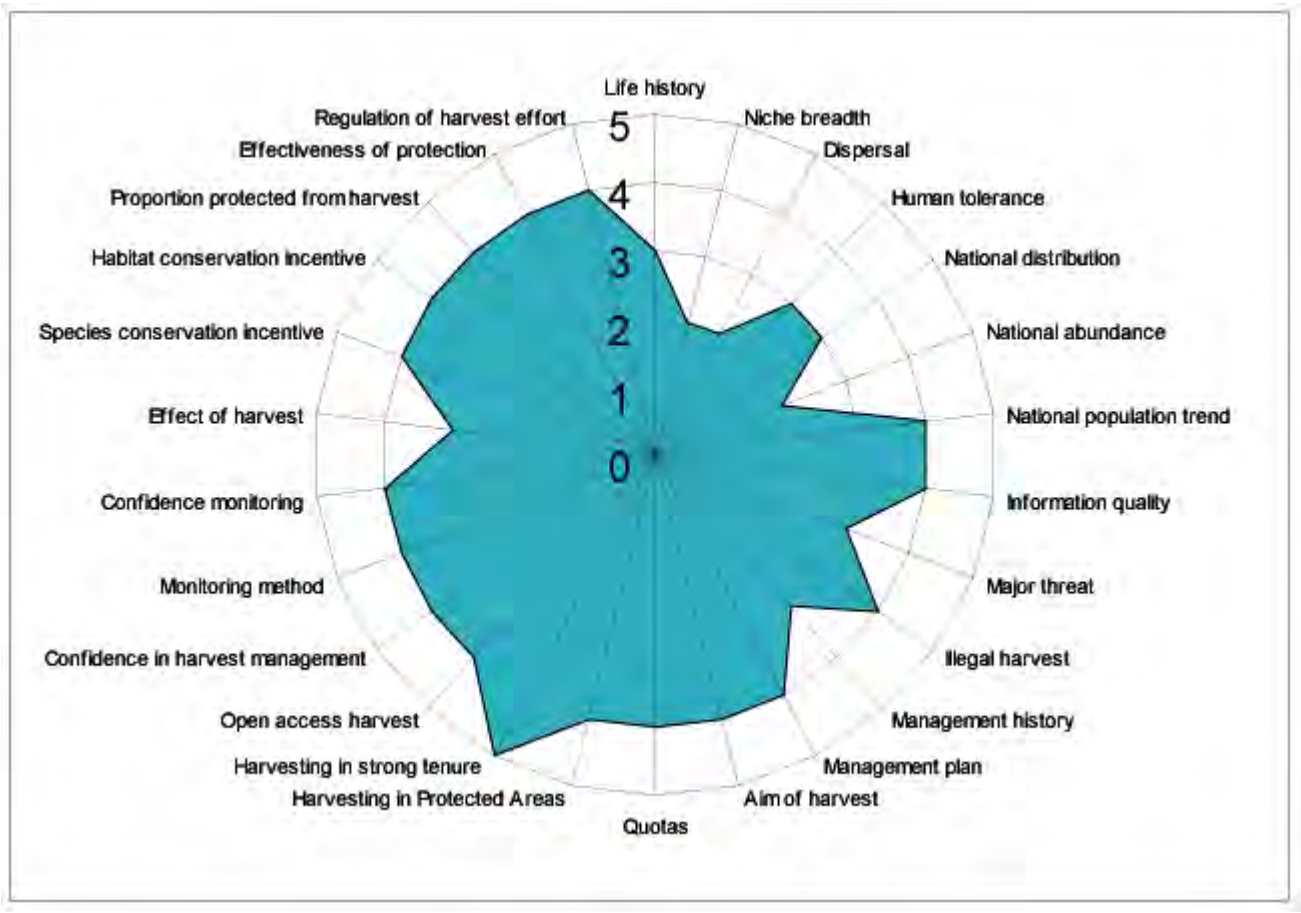


Table 6
The most critical criteria determined in the trade of the Oriental Rat Snake (those which scored 4 and 5, cf. Figure 18)

Criteria	Assessment	Criteria	Assessment
National population trend	Uncertain	**Harvesting in protected areas**	None
Information quality	Anecdotal	**Harvesting in strong tenure**	Uncertain
Illegal harvest	Severe	**Open access harvest**	high
Management plan	No approved plan	**Confidence in harvest management**	No confidence
Aim of harvest	Unselective	**Monitoring method**	National monitoring of exports
Quotas	Arbitrary	**Confidence monitoring**	No confidence
Species conservation incentive	None	**Proportion protected from harvest**	None
Habitat conservation incentive	None	**Effectiveness of protection**	No confidence
Regulation of harvest effort	None		

The basic NDF assessment tool developed by IUCN has been demonstrated in the case of Oriental Rat Snake to entail an important process whereby available evidence is collated and evaluated. This shows that the information available remains inadequate, and that there is a probability that international trade is detrimental to the species, especially at a localized level.

While the Scientific Authority proposed at the NDF workshop to increase and improve scientific surveys based on standardized methodologies, in addition to implementing monitoring schemes for the trade, the BKSDA conversely, cognizant of Indonesia's weak enforcement capacity, suggested strongly that law enforcement should be increased and improved since trade activities cannot be halted. IRATA suggested that obtaining sound scientific data may be enabled through international cooperation, possibly with Indonesian higher degree students working in collaboration with overseas students on long-term studies.

Mark Auliya/TRAFFIC Southeast Asia

Figure 19: Oriental Rat Snakes; meat and skins separated

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Figure 20: Frozen Indo-Chinese Rat Snakes in East Java

Mark Auliya/TRAFFIC Southeast Asia

Figure 21: Adult Oriental Rat Snake, with a total length of 239 cm

Proposed non-detriment finding method

Species resilience

Biology and ecology of the Oriental Rat Snake

- Large colubrid snake
- Reaches maturity at ~ nine months ~120 cm for females
- Clutch size average 13
- May lay two clutches per year
- No correlation between body size and clutch size and frequency has been found
- Widespread – probably most common in Central and East Java, areas with lower rainfall
- Generalist – thrives in human modified environment
- Unknown density and population trends; further data are required
- No major additional threats known

Current conclusion: *It is likely that due to its biology and ecology, the species has a fairly high resilience to harvesting.*

Managing harvest

Ability to set correct quotas and adaptively manage harvest

- No quantitative data are available for domestic demand therefore the total off-take is unknown, although domestic demand is believed to be low; quotas currently allow for 10% of quota as domestic use
- Export quotas could be set for all products in demand based on the harvest quota for number of specimens; it appears that the species is not in demand for the pet trade, therefore a live trade quota is not necessary
- Size restrictions to ensure specimens have reached maturity and reproduced could be set for export (e.g. minimum 140 cm total snake length); snake skins are stretched when drying and would not be a reliable measure of snake length or maturity
- Seasonal restrictions are not appropriate as there may be two breeding seasons and harvest takes place around agricultural activities
- Due to lack of reliable population estimates it is essential that any harvest or export quota systems is adaptively managed based on monitoring of population trends the species and harvest

Conditions of harvest and ability to change these

- Widespread harvest in natural and agricultural habitat
- Some harvesting is done by dedicated harvesters and some harvesting is done by farmers
- Farmers harvest out of crop growing season – mainly November to January; snake capture is secondary to farming activities and appears to be carried out in an ad hoc manner
- Dedicated snake harvesters mainly harvest the Oriental Rat Snake during the wet season when snakes are most commonly encountered

- Cost of harvesting – low but may be increasing as there is some evidence CPUE is decreasing; very low for ad hoc harvesting by farm workers
- Species is effectively an open-access resource
- Little is known on the areas subject to harvest and intensity of harvest in different areas; intensity of collection in different areas should be mapped and monitored to show shifting patterns in harvesting, which could indicate localised depletion

Capacity to control harvest/trade

- Widespread harvesting in natural habitat and farmland makes it almost impossible to enforce harvesting restrictions; establishing a harvest permit system (see CITES, 2005) would be unlikely to be effective
- Not all products in demand are legally exported and there seems to be no effective control measures in place to combat this; there are allegations that illegal meat trade was substantial during the trade ban on skins; this is believed to have continued and currently levels of illegal international trade in meat are thought to be high; enforcement is hampered by inability to easily distinguish meat of small Oriental Rat Snakes from the Indo-Chinese Rat Snake*;* results of this study suggest that illegal trade may result in some additional harvest of the snakes rather that as a by-product of the skin trade; some meat may be being traded as the Indo-Chinese Rat Snake, which is not controlled under CITES. It is possible to differentiate between skins of the two species. Shipments of the Indo-Chinese Rat Snake are of skinned, semi-skinned or whole specimens, usually frozen. The appearance of a skinned Oriental Rat Snake would be difficult to distinguish from a skinned Indo-Chinese Rat Snake. Increased enforcement and capacity is needed to reduce illegal trade
- It appears that harvest quotas are currently not communicated through the trade chain so a reduction in export quota is unlikely to result in a reduction in harvesting. There is no evidence that there is implementation of a system of harvest permits issued by the Head of BKSDA and this is unlikely to be implemented given many of the harvesters are farmers

Current conclusion: *Currently insufficient data are available on distribution, population and harvest areas to be sure that a quota is set at a non-detrimental level; quotas should be set and adaptively managed based on field and harvest monitoring. Currently there is little knowledge about quotas at harvester and small scale collector level showing poor communication. Setting export or harvest quotas is unlikely to reduce harvest given the low cost and ad hoc nature of some harvesting (farmers) and apparent illegal trade. Without baseline and ongoing field monitoring data it would be extremely difficult to determine whether harvest is non-detrimental. However, such data would be time consuming and expensive to collect given the widespread nature of the species and differences in activity through the year. Domestic and illegal trade levels are only partially known. If quotas were enforceable suggest reducing current quotas (export quota was reduced by 10 050 for year 2008) until baseline monitoring has taken place.*

Monitoring Impact

Species monitoring

- Ongoing field studies should be established in a sample of harvested and non-harvested populations to monitor population dynamics, including density changes through surveys for CPUE, sex ratio, size etc. To date there are no reliable baselines from which to monitor change as data to date are from harvested specimens rather than field surveys:

    - Density estimates – monitoring snake species through trapping or catching – may not give accurate measures, however ongoing monitoring should identify changes. **Continuing decline in density would indicate detrimental harvest and lack of recruitment.**
    - CPUE estimates from Sugardjito *et al.* (1998) are for harvesters and there is no indication as to whether this represents all snakes encountered or only harvested snakes, which may have been a sub-set of the former, if specimens were taken selectively. **Decreasing CPUE would indicate harvest is likely to be detrimental.**
    - Size estimates from Sugardjito *et al.* (1998), Boeadi (*in litt*., 2007) and this study are from different times of the year. **Declining average size in the wild would indicate unsustainable harvest**. Particular attention should be paid to proportion of individuals above the size of maturity and to identify problems with recruitment. Further, it has to be taken into account that the varying climate regime across Java may as well influence growth and specific life history and behavioural traits. This has been proven in other Southeast Asian snake species (Daltry *et al*., 1998; 2004).
    - Further information on the population structure and reproductive success/recruitment under altered conditions would be beneficial in adaptively managing the harvest.

Harvest monitoring

- Harvest monitoring — a year's baseline should be established from which to monitor change for each of the following measures ensuring regular and standard monitoring systems are in place:

    - CPUE for harvesters (difficult for casual harvesters e.g. farmers). **Continuing decline would indicate that the population was reducing.**
    - A change in natural sex ratio of harvested populations could indicate a misbalanced population structure. According to current data (a predominance of captured males) it is therefore very likely that mating events could be distinctly reduced, and thus would lead to a collapse of local populations. **An increase in female to male ratio could therefore also be conducive to a reduction in mean male size.** However, caution should be taken when comparing sex ratios for different times of the year as it is likely that there are differences in activity levels for each sex through the year, e.g. this study documents that sample sizes of male specimens were distinctly larger in the period October to January, indicating that males may have higher activity levels during the wet season, hence increasing the likelihood of their capture.
    - Size differences should be compared by sex against monthly averages. The Oriental Rat Snake's growth is rapid.

- Size should be well above size of mature females i.e. above 120 cm (the size at which females first reproduce according to traders interviewed). As a precaution a minimum total length could be set at 140 cm (although according to Kopstein (1938) this would still represent immature specimens) or at a much more precautionary level of 150 cm SVL, as tails may be damaged and blunt, thus total length would not be indicative. **Ongoing reduction in size of harvested specimens would indicate a declining population.**
- Harvesting area and pressure should be mapped in order to monitor **shifting patterns in exploitation which could indicate localised depletion.**

Current conclusion*: According to this study the average size for both male and female (ratio unknown) is 189.51 cm (n= 60) and therefore likely to be above the age of maturity according to traders' knowledge and Kopstein's findings. If this measure was based on a much larger sample of harvested specimens from a representative sample of traders (including illegal traders) it could be concluded that off-take currently allows individuals to grow to maturity and to reproduce before harvest takes place. However given that legal export is in the order of a hundred thousand specimens and there is a considerable illegal harvest and export a much larger sample would be necessary to determine statistical significant trends and non-detriment with any confidence. A much more representative sample along with additional information on CPUE would also be necessary to make this finding with any confidence. Although sampling would not monitor the illegally traded specimens, sampling of size and CPUE (including harvesting area changes) should demonstrate declining population, if this is the case.*

CONCLUSIONS

The Indonesian Management Authority (in CITES, 2005) proposed a thorough method to assess harvesting and adaptively manage export quotas and harvesting in order to ensure that Oriental Rat Snake export is not detrimental to the species on Java. In reality the harvesting and trade chain is not conducive to the approach of export/trade quota setting to control the harvest; the present system for allocation of quotas does result in any harvest control with little knowledge of quotas at the field level. It is evident that there are difficulties with the enforcement of harvest and export quotas and prevention of illegal trade. It appears that there is a significant trade that is not being regulated. The feasibility of controlling the products in demand in international trade merits review by the Indonesian Government.

Nevertheless, the species is likely to be fairly resilient and therefore despite high levels of illegal trade it may be feasible that the current level of harvesting is not detrimental to all populations of the species. From the limited survey of snake length it would seem that snakes are harvested at sizes well after females mature. However this could be a result of harvesters travelling further to collect larger sized specimens having over-harvested in areas more easily accessible; this could be ascertained through a better understanding of collection pressure, the spatial location of collection areas, and the timing of collection. Monitoring of changes in these is necessary in conjunction with monitoring of harvested specimens.

This study has shown that monitoring (field and harvest) would be crucial in adaptively managing the species's harvest and in allowing a determination that harvest was not detrimental. Much information has come from collectors and traders and a strong collaboration with them should help facilitate monitoring as could collaboration with universities. However, in some cases the interviewees gave inconsistent or conflicting opinions about abundance and trends. At present, sound information on the date and location

of snake collection is not consistently available; skins are not tracked through the trade chain, they may be stockpiled for different periods and skins from different areas and collection times are aggregated into larger consignments.

The above proposed method of making an NDF for the Oriental Rat Snake has focused on Java, the main, or possibly only, exporting island of Indonesia. The species occurs on other Indonesian islands. In effect therefore a large proportion of the species range in Indonesia is not subject to harvest, although these areas cannot without human intervention act as a source if Java were to be acting as a sink.

RECOMMENDATIONS

- As an immediate response of this study it is important to conduct field studies to estimate population sizes in different harvest regimes, in order to advise decision makers.

- Studies of the species's biology should be carried out throughout the year. Further investigation of reproductive size and reproductive status of harvested specimens would help in confirming the age of maturity to ensure that any minimum catch size is appropriate.

- Mapping of harvested areas to monitor shifting patterns in exploitation which could indicate a decline of local populations. This may well be achievable as an annual monitoring tool.

- Field and harvest monitoring should be established including mapping of harvest pressure. IRATA has suggested that obtaining sound biological and monitoring data may be enabled through international cooperation, possibly with Indonesian higher degree students working in collaboration with overseas students on long-term studies.

- Quotas could be set for the number of individuals harvested that could be extracted from the wild without detriment. The Government of Indonesia could review the current and future merits and feasibility of controlling the products in demand and which products are allowed for export.

- Minimum size (length or weight) could be set, if there was capacity to enforce these.

- Increased enforcement is needed to reduce illegal trade. In this context IRATA proposed to tie in the "Société Générale de Surveillance" (SGS), the world's foremost inspection, verification, testing and certification provider (SGS, 2009). However, next to measures of increased enforcement and given the widespread nature of the trade, high levels of demand and ubiquity of the species in agro-ecosystems, and the species's potential importance as a pest-controller, it is as well a valuable asset to create awareness among agricultural workers for adopt sustainable harvest levels.

- Consider the merits of listing the Indo-Chinese Rat Snake in the Appendices of CITES as a look-alike species to aid the control of the meat trade.

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TRAFFIC, the wildlife trade monitoring network, works to ensure that trade in wild plants and animals is not a threat to the conservation of nature. It has offices covering most parts of the world and works in close co-operation with the Secretariat of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

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