



## The Exploitation of Homalopsid Water Snakes at Tonlé Sap Lake, Cambodia

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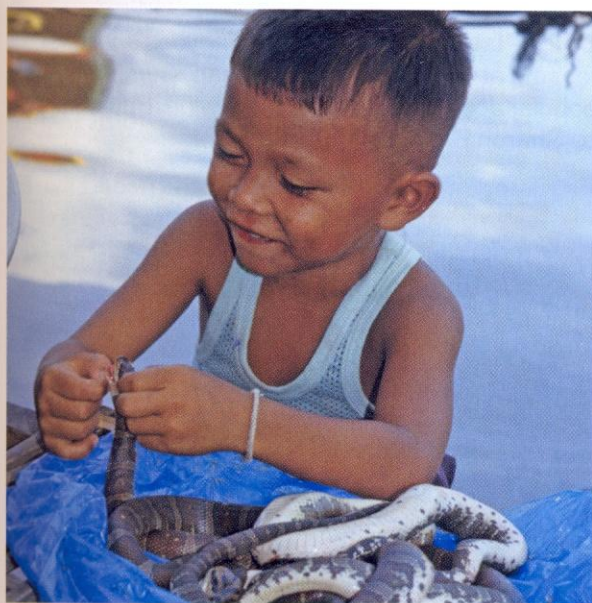
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The exploitation of watersnakes at Tonlé  
Sap Lake probably represents the world's largest  
snake hunting operation, with an estimate of 3.8  
million snakes collected per annum (Brooks,

unpublished data). This exploitation primarily  
involves six species of snakes in the subfamily  
Homalopsidae, which are targeted by local  
fishers in times of fish scarcity when alternative  
sources of protein are lacking. Three-quarters of  
these snakes are represented by a single species,  
*E.enhydris*.

This extraordinary activity first came to  
light when Stuart et al. (2000) provided a  
description of the activity, initial estimates of  
trade volume and composition of the catch, based  
on visits to the area in 1999–2000. We initiated  
the Cambodian Snake Trade Project in 2004 to  
study both the ecological and socioeconomic  
aspects of this trade, in order to deduce impacts  
on snake populations, as well as the importance  
of the trade for local people for whom it  
represents a significant source of income. This is  
providing much needed information that will aid  
the development of appropriate management  
practices for the long-term persistence of this  
snake assemblage.



**Color Plate 15.** A future Cambodian herpetologist  
with harvested Linne's water snakes, *Homalopsis*  
*buccata* at Chong Khneas. JCM

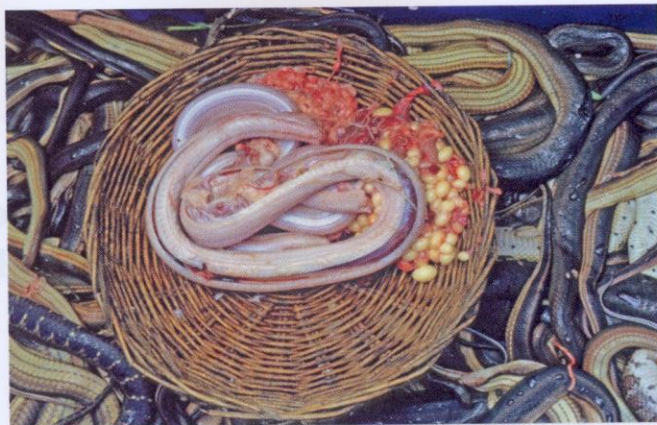


**Color Plate 16.** Local buyers purchasing snakes at  
the edge of the Tonle Sap Lake. Photograph by  
Sharon Brooks.





**Color Plate 17.** Local fisher with a daily catch of homalopsid snakes. These are all rainbow mud snakes, *Enhydris enhydris*. Photograph by Sharon Brooks.



**Color Plate 20.** Skinned rainbow mud snakes, *Enhydris enhydris*, and its ova ready for cooking. JCM



**Color Plate 18.** A local fisher extracting snakes from a gill net set on the floodplain of Tonlé Sap Lake, Cambodia. Photograph by Sharon Brooks.



**Color Plate 21.** Fried snake (*Enhydris enhydris*) for sale at market stall, Siem Reap, Cambodia. A popular accompaniment to palm wine. Photograph by Sharon Brooks.



**Color Plate 19.** A crate of dead snakes ready to be taken to a local crocodile farm, Cambodia 2004. Photograph by John Reynolds.



**Color Plate 22.** Sharon Brooks and Daryl Karns collect data from harvested snakes at Chong Khneas near Siem Reap Cambodia. JCM



### The Tonlé Sap Setting

The Tonlé Sap Great Lake is the largest lake in Southeast Asia and one that exhibits a unique hydrological system. Each year, as a result of the increased flow of the Mekong River during the southwest monsoon, the Tonlé Sap River changes direction and floods the lake, increasing its area from 2,500 km<sup>2</sup> to between 10,000 and 16,000 km<sup>2</sup> (Lim et al., 1999). This immense and dynamic wetland area supports an incredibly rich and diverse ecosystem which has been a focal point of Cambodia throughout its history. It hosts one of the most productive inland fisheries in the world and directly supports the livelihood of over 1.2 million people (Nettleton and Baran, 2003).

In the last 20 years Cambodia has shifted from a largely agrarian subsistence to an export-led economy, with new markets for exporting fish and other natural resources out of the country (Degen et al., 2000; Bonheur and Lane, 2002). In combination with increasing human population pressure, poor governance, inequitable access, insufficient tenure rights, and high levels of poverty, the result has been a gross overexploitation of many fish species (Lim et al., 1999; Sitherith, 2000) and intensive hunting of other wildlife.

The major driving force behind the snake hunting activity however, has been the recent boom in the local crocodile farm industry, which is breeding and rearing the native (and critically endangered) Siamese crocodile, *Crocodylus siamensis*, as well as hybridizing it with the non-native Cuban crocodile, *Crocodylus rhombifer*, for commercial purposes. This industry has added considerable pressure to the demands for protein from the lake, creating markets for previously unexploited resources, especially snakes. Crocodiles on farms consumed over 90% of the snakes that were traded. This began in the 1990s, and its enormous scale gives the most cause for concern. Crocodile farms show no preference for particular species and therefore, the catch is largely indiscriminate. The snakes are targeted using gillnets that catch snakes mainly within the size range of 40–80 cm snout to vent length, those being the smaller-bodied species in the assemblage. There is a small side market for these snakes as a source of human food and they are frequently seen being sold

locally fried, dried, or in a soup. The ova of *E. enhydris*, which is breeding during the hunting season are also a popular delicacy.

There are other trades, distinct from those that supply the crocodile industry, whereby larger-bodied snakes are sold at a relatively high price, either dead for their skins or exported live for their meat. Cobras (*Naja* sp.), are also sold live for their blood, a popular delicacy throughout Southeast Asia, and consumed to increase virility, strength, and for its healing powers. Many of these larger-bodied snakes are entering the international market that is largely driven by the demand from China (Stuart et al., 2000; Zhou and Jlang, 2004). These trades have a longer history in Cambodia, with reports of them existing in the pre-Khmer Rouge period (1970s, or earlier). However it is likely that export has increased in recent years as Cambodia has become a major source country for many reptile species that occur in regional trade as a result of depleted populations in surrounding countries (Stuart, 2004). *Homalopsis buccata* and *Enhydris bocourti* feature frequently in these trades and are targeted with specific gear such as spears, baited hooks, and gillnets of a larger mesh size than those used for catching snakes for crocodile food.

There are strong indications that there has been a substantial increase in snake hunting in recent years, with more people entering the activity as a result of both the developing market for snakes and a decline in alternative income sources. There are currently tens or possibly even hundreds of thousands of people involved in snake hunting on Tonlé Sap, purely to supply the crocodile farm industry. Possibly as a result of this massive effort, the catch size per fisher is thought to have declined drastically, with 10-fold declines being reported by snake hunters in recent years.

### Volume and Composition

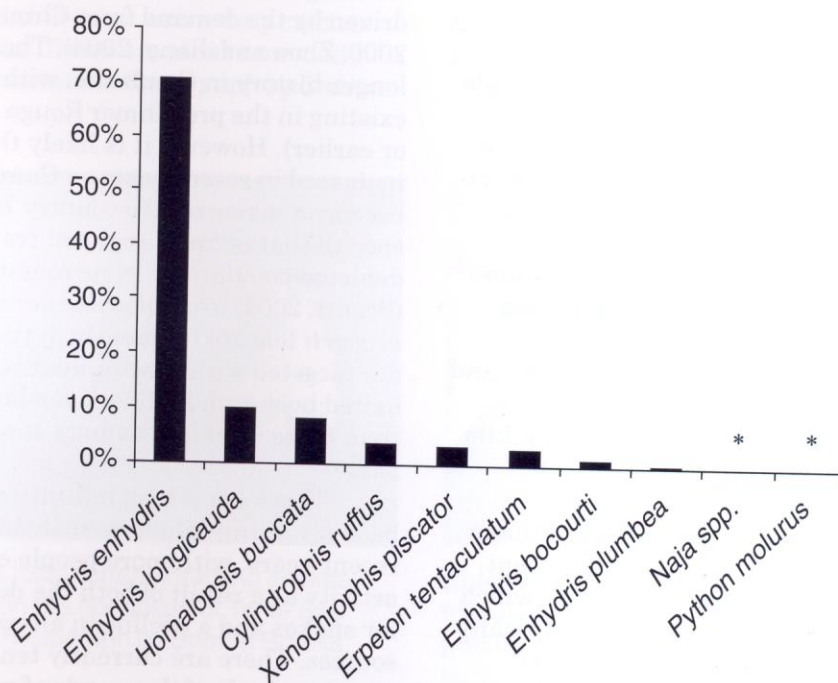
Our preliminary estimates suggest that 3.8 million snakes were traded through the three major landing sites between June 2004 and January 2005 (Brooks, unpublished data). These estimates will be refined in future years, as our sampling expands to include consumption of snakes for food by people living on the lake and by crocodiles being reared in small holdings out



on the lake, as well as trade through other landing sites that are not yet identified.

We have identified a total of 14 species in the catch, with 8 appearing regularly, 6 of which are homalopsids. Figure 1 illustrates the species composition of the catch based on data collected in 2004 and 2005 from Prek Toal, a floating village in the northern end of the lake where there is a large trade in snakes. *E. enhydris* is by far the most abundant species in the catch, representing 72% of the catch overall. *E.*

*longicauda* is the second-most abundant species in the catch and we have found it to be even more common further south where it represents almost half of the total catch. This species is endemic to the Tonlé Sap Lake and river and is Cambodia's only known endemic reptile. As such, it is of particular conservation interest, and featured on local educational posters of wildlife in the Tonlé Sap Basin. The Cambodian Snake Trade Project is working to raise awareness about this poorly known reptile.



**Figure 1.** The species composition of the snake trade at Tonlé Sap Lake 2004 based on the catch at Prek Toal hunting ground in the north of the lake. The species *Enhydris subtaeniata* (previously recorded as *Enhydris jagorii*), *Boiga ocellata*, *Boiga cyanea* and *Ptyas korros*, have also been sighted in the catch but are rare in the trade.

### Seasonality

As with all aspects of life in the Tonlé Sap basin, there is a great deal of seasonality in the volume of snakes traded throughout the year as a result of the seasonal flooding of the lake. Snakes first become available to large-scale exploitation in June when the Tonlé Sap River reverses and the forest becomes inundated. They continue to be exploited until the water recedes from the forest in February/March. The volume

of trade peaks both as the water is rising and again as it is receding. These trade fluctuations are due to an inconsistent level of targeting throughout this period, as a result of both changes in the behavior of the individual fishers as well as changes in the number of people fishing in areas where snakes occur. When alternative and more profitable resources, primarily fish, become available, fishers switch to target this resource, at which point snakes become a bycatch.



The distribution of the snakes and how they are responding to the flood cycle of the lake will influence the catch success of the hunters and their resulting hunting strategy. The highest catch success is achieved by hunting in the shallow edge of the lake that moves several kilometres back and forth each year. This is in accordance with previous research that has shown some of these species to be closely associated to shallow edge habitats and mud root tangle (Murphy et al., 1999; Voris and Karns, 1996). At this time we cannot separate catchability effects (snakes become less "catchable" in deeper clearer water) from density effects (snakes move with the edge and are therefore in lower densities in deeper clearer water); however, based on what we know about these species, it is likely that they are associated with this moving edge of the lake. Previous studies on *E. enhydris* showed that while these snakes are relatively active day and night, they seldom move more than 100 m (Murphy et al., 1999). However, these studies were conducted in different environments with comparatively little fluctuation in water levels. The Tonlé Sap ecosystem provides a unique and dynamic environment to which the local populations have undoubtedly adapted.

When the water recedes from the forest in March, snakes are no longer caught and traded, indicating that they are not present in the open water and that they remain in the dry forest. Under the direction of local fishers we have found both *E. enhydris* and *H. buccata* estivating in the dry floodplain of the lake during this period, indicating a close association with the forest habitat and demonstrating the snakes' ecological adaptations to life in the Tonlé Sap.

### Economic Value

The economic value of the snakes varies throughout the season and depends on the type of trade. The price of snakes for crocodile food ranges from US \$0.25 to \$0.75 per kg depending on the seasonal availability of fish and other resources that are also used as crocodile food. The prices paid for *H. buccata* and *E. bocourti* that are traded internationally for their skins are considerably higher, ranging between US\$0.63 and \$1.25 per kg. Contrary to the situation with the trade for crocodile food, this

price appears to rise when availability is low as there is no alternative to meet the demand. These species are also traded live for international export, fetching an even higher price of US\$1.25 – 3.3 per kg for *H. buccata* and US\$2.5 – 5.0 per kg for *E. bocourti*. The prices quoted here reflect that paid at landing sites around the lake. The prices paid by the final consumer in the market chain will be significantly higher.

### Sustainability of Exploitation

As the Cambodian Snake Trade Project is only entering its second year, we are not yet able to assess sustainability of this exploitation with any confidence. Our research has shown that catch sizes are declining, which may reflect real declines in snake populations. Furthermore, we have received anecdotal reports of declines in the number of snake traders in certain areas of the lake indicating local declines in total catch volumes. In the absence of temporal population data, sustainability can be inferred from the intrinsic life history traits of the exploited species as well as from predictions of how exploitation will continue in the future.

Most of our knowledge of snake biology has been obtained from temperate zone populations, which show snakes to be poorly suited to exploitation, due to slow growth, late maturation, and low fecundity. However, there are proving to be considerable differences in the intrinsic abilities of tropical snakes to sustain intensive levels of hunting (Shine et al., 1999), and such differences are apparent in the assemblage being exploited in Tonlé Sap Lake. Although information on the biology of homalopsids is scarce, these species appear to show quite rapid growth as a result of frequent feeding, a probable early age of maturation, and relatively high reproductive output based on the maximum observed clutch sizes of some of the species (Murphy et al., 2002). Where these snakes occur they are often relatively abundant (Voris and Karns, 1996) and there are indications that they may be able to thrive in areas of intense fishing because reductions of large fish species remove many of the natural predators of the snakes (Harold Voris personal communication). Perhaps reductions in natural mortality help offset the impacts of hunting pressure. However, as a result of differing life histories



and economic values of the various species in the assemblage, there are likely to be differences in their vulnerabilities to hunting, as has been shown in other taxa (Reynolds, 2003).

*Homalopsis buccata* and *E. bocourti* show many traits that highlight them as species of concern. Based on their large maximum size relative to the other species in the catch, it is likely that they have a greater longevity and a larger size at maturity. Many of the individuals caught in the indiscriminate catch for crocodile food are therefore immature and few would have bred successfully before capture. These species are also likely to experience a higher exploitation rate as a result of the additional targeted catch of the larger individuals for the skin and live trade, which removes the larger and more fecund individuals from the population. Although the skin trade is minor compared with the trade for the crocodile industry, it is likely to have a negative impact on these populations. The economic value of large specimens of these two species is expected to be a motive for hunting to continue even as populations decline and become more difficult to exploit.

Many other ecological and behavioral traits of these snakes will also affect their resilience to hunting, including foraging and mating strategies (Reed and Shine, 2002), which will affect their activity periods and habitat associations and hence their "catchability." This underscores the value of obtaining such fundamental natural history information, as summarized in this volume.

The future of Tonlé Sap snakes is intricately tied to the future livelihoods of the hunters and the availability of alternative protein and income sources. While an understanding of the natural history of the species helps us to predict how the snakes will respond to exploitation, conservation intervention will require a thorough understanding of the social and economic component of this extraordinary activity.

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