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Population Status of Two *Varanus* species (Reptilia: Sauria: Varanidae) in Sri Lanka's Puttalam Lagoon System, with Notes on their Diet and Conservation Status

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Abstract - In Sri Lanka, varanid lizards (Genus: *Varanus*) are represented by only two species: *V. bengalensis* and *V. salvator*. During 46 days of field work in the Puttalam Lagoon system from 2008 to 2009, we recorded three *V. salvator* and 76 *V. bengalensis*. Of the *V. bengalensis*, 37 (48%) were males, 24 (32%) females and 15 (20%) juveniles. The male to female sex ratio of recorded specimens was 3:2. Most *V. bengalensis* were recorded from residential gardens and others from forested areas, while *V. salvator* were only recorded from forested areas. There is a local belief that eating the tongues of *V. bengalensis* increases memory capacity. Some villagers also extract an oily liquid from roasted *V. salvator* and consider it to be a deadly poison. We recorded 42 additional specimens of *V. bengalensis* killed on roads- most were hit during afternoon hours, as well as 26 individuals that were hunted. Current environmental threats and suggested conservation measures are also discussed.

Introduction

Sri Lanka harbors a rich biodiversity, which includes high herpetofaunal diversity (Bossuyt *et al*., 2004; Gunawardene *et al*., 2007; Meegaskumbura *et al*., 2002; Myers *et al*., 2000). There are 96 species of lizards native to Sri Lanka including 74 (77%) which are endemic to the island (de Silva, 2006; Somaweera & Somaweera, 2009). According to Koch *et al*. (2010), the genus *Varanus* Merrem, 1820 consists of 73 extant species (including 21 subspecies). Two species occur in Sri Lanka: *V. salvator* Laurenti, 1768 and *V. bengalensis* Daudin, 1802 (de Silva, 1996, 1998; Das, 2001; Deraniyagala, 1953; Smith, 1935). In Sri Lanka, *V. salvator* is distributed in areas below 500 m in elevation and *V. bengalensis* occurs up to 460 m elevation (Das & de Silva, 2005; Rathnayake, 2001; Whitaker & Whitaker, 1980), but outside of Sri Lanka, *V. salvator* is known to occur up to 1100 m (Erdelen, 1991) and *V. bengalensis* up to 1500 m (Auffenberg, 1994). Although both are

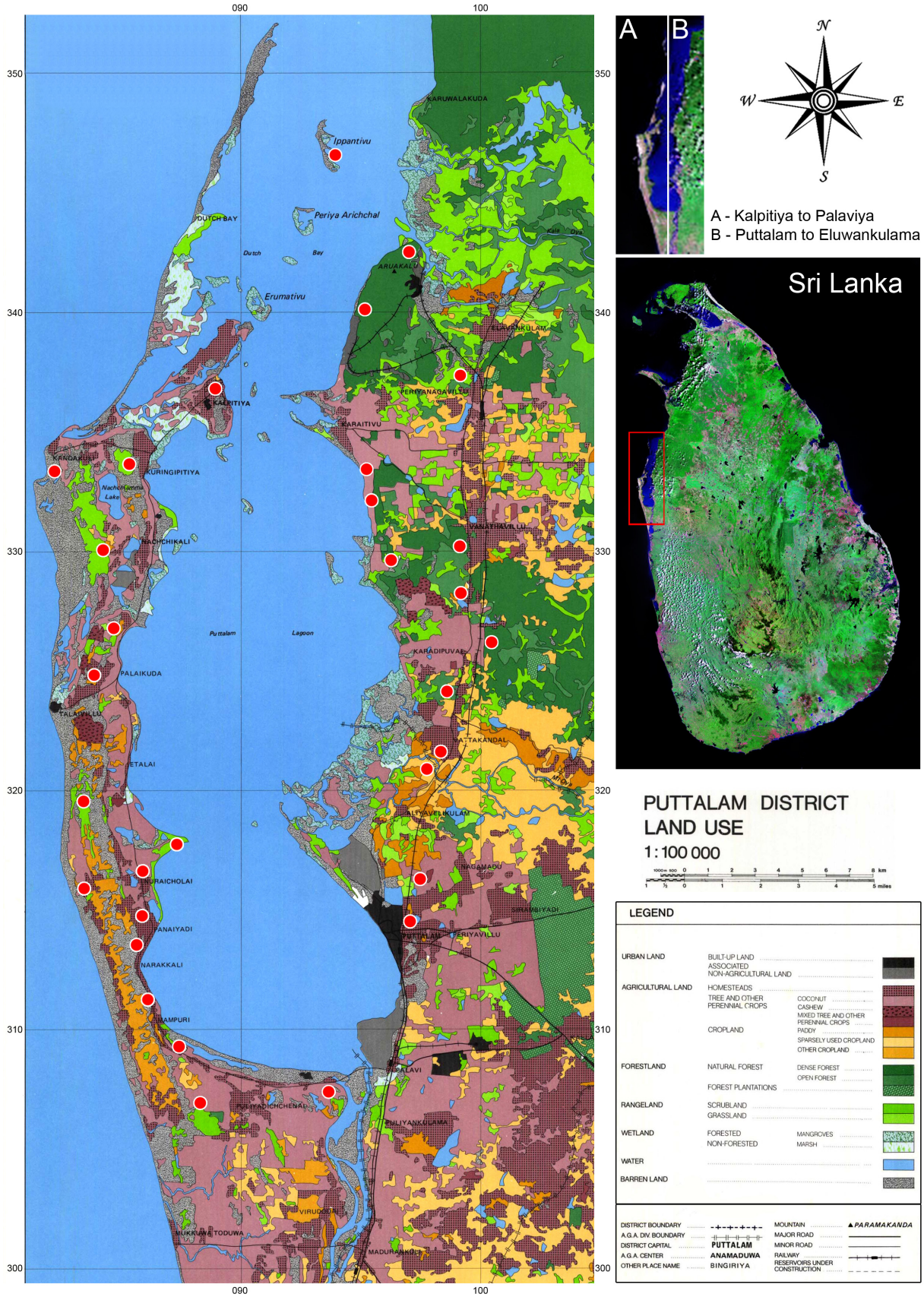

Fig. 1. Map of the 2008-2009 study areas in the Puttalam Lagoon system. Red dots indicate study points.

commonly encountered in anthropogenic habitats, *V. salvator* is semi-aquatic, whereas *V. bengalensis* is semi-arboreal. Both species are threatened due to various human activities (Amarasinghe *et al*., 2009; Daniel, 2002; Gaulke & de Silva, 1997). *Varanus salvator* has been heavily exploited for many decades by the reptile skin trade in Indonesia (Shine *et al*., 1998); *V. bengalensis* has been restricted from international trade under the Convention on International Trade in Endangered Species (CITES) since 1975.

One of the biggest challenges facing the conservation of varanids in Sri Lanka is a lack of information on their distribution and ecology since only a fraction of populations present in the country are hitherto known to science. Hence, it is essential to gather information on their distribution and ecology in different areas of the country as a first step towards their conservation. This article contributes new information to what is currently known about *V. salvator* and *V. bengalensis* within the Puttalam Lagoon system.

Materials and Methods

Surveys of the *V. salvator* and *V. bengalensis* populations in the Puttalam Lagoon system were conducted over 46 field days (Kalpitiya ~27 and Puttalam ~19) between November 2008 and October 2009. Observations were made by eye at a distance of 2 to 20 m between 0700 and 2000 h (sometime 8×40 binoculars were used). Varanids were primarily surveyed using the Visual Encounter Survey (VES) method (Magurran, 2004), but searching was also carried out in potential microhabitats such as beneath decaying logs and stones, and in tree holes and house roofs. Some specimens were captured for sex determination, examination of scale patterns, and for external measurements. These animals were photographed and released in the same habitat they were captured. External measurements were taken to the nearest 1 mm using a manual vernier caliper and a 1 m measuring tape. Egg measurements were also taken with a vernier caliper before carefully placing them back into their original nest hole. A thermometer and hygrometer were used to record temperatures and relative humidity during observations. Road kills and data on animals killed by villagers were also included as additional sources of information. We interviewed villagers using our own questionaire forms. Diagnostic keys and characters given by Daniel (2002), Das & de Silva (2005), Deraniyagala (1953), Smith (1935), Somaweera & Somaweera (2009) and Taylor (1953) were used for species identification.

Study area and Habitats

Puttalam Lagoon (study areas) runs through Eluwankulama to Kalpitiya (Fig. 1) over a road distance of ca. 80 km (8° 10 N and 79° 50 E) and is located in Puttalam District (Weerasinghe, 2008) (Fig. 2). The area ranges in elevation from 1-20 m above sea level, and has been characterized as dry and arid lowlands (Ashton *et al*., 1997). According to the floristic classifications of Gunatilleke & Gunatilleke (1990), the major vegetation types of this area include tropical dry mixed evergreen forests (*Manilkara* as well as mixed communities dominated by *Chloroxylon*, *Vita*, *Benya*, and *Schleichera*), tropical thorn forests (*Manilkara*, *Chloroxylon*, *Salvadora*, and *Randia* as dominant genera), Damana and Villu grasslands (Fig. 3; see Gunatilleke & Gunatilleke, 1990), flood-plain wetlands, riverine and gallery forests, and extensive mangrove habitats (Fig. 4). Forested areas are mainly composed of the trees Palu (*Mimosop hexandra*),

Fig. 2. Sand dune habitat in the Kalpitiya area.

Fig. 3. Grassland habitat around the Sethta Villu in Aruwakkalu.


Fig. 4. Mangrove habitat in Sevwanthive.


Fig. 5. Natural forest habitat in Eluwankulama.

Weera (*Drypetes sepiaria*) and Tammenna (*Mischodon zeylanicus*). Common shrub species found in the area are Nerenchi (*Acanthospermum hispidum*), Karamba (*Carissa spinarum*), Ranawara (*Cassia auriculata*), Wal kapu (*Ceiba pentandra*), Andara (*Dichroatachys cinerea*), Eraminiya (*Zizyphus rugosa*), Gandapana (*Lantana camara*), Mádan (*Syzygiun cumini*) and Podisingchomaran (*Eupatorium odoratum*) (Fig. 5). Introduced plants such as coconut palms (*Cocos nucifera*) and cashews (*Anacardium occidentale*) are also present.

The average annual rainfall is < 1100 mm, with most of the rain occurring during the months of November and December (Somasekaran, 1988). Occasional showers do occur at other times of the year, and the weather is driest between May and September. Highest temperatures were recorded during August (around 34.8 °C). The mean annual temperature in the Puttalam area is 29.6 °C, with a minimum of 25.4 °C.

Results

During 46 field days encompassing both dry and wet seasons, we recorded three sightings of *V. salvator* (all adults) and 76 of *V. bengalensis* (Fig. 6). One *V. salvator* was recorded from an isolated islet in Puttalam Lagoon near Kalpitiya; the other two locations were Eluwankulama and Vanatha-villuwa. We did not record any *V. salvator* from the area between Palaviya and mainland Kalpitiya. According to surveys conducted among villagers over 50 years in age (n=100), 80% of them had seen *V. salvator* only once in last 25 years, and the other 20% saw this lizard twice (Fig. 7). Sixty percent of villagers between the ages of 25-49 years

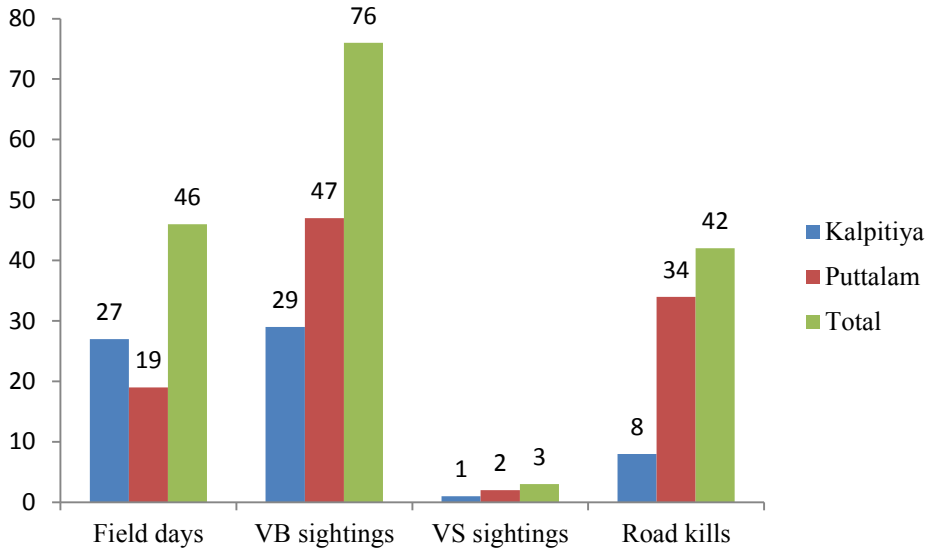

Fig. 6. Comparison of days and sightings of two *Varanus* species in the survey area (VB = *V. bengalensis* and VS = *V. salvator*).

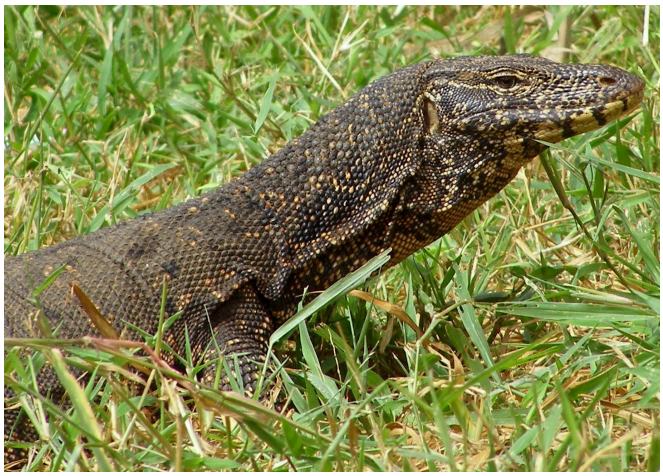

Fig. 7. Adult female *V. salvator* in grassland habitat.

Fig. 8. Foraging behavior of *V. salvator* in an aquatic habitat.

(*n*=200) had only seen *V. salvator* once in the last 10 years, whereas the other 40% hadn't seen the species at all. All villagers claim to have seen *V. bengalensis* more than 100 times in their lifetime, and 26% claim to have seen *V. bengalensis* nesting sites. There are many freshwater bodies in the area, with almost all occupied by crocodiles (*Crocodylus palustris*). Some villagers have observed *C. palustris* feeding on *V. salvator* about 10 years back.

According to villagers, the *V. salvator* in the area feed on cobras (*Naja naja*), rat snakes (*Ptyas mucosa*), keelbacks (*Xenochrophis* cf. *piscator*), peacock eggs and chicks, cormorants (*Phalacrocorax niger*), crows (*Corvus splendens*), black tortoises (*Melanochelys trijuga*), crabs, and shrews (*Suncus* sp.) (Fig. 8). During the course of study, we observed *V. salvator* feeding on kukri snakes (*Oligodon taeniolata*) as well as on fish, beef, pork and other discarded meat in the garbage. According to villagers, the main predators of juvenile and adult *V. salvator* are wild boars (*Sus scrofa*), which are very common in the area, and crocodiles (*C. palustris*). Wild boars especially feed on hatchlings and eggs. Some people do not like *V. salvator* and chase them on sight, throwing stones and sticks at them and sometimes killing them, but never eat their meat. However, skeletal remains of *V. salvator* found in the caves of Balangoda Man (35,000 to 40,000 BC) indicate that *V. salvator* was consumed by prehistoric inhabitants (Manamendra-Arachchi, pers. comm. 2011). No *V. salvator* road kills were recorded during the study period, nor did we observe any courtship or mating behaviors. There are many mythical beliefs about this species, and according to villagers aged over 50 years, *V. salvator* is a shy reptile and avoids humans. Two individuals were purportedly killed over the past few years.

The *V. bengalensis* population from Puttalam to Eluwankulama appears to be very large, with 47 sightings (males, 23; females, 15; juveniles 9) recorded from the Eluwankulama area (5:3 male-female sex ratio), and another 29 (males, 14; females, 9; juveniles 6) from the Kalpitiya area (3:2 male-female sex ratio). In total, 85% of *V. bengalensis* sightings were recorded from residential gardens, and the rest from forested areas. By contrast, all *V. salvator* sightings were recorded from forested areas. *Varanus bengalensis* were never recorded near lagoons, mangroves or any other aquatic habitats close to the lagoon. A large number of ectoparasites and endoparasites were recorded from both species (Fig.

Fig. 9. Ectoparasites on the tail base of *V. bengalensis*.

Fig. 10. Morning foraging behavior in a *V. bengalensis*.

9). Combat behavior between male *V. bengalensis* was infrequently observed during the months of August and September. Combat behavior mostly occurred when temperatures were between 30.2-33.5 °C, and humidity levels were between 68-73%.

The average snout to vent length (SVL) for adult male *V. bengalensis* was 422 ± 25 mm (range 388-474 mm) and 439 ± 14 mm (range 418-463 mm) for females. Average head length (HL) was 98 ± 8 mm (range 84-108 mm) in males and 104 ± 3 mm (range 99-108 mm) in females (*n*=12; see Table 1). Eggs of *V. bengalensis* averaged 45.5 ± 1.35 mm in length (range 42.6-47.4 mm) and 24.4 ± 0.61 mm in width (range 23.5-25.2 mm).

According to villagers, *V. bengalensis* feeds on agamid lizards (*Calotes versicor*, *Sitana ponticeriana*), crabs (*Oziothelphusa hippocastanum*), toads (*Duttaphrynus melanostictus*), juvenile tortoises (*Geochelone elegans*), juvenile freshwater turtles (*Lissemys ceylonensis*), small mammals (*Ratus ratus*), juvenile birds (house sparrows, chickens, lapwings, pigeons) and eggs, and bats (*Pipistrellus* sp.). During this study, we also observed *V. bengalensis* feeding on frogs (*Euphlictis hexadactylus*, *E. caynaphlictis*, *Hoplobatrachus crasus*, *Hylarana gracilis*), tree frogs (*Polypedatus maculates*), snakes (*Calliophis melanurus*, *Amphiesma stolata*, *Lycodon striatus*, *Rhinophis* sp.), earth worms (Fig. 10), centipedes, dung beetles, and juvenile chameleons (*Chamaeleo zeylanicus*). From the undigested gut contents of road killed specimens, we recorded additional prey items including snakes (*Ptyas mucosa*, *Oligodon arnensis*), skinks (*Europis carinata*, *E. tammanna*), geckos (*Hemidactylus leschinaulti*), and land snails (*Achatina fulica*).

Table 1. External body measurements of mature *Varanus bengalessis* in Puttalam area (*n*=12). Abbreviations: SVL = snout to vent length; HL = head length.

ID No.	Males (mm)		Females (mm)	
	SVL	HL	SVL	HL
01	391	85	426	101
02	413	98	453	107
03	427	102	432	104
04	398	88	447	106
05	442	105	463	108
06	405	91	428	102
07	432	103	425	103
08	388	84	436	104
09	451	106	418	99
10	418	99	446	106
11	426	102	457	108
12	474	108	442	104

Humans are the primary predator of adult and juvenile *V. bengalensis*, but according to villagers other predators include changeable hawk-eagles (*Spizaetus cirrhatus*), pythons (*Python molurus*), peacocks (*Pavo cristatus*), Sri Lankan grey hornbills (*Ocyceros gingalensis*) and white-bellied sea-eagles (*Haliaeetus leucogaster*). Egg predators include wild boars (*Sus scrofa*), rat snakes (*Ptyas mucosa*), domestic cats (*Felis cattus*), and dogs (*Canis familiaris*). During the study period, we observed 42 road kills (41 juveniles and 1 adult) and 26 individuals hunted by humans (9 juveniles and 17 adults).

We found two *V. bengalensis* nests comprised of 8 and 11 eggs located in the bottoms of abandoned termite mounds (Fig. 11). Nest temperatures and humidity levels for these clutches were 30.6 °C and 69%, and 31.2 °C and 62%, respectively. At the time of their discovery, these mounds were also being utilized by cobras and vipers. Walikanna & Karunarathna (2009) also noted that termite mounds in Sri Lanka were utilized by cobras

Table 2. Measurements of *V. bengalesis* eggs (*n*=10) in two locations (Abbreviations: EL = egg length; EW = egg width; SD = standard deviation).

	Thirikkapallama August					Vanathavilluwa October					
	1	2	3	4	5	6	7	8	9	10	Mean ± SD
EL (mm)	45.7	46.3	45.7	45.8	47.4	46.3	43.9	45.6	46.1	42.6	45.5 ± 1.35
EW (mm)	23.5	24.8	25.2	24.6	24.7	24.6	23.6	24.2	25.1	23.8	24.4 ± 0.61

(*Naja naja*) as well as skinks (*Eutropis carinatus*). All eggs were deposited in holes inside termite mounds with good air circulation and in areas of minimal human disturbance. The nesting substrate was not packed down by the female after egg deposition (Table 2). We did not observe juveniles emerging from eggs, but were able to locate newly hatched juveniles in human habitations (*i.e*., on roofs, in kitchens, etc.). Juveniles live mostly in areas 3-5 m above the ground, especially on trees, walls and electric pillars (Fig. 12); Deraniyagala (1953) reported similar behavior.

Forty-one road-killed juvenile *V. bengalensis* in the size range of 218 to 283 mm SVL (*n*=41), and only one adult road kill (462 mm SVL) were recorded. This is an interesting record, because more than 97% of road kills were juveniles (Fig. 13). This may be due to their activity period and foraging patterns, as most were killed in the afternoon (1100 to 1500 h). Road killed specimens were mostly recorded when temperatures were between 29.8-32.6 °C and humidity levels were between 55-74%. According to published records including Auffenberg (1986), Cota (2011), Wikramanayake (1995) and Wikramanayake & Green (1989), *V. bengalensis* tend to move and forage in the afternoons. Varanids are primarily diurnal and are usually active between 0700-1700 h (Jolley & Meek, 2006; Meek, 1978; Wickramanayake, 1995; Wikramanayake & Dryden, 1993), but we observed one *V. salvator* active at 1840 h and four *V. bengalensis* active between 1725 and 1855 h.

Fig. 11. Adult male *V. bengalensis* emerging from a termite mound.

Discussion

The narrow area between Palaviya and Kalpitiya is mostly dry with sandy earth, but there are also mangrove habitats. While a small population of *V. bengalensis* (*n*=29) was recorded from this area, *V. salvator* was not observed. There are also no records of *V. salvator* occurring in this area over the last 25 years, and before that, only one record exists. The only individual we recorded was from Ippantivu Islet in Puttalam Lagoon, situated 2.2 km from the mainland (Fig. 14). In Sri Lanka, this is the greatest distance that *V. salvator* has been recorded from the mainland, even though there are many records of this species swimming between islands in Indonesia (Borden, 2007; De Lisle, 2007). Although similar in habitat to Potuvil Lagoon (North-eastern province), the *V. salvator* population in the Puttlam Lagoon system appears to be considerably lower. We also failed to record any *V. salvator* from lagoons around Panama, although they were present near inland water holes (Somaweera *et al*., 2004). In southern parts of Sri Lanka (*e.g*., Rath-ganga, Benthota-ganga, Madu-ganga and Kalu-ganga), *V. salvator* was very common close to river mouths.

According to published accounts, interviews with fishing communities, and personal observations, there

Fig. 12. Juvenile *V. bengalensis* found in a village house in Thirikkapallama.

Fig. 13. A road killed juvenile *V. bengalensis* in Vanathavilluwa.

does not appear to have been migrations of *V. salvator* between Sri Lanka and India in the past 50 years. Therefore, Sri Lanka populations may be isolated from other *V. salvator* populations found in northeastern India and the Nicobar and Andaman islands (Koch *et al*., 2007). In Puttalam Lagoon, they have the ability to migrate over short distances between more than 10 islands. A similar occurrence was documented by De Lisle (2007) in North Sulawesi. Even though there is suitable habitat and an abundance of food (*i.e.,* excess fish, discarded meat and garbage) around Puttalam Lagoon, the *V. salvator* population is very low and would be interesting to investigate. Both *V. salvator* and *V. bengalensis* have been known to eat boiled rice and cooked foods, and according to published accounts, *V. salvator* are known to live around garbage dumps and polluted areas in Sri Lanka, as well as Indonesia (Das & de Silva, 2005; Karunarathna *et al*., 2008a; Shine, 1986; Somaweera & Somaweera, 2009; Uyeda, 2009). Both species are valuable as pest control agents in these areas (de Silva, 2006; Deraniyagala, 1953; Rathnayake, 2001).

Varanus bengalensis and *V. salvator* are also valuable to tourism in Sri Lanka, as many foreigners enjoy watching them and their behaviors (Gramentz, 2008, 2010). Unfortunately, we have noticed numerous tour guides including many naturalists introduce them as iguanas. In the areas of Bentota, Kalutara and Galle we observed many foreigners photographing these lizards, but we have also observed many road-killed *V. bengalensis*, including some killed by DWC vehicles and hired jeeps, inside Udawalawa, Yala, Wilpattu, Kumana and Maduru-oya National Parks between 2010 and 2012.

Varanid lizards are also an important feature in local art, and both species have a place in folklore and are closely associated with the day to day life of humans. They are subjects of many stories and poems in Sinhala literature. The following village poems mention both species of *Varanus* in Sri Lanka. In the poems below, 'kabaragoya' refers to *V. salvator*, and 'thalagoi patiya' refers to a juvenile *V. bengalensis* (*thalagoya* = land monitor; *thalagoi* = land monitor's; *patiya* = infant).

(1) *Tikiri Tikiri Tikiri liyà*
[Young woman]
Käleth aran lindata giyà
[Went to the well (to take water) with a pot]
Linda watakara kabaragoyà
[There was a water monitor circling the well]
Käkula käpi diya bariya
[Its leg was bitten by a keelback snake]

(2) *Mä-Bälë athi kala thalagoi patiyà*
[The baby land monitor kept as a pet when I was a kid]
Mata thaniwata midulë pem kelimin sitiyà
[Was playing with me in front of the house, because I was alone]
Ugé maruwä awidin u aregena giyäsatiyà
[Death came and took him away]
Niwan purë palayan thalagoi patiyà
[Go to heaven, baby land monitor]

(Source: Education Department, 2006; Mahendra, 2000; Chandana & Liyanage, 1992)

Although people do not eat *V. salvator* flesh because

Fig. 14. One of the small islands located in Puttalam Lagoon.

there is a mythical belief that it is poisonous, we observed some villagers that killed a *V. salvator* and hung it by the tail. A fire was lit underneath it to help collect oily liquid secretions from the body. The liquid is then mixed with their enemies' alcoholic drinks. Many villagers told stories of how some people had died after drinking alcohol laced with this liquid. Some people also believe that if *V. salvator* scat is applied to a wound it will fester and require amputation, so this has compelled people to kill *V. salvator*. Many people eat *V. bengalensis*. To kill the animals when hunted, they are swung by the tail and struck on a hard surface. There is also a mythical belief that if *V. bengalensis* tongues are eaten, and individual's memory capacity will be increased. *Varanus bengalensis* are occasionally caught in noose traps (Fig. 15). According to Subramanean & Reddy (2012), there has recently been an increase in demand for its flesh in India, especially the tongue, due to the belief that it has curative properties for AIDS.

Conservation

Surprisingly, *V. bengalensis* has been assessed as a species of least concern by the IUCN Red List Category in 2011. Though it is currently listed as safe, further research and monitoring of this species is needed to ensure that the species does not become threatened in the future (*e.g*., Subramanean & Reddy, 2012). In Sri Lanka, both *V. bengalensis* and *V. salvator* are protected under the Flora and Fauna Protection Ordinance (FFPO) (de Silva, 1998), and *V. bengalensis* is listed in CITES Appendix 1 (Somaweera & Somaweera, 2009). However, there is no management plan of the Forest Department (FD) or Department of Wildlife Conservation (DWC) for this species to reduce its threats.

In 2009, the areas between Kalpitiya and Palaviya, and between Puttalam and Eluwankulama were designated as tourism zones. This project has been helpful for increasing tourism revenue in Sri Lanka, but thousands of hectares of mangroves and natural forests continue to be cleared for development projects (Fig. 16). Additionally, more than 1000 hectares of mangroves and inland dry zone forest (mainly scrub) had been cleared for prawn cultivation and salterns between 1990 and 2005 (Weerasinghe, 2008). Presently, these areas have been abandoned due to the poor management and monoculture of the prawn farms.

Limestone extractions in the area are causing natural bodies of water to fill with mud as well as various other environmental problems (see Kumarasinghe *et al*., 2010; Karunarathna *et al*., 2009 for further details on environmental issues of this area). The DWC and relevant authorities should especially take responsibility for these issues, and implement relocation and conservation programs to parallel governmental development programs. Education and awareness programs should focus on villages, school students and the general public, and universities should use these areas for research and experimental programs. Art, photography, writing, and debate competitions should be introduced to the general public through child scout groups as well as "*Parisara Niyamu Bata Kandayam*" in the Central Environmental Authority (CEA). Together with customs, the DWC should monitor any international trade in these Sri Lankan *Varanus* species, especially since *V. salvator* has been heavily exploited for several decades by the reptile skin industry in several Asian countries (Gaulke, 1992; Shine *et al*. 1996, 1998).

Fig. 15. Adult *V. bengalensis* caught in a noose trap.

Finally, we conclude that further ecological and behavioral research is needed to help conserve Sri Lanka's monitor lizards and other faunal groups, and it is our own responsibility to conserve these species before they become just a legend in history.

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Fig. 16. Forest clearance in Eluwankulama which has been put up for sale.

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