Ecology of two endemic turtles in the Western Ghats

Final Technical Report

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A Radio tagged Female Cane turtle # 6 monitored during the study

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EXECUTIVE SUMMARY

This project was initiated on the 16th January 2006 with an aim to generate natural history information on two out of the three endemic species of terrestrial turtles. India has 28 species of freshwater turtles and tortoises, of them three species are endemic. The endemic species: Cane turtle, *Vijayachelys silvatica*; Travancore tortoise *Indotestudo travancorica*; Leith's softshell *Nilssonia leithii*, are restricted to the southern peninsula and the Western Ghats. In this study the focal species were the Cane turtle and the Travancore tortoise which had their distribution in the Western Ghats. The objectives of the project were (i) to estimate the population density of Travancore tortoise and cane turtle in a fragmented landscape; (ii) to quantify the diet of these two species and describe the feeding ecology with respect to their role in seed dispersal; (iii) to identify threats to the turtle population based on their habitat use ranging pattern and food habits and recommend measures for their conservation; (iv) to carry out a survey of these two species along the Western Ghats to ascertain the exact distribution in the context of Protected area network in the region.

The study employed methods to study the population, diet and ranging patterns of the Cane turtle and the Travancore tortoise in Anamalai and Parambikulam Tiger Reserves. In the case of Travancore tortoise, the animals were searched on forest trails scattered in the reserves and repeated over three years to determine the proportion of area occupied accounting for imperfect detections. These surveys revealed that about 82% of the area surveyed is occupied by the tortoise, suggesting that the reserves hold sizeable population of the tortoise. The occupancy of the Travancore tortoise was negatively influenced by anthropogenic disturbance levels and positively influenced by the availability of water bodies and grass marsh in different sites. Only 35% of the sites occupied by the species resulted in detections, suggesting that it was cryptic. The important constituents of its diet were grass, other plant matter, invertebrates and other animal matter. The *vayal* (grass openings within woodland) habitat might be crucial for foraging by Travancore tortoise. The five individuals that were radio-tagged used an area from 5 to 35 ha covering evergreen, bamboo and open scurb-grass marshes. The animals spent about 98% of their time under leaf litter, logs, rocks crevices, tree holes, termite or pangolin burrows, bamboo tickets and under grass.

In the case of cane turtle, various search methods employed did not yield detections and therefore, an intensive area was combed intensively. This resulted in detections of the elusive cane turtle. During the study spanning over four years, 42 ha of the evergreen forests in the reserve resulted in sightings of 27 different individuals of the cane turtle. This suggests that the species occurs in high density in the evergreen forests. Six cane turtles were fixed with radio-transmitters and monitored for two years. They used an area from 3.5 to 14.2 ha restricted to the evergreen

forests alone. They also had extensive overlap in their home-ranges, suggesting no territoriality in the species. The movement of the animals were influenced by temperature and rainfall in the intensive study area. Diet of the species consisted of forest floor invertebrates, seeds and other plant material. The field observations on feeding on a large land snail and aggressive encounters between males of the cane turtle were the highlights of the study on the species.

A survey of the three endemic species of turtles was taken up in the fifth year of the project. The survey involved visiting 12 sites in the states of Karnataka and Tamil Nadu. The potential sites where the species might be found were visited and the locals were interviewed in order to document the occurrence of the species. This resulted in one new locality record for cane turtle and two new records for Travancore tortoise. The Leith's softshell was reported from five different locations in Karnataka and Tamil Nadu based on the interviews with locals. The sites occupied by the species were located within and outside protected areas. So far the study has resulted in three peer reviewed publications and two presentations in international conference.

Based on the findings of the study it could be inferred that the Travancore tortoise is sensitive to human disturbance. This might be the consequence of exploitation of the animal by the locals in the reserves where the study was conducted. It is not uncommon to find locals using domestic dogs during their forays into the forest. We speculate that there is some level of subsistence exploitation of the species in the region. The behaviour and ranging pattern of the species make them cryptic for detection by humans, but vulnerable to detection by domestic dogs. The study revealed that there is poor awareness among wildlife protection staff in the reserves on the species in general. Increasing the awareness of the staff could result in curbing subsistence exploitation of the species in the reserves. The *vayals* in the reserve are crucial habitats for the species; therefore, their protection and monitoring should be of importance for the persistence of the tortoise population. In the case the cane turtle, contrary to our initial expectations they survive in high densities (60 individuals in 1 sq. km) in the middle and low elevation evergreen forests (between 10 – 1000 m above mean sea level). The Karian Shola National Park is having a large population of this species which is of importance of the management of the protected area. The species is extremely stenotypic, showing strong preference to a narrow range of microclimatic variation prevailing in evergreen forests that are below 1000 m elevation in the Western Ghats. This indicates that the low elevation evergreen forest areas are crucial habitats for the species. Our intensive study on the species spanning over four years did not yield much information on the reproductive ecology of the species, because of their secretive lives. We recommend studies on the reproductive biology of the species, which might be important in the context of conservation breeding of the species. In the case of Leith's softshell, we suggest extensive surveys to document the distribution, the status of population and, the genetic and morphological variation in the populations in peninsular India.

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Introduction

The turtle fauna of India is represented by 41 species, which includes 32 freshwater, five marine and four land dwelling species. India has three endemic species of turtles. The turtle species diversity is high in the north and north eastern part of the country. The southern and the western part of the country are impoverished in turtle fauna. However all the three endemic species; Travancore tortoise (*Indotestudo travancorica*), Cochin forest cane turtle (*Vijayachelys silvatica*), and Leith's softshell turtle (*Nilssonia leithii*) are found only in south India (Groombridge *et al.,* 1983; Moll, 1989). Both Travancore tortoise and Cochin forest cane turtle are reported only from few localities in the Western Ghats of Tamil Nadu, Karnataka and Kerala states (Das, 1991; Bhupathy & Choudhury*.,* 1995). Western Ghats is one of the thirteen global mega biodiversity hotspots. A wide range of rare and endemic vertebrates survive in these hill ranges despite severe human interference. India has three endemic turtles and all of them are only found in the Western Ghats. Information on the ecology and the threats that might impact their population is lacking and therefore there is a void in strategies that can be adapted to conserve them.

The Travancore tortoise is protected under Schedule IV of the Indian Wildlife (Protection) Act of 1972 and is listed in Appendix II of CITES. The cane turtle, thought to be extinct was rediscovered almost after eight decades (Vijaya, 1982). It is protected under Schedule I of the Indian Wildlife (Protection) Act of 1972 indicating that capture, trade or possession is prohibited. While Travancore tortoise is listed as vulnerable, cane turtle is an endangered species (IUCN, 2002). Detailed ecological information on both the species is lacking and population estimates are not available to suggest conservation measures (Groombridge *et al,* 1983; Frazier, 1989; Moll, 1989). Existing literature on both these endemic chelonians is largely confined to locality records and brief notes on their habits; the latter mainly based on captives and conversations with locals (Vijaya, 1982; Groombridge *et al,* 1983; Moll *et al,* 1986; Bhupathy & Choudhury, 1995).

The forests in which these species survive are subjected to forest fragmentation and frequent ground fires (Sekar & Ganesan, 2003). Man made barriers such as reservoirs, roads and plantations have possibly fragmented the population of these species, which were once contiguous. The hazards of ground fire on small ground dwelling vertebrates are thought to be severe. However, there is no information on these threats to the population of these endemic testudines in the Western Ghats.

Objective

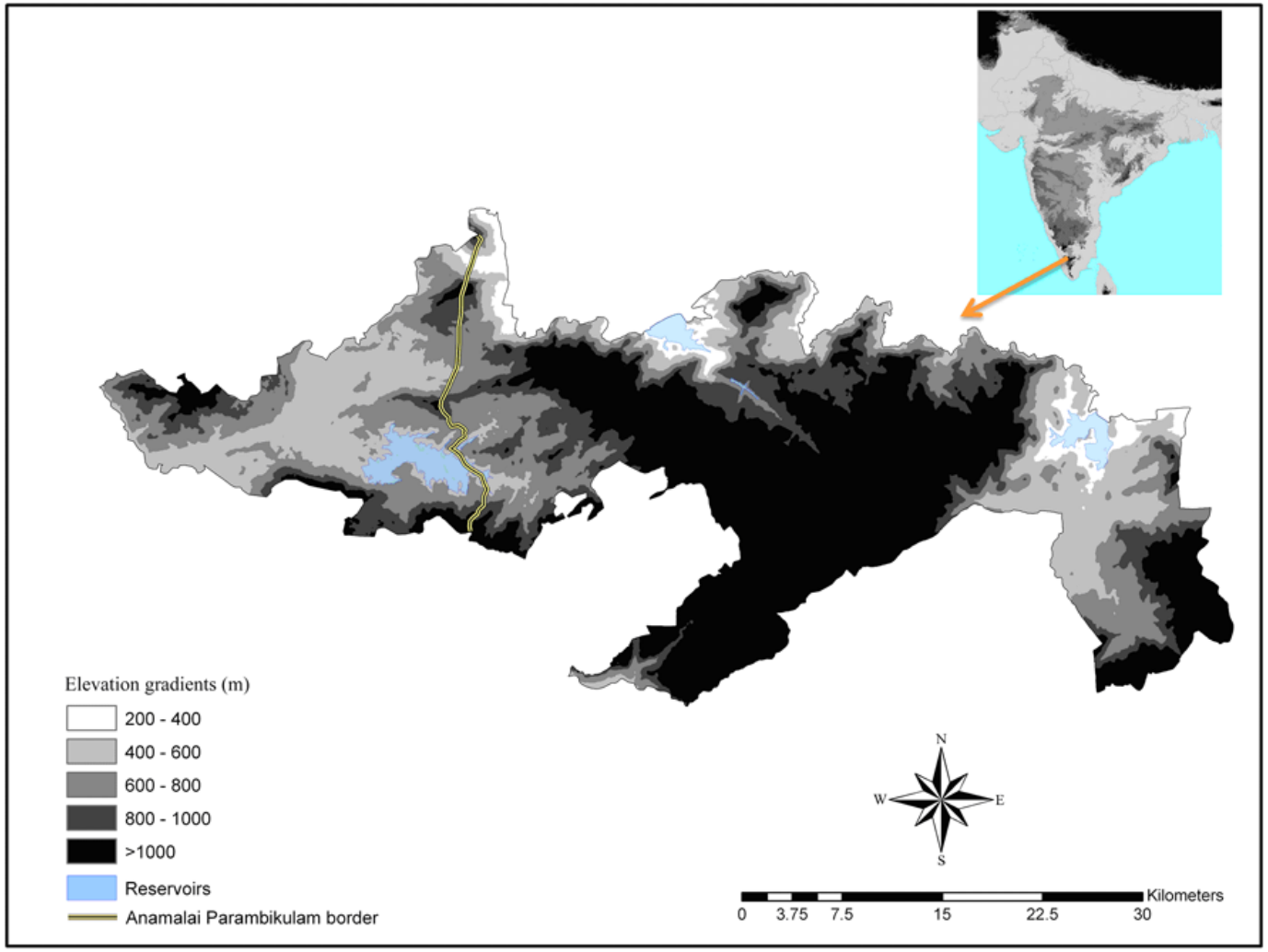
Considering the fact that both the turtles are endemic, rare and lack of information on the biology of the species, the present study was proposed with the following objectives:

1. To estimate the population density of Travancore tortoise and cane turtle in a frag mented landscape;
2. To quantify the diet of these two species and describe the feeding ecology with respect to their role in seed dispersal;
3. To identify threats to the turtle population based on their habitat use ranging pattern and food habits and recommend measures for their conservation;
4. To carry out a survey of these two species along the Western Ghats to ascertain the exact distribution in the context of Protected area network in the region.

Study area

The study area includes two protected areas Anamalai Tiger Reserve, Tamil Nadu and Parambikulam Tiger Reserve, Kerala. The study area has a mosaic of vegetation in our sampling we considered four major vegetation types: classified as southern tropical wet evergreen forest (Champion & Seth, 1968), *Dipterocarpus indicus-Dipterocarpus bourdilloni – Strombosia ceylanica type* (Pascal et al., 2004); Bamboo forest with mixed deciduous trees (*Grewia telifolia, Terminalia tomentosa, Lagerstromia lanceolata* and *Cassia fistuala*); Moist Deciduous (*Terminalia tomentosa, T. bellarica* & *T. paniculata, Dalbergia siso, Dillenia pentagyna*). More than % of the protected areas are monoculture teak plantations. The habitat had been severely modified in the historic past due silviculture practices (Sekar & Ganeshan, 2003). The elevations in the sampled area varied from 200-2500 m above mean sea level (MSL) (Fig. 1). However sampling sites for Tortoises were only below 1000 m MSL, where the tortoises are found. Annual rainfall measurements for the year 2006, 2007, 2008, 2009 were 1408, 2158, 1276 and 2000 mm respectively.

Figure. 1. Physical attributes of the study areas: Parambikulam Tiger Reserve 285 km^2 in Kerala and Anamalai Tiger Reserve in Tamil Nadu state 985 km^2.



Chapter 1

2.1 Review of literature

First described by Henderson in 1912 based on two specimens, no further information was available on the species until 1982. Rediscovery of the species from near the type locality by J. Vijaya and a follow up study by her added significant information on natural history, diet and distribution the species (Vijaya, 1982; Groombridge *et al,* 1983; Moll *et al,* 1986; Whitaker & Jaganathan, 2009). The cane turtle is a terrestrial turtle, sympatric with Travancore tortoise. Cane turtles was thought to be rarer than the Travancore tortoise (Groombridge *et al,* 1983; Moll *et al,* 1986; Das, 1991). However long term studies had found them to be commoner than what they were thought to be (Whitaker & Jaganathan, 2009). Cane turtles have been found under leaf litter, or under dense undergrowth and show a crepuscular-nocturnal pattern of activity. It is an omnivorous species (Groombridge *et al,* 1983; Moll *et al,* 1986). Sexual dimorphism is prominent in the species with females being larger than the males; however they were not significantly different in their straight carapace length (Whitaker & Jaganathan, 2009). They have marked sexual dichromatism; males have a bright red, yellow, pink and black head than females which are drab with or without a pink line behind the eye (Moll *et al,* 1986). Mating in the species is observed during monsoon from June till November. Oviposition was observed in January and February (Whitaker & Jaganathan, 2009). The cane turtle has a restricted distribution in the evergreen forests of Western Ghats. Recently they are sighted from many different localities: Chalakudy, Poyankutti, Kulathupuzha and Nadukani reserve forests; Peechi-Vazhanai, Neyyar, Peppara, Idukki and Aralam Wildlife Sanctuaries; Parambikulam Tiger Reserve in Kerala, Anamalai Tiger Reserve (formerly Indira Gandhi Wildlife Sanctuary) and Kodayar in Tamil Nadu, Mookambika Wildlife Sanctuary, Sharavathi, Kathlaekan, Agumbe and Neria forest divisions in Karnataka (Vijaya, 1982; Sharath, 1990; Das, 1995; Daniels, 2001; Ease & Ramachandran, 2004; Jose *et al*, 2007; Deepak & Vasudevan, 2009). Besides, studies by J. Vijaya and few anecdotal observations, the existing literature on the ecology of the species is sparse.

2.2 MATERIALS & METHODS

2.2.1 Population

All individuals captured were marked with individual scute mark ID (Cagle, 1939). Time constrained searches were carried out to locate cane turtles in four different evergreen forests.

2.2.2 Diet

Faecal samples were collected to identify their diet content. Collected samples were dried under 40w bulb. The dried materials were then separated and examined using a 10 X hand-held lens.Components of diet in individual faecal samples were scored as 1 – low, 2 – medium and 3 – high, based on the quantum of material found in each faecal sample. Direct observations on feeding behaviour were made whenever possible.

2.2.3 Temporal movement pattern

Four temperature loggers (Onset Computer Corporation, Bourne, MA) were randomly placed in the study area on a wooden stake 150 mm above ground. One logger was placed for each radio tracked turtle on wooden stake which was moved to every day animal locations. The temperature loggers are launched and programmed to collect data for every hour. Rainfall in the study area was measured to the nearest mm using a rain gauge located 800 m away from the centre of the study area. Straight line distances were calculated between radio locations. We used a generalized linear model (GLM) with binomial errors and logit link to find out the factors influencing movement.

2.2.4 *Home range and spatial movement patterns*

Six individuals (3 males & 3 females) were fitted with radio transmitters and tracked on a daily basis. Data on microhabitat used by the turtles was collected every time the turtle was located. The study was initiated on 20th July 2007 and completed on 28th March 2009 in Karian shola. Transmitters on the turtle were attached following Boarman *et al* (1998) protocol. Epoxy adhesive Hysol E-120 HP (Loctite Corp, U.S.A) was used to attach the transmitter on the turtle's carapace. The transmitters were enclosed in a waterproof sleeved antenna (G3-IV type), weighed 5.4 -6.2 g (AVM instruments Co, California, U.S.A) and constituted less than 5% of the turtle's body weight (mean = 2.5%; N = 6). In field, the turtles were located using portable radio telemetry receiver (Model: LA 12Q) and hand held collapsible Yagi antenna (AVM instrument Co, California, U.S.A).Home ranges Minimum convex polygon (MCP) and Local Convex Hull (LCH) were estimated in Program R with "adehabitat" package (Calange, 2006). Home range overlaps were

calculated using R scripts in Huck *et al* (2008).The three dimensional study area was mapped into 100 x 100 m two dimensional grids using a clinometer, compass and measuring tape. Every day locations of the turtle's movement were mapped from the permanently marked corners of the grids.

Microhabitat variables were collected in four 20 x 20 m quadrats in every 100 x 100 m girds within the 42 ha mapped area. Microhabitat variables measured were leaf litter depth using a needle and the number of leaves were counted, percentage leaf litter cover were noted in four 10 x 10 m quadrats within 20 x 20 quadrats, number of lianas, number of trees with buttress, number of fallen logs (above 250 mm width) were counted, length of logs were measured using a measuring tape, number of small (>0.5m), medium (0.5 x 0.5 m) and large rocks (1 x 1 m) were counted and a weighted average from these size classes were used in the analysis as rock index, canopy cover was measured using a canopy densitometer and distance to water using a measuring tape.

2.3 Results and Discussion

2.3.1 Population

Sixty four individuals of cane turtle were captured and marked during the study. A total of 312 man hours of searches were carried out in the Anamalai hills from February 2006 till October 2009. Forty nine *Vijayachelys silvatica* were found during the Visual Encounter Survey (VES) (Table 2.1). Within the 42 ha sampling area we found 27 individuals 12 were found from VES and 15 individuals were found near the radio tracked turtles (Table 2.2). Out of the 27 individuals, found in the 42 ha plot, males were higher in the population (17 males) compared to females (8) and juveniles (2) (Fig 2.1). Approximately one individual for every two hectare area was found in the 42 ha tracking area sampled from January 2007 till October 2009. Previous study on the *Vijayachelys silvatica* from Chalakudy, Kerala in the Anamalai hill range reported 135 individuals from 1390 ha area, approximately 0.1 individual per hectare (Whittaker and Jaganathan, 2009). In the current study we occasionally sampled another evergreen forest patch (Anaikundhi shola). In this patch we found these 22 individuals in an area of 200 ha, approximately 0.1 individuals per hectare. Inspite of low sampling effort of only 54 man hours of search we found 22 individuals (Table 2.2). These low densities are probably an artefact of ad hoc sampling. However, radio tracking in a small area (42 ha) over 2 years period along with VES allowed us to find more individuals (0.6 individuals per hectare), thus giving an indication that the species can actually occur in higher densities.

2.3.2 Diet

Fifty five fecal samples collected from 50 individuals comprising of thirty males, sixteen females and four juveniles were examined. All feacal samples contained at least one identifiable prey item. Based on the occurrence of different food material in the faeces, 85% had insects and molluscs; 82% had plant matter; 76% had sand; 31% had millipede remains and seeds. There were diet contents that could not be assigned to any category and therefore termed 'unidentified', and 84% of the faecal samples had such remains. All diet components were shared by males, females and juveniles (Fig. 2.2). Fifteen out of the fifty five samples had seeds, of which seven belonged to *Glycosmis arborea*, six belonged to *Diospyros buxifolia,* one belonged to *Ficus sp* and one unidentified climber species.

On 27 November 2006 at 1430 h an individual *Indrella ampulla* snail was found in the forest floor covered with froth around its body and about a foot away from the snail the male cane turtle (# 7) was observed. *Indrella ampulla* is a large terrestrial snail of the family Zonotidae and is endemic to Western Ghats found in the western slopes of Wyanaad, Nilgiri and Anaimalai hills (Blanford & Gowin-Austen, 1908). The turtle was immobile and it had soil and litter debris stuck on the anterior part of its body. Upon close examination, it was found that the head, forelimb and neck of the male turtle had sticky mucous that came from the frothy secretion of the snail. The carapace of the turtle also had some froth that was produced by the snail. It was inferred that the turtle probably attempted feeding on the snail and in response to this the snail produced an adhesive frothy secretion that stuck to the head, neck and limbs of the turtle and the movement of the turtle was temporarily impaired. Observations corroborating the fact that the land snail *Indrella ampulla* formed an important component of cane turtle diet were made on three different occasions. On 26 July 2007 at 13.50 h and on 10 November 2007 at 1630 h the male radio tagged turtle (# 9) was located with fragments of the land snail shell and froth within 10 cm from the turtle. On 12 February 2008 at 09.45 h, a female radio tagged turtle (# 6) fed on the land snail at the base of a tree trunk (Fig.2.3). It was inferred that the mucous secreted by the land snail was in defense from predation by the cane turtle. Production of sticky mucous as a defense against predators is well known in molluscs (e.g. Eisner & Wilson, 1970; Parkarinen, 1994; Mair & Port, 2002). The mucous in snails primarily help them in navigation, surviving desiccation, providing structural support and locomotion (Denny, 1989). These observations confirm that *Indrella ampulla* is part of cane turtle diet. It also suggests that *Indrella ampulla* has a unique mechanism that can deter its predators, such as the cane turtle. On 2 August 2007 at 12. 30 h, a female cane turtle (# 5) was observed feeding on *Diospyros buxifolia* fruits. The female cane turtle spent four days under one fruiting *Diospyros buxifolia* tree and fed on the fruits.

On 12 October 2007 10. 40 h, a female cane turtle (# 6) was observed feeding on earthworm. Our studies are consistent with Moll *et al* (1986), highlighting the forest floor macro-invertebrates in the diet of the species.

2.3.3 Temporal movement pattern

The mean velocity of movement showed a bimodal pattern in general and was different for the four individuals (Fig. 2.4). There was increase in mean velocity of movement at 09.00-10.00 h later a decrease and again an increase around 12.00 h and started decreasing after 17.00 h (Fig. 2.4).

The overall movements in the radio tracked individuals were not different from each other (Fig. 2.5). Minimum temperature had a significant effect on the movement of male # 1 & # 2 and female # 1 & # 2 (Table. 2.3, Fig. 2.6). Maximum temperature had a significant negative effect on the movement of female #1 and a positive effect on the male # 1, female # 2 and did not have significant effect on the movement of male # 2 (Table. 2.3, Fig. 2.7). Minimum and maximum in a two way interaction had significant effect on the movement of male # 1 and female # 1 (Table. 2.3). Minimum and rainfall in a two way interaction had significant effect on the movement of male #1 (Table. 2.3). Rainfall had a significant effect on the movement of male# 1 & # 2, female # 2 and did not have any significant effect on the movement of female # 1 (Table. 2.3).

In chelonians thermoregulatory behaviour has been observed in all of the three major life forms: terrestrial, semi-aquatic and marine (Avery, 1982). Behavioural thermoregulation includes restriction of activity periods and microhabitat selection (Huey, 1982; Minnich, 1982, Heatwole & Taylor, 1987) and function in reducing water loss. Studies on seasonal changes in activity of turtles (e.g, Converse *et al,* 2002; Plummer, 2003) provided insight to their activity levels, overwintering behaviour and aestivation. Plummer (2003) reported that surface activity of *Terrapene ornata* was greatly affected by rainfall and operative temperatures both seasonally and daily. Frequency of daily activity of *Terrapene ornata* was found to be 60% greater in the wet season, compared to dry season. In the box turtles in North America (*Terrapene Carolina* and *T. carolina triunguis*) activity was found to be triggered by rainfall (Strang, 1983) while during the periods without precipitation, they were buried under leaves. Rainfall with their effect on minimumand maximum temperature of the day could possibly affect movement in cane turtle and this is the period when they actually mate and interact with other individuals. It could also be the time when they can find more forest floor invertebrates to feed.

Janzen's (1967) predicted that tropical organisms would not only have relatively small tolerance zones, but also limited acclimation responses. Janzen presumably assumed that acclimation is favoured only in seasonal environments, where the benefits of physiological compensations would outweigh the costs (e.g., Hoffmann, 1995) of maintaining the capacity to acclimate (Ghalambor *et al.,* 2006). Movement of cane turtles were influenced by temperature (minimum & maximum) and rainfall in the study area. Movement of cane turtles in response to environmental variables were different for individuals. The other freshwater turtle (*Melanochelys trijuga)* found in the area were found basking, no particular basking behaviour in cane turtles. Instead cane turtles temporarily seized their activity by burying under leaf litter; Female # 1 was observed in the same locality for 45 days under leaf litter during summer.

2.3.4 Home range and spatial movement patterns

All the fixes were used to estimate MCP; male#1 had the biggest home range and the male # 2 smallest out of the four (Fig. 2.8a,Table. 2.4). Proportion of LCH in MCP shows the used area by the turtles and darker isopleths in LCH, the intensively used areas (Fig. 2.8a, 2.5b, 2.5c, 2.5d, Table. 2.4). Radio tracked turtles had an extensive overlap (15-92 %) in their MCP home ranges (Table. 2.5). Overlap in the intensively used home ranges (LCH) was comparatively less between 0-65 % (Table. 2.5). Male # 2 had 21.5 % overlap in female # 1's home range and female # 5 had 35.1% overlap in male # 2's home range, when calculated using MCP. However, both of them did not have any overlap when calculated using LCH method. Apart from the six radio-tracked individuals twenty other *Vijayachelys silvatica* were found within the 42 ha tracking area. Eleven out of the sixteen male *V.silvatica* and six out of the seven females were found in Male # 1's home range. Five out of the sixteen male and two out of the seven females were found in male # 2's home range. Seven out of the seventeen males and one out of the six females were found in female # 1's home range and six out of the seventeen males and three out of the six females were found in female # 2's home range. Two juveniles were found only in male # 1's home range. Overlaps in home ranges were higher when calculated using MCP compared to LCH (Table 2.5). Interestingly male # 11 and female # 5 mated twice during the 2008 monsoon once during June and once during August. However, these areas were outside their intensively utilized areas in twoindependent places, from which the adaptive LCH method cannot create isopleths. Male # 9 had 62.9% overlap on male # 11's home range and male # 11 had 0.9% overlap on male # 9's

homerange, despite the fact that male # 9 & male # 11 never met each other during the study period. Female # 5 had 45.8% overlap on female # 6 and female # 6 had 64.5% overlap on female # 5 (Table.2.5). An average 50% overlap between all the four individuals (n=12) was calculated using MCP and 25% overlap using LCH method. Seventeen other individuals were found in male # 9's home range and seven other individuals in male # 11's home range. Eight individuals were found in female # 5's home range & nine individuals were found in female # 6's home range. All these results and observation construe to the fact that they have extensive overlap in their home ranges. However their LCH home ranges are not shared much as compared to MCP. Cane turtles do fight with other males and they have a defence mechanism when they fight (Moll *et al.*, 1986; present study) but they don't actively defend their territory. It is only when they meet each other that they fight and this is mostly during their breeding season.The MCP home ranges were different during seasons and their LCH home ranges were small compared to the MCP. They did have an extensive overlap in their both MCP and LCH home range. Cane turtles were more active in monsoon compared to other seasons and they showed symmetrical activity pattern. They do not have a defined territory. The only plausible explanation for their high densities is that they have plenty of resources which they can share with their neighbours without actively defending them.

The movement of cane turtles with in the study area was higher in level plains compared to steeper areas (Fig. 2.9, 2.10). Distance away from the perennial water source also appears to be the preferred space for cane turtle (Fig. 2.10). Rockiness appears to be higher in the areas used by cane turtles (Fig. 2.10). Canopy cover was uniform in the 42 ha study area (Fig. 2.10). Number of logs, trees with buttresses, leaf litter cover, and leaf litter depth did not show any particular pattern with respect to area used by cane turtle (Fig. 2.10). Use of level plains compared to steeper areas is probably because they have more leaf litter cover under which the turtles burry themselves during summer. Apart from the thermegulatory importance, deeper leaf litter might harbor more number of invertebrates hence attracting the turtles to areas with deep leaf litter in level plains. Distance away from perennial water in the study area also means distance away from the other habitat types (Bamboo mixed forest). Moll *et al* (1986) mentions about the non association of the cane turtles to streams in their study site. The turtles moved only within the evergreen forests where the canopy cover did not vary (Fig. 2.10). There were only two occasions when female # 1 and female # 2 moved close (5 m) to the bamboo forest, however the 2 males were moving only within the evergreen forest. Cane turtles show strong affinity to evergreen forest, they are specialist, restricting themselves to single environment.

Table. 2.1. Total sampling effort in Anamalai hills between 2006-2009

LOCATION	MAN HOURS	NO. OF TURTLES	INDIVIDUALS/MAN HR
KARIAN SHOLA	155	22	0.1
VARAGALIAR	36	2	0.1
ANAIKUNDHI	54	22	0.4
ORUKOMBAN	32	2	0.1
KARIMALA	10	0	0.0
MANAMBOLI	30	0	0.0
TOTAL	317	48	_

Table. 2.2. Sampling effort for cane turtle in the intensive sampling area.

YEAR	RADIO TRACKING		TIME CONSTRAINED SEARCHES	
	TRACKING DAYS	NO. OF TURTLES	MAN HRS	NO. OF TURTLES
2006	_	_	42.2	11
2007	192	2	44.8	4
2008	356	13	10	3
2009	54	9	58	4
TOTAL	602	15	155	22

Table. 2. 3. GLM results for the best selected models for individuals based on minimum AIC value.

Parameter	Estimate	SE	z value	Pr(>|z|)
Male # 1				
(Intercept)	48.58	19.50	-2.49	**0.01**
min	2.93	1.00	2.95	< **0.00**
max	1.58	0.79	2.00	<**0.05**
rain	1.15	0.58	1.99	<**0.05**
min:max	- 0.10	0.04	-2.49	**0.01**
min:rain	-0.06	0.03	-1.98	<**0.05** Residual deviance: 429.41; 373 degrees of freedom; AIC: 441.41
Female # 1				
(Intercept)	-77.07	29.30	-2.63	<**0.00**
min	4.66	1.48	3.16	<**0.00**
max	2.36	1.19	1. 99	<**0.05**
rain	24.68	15.91	1.55	0.12
min:max	-0.15	0.06	-2.56	**0.01**
min:rain	1.28	0.80	-1.58	0.11
max:rain	- 1.10	0.73	-1.51	0.13
min:max:rain	0.06	0.04	1.55	0.12 Residual deviance: 268.88; 360 degrees of freedom; AIC: 284.88
Female # 2				
(Intercept)	-2.27	2.03	-1.12	0.26
min	0.33	0.11	2.89	<**0.00**
max	-0.21	0.07	-2.83	**0.01**
rain	0.07	0.03	2.36	**0.02** Residual deviance; 199.93; 196 degreesof freedom; AIC: 207.93
Male # 2				
(Intercept)	-5.26	2.43	-2.17	**0.03**
min	0.36	0.11	3.18	<**0.00**
max	- 0.11	0.07	-1.63	0.10
rain	0.08	0.02	3.08	<**0.00** Residual deviance: 263.61;240 degrees of freedom; AIC: 271.61

Table. 2.4. Home range size (ha) for four different cane turtles using different home range estimators (100% MCP, LCH).

METHOD	MALE # 1	MALE # 2	FEMALE # 1	FEMALE # 2
MCP	14.2	3.5	5.6	5.5
LCH	5.17	0.8	2.1	2.9
PROPORTION LCH IN MCP	36.4	22.0	36.3	52.6
NO OF FIXES	265	84	175	65
DAYS	551	264	495	220

Table. 2.5. Overlap matrix of MCP & LCH home ranges between the four radio tracked cane turtles.

METHOD	ID	MALE#1	MALE#2	FEMALE#1	FEMALE#2
MCP	MALE#1	0.00	78.7	92.1	63.4
	MALE#2	30.3	0.00	21.5	59.9
	FEMALE#1	36.5	35.1	0.00	65.8
	FEMALE#2	15.4	37.7	67.6	0.00
LCH	MALE#1	0.0	62.9	6.1	51.0
	MALE#2	0.9	0.0	0.0	3.0
	FEMALE#1	24.9	0.0	0.00	45.8
	FEMALE#2	28.4	11.2	64.5	0.00

Figure.2. 1. Locations of 27 different cane turtle within the 42 ha mapped area.

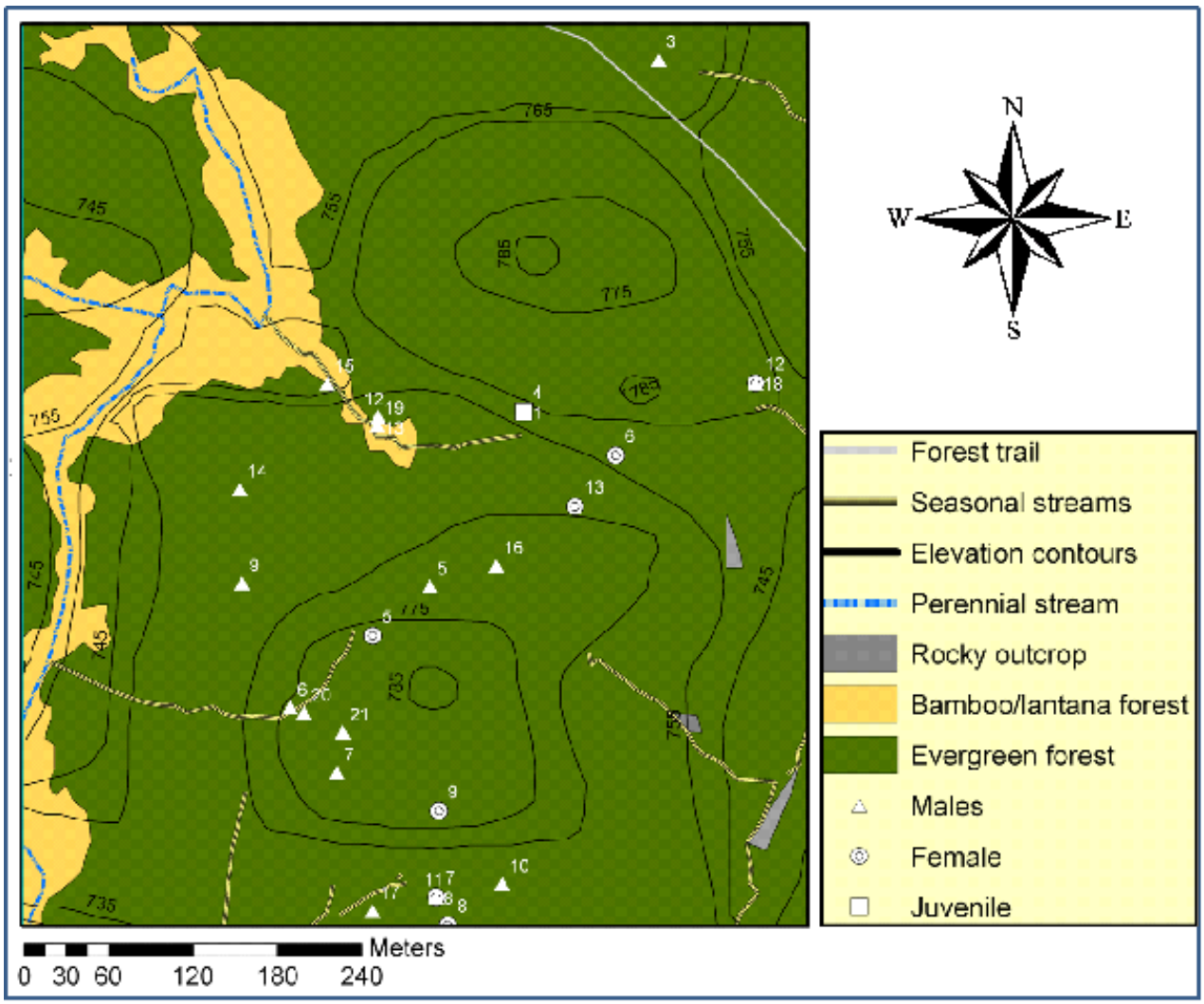


Figure. 2.2. Mean score of different food items in the droppings collected during the study.

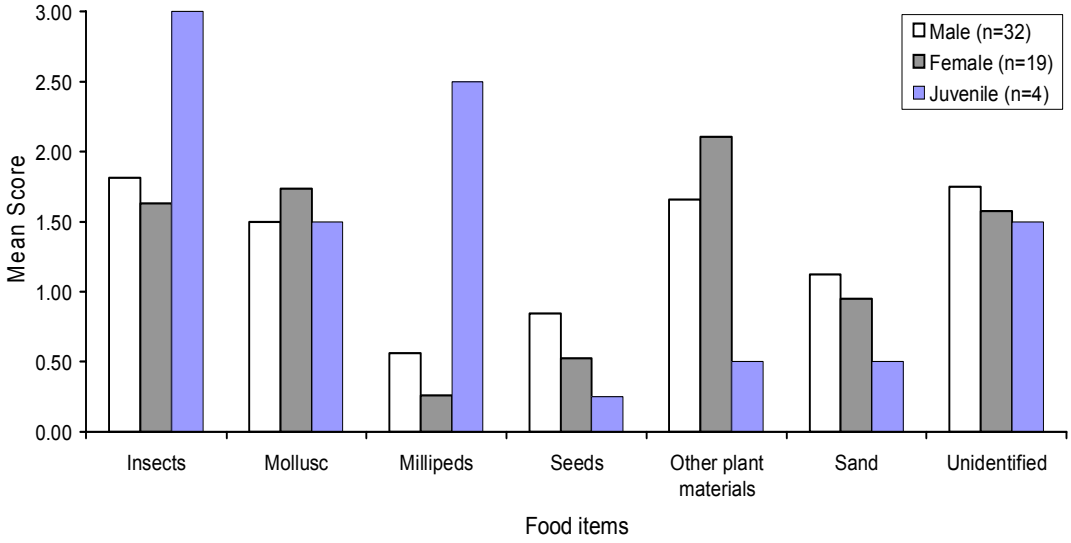


Figure. 2. 3. *Vijayachelys silvatica* preying upon *Indrella ampulla* snail on the base of a tree trunk.

Figure. 2.4. Mean velocity of movement in cane turtles in relation to time interval.

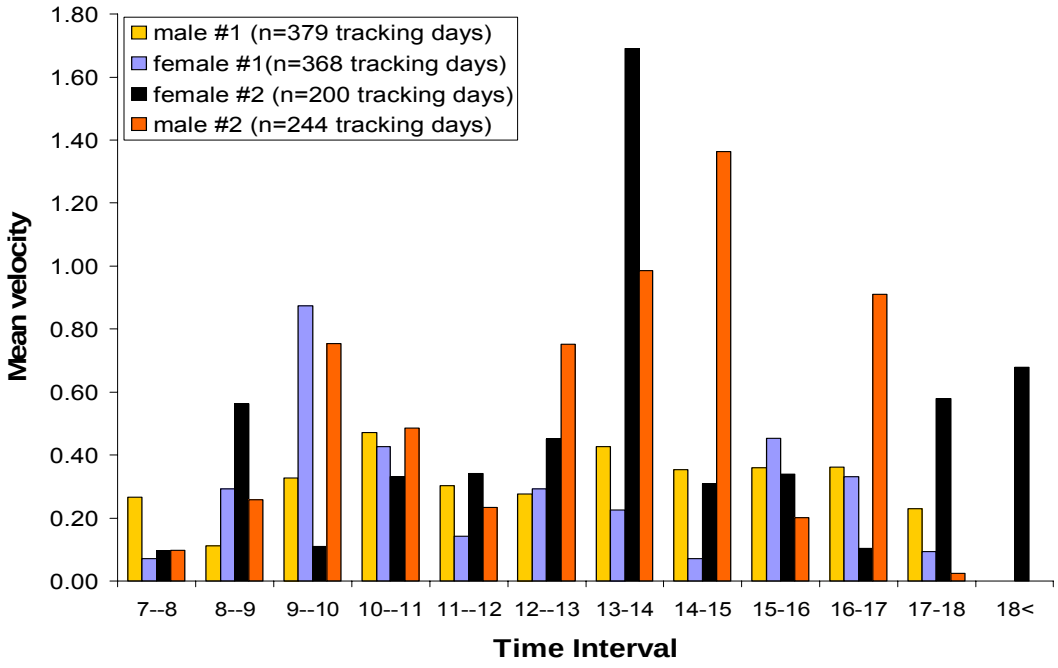


Figure. 2.5. Box plot for the movement of the four radio tracked cane turtle

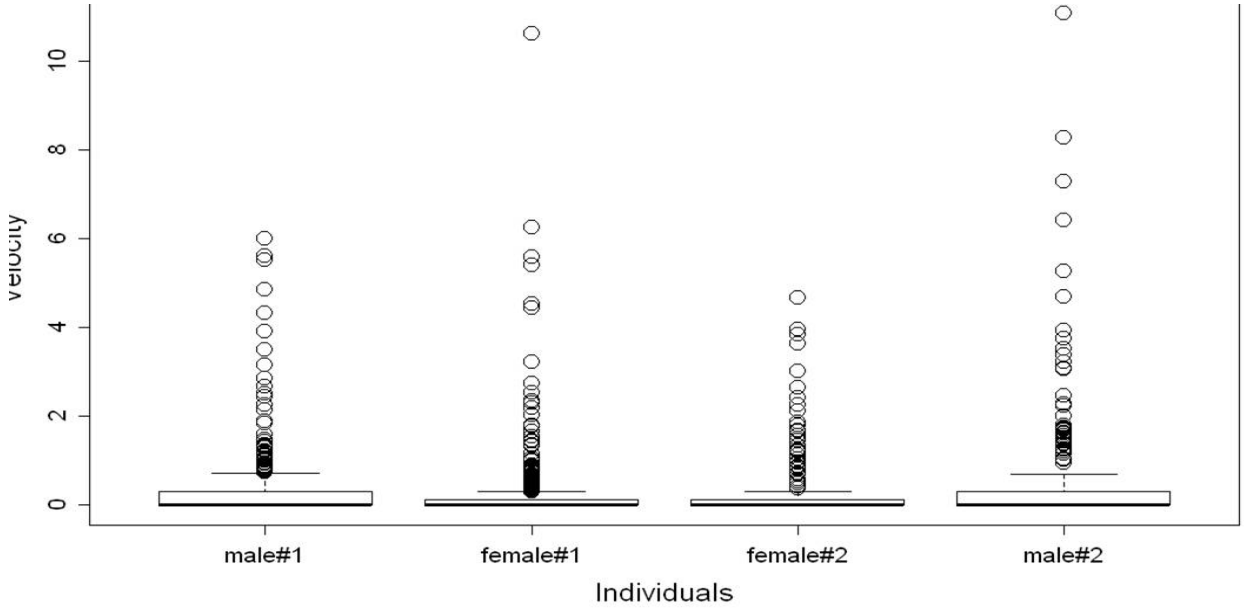


Figure. 2.6. Velocity of movement in cane turtles in relation to minimum temperature of a day.

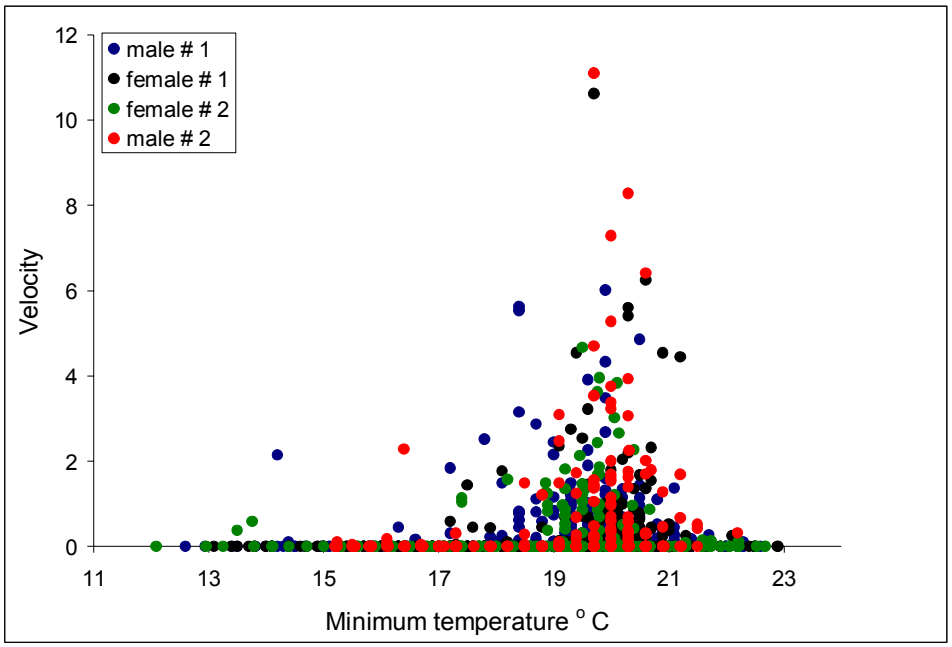


Figure. 2.7. Velocity of movement in cane turtles in relation to maximum temperature of a day.

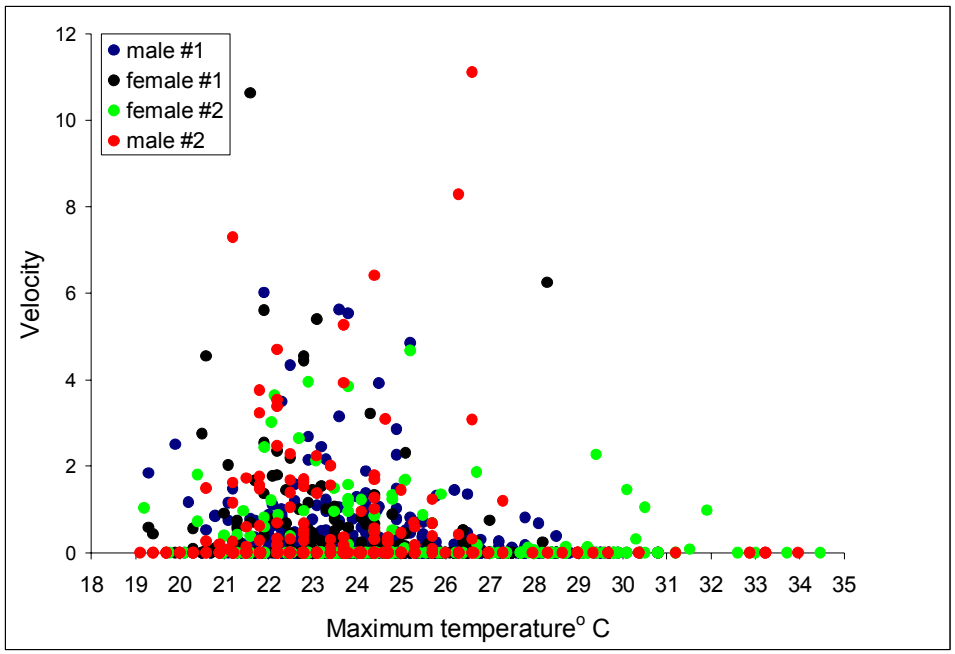


Figure. 2.8. MCP and LCH home ranges for the four monitored *Vijayachelys silvatica*. A. Male # 2,B. male # 1, C. female # 2 and D. female # 1. Note. Open circle represents radio locations; straight contours unfilled area the 100% MCP; straight contours and filled areas 95% LCH.

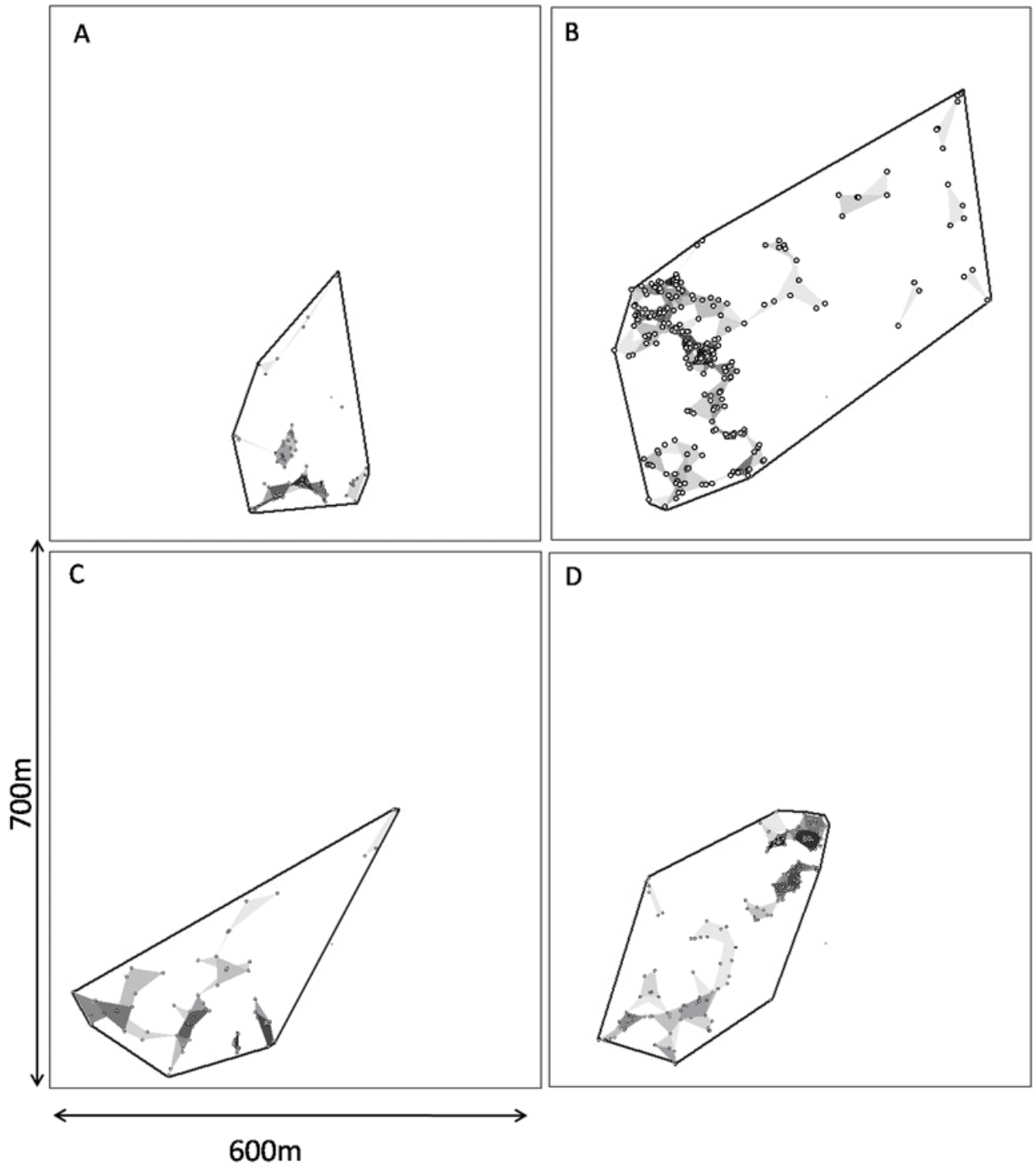


Figure. 2.9. Digital Elevation Model (DEM) of the study area interpolated from every 20 m within the 42 ha study area. Radio locations & locations of all the cane turtles in blue.

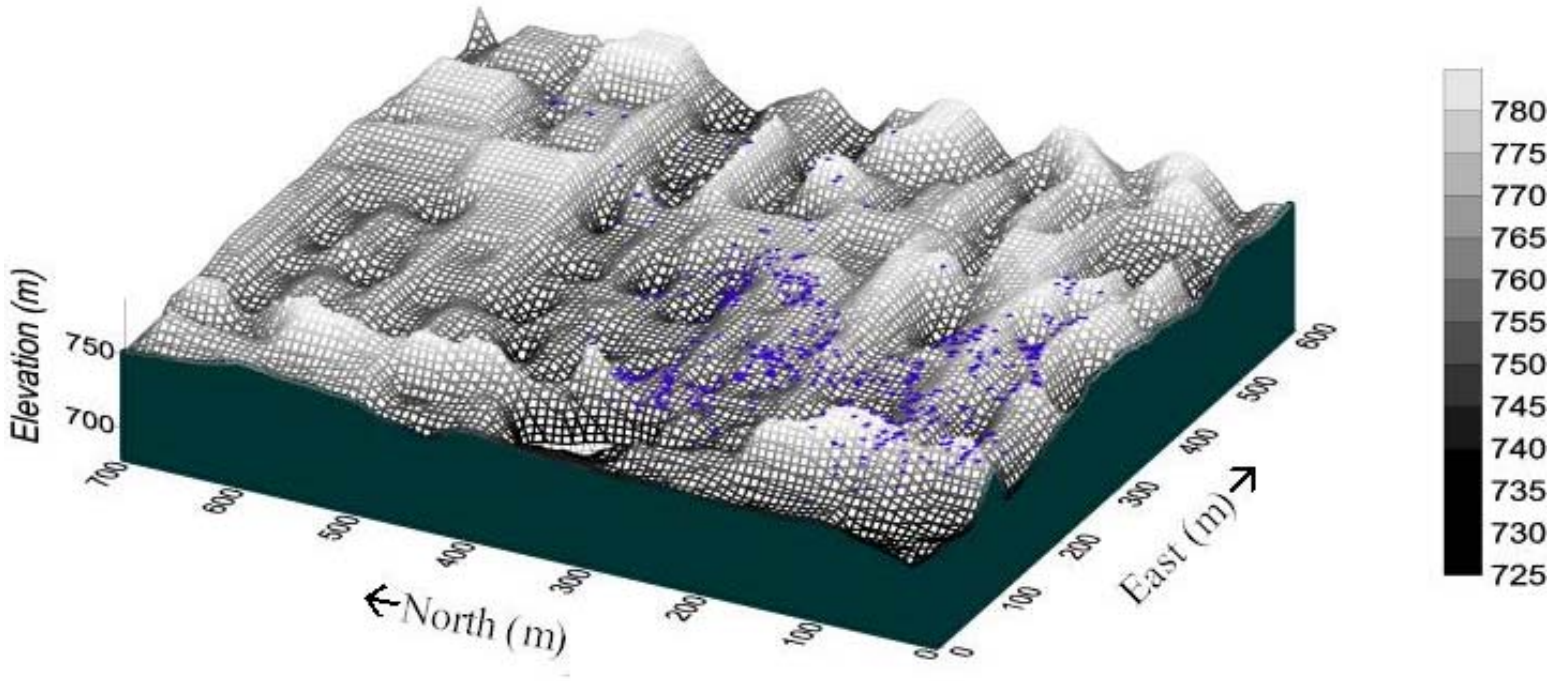
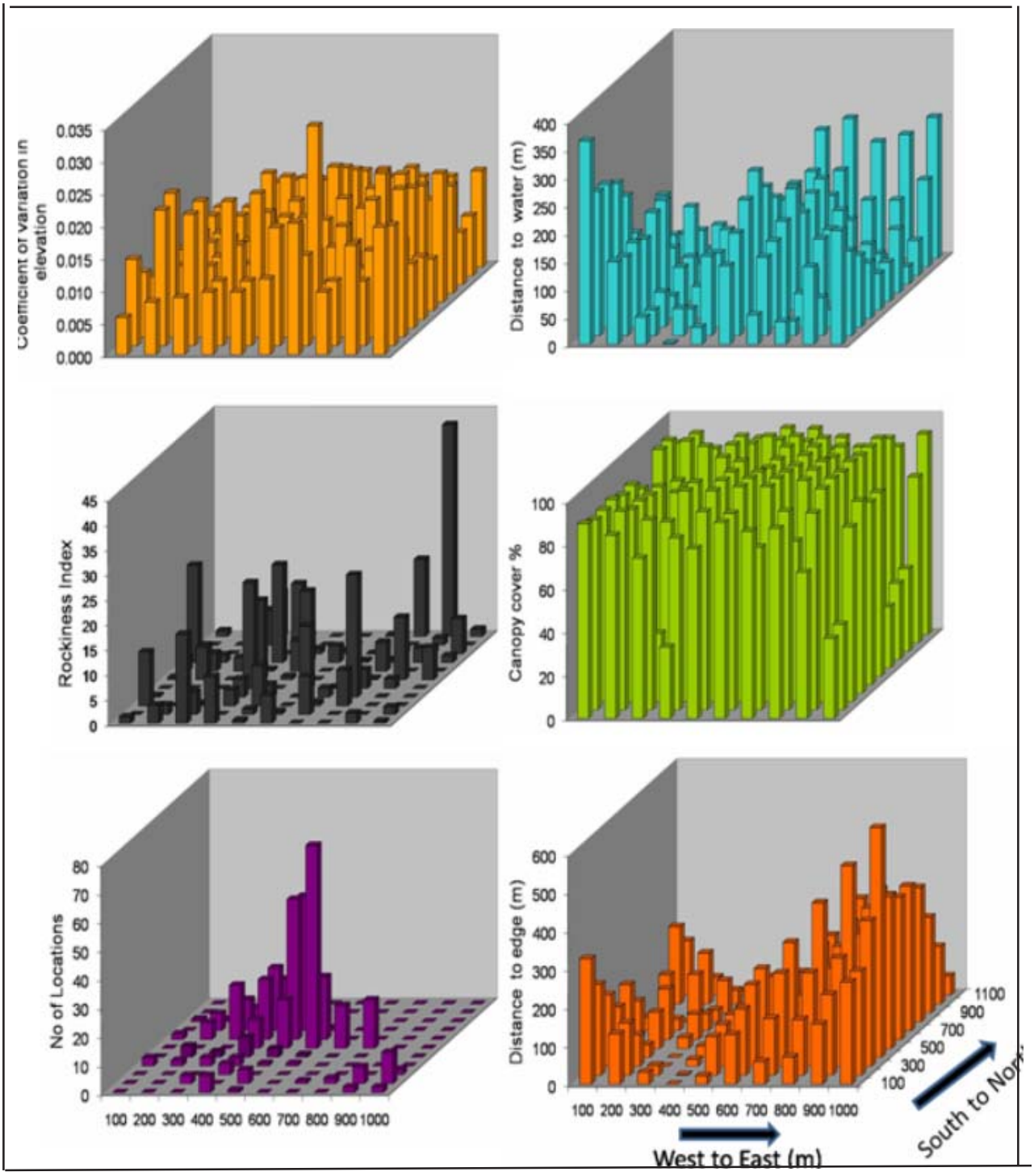


Figure. 2.10. Spatial patterns of locations, microhabitat and habitat variable distributions.



Chapter 2

3.1 Review of literature

Boulenger (1907) described Travancore tortoise from the “Travancore” a region the region that corresponds to Peninsular India. According to Dr. Ferguson who collected the tortoises inferred that the species was common in the Travancore hills of Kerala. *Indotestudo travancorica* is endemic to the mountain ranges of the Western Ghats, in the south-western India (Das, 1991, Iversion et al, 2001). Boulenger noted that it resembled to both *Testudo elongata*, from the northern and eastern parts of the Indian subcontinent, and *T. forstenii* [sic] from Celebes (now Sulawesi, Indonesia) and the neighbouring Gilolo Island (now Halmahera Island, Maluku, Indonesia). It was also considered *T. travancorica* as very closely allied to *T. elongata*. *I. travancorica* was synonomised with a tortoise in Sulawesi Island (Smith, 1931). After a series of taxonomic shuffle a recent study using molecular phylogeny found *I. travancorica* as a distinct species endemic to the Western Ghats (Iversion, 2001). Travancore tortoise is a large tortoise growing upto 330 mm in SCL (Das, 1991). It is found in the evergreen, semi-evergreen, moist deciduous, bamboo forests, rubber and teak plantations in Western Ghats (Vijaya, 1983; Bhupathy & Choudhury, 1995, Ramesh, 2008). They feed on mushrooms, tender bamboo shoots, fallen fruits of *Artocarpus sp*., *Dillenia pentagyna*, *Ficus virens* and leaves of herbaceous plants such as *Synedrella nodiflora*, *Desmodium repandum*, *Senecio scandens*, and *Veronica buabaumii* (Vijaya, 1983; Ramesh & Parthasarathy, 2006). Travancore tortoises are known to frequent mostly grass marshes and rocky outcrops close to streams (Vijaya, 1983; Bhupathy & Choudhury, 1995; Ramesh, 2008). Endemic to the Western Ghats of peninsular India, *I. travancorica* has been reported from states both south (Kerala, Tamil Nadu) and north (Karnataka) of the Palghat Gap from 100-1000 m a.s.l (Boulenger, 1907; Smith, 1931; Vijaya, 1983; Das, 1991; Bhupathy & Choudhury, 1995). The breeding season of *I. travancorica* is from November to January (Auffenberg, 1964a).A detailed note on their courtship behaviour was reported by (Auffenberg, 1964b). In captivity, the species excavated small chambers near the roots of trees, shrubs for laying eggs, and the entire process took about 50 minutes. Eggs were 47 x 38 mm in dimension and weighed 41 g (Ramesh, 2007). In captivity, clutch size varied from 1-5 eggs but is often three (Vijaya, 1983; Sane & Sane, 1989; Das, 1991, Ramesh, 2007); eggs have also been found on the floor of the enclosure (Sane and Sane, 1989) or in leaf litter (Das, 1991) probably due to lack of a suitable nesting substrate. The incubation period varied from 141-149 days in captivity and a hatchling measured 55 mm (SCL) and weighed 35 g (Sane & Sane, 1989; Das, 1995).

Previous studies on the species were based on short term surveys and anecdotal notes (Groombridge et al., 1983; Vijaya, 1983; Frazier, 1989; Moll et al, 1989; Das, 1991; Bhupathy & Choudhury, 1995). Only one study has attempted to estimate the relative abundance of the species in the Anamalai Tiger Reserve (Ramesh, 2008). It was quantified that 3.4 h of effort is necessary to find a tortoise between December to March (Ramesh, 2008).

3.2 Materials & methods

3.2.1 Population

Decision on the time and season of sampling was made a prior to obtain maximum detections during the surveys. Precipitation pattern in the area showed two seasonal peaks each year: one during the South West monsoon in June to August and the other during the North East monsoon in September to November (Kannan & James, 1999). Native people's knowledge on the species allowed us to sample more during the monsoon months when the tortoises were said to be more active. Ramesh (2003) stated that searches conducted between 1400 – 1900 h were more efficient and also the Native people's knowledge of searching them during late evening hours helped us to decide and carry out all our survey between 1600- 1900 h. Indirect evidences such as trails, spoors and bite marks on grass and herbs were recorded. Trail marks of tortoises on the grass and grass marshes were prominent during the monsoon and post monsoon.

A stratified random sampling approach was followed to sample Travancore tortoise; ten trails were marked in four different habitat types in the study area (Fig. 3.1, see chapter 1). The start points of the trails were determined randomly and the trails were animal trails / human trails. All the trails were marked permanently and were forced to cut through one habitat type. However they dissected through multiple microhabitat types grass marshes, rocky outcrops and streams. Due to logistic difficulties only twenty five trails were sampled during monsoon and post monsoon 5, 3, 7 and 3 repeats were carried out during the year 2006, 2007, 2008 and 2009 respectively. We had 108 missing surveys out of the 18 sampling occasions (18 x 25 = 450 surveys). Each trail (site) was sampled up to seven meters on either side of the trail by two observers. The following four site covariates were measured: (i) The extent of grass marshes in each site measured using measuring tape, (ii) Number of water bodies within 10 m distance on either side of the trail (ponds, streams), (iii) six different measures were used to account for disturbance.

(1) High human use trail (2) Tuber collection (3) Nearest distance at any point in the trail to the hamlet (> 1 km = 1 (high), < 1 km = 0 (low) (4) Nearest distance at any point in the trail to Jeep able road (> 1 km = 1 (high), < 1 km = 0 (low) (5) Firewood collection (0/1) and (6) Frequented by domestic dog at least once during the study (1) or (0). The cumulative frequency of the scores were summed up to obtain a measure of disturbance as one single disturbance covariate. 4. Habitat type which is categorical. One sampling covariate: Time spent in each trail during every sampling occasion was recorded and the mean of this effort was calculated for each site each year and used as site covariate. Multiple season occupancy models described by MacKenzie *et al,* 2003 were used to estimate Occupancy and detection probability taking into account of colonization and local extinction probabilities. We considered top models to be those with ÄAIC </=2.0 (Burnham & Anderson, 2002) from the best model. We kept only the models with AIC weight >0.1 and so that the weights of the top-ranking models summed to 100% (MacKenzie & Bailey, 2004), then we did overall model averaged estimate of occupancy (ø). We also did a relative importance of variables weights following Burnham & Anderson (2002), by summing the AIC model weights across all the models where a variable occurs. This analysis were done using program PRESENCE 3.1(Hines & MacKenzie, 2004).

3.2.2. Diet

Faecal samples were collected to identify their diet content. Collected samples were dried under 40w bulb. The dried material was then separated and identified using a 10 X hand-held lens. Components of diet in individual faecal samples were scored as 1 – low, 2 – medium and 3 – high, based on the quantity of material found in each feacal sample. Direct observations on feeding were made whenever possible. The percentage of each diet item in the sample was calculated.

3.2.3. Home range and spatial movement patterns

Five individuals (2 males & 3 females) were fitted with radio transmitters and tracked on a daily basis. Microhabitat used by the tortoises was noted every time the tortoise was located. The study was initiated on 13 th Feb 2008 and completed on 13 th March 2010 in Karian shola.

Transmitters on the tortoises were attached following Boarman et al (1998) protocol. Epoxy adhesive Hysol E-120 HP (Loctite Corp, U.S.A) was used to attach the transmitter on the tortoise's carapace. The transmitters were enclosed in a waterproof sleeved antenna (G3 type), and weighed 25 -27 g (AVM instruments Co, California, U.S.A). The tortoises were located using portable radio telemetry receiver (Model: LA 12Q) and hand held collapsible Yagi antenna (AVM instrument Co, California, U.S.A). Home range sizes (MCP & LCH) were estimated in Program R with "adehabitat" package (Calange, 2006). Home range overlaps were calculated using R scripts in Huck et al (2008).

The 110 ha study area was mapped into 100 x 100 m two dimensional grids using a clinometer, compass and measuring tape (Fig. 3.12). The clinometer readings were also used to create a Digital Elevation Model (DEM) of the study area (Fig. 3.10). Every day locations of the tortoise's movement were mapped from the permanently marked corners of the grids. Microhabitat variables were collected in four 20 x 20 m quadrats in every 100 x 100m girds within the 42 ha mapped area. Microhabitat variables measured were leaf litter depth using a needle and the number of leaves were counted, percentage leaf litter cover were noted in four 10 x 10 m quadrats within 20 x 20 quadrats, number of lianas, number of trees with buttress, number of fallen logs (above 250 mm width) were counted, length of logs were measured using a measuring tape, number of small (>0.5 m), medium (0.5 x 0.5 m) and large rocks (1 x 1 m) were counted and a weighted average from these size classes were used in the analysis as rock index, canopy cover was measured using a canopy densitometer. Distance to water and distance to the edge habitat (bamboo forest) from the center of the grids were calculated using Arc view 3.2. Coefficient of variation in the elevation in each grid was calculated from the elevation measured every 20 m.

3.3. Results and Discussion.

3.3.1. Population

Thirteen out of the 25 trails surveyed had 17 tortoises during the year 2006; one of 17 trails sampled had one tortoise in 2007; only one out of the 25 trails samples had one tortoise during 2008 and nine out of the twenty five sampled trails had 20 tortoises in 2009 (Fig. 3.2).

Detection probability

Detection probability of Travancore tortoise range between 0.14 – 0.45 and evergreen habitat had consistently low detection probability during the four years of sampling (Fig. 3.3). There was

only one top model among the detection probability model set with d" 2.0 delta AIC and it had water bodies, grass marsh, effort and year (Table. 3.1).The top-ranking models in the detection probability model set had number of water bodies, extent of grass marsh, Year, effort covariates and habitat and their cumulative AIC weights were 0.84, 0.70, 0.79, 0.77 and 0.01 respectively. The constant model had a low AIC weight (0.03) in the top models.

There were two top models among the occupancy set of models with > 2.0 delta AIC and the former had water bodies, grass marsh and the later had effort and year along with water bodies, grass marsh (Table. 3.2). Cumulative AIC weights were higher for occupancy model set with water bodies (0.90) and extent of grass marshes (0.90) compared to models with effort (0.29) and year (0.29) and habitat type did not come in the models with weight and the constant model had very low AIC weight of 0.004 (Fig. 3.4).

The top model in the occupancy model set had number of water bodies and extent of grass marsh. Number of water bodies seems to have a positive influence on detection probability of the tortoise (Fig. 3.5). Their activity of the radio tracked individuals were mostly near water bodies and grass marshes (Section 3.1.1; Fig. 3.12).The diet of Travancore tortoise were primarily grass and other plant material (Section 3.2.2; Fig. 3.8), which is why the detection probability were more in sites with more water bodies and grass marshes. Travancore tortoises are known to occur near streams, water bodies and grass marshes in the forest (Bhupathy & Choudhury, 1995). The areas near streams and nullahs also has less scrub cover compared to the forest interiors and the contrast of the tortoise on this background stands out, where the observers visibility is better than forest interiors. Evergreen habitat had consistently low detections during the four years of sampling (Fig. 3.3).

Occupancy

The models that included more than one variable on occupancy ø and models with year (time), yielded unrealistic standard error because estimates were approaching parameter boundary values (= 0 or 1; Anderson, 2008). These models were not included for analysis, the list of models with errors are listed in Appendix (1a). The models which were removed from the model averaging are listed in Appendix (1b).

Both the top models with delta AIC < 2.0 had disturbance level on occupancy (Table. 3.2). The cumulative AIC *wt* of the Top-ranking models was very high 0.83 for disturbance level on occupancy (ø) whereas it was very low for grass marsh (0.05) and water bodies (0.13) and habitat type did

not come in the models with weight and the constant model had very low AIC weight 0.004 (Fig. 3.6). The top models reveal that disturbance level on different trails in the study area seems to have gradient in occupancy of the Travancore tortoise (Fig.3.7). In most of its known distribution, the species is hunted and consumed. Tribes of the Western Ghats such as the *Kadar, Malai Pandaram, Malasar* and *Malaimalasar* hunt them using dogs or by following their tracks (Vijaya, 1983; Frazier, 1989; Moll, 1989; Bhupathy & Choudhury, 1995). More the disturbance level in an area more likely the species will be hunted by the locals which is probably the reason why there is low occupancy in highly disturbed sites. Despite the fact that the tortoises are cryptic and hidden 95% of the times, sniffer dogs used by the locals easily locate tortoises even inside thick bushes and under leaf litter.

3.3.2. Diet

Thirty two faecal samples were collected from 8 males, 15 females and 9 juveniles during the study. All fecal samples contained atleast one diet item. The diet item in the samples had more representation of plant matter: 90.6% had grass & bamboo remains; 93.8% other plant materials (leaf remains, fiber, and twigs); 37.5% had seeds; 75% had insect remains; 62.5% had sand; 21.9% had vertebrate remains (hair, bones & scales); 18.8% had mollusc; 9.1% had crabs & scorpion remains and 3.1% millepeds. There were also diet remains which we could not identify the samples had 71. 9% of such remains. Millipede remains were found only in juvenile faecal samples and the rest of the diet items were represented in all the sexes (Fig. 3.8). The seeds in the faecal samples were identified as *Grewia tilaefolia*, *Lantana camera* & *Dillenia pentagyna*. The direct observations on the tortoises revealed that they also feed on Mushrooms, herbs (*Mimosa pudica, Synedrella nodiflora*) and bamboo shoots (*Bambusa arundanacea*). They also scavenged on carcasses of mammals such as sambar (*Cervus unicolor*).

Twenty nine out of thirty two samples contained grass blades and bamboo shoots and thirty out of thirty two faecal samples had plant remains. Previous studies reported them feeding on herbaceous plants such as *Synedrella nodiflora*, *Desmodium repandum*, *Senecio scandens*, and *Veronica buabaumii* (Ramesh & Parthasarathy, 2006). Most reptiles are carnivorous but numerous turtles and lizards are at least partly herbivorous and many species are known or suspected to play a role in seed dispersal (Braun & Brooks, 1987; Macdonald & Mushinsky, 1988; Moskovits & Bjorndal, 1990; Moll & Jansen, 1995 and reference therein; Mason *et al*, 1999; Strong & Fragoso, 2006). There have been very few studies of the diet of wild reptiles in the Oriental region (Corlett, 1998).

Travancore tortoises are known to feed on fallen fruits of *Artocarpus spp, Dillenia pentagyna* and *Ficus virens* (Vijaya, 1983; Ramesh & Parthasarathy, 2006). Fallen fruit also appears to be a major food items of other tortoises in the Oriental region including *Manouria spp, Indotestudo elongate* and *Geochelone spp.* (Ernst & Barbour, 1989). Ten out of the thirty two samples (37.5 %) contained seeds which indicate that considerable proportion of their diet contains fallen fruits and their role as seed dispersers cannot be ruled out. Plant matter constituted 45 % of the total diet in the faecal samples which indicates that they are primarily herbivores (Fig.3.8).

Invertebrates are an important part of diet in the African Tortoise *Kiniyxs spekii* in Zimbabwe (Hailey *et al,* 2001) and the invertebrates eaten were mostly slow moving (millipedes & beetles), as expected by the limited speed of the terrestrial chelonians (Klimstra & Newsome, 1960). Twenty six out of the thirty two samples examined in this study (16.5%) contained invertebrate remains including millipedes, insects, mollusc, scorpions and crab. In captivity Travancore tortoises fed on animals such as frogs, insects and millipedes (Das, 1991, 1995). We had three independent observations of different individuals feeding on carcasses and seven out of the thirty two faecal samples contained vertebrate remains (4.4 %). Overall 28 % of the faecal samples examined contained animal matters which show considerable consumption of animals by the Travancore tortoise (Fig. 3.8). However the animal matter in the diet scores were minimum compared to that of plant matter (Fig. 3.8). Animal matter provides additional source of high quality protein, calcium and a high ratio of sodium: potassium (Hailey *et al,* 1998; Manson *et al,* 1999; Hailey *et al,* 2001). Animal matter were previously reported in the diet of many herbivorous and frugivorous tortoises (*Geochelone paradalis,* Van Zyl, 1966 and Milton, 1992; *G. sulcata,* Cloudsey-Thompson, 1970; *Gopherus polyphemus,* Macdonald & Mushinsky, 1988; *Geochelone denticulata & Geochelone carbonaria,* Moskovits, 1985; Moskovits & Bjorndal, 1990).

3.3.3. Home range and spatial movement patterns

One out of the five individual's transmitter failed with in four days, only four individuals were used in our home range analysis. Female # 1 had the largest home range encompassing two other males home range (Table.3.3 & Fig. 3.11). However Female # 1's proportion of LCH in MCP

home range was comparatively small than the male # 1 & female # 2) (Table.3.3). Number of fixes for male # 2 was insufficient to calculate LCH home ranges (Table.3.3). Female # 1 had extensive overlap with male # 1 and male # 2 MCP home ranges. Female # 2 did not have any overlap with the other three individuals (Table. 3.4, fig. 3.11). The tortoises used a variety of microhabitat including lantana camera bushes, bamboo thicket, under grass, fallen logs or liana, inside tree hole, rock holes and termite hill burrows (Fig. 3.9). More than 95% of the times they were using one of the cover types which made their detection difficult (Fig. 3.9). Male # 2 spent 106 days inside a termite hill burrow. Burrows serve as a thermal refuge for Desert tortoises (*Gopherus agassizii*) (Bulavo, 2002). Burrow use in Travancore tortoises were found both during monsoon and post-monsoon seasons in the study area. The spatial movement of all the four radio tracked individuals showed affinity towards perennial water bodies and bamboo-lantana habitat associated with grass patches (Fig. 3.12 & 3.13). Coefficient of variation in elevation within each grid, canopy cover, leaf litter cover, number of trees with buttresses and rockiness index did not show any particular pattern (Fig. 3.13 & 3.14) in relation to tortoises habitat use. However the number of lianas was less in the tortoises high uses areas, which might be an artifact of the vegetation structure in the evergreen and bamboo-lantana habitat (Fig. 3.14).

Table. 3.1. Results of models investigating relationships between site covariates and detection probability of *Indotestudo travancorica* based on surveys from 2006-2009. Results are based on constant detection occupancy ψ (.), colonization probability γ (.) and local extinction probability ε(.). Dist=Disturbance; Water=Water bodies; Grass= Grass marsh.

Models	K	-2Log*L*	ΔAIC	AIC*wt*
ψ(.) γ (.) *p*(Water + Grass+ Year + effort)	12	310.52	0.00	0.56
ψ(.) γ (.) *p*(Water + Year + effort)	11	315.07	2.55	0.16
ψ(.) γ (.) *p*(Water)	4	330.19	3.67	0.09
ψ(.) γ (.) *p*(Grass)	4	331.54	5.02	0.05
ψ(.) γ (.) *p*(Grass+ Year + effort)	11	317.78	5.26	0.04
ψ(.) γ (.) *p*(Water + Grass)	5	330.01	5.49	0.04
ψ(.) γ (.) *p*(.)	3	334.68	6.16	0.03
ψ(.) γ (.) *p*(Grass +Year)	7	327.29	6.77	0.02
ψ(.) γ (.) *p*(Year + effort + Habitat)	13	316.86	8.34	0.01
ψ(.) γ (.) *p*(Water + Year)	7	329.25	8.73	0.01
ψ(.) γ (.) *p*(Habitat)	6	331.65	9.13	0.01
ψ(.) γ (.) *p*(Year + Effort)	10	323.88	9.36	0.01
ψ(.) γ (.) *p*(Year)	6	333.23	10.17	0.01
ψ(.) γ (.) *p*(Year +Habitat)	9	330.48	13.96	0.01
ψ(.) γ (.) *p*(Occasions)	20	311.17	16.65	0.00

Table.3.2 Top models investigating effect of site covariates on Occupancy and detection probability of *Indotestudo travancorica*. Dist=Disturbance; Water=Water bodies; Grass= Grass marsh.

Models	K	-2Log*L*	ΔAIC	AIC *wt*
ψ (Dist) γ (.) *p*(Water + Grass)	6	318.57	0.00	0.549
ψ (Dist) γ (.) *p*(Water + Grass+ Year + effort)	13	306.49	1.92	0.210
ψ (Dist) γ (.) *p*(.)	4	326.86	4.29	0.064
ψ (Water) γ (.) *p*(Water+ Grass + Year + effort)	13	309.21	4.64	0.054
ψ (Water) γ (.) *p*(Water+ Grass)	6	323.59	5.02	0.045
ψ (Grass) γ (.) *p*(Water+ Grass + Year + effort)	13	310.47	5.90	0.029
ψ (Water) γ (.) *p*(.)	4	328.52	5.95	0.028
ψ (Grass) γ (.) *p*(Water+ Grass)	6	325.42	6.85	0.018

Table.3.4. Overlap matrix of MCP & LCH home ranges between the four radio tracked Travancore tortoises. "_" fixes were insufficient to calculate LCH for Male #2.

METHOD	MALE# 1	MALE# 2	FEMALE# 1	FEMALE# 2
MCP	9.3	5.2	34.7	9.0
LCH	2.0	_	4.1	2.1
PROPORTION OF LCH IN MCP	21.5	_	11.8	23.3
NO OF FIXES	154	17	242	39
DAYS	613	211	731	92

Table. 3.3. Home range size (ha) for four different Travancore tortoise using different home range estimators (100% MCP, LCH). Note: "_" fixes were insufficient to calculate LCH for Male # 2.

METHOD	MALE# 1	MALE# 2	FEMALE# 1	FEMALE# 2
MCP	9.3	5.2	34.7	9.0
LCH	2.0	_	4.1	2.1
PROPORTION OF LCH IN MCP	21.5	_	11.8	23.3
NO OF FIXES	154	17	242	39
DAYS	613	211	731	92

Figure. 3.1. Map showing locations of the trails in the study area. The tortoises are known to occur in elevations <1000 m.

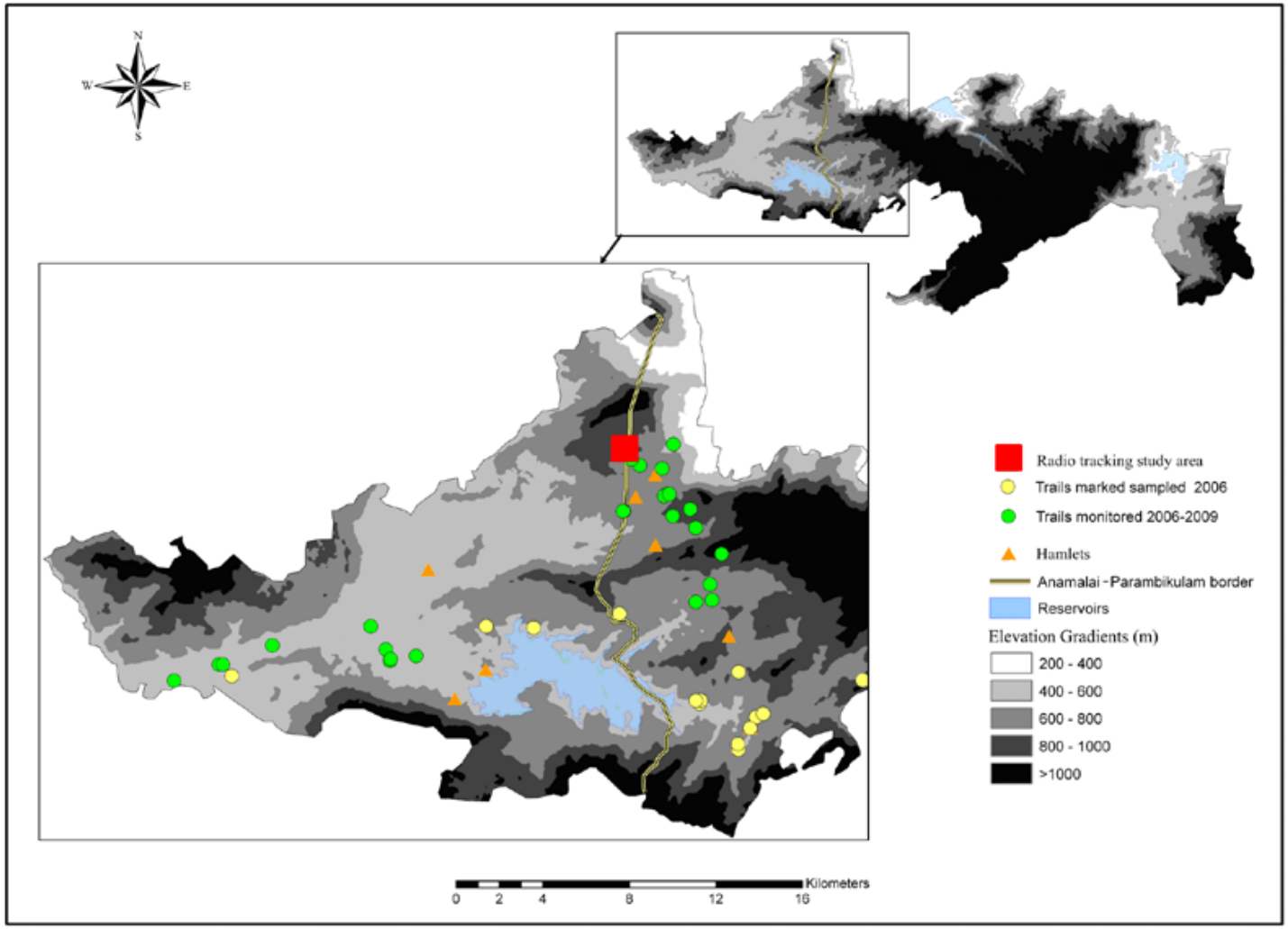


Figure.3.2. Number tortoise and signs recorded in 25 sampling trails for 5, 3, 7 & 3 sampling occasions during the year 2006, 2007, 2008 and 2009.

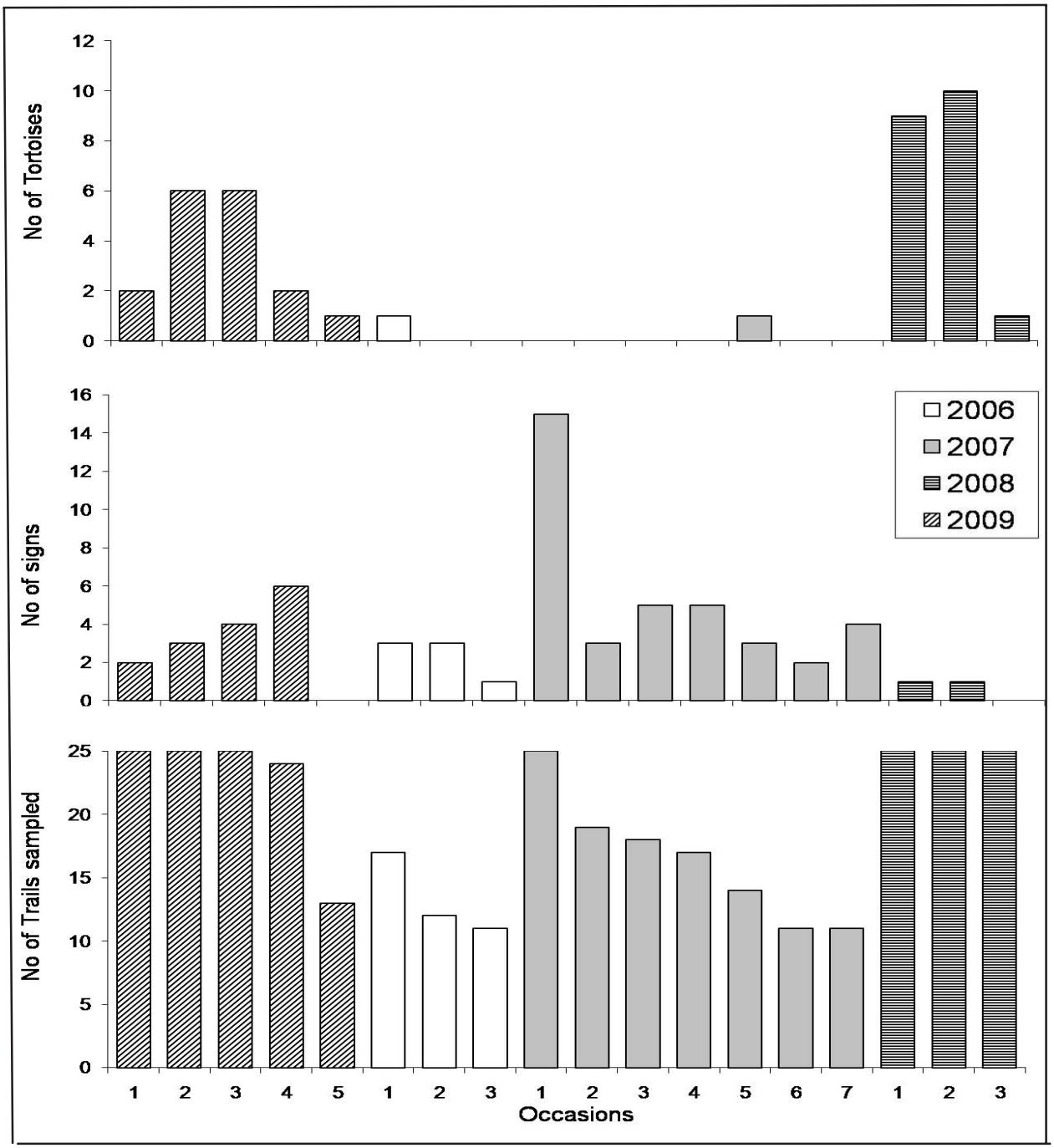


Figure.3.3. Detection probability of Travancore tortoise in different habitat types in 2006-2009.

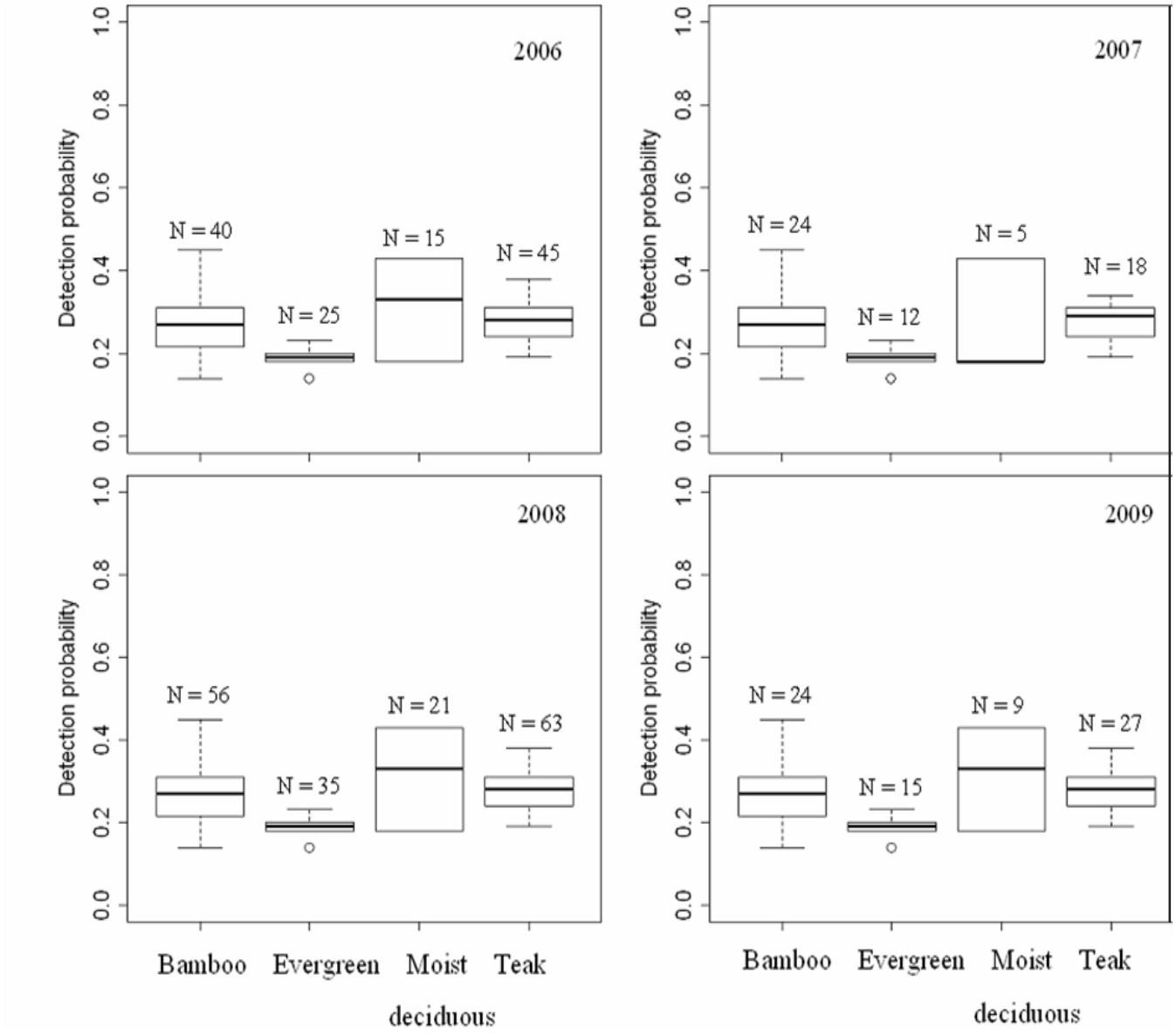


Figure: 3.4. Relative importance of predictor variables on detection probability (*p*) in occupancy models.

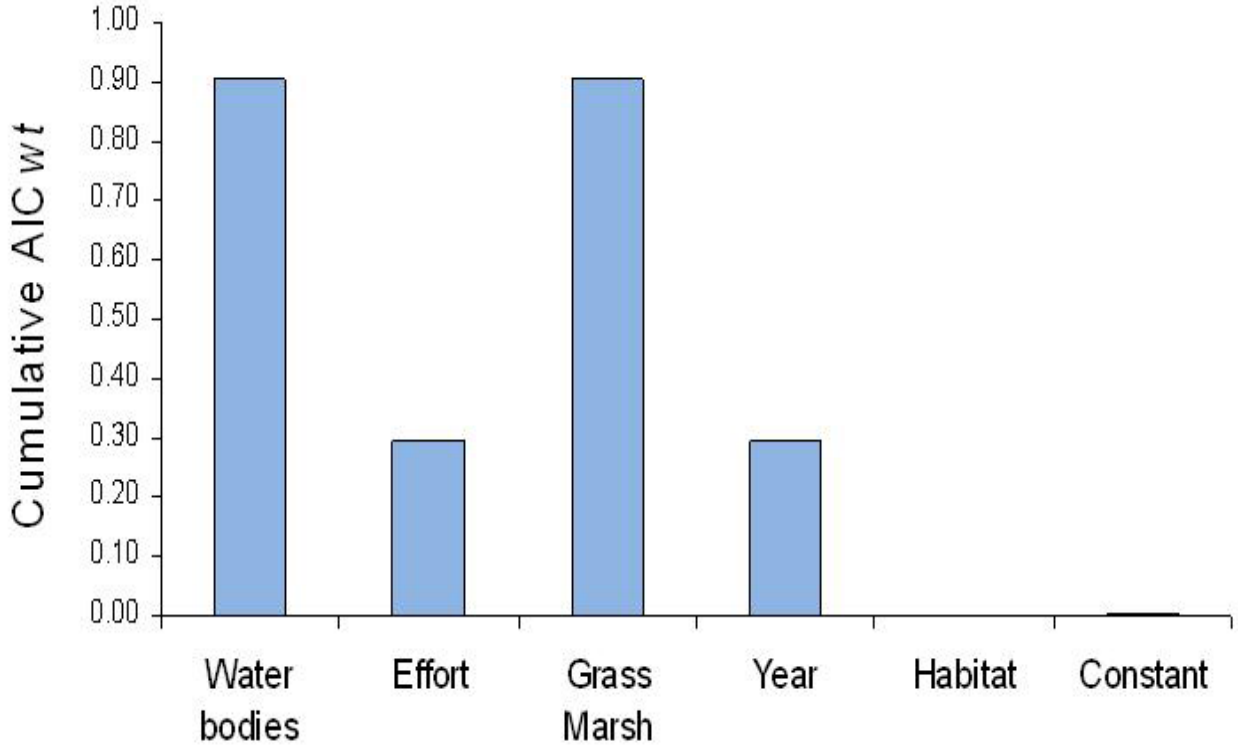


Figure. 3.5. Jitter plot showing influence of water bodies and grass marshes on the detection probability of Travancore tortoises in 25 sampled sites.

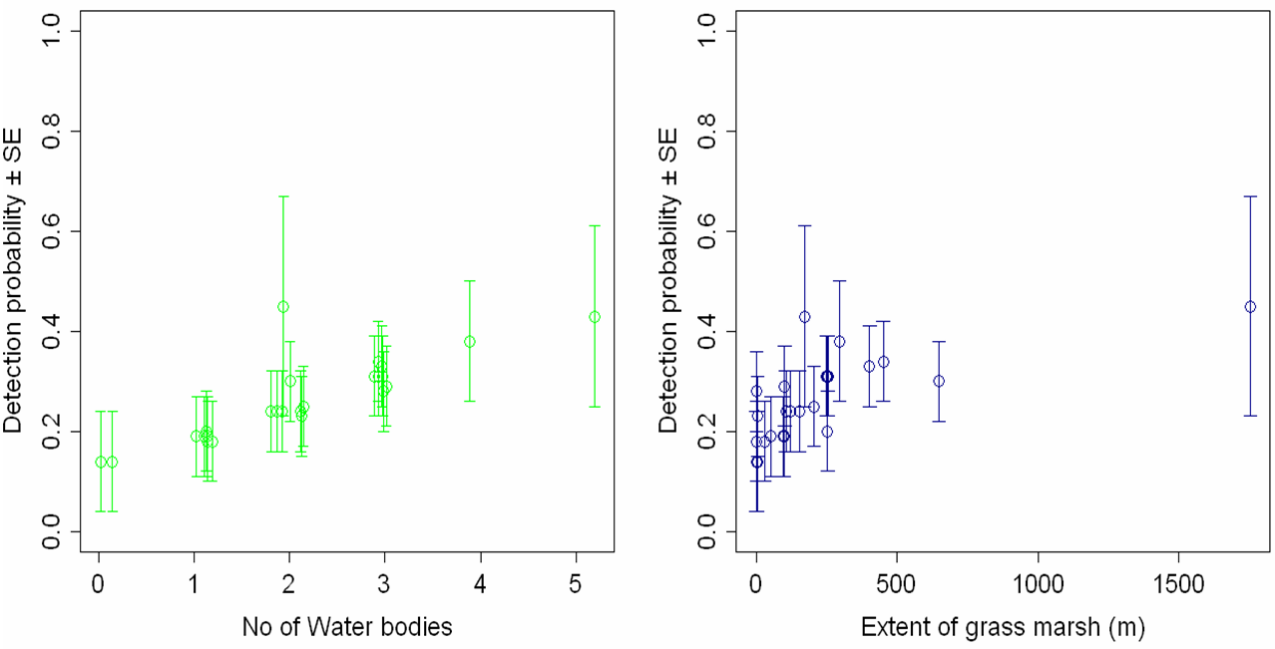


Figure. 3.6. Relative importance of predictor variables on occupancy.

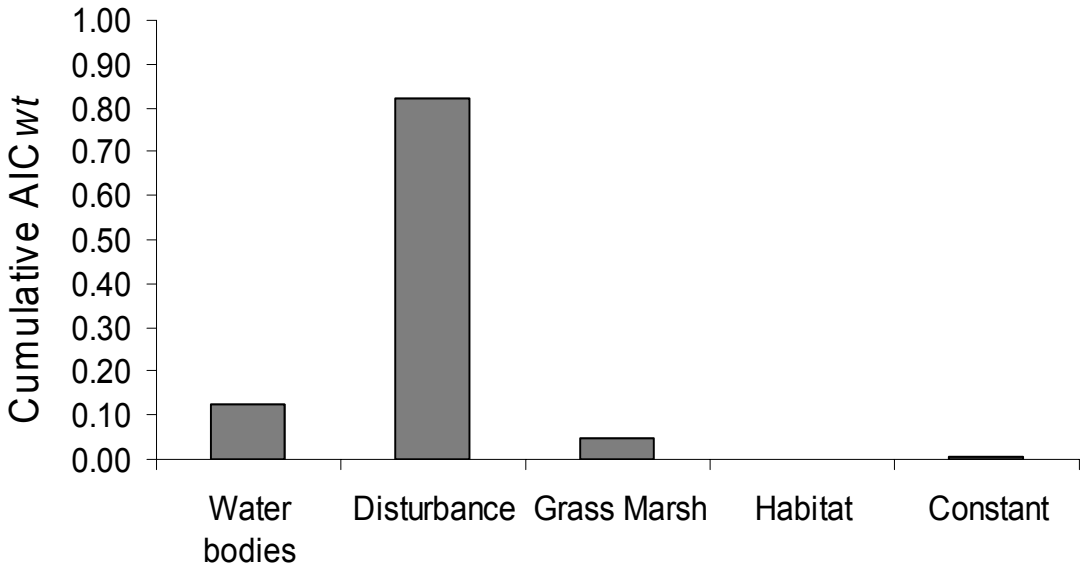


Figure. 3.7. Jitter plot showing level of disturbance on the site occupancy Travancore tor toises in 25 sampled sites

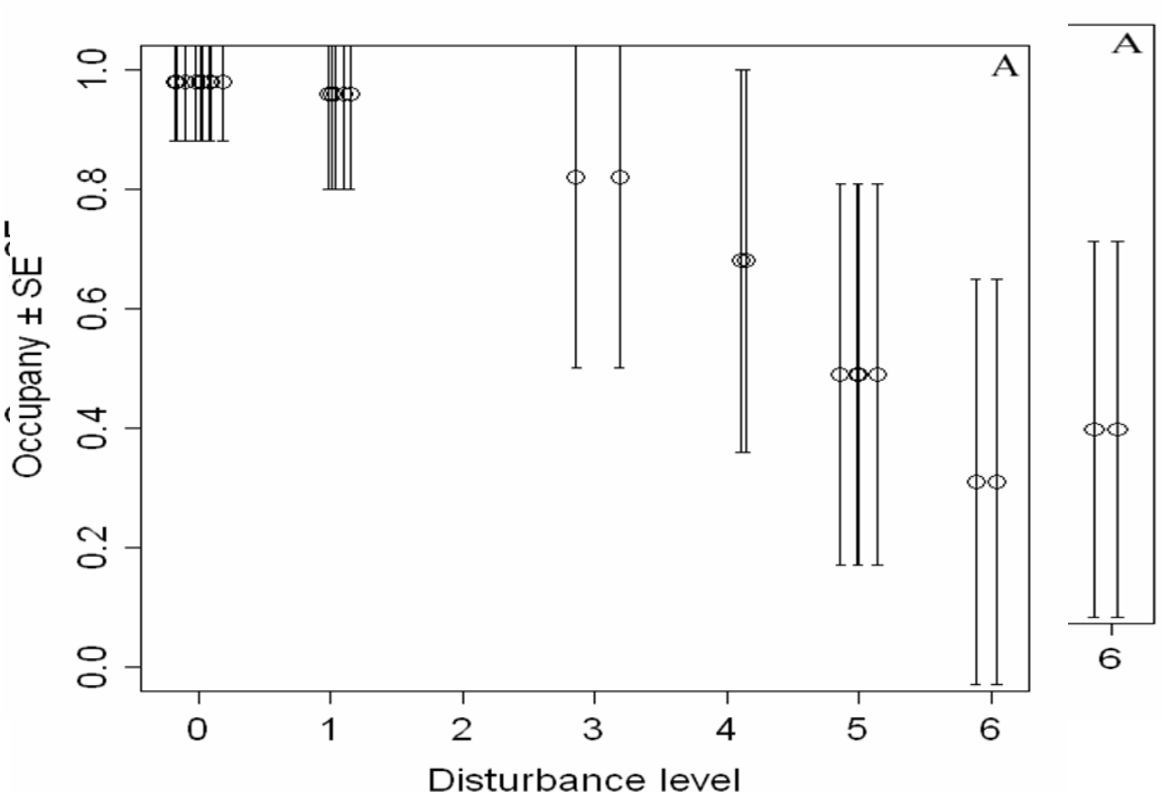


Figure.3.8. Mean score of different diet item in faecal samples of Travancore tortoise.

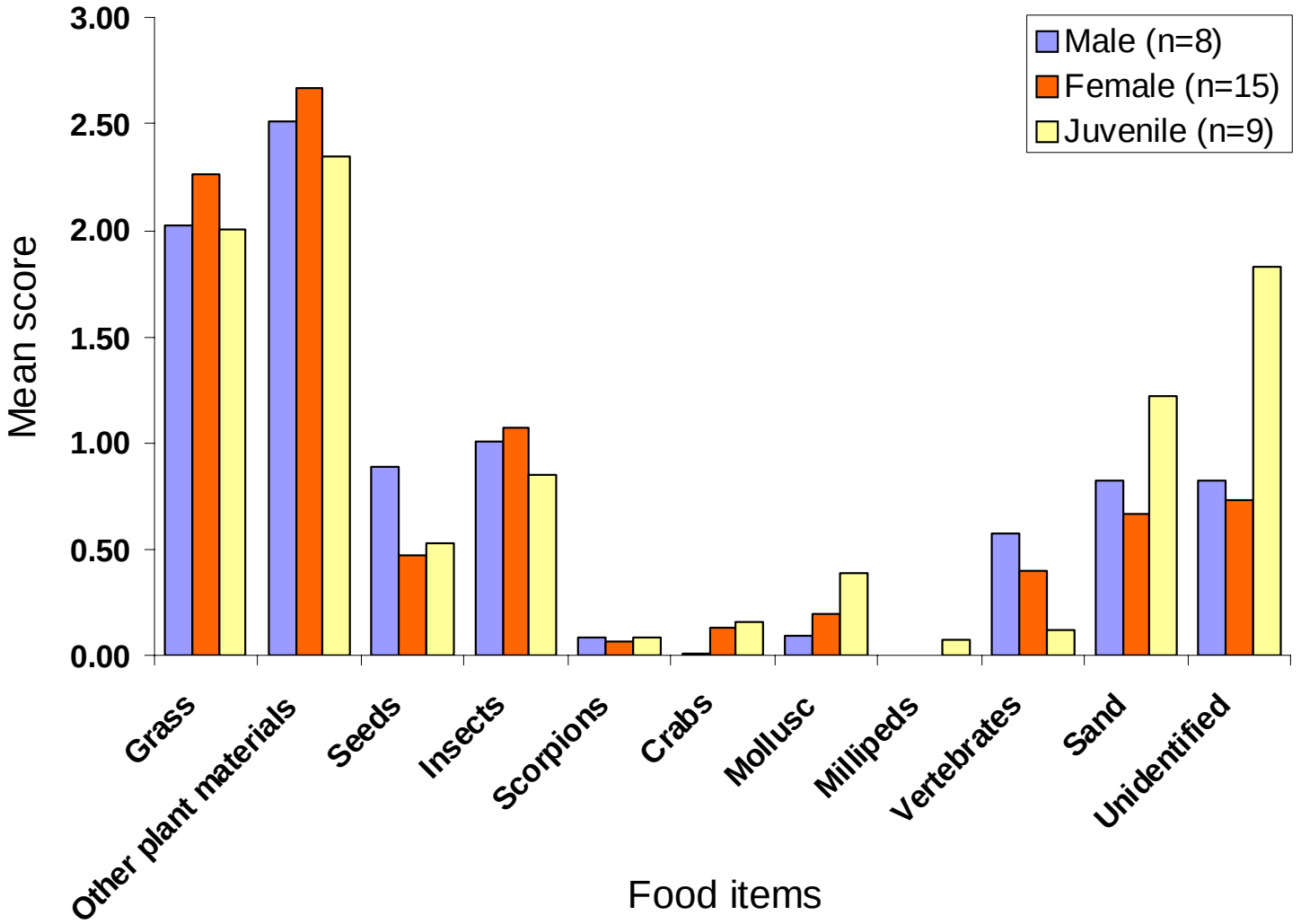


Figure.3.9. Microhabitat used by the radio tracked tortoises.

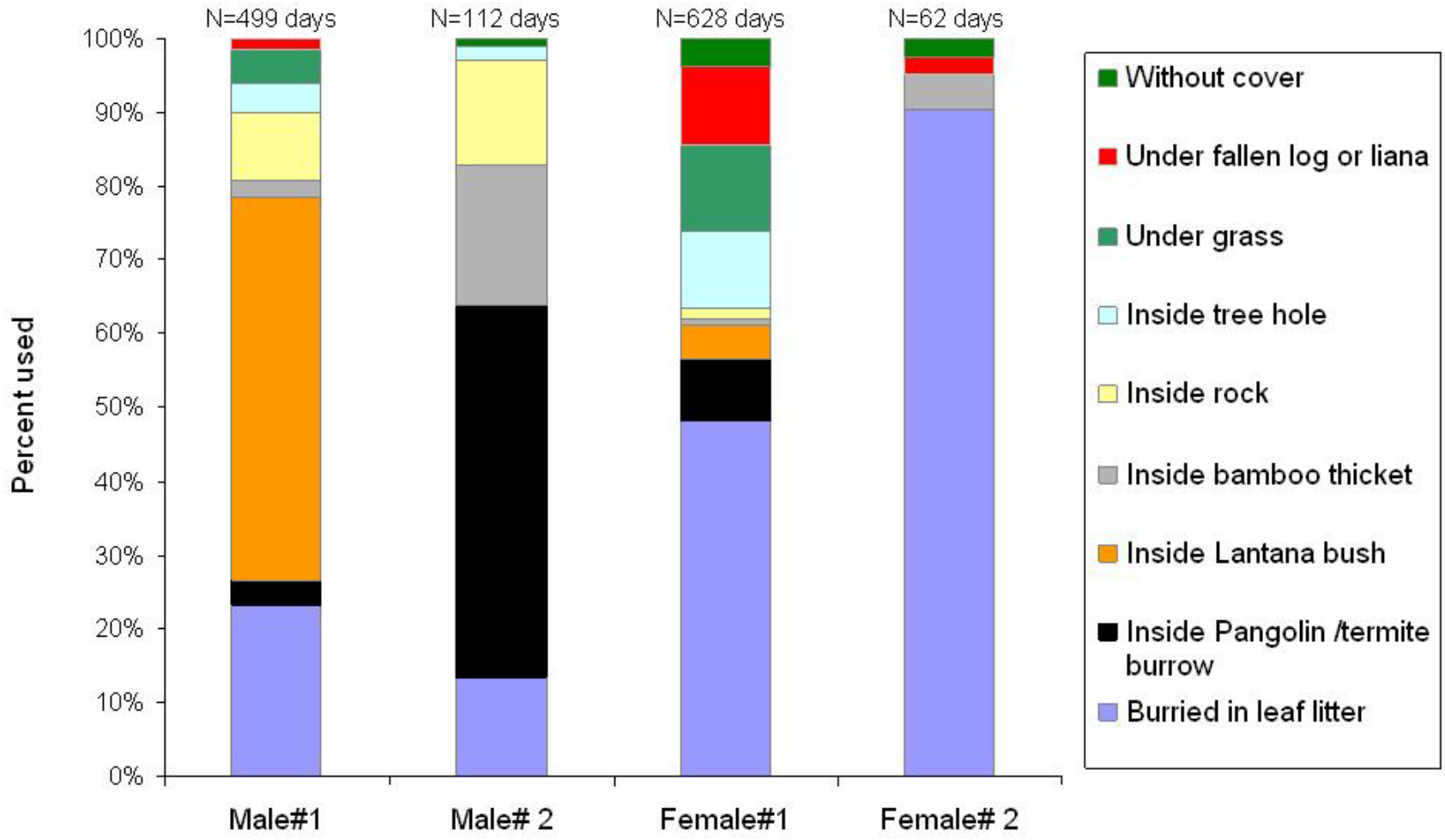


Figure. 3.10. Digital Elevation Model (DEM) of the 110 ha mapped study area during the radio tracking study of Travancore tortoise.

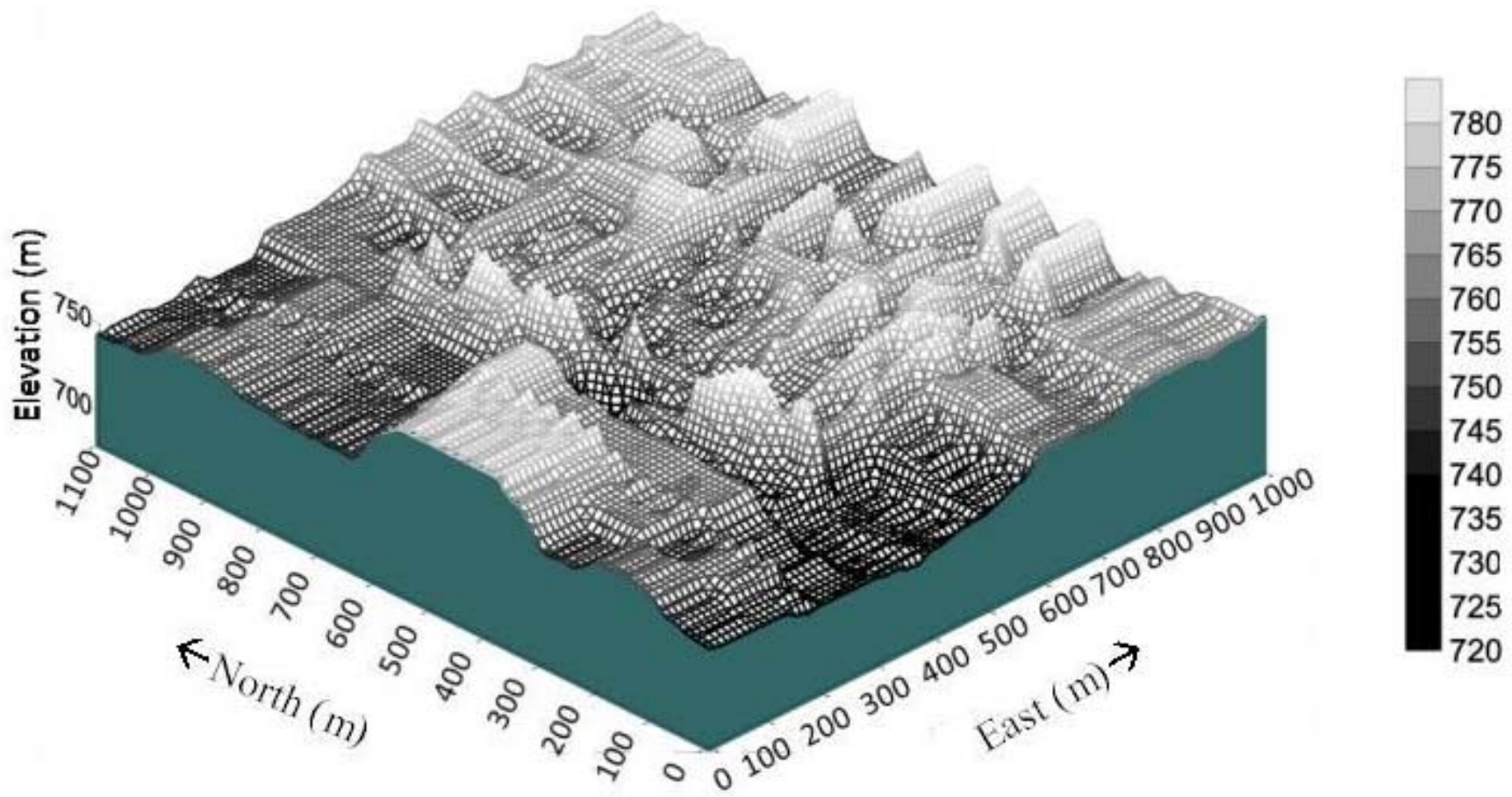


Figure. 3.11. MCP and LCH home ranges of four radio tracked Travancore tortoises

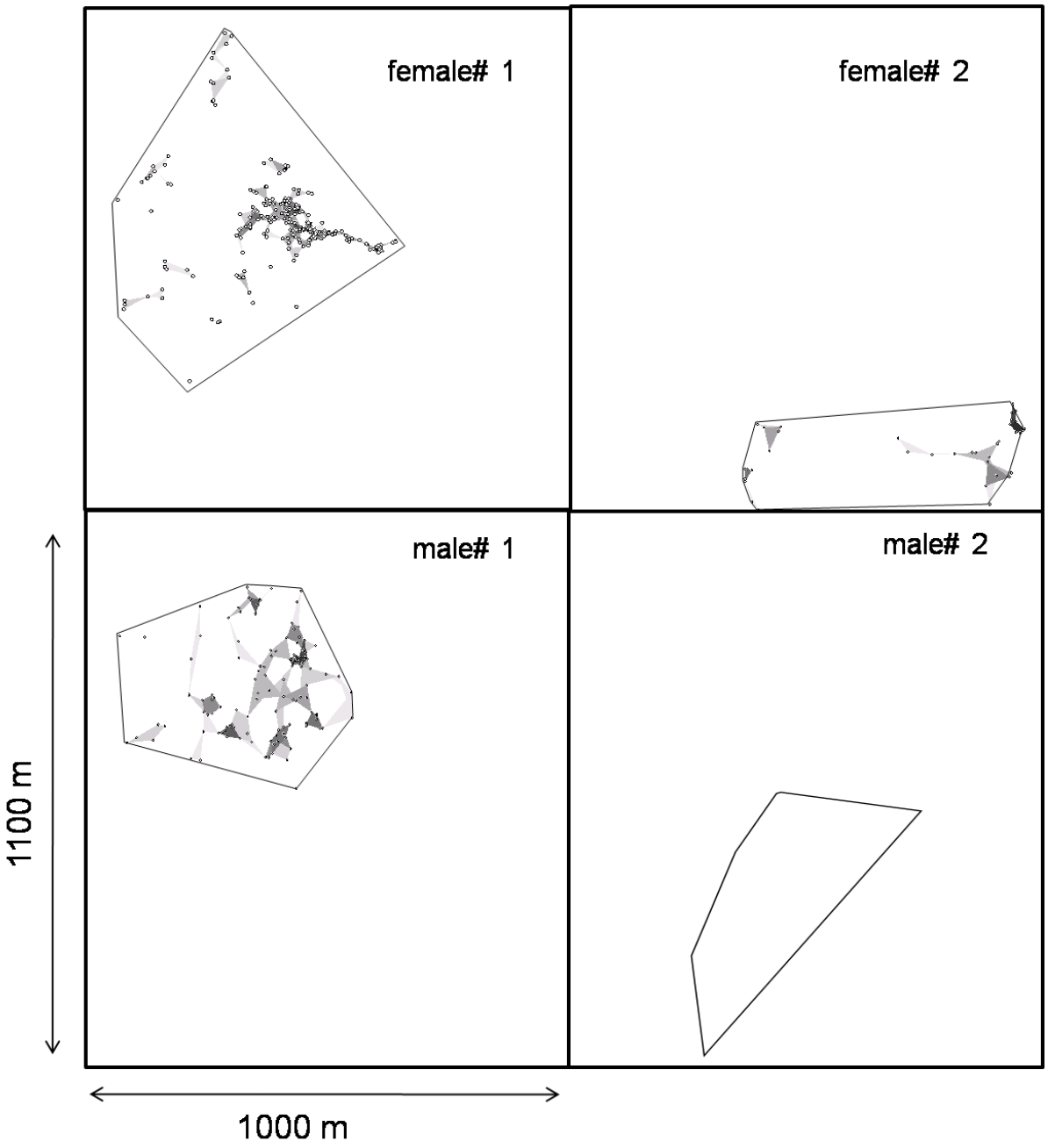


Figure. 3.12. Map of the study area showing locations of the four radio tracked tortoises showing affinity towards perennial water source and bamboo & lantana associated forest with grass patches.

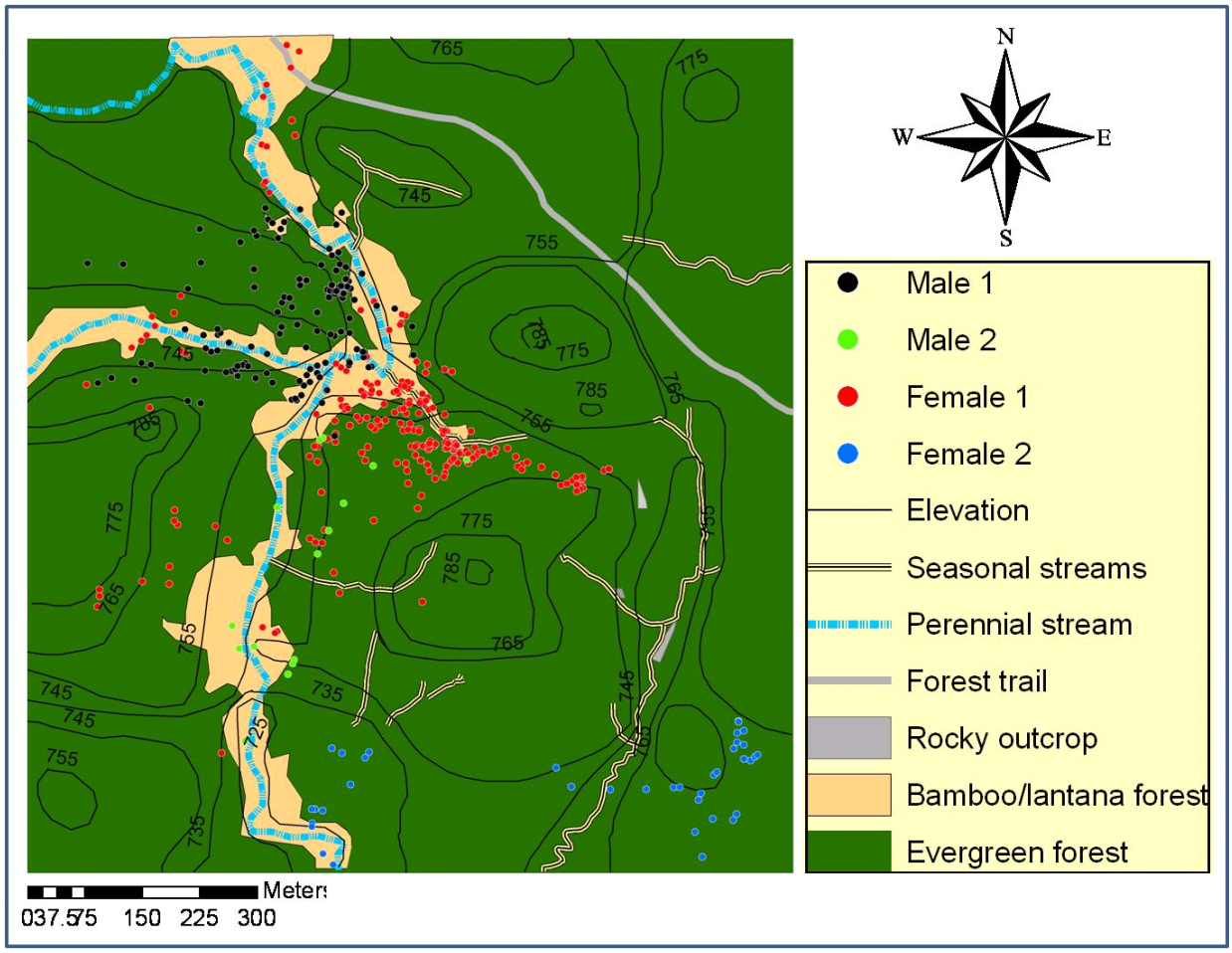


Figure. 3.13. Spatial patterns of locations, microhabitat and habitat variable distributions in the 110 ha mapped study area.

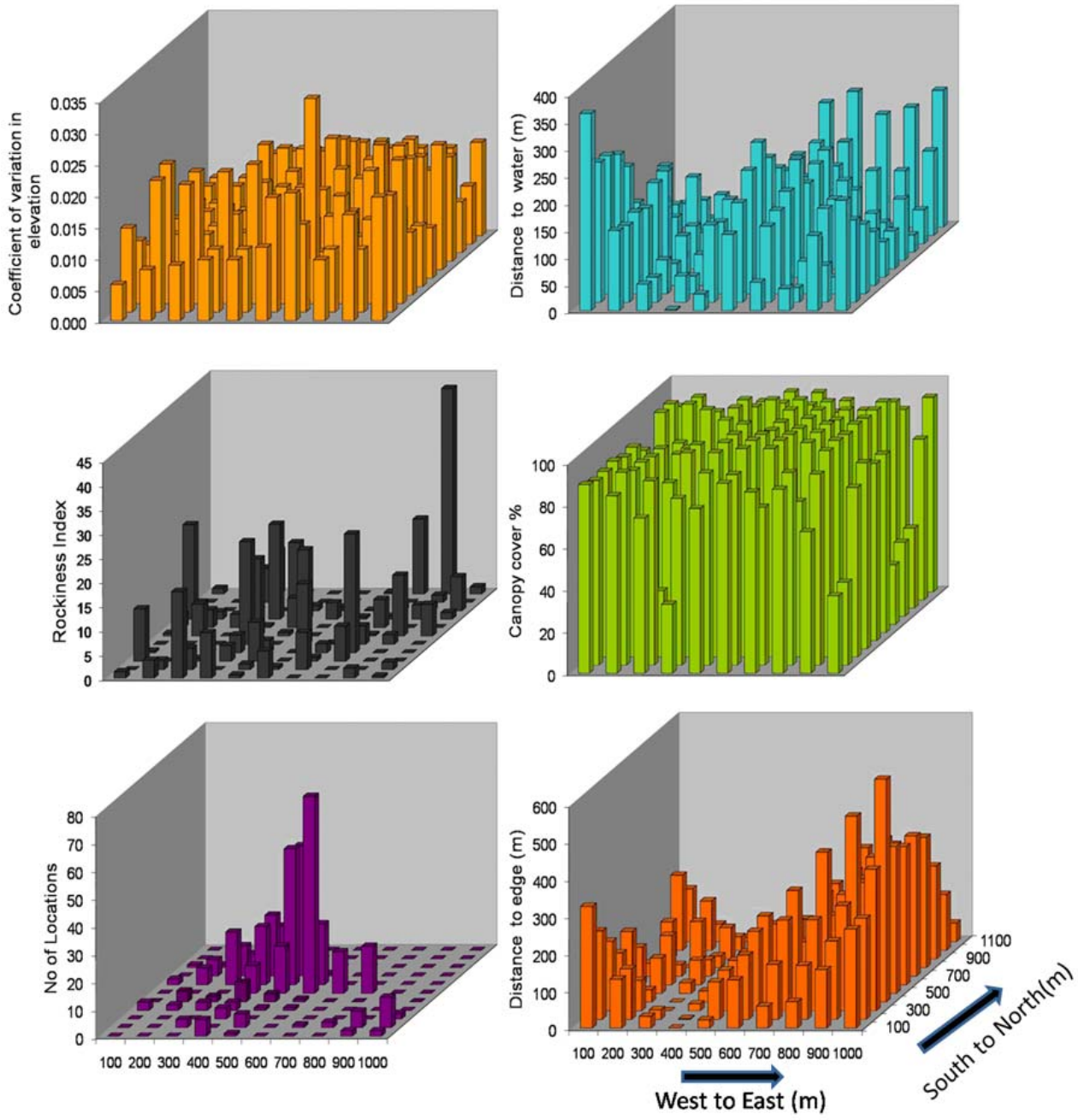
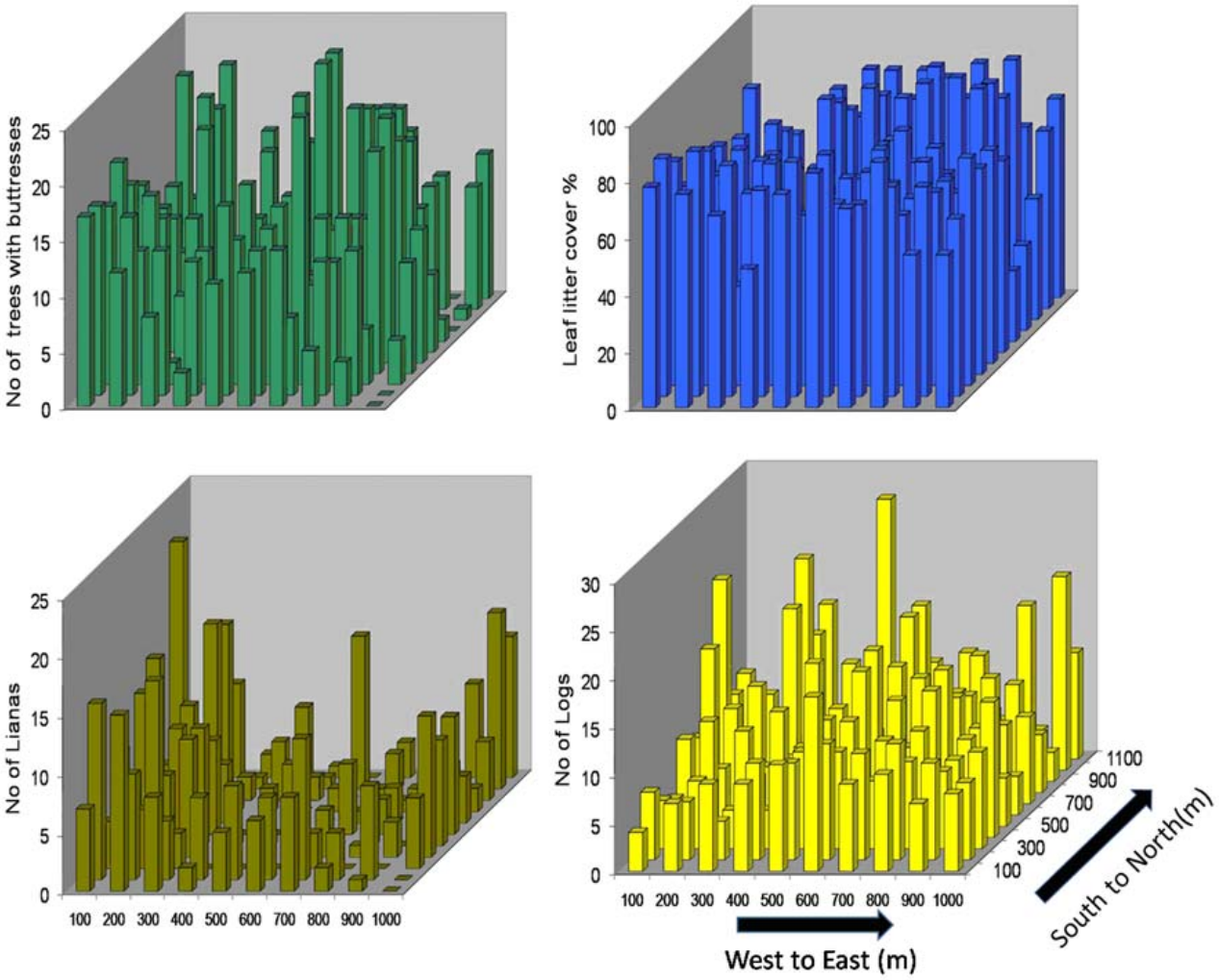


Figure. 3.14. Spatial patterns of microhabitat and habitat variable distributions in the 110 ha mapped study area.



Appendix. 1. A) list of models with unreliable parameter estimates removed from the analysis. B) List of models deleted before model averaging with AIC *wt* less than 0.001.

A

1 ψ (Habitat) γ (.) *p* (Water + Grass + Year + Effort)

2 ψ (Year) γ (.) *p* (.)

3 ψ (Year) γ (.) *p* (Year)

4 ψ (Habitat) γ (.) *p* (Water + Grass)

5 ψ (Year) γ (Year) *p* (.)

6 ψ (Year) γ (Year) *p* (Year)

7 ψ (Year) ε (Year) *p* (.)

8 ψ (Year) ε (.) *p* (.)

9 ψ (Year) ε (.) *p* (Year)

10 ψ (Year) ε (Year) *p* (Year)

11 ψ (.) γ (.) *p* (.)

B

1 ψ (Grass) γ (.) *p*(.)

2 ψ (Dist) γ (.) *p*(.)

3 ψ (Habitat) γ (.) *p*(.)

Chapter:4

Distribution of three endemic turtles and threats to their population

4.1 Review of literature

4.1.1. Leith's softshell

Distribution

Endemic to peninsular India, *Nilssonia leithii* has been reported from major rivers from peninsular India (Fig.3); Cauvery & Vaigai from Tamil Nadu, Krishna & Godavari from Andhra Pradesh, Neethravathi from Karnataka, Chalakudy, Bharathapuzha & Chaliyar in Kerala, Pawna in Maharashtra & Godavari in Orissa (Gray, 1872; Boulenger, 1890; Moll & Vijaya, 1986; Kalaiarasan, 1992; Thomas *et al,* 1997; Kumar, 2004; Vasudevan *et al,* 2006; Nameer *et al,* 2007; Praschag, *et al,* 2007; Deepak & Vasudevan, Unpubl; Whittaker *pers comm*). Juvenile specimen's of *N. gangeticus* from the river Ganges & Hadso, Mahanadhi was possibly misidentified by Annandale (1912 a & b) as *N. leithii* (Moll & Vijaya, 1986; Peter Praschag *pers comm.*). Smith's (1931) assessment of its range as river Ganges was again *following* Annandale (1912 a & b & 1915). The present distribution range of the species includes Pawna (Maharashtra) as Northern & North-Western limit of the species; Balimela reservoir, Godavari in Orissa is the North-eastern distribution limit and Chalakudy River in Kerala is the southern most distribution of the species to be known so far (Fig. 4.1). Reports on the Leith's softshell since its description in 1859 were less until 1980, till date where there are increased reports of the species (Fig. 4.4).

Threats

In most of its range, the species is hunted and consumed (Kalaiarasan, 1992; Kumar, 2004). Kumar (2004) noted that the animals are supplied to local markets & toddy shops in Kerala and it costs 100-300 rupees depending on the size. Distribution range is reduced due to river alteration and other habitat impact (IUCN, 2008).

4.1.2. Cane turtle

Distribution

Cane turtles are endemic to Western Ghats. Recently they are sighted from many different localities: Chalakudy, Poyankutti, Kulathupuzha and Nadukani reserve forests; Peechi-Vazhanai, Neyyar, Peppara, Idukki and Aralam Wildlife Sanctuaries; Parambikulam Tiger Reserve in Kerala. Anamalai Tiger Reserve (formerly Indira Gandhi Wildlife Sanctuary) and Kothayar in Tamil Nadu, and Mookambika Wildlife Sanctuary, Sharavathi, Kathlaekan, Agumbe and Neria forest divisions in Karnataka (Vijaya, 1982; Sharath, 1990; Das, 1995; Daniels, 2001; Ease & Ramachandran, 2004; Jose *et al*, 2007; Jaffer Palot *pers comm.*; T. V. Ramachandran *pers comm.;* Gururaja *pers comm;* S. Bhupathy *pers comm.*) Fig. 4.2.

Threats

Hunting of cane turtles using dogs by native people for consumption is reported from Chalakudy, Kerala (Vijaya, 1982).

4.1.3. *Travancore tortoise*

Distribution

Endemic to the Western Ghats of peninsular India, *I. travancorica* has been reported from Kerala, Tamil Nadu and Karnataka states from 100-1000 m asl (Fig. 3) (Boulenger, 1907; Smith, 1931; Vijaya, 1983; Das, 1991; Bhupathy and Choudhury, 1995). They have been reported from ten different locations from the state of Kerala (Moll, 1989; Bhupathy & Choudhury, 1995; Radhakrishnan, 1998; Easa & Ramachandran, 2004; Vijaya, 1983). In Karnataka they were recorded from five different locations (Sharath, 1990; Bhupathy & Choudhury, 1995). It is reported from two different locations in Tamil Nadu namely Anamalai Tiger Reserve and in Kothayar (Bhupathy & Choudhury, 1995).

.Threats

In most of its range, the species is hunted and consumed. Tribes of the Western Ghats such as the *Kadar*, *Malai Pandaram, Kani*, *Malasar and Malaimalasar* hunt them using dogs or by following their tracks (Vijaya, 1983; Frazier, 1989; Moll, 1989; Choudhury & Bhupathy, 1993).

Sometimes, tortoises are also reared as pets till they attain a size suitable for consumption. *Kani* tribals also use charred shell mixed with oil as a cure for external injuries and skin rashes (Bhupathy & Choudhury, 1995). So far this species has not been reported in trade (Choudhury & Bhupathy, 1993). However, subsistence hunting of the species could reduce their population (Vijaya, 1983; Frazier, 1989; Moll, 1989; Bhupathy & Choudhury, 1995). Habitat alteration and fragmentation of forest due to hydroelectric reservoirs is known from almost all areas where the tortoise occurs (Bhupathy & Choudhury, 1995).

4.2. Materials and Methods

Distribution

Three different states in the Peninsular India where cane turtle distribution is known were selected for the survey. The three states were grided into 5x5 km^2. Land cover layer acquired from the world clim database. The evergreen forest cover alone was extracted from the layer and imposed on the grids. Areas with potential evergreen cover below 900 m ASL was selected for the survey. Fifteen such grids were selected for the state of Karnataka and four grids were selected for the state of Tamil Nadu. Each grid was sampled atleast 3 times for the two endemic turtles.
Self explanatory handouts on the three endemic turtles in four different languages were used for the questionnaire surveys (Appendix 1-3).

Threats

During the four years intensive study we recorded incidents when people accompanied by dogs in the forest. We did a questionnaire surveys in the Anamalai and Parambikulam Tiger Reserve during 2006. We also enquired people during the final survey if they consume turtles.

4.3. Results and discussions

Distribution

Eight out of the fifteen selected grids were sampled in the state of Karnataka. In one of the sampled grids we found cane turtle and two of the grids we found Travancore tortoise. In Four out of the

eight sampled grids, people have seen Leith's softshell in the neighboring rivers (Table.4.1). None of the sampled grids in Tamil Nadu we found any of the three surveyed turtles or evidence of them in the sampling area (Table. 4.1).

Reports on *I. travancorica* were sparse until recently (Fig.4.6). Bhupathy & Choudhury (1995) did the only extensive study which documented the distribution of Travancore tortoise in the Western Ghats. The northern most limits of the species are still unknown. Cane turtle was rediscovered in 1982 by Vijaya (1982) after its description in 1912; recently there is steady increase on the number of locality records (Fig. 4.5). Leith's softshell reports were poor in the past and in recent days the number of locality records is steadily increasing (Fig. 4.4)

Threats

Being a large softshell species in most of the places where it is reported, the Leith's softshell is hunted for its meat (Kalaiarasan, 1992; Kumar, 2004). The Leith's softshell are being hunted using unbaited hooks in many rivers in Central Karnataka (Murthy *pers comm*). During the survey we did not come across any Leith's softshell. In four sampling grids we got to know about large softshell turtles inhabiting the rivers. Distribution range reduced due to river alteration and other habitat impact (IUCN, 2008).

The cane turtle being one of the elusive forest species even the local people have little knowledge on the species. During this study we did not come across people hunting or consuming cane turtle. Other than Vijaya's report in 1982 there is no report of people hunting of cane turtles for consumption.

In Fourteen out of the forty marked trails we came across people accompanied by dogs. In Kothanadukka village adjoining Pushpagiri wildlife sanctuary we found a shell of the tortoise in a person's house who had consumed its meat a few months back. In the localities where we saw Travancore tortoise (Table 1) seven people said they had consumed Travancore tortoise meat. Travancore tortoise was recognized by most of the local people and forest staff in the Anamalai and Parambikulam Tiger Reserve. Hunting tortoises following their tracks or using dogs in the Western Ghats is a well documented fact in the past (Vijaya, 1983; Frazier, 1989; Moll, 1989; Choudhury & Bhupathy, 1993).

Habitat alteration and fragmentation is a well-documented scenario in Western Ghats (Nair, 1991) which eventually fragments the turtle's population. Habitat alteration and fragmentation of forest due to hydroelectric reservoirs is known from almost all areas where the Travancore tortoise occurs (Bhupathy & Choudhury, 1995). Cane turtles areas are also recorded in these areas. There are 24 operational and 12 proposed hydroelectric projects to be implemented in the state of Kerala alone, which would severely impact the biodiversity of this region (Sreekumar & Balakrishnan, 1998). Submerging large tracts of forest for Dams can be an immediate threat to the species and their habitat. These projects also bring in settlers, who in turn pose a threat to the species by disturbing the habitat and hunting them.

Table. 4.1. Interview of forest department staff (n=15) in Anamalai and Parambikulam Tiger Reserve conducted during 2006.

Questions	Yes	No
Recognize a Travancore tortoise	80.0%	20.0%
Recognize a cane turtle	26.7%	73.3%
Report on locals collecting Travancore tortoise	26.7%	73.3%
Report on locals collecting cane turtle	0%	100.0%
Have knowledge on ecology of the Travancore tortoise	80.0%	20.0%
Have knowledge on ecology of the cane turtle	26.7%	73.3%

Table. 4.2. Interview to the local people (n = 19) inside Anamalai and Parambikulam Tiger Reserve conducted during 2006.

Questions	Yes	No
Recognize a Travancore tortoise	89.5%	10.5%
Recognize a cane turtle	52.6%	47.4%
Reported having consumed Travancore tortoise meat	26.3%	73.7%
Report on locals collecting cane turtle meat	0%	100.0%
Have knowledge on ecology of the Travancore tortoise	89.5%	10.5%
Have knowledge on ecology of the cane turtle	26.7%	47.4%

Table. 4.2. Details on the survey of three endemic turtles. D = Direct observations of the turtles or shell, I = secondary information from locals and forest department.

Site name	State	GPS location		No. of days	Cane turtle		Travancore tortoise		Leith's softshell	
		N	E		D	I	D	I	D	I
Meladakka	Karnataka	12.444	075.445	2	1	1	0	1	0	0
Subramanya	Karnataka	12.681	075.611	3	0	0	0	0	0	1
Marigundi	Karnataka	12.629	075.644	1	0	0	0	0	0	0
Kothanaduka	Karnataka	12.566	075.668	4	0	0	1	0	0	1
Agumbae	Karnataka	13.519	075.089	2	0	1	0	0	0	0
Hosmar	Karnataka	13.163	075.147	2	0	0	0	0	0	0
Kollur	Karnataka	13.860	075.793	3	0	0	0	0	0	1
Gersoppa	Karnataka	14.227	074.655	2	0	0	1	0	0	1
Srivilliputur	Tamil Nadu	9.418	077.353	3	0	0	0	0	0	0
Mundanthuri	Tamil Nadu	8.703	077.272	1	1	0	0	0	0	0
Mayilar	Tamil Nadu	8.625	077.336	1	0	0	0	0	0	0
Injikuli	Tamil Nadu	8.624	077.281	1	0	0	0	0	0	0

Figure. 4.1. Map of Peninsular India showing locations of *Nilssonia leithii*

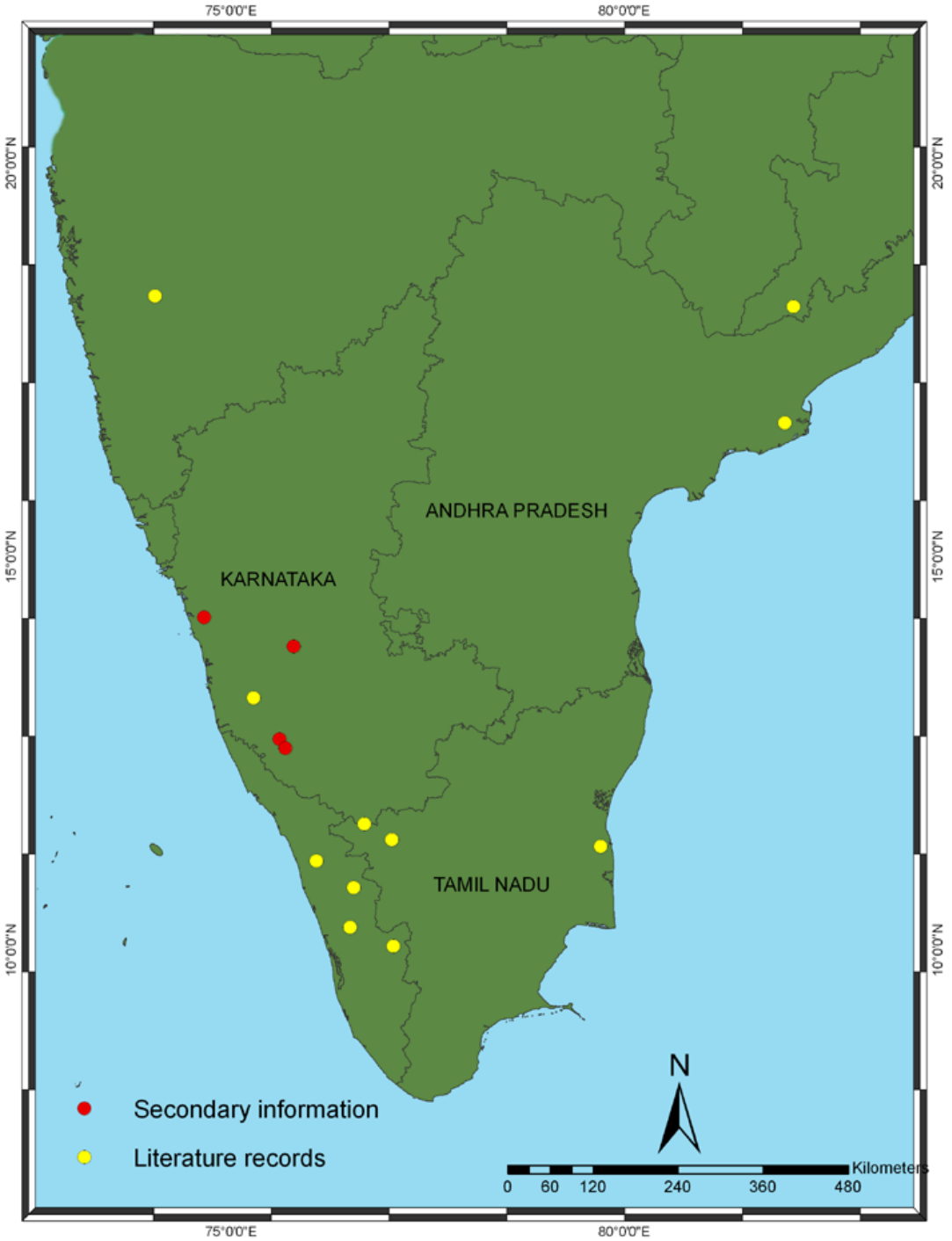


Figure 4.2. Map showing locations of cane turtle in three different states of Peninsular India.

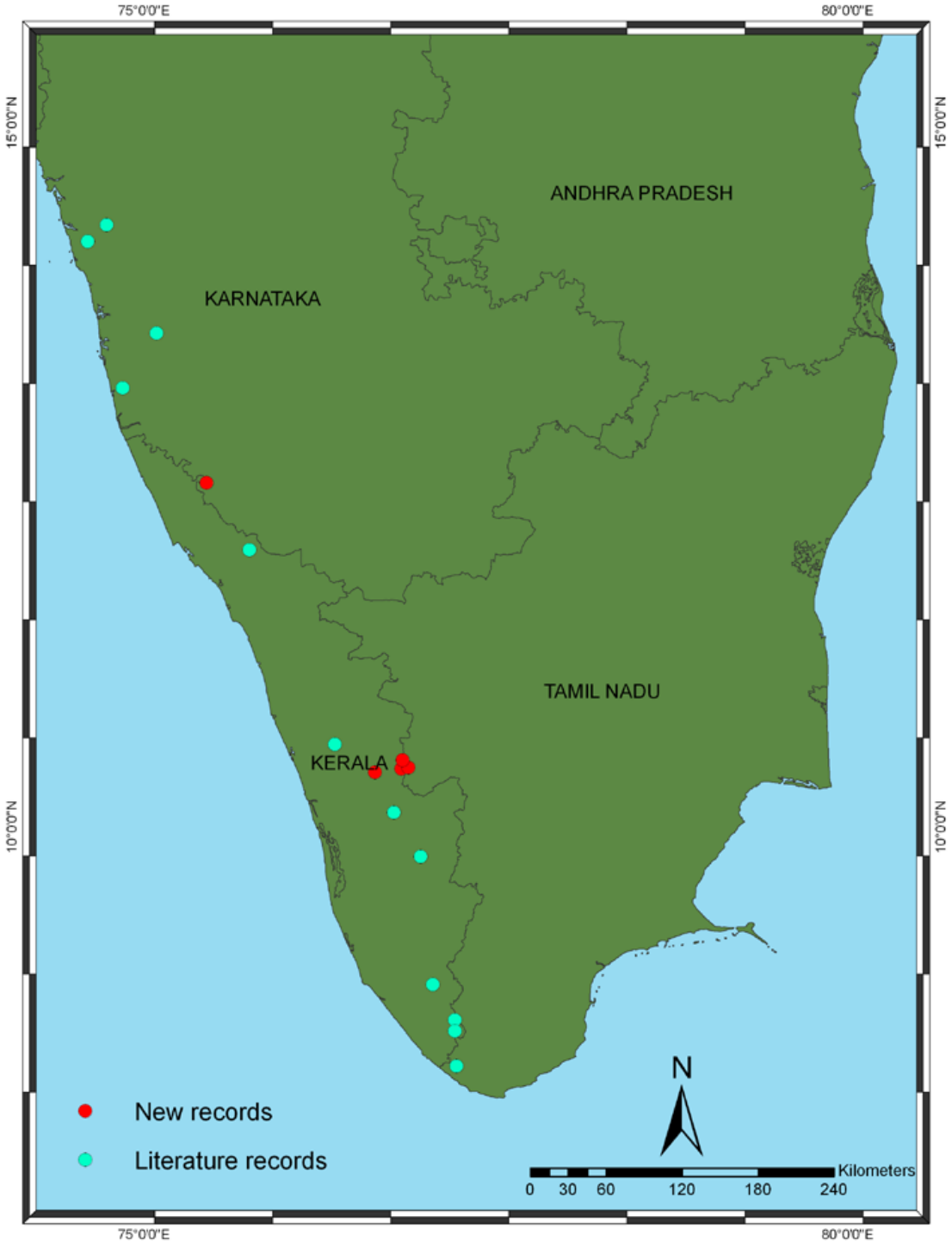


Figure . 4.3. Distribution records of Travancore tortoise in Peninsular India.

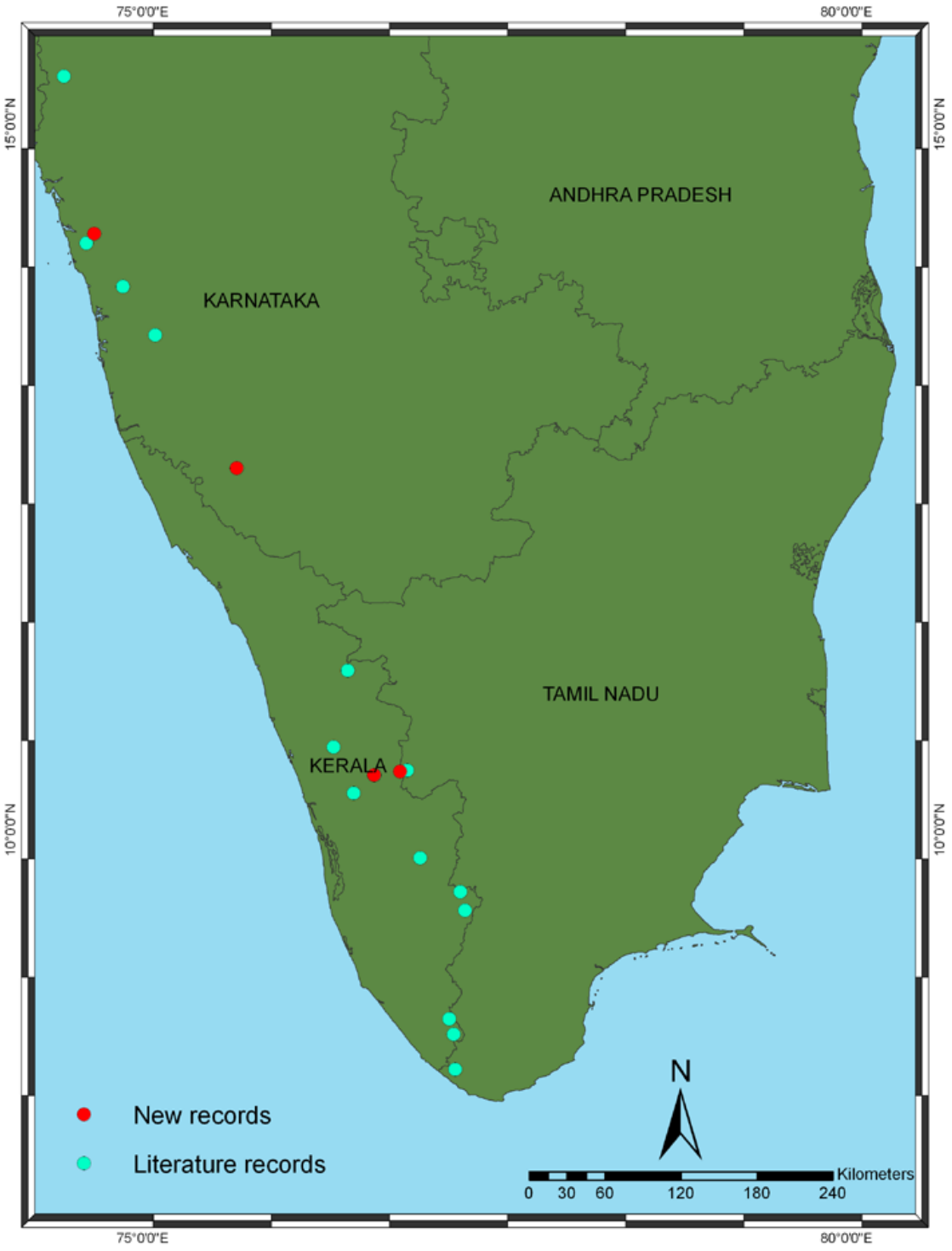


Figure. 4.4. Literature records on Leith's softshell turtle over years since its description in 1989.

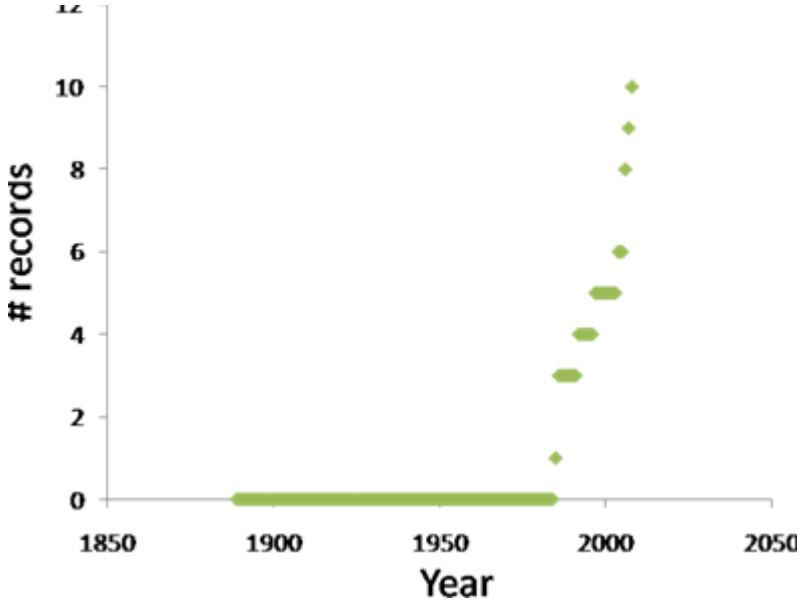


Figure. 4.5. Literature records on cane turtle over years since its description in 1912.

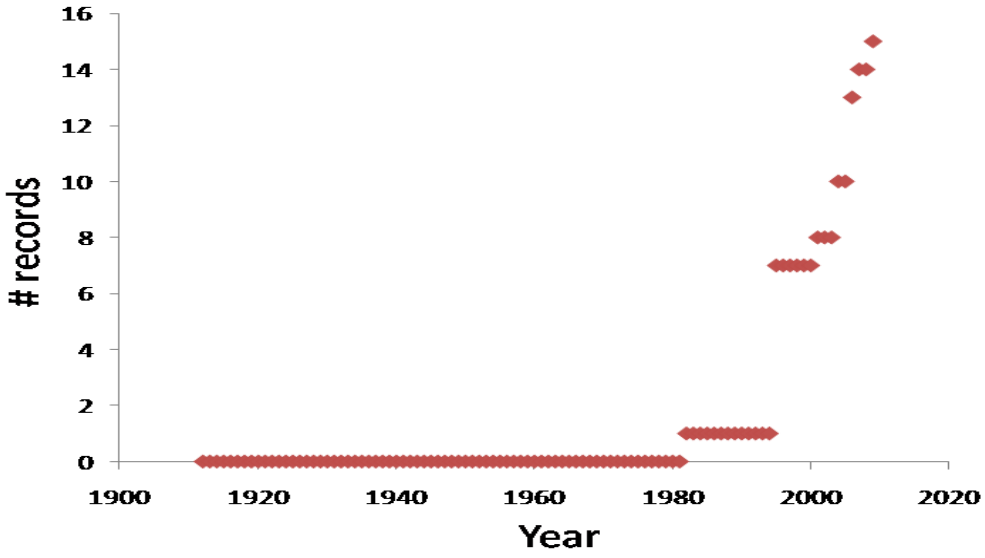
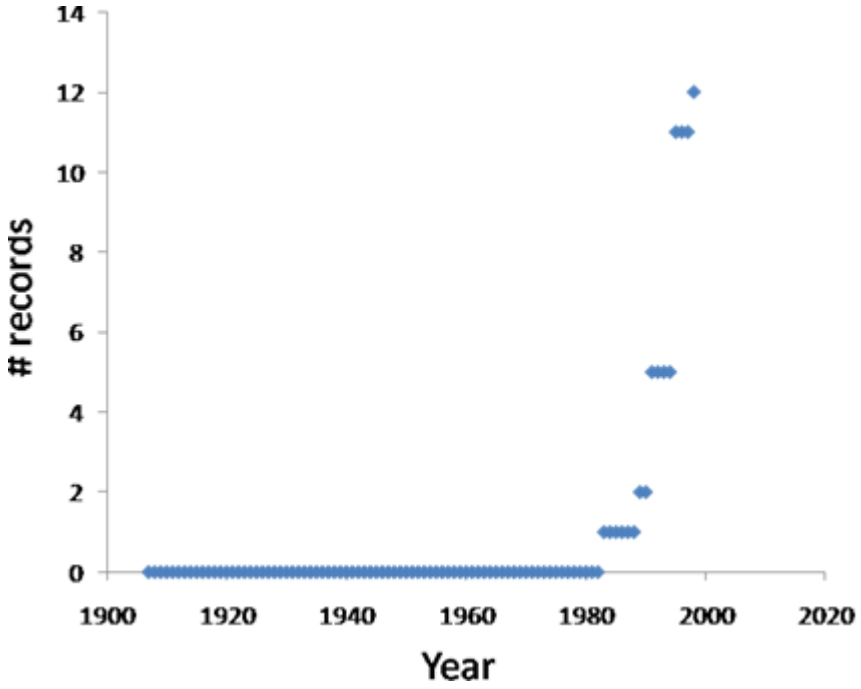


Figure. 4.6. Literature records on Travancore tortoise over years since its description in 1907.



Appendix. 1

இந்தியாவில் மட்டும் காணப்படும் ஆமைகள்

ഇന്ത്യയിൽ മാത്രം ജീവിക്കുന്ന ആമകൾ

ಭಾರತಕ್ಕೆ ಸೀಮಿತವಾದ ಆಮೆಗಳು

India's Endemic Turtles

Locality records

கேன் டெர்டில் (cane turtle) ஒரு சிறிய காட்டு ஆமை, அலை 139 மிமீ நீளம் வரை வளரக்கூடியவை. நத்தைகள், பூச்சிகள், மண் புழுக்கள், மற்றும் பழங்களை உணவாக உட்கொள்ளும். பச்சைக் காடுகளில் 10 முதல் 800 மீ கடல் மட்ட உயரத்தில் காணப்படும். இவ்வகை ஆமைகள் ஆண், பெண், நிறத்தில் வித்தியாசமாக காணப்படும். ஆண் ஆமைகளுக்கு தலை பளிச்சென்ற மஞ்சள், கருப்பு, மற்றும் பிங்க் நிறத்தில் இருக்கும். அதுவே பெண் ஆமைகளின் தலையில் பிங்க் நிறத்தில் கோடு இருக்கும். இனச்சேர்க்கை பருவ மழைக் காலங்களில் (ஜூலை முதல் அக்டோபர்) நடைபெறும். 1 முதல் 3 முட்டைகள் இடும். வாழிடம் நாசக்கேடு மற்றும் வாழிடம் துண்டாதல் இவ்வினத்தின் அழிவிற்கு முக்கியக் காரணமாக அமையும்.

இனம் கண்டறிதல்: சிறிய தட்டையான மேல் ஓடு. ஆண் ஆமைகளின் தலையின் நிறம் பளிச்சென்று இருக்கும்.

நகுதி: ஐயூசிஎன் (IUCN) ரெட் லிஸ்ட் - எண்டேன்ஜர்ட். இந்திய வனவிலங்கு (பாதுகாப்பு) சட்டம் செட்யூல் - I.

பரவியிருத்தல்: மேற்கு தொடர்ச்சி மலைப்பகுதியில் மட்டும் காணப்படுகிறது. தமிழகம், கேரளம், மற்றும் கர்நாடகா மாநிலங்களில் காணப்படுகிறது.

அவரவர் மொழிகள்: தமிழ்: வெங்கல ஆமை, மலையாளம்: சூரல் ஆம கன்னடம் : பெட்டடா ஆமே, துளு: குண்டே ஆமே, காடர்: சேங்கனி ஆமை காணி: அயிலி இலை ஆமை, சேங்கண்ணன் ஆமை, மோட்டல் ஆமை.

இவ்வின ஆமையை உங்கள் பகுதியில் பார்த்தாலோ, கேள்விப்பட்டாலோ தயவு செய்து கீழ்க்கண்ட முகவரிக்கு தெரிவிக்கவும். நாங்கள் கண்டிப்பாக உங்களை தொடர்புக் கொள்வோம்.

ಕೇನ್ ಟರ್ಟಲ್ (cane turtle) ಕಾಡಿನಲ್ಲಿ ಕಂಡು ಬರುವಂತಹ ಸಣ್ಣ ಆಮೆ. ಇದು 139 ಮಿಮೀ. ಉದ್ದದವರೆಗೂ ಬೆಳೆಯುತ್ತದೆ. ಇವು ಸರ್ವಭಕ್ಷಕಗಳು ಹಾಗಾಗಿ ಇವು ಮೃದ್ವಂಗಿಗಳು, ಕೀಟಗಳು, ಎರೆಹುಳು ಮತ್ತು ಹಣ್ಣುಗಳನ್ನು ತಿಂದು ಜೀವಿಸುತ್ತದೆ. ಸಮುದ್ರ ಮಟ್ಟದಿಂದ 10 ರಿಂದ 800 ಮೀ. ಎತ್ತರದಲ್ಲಿರುವ ನಿತ್ಯ ಹರಿದ್ವರ್ಣ ಕಾಡುಗಳು ಮತ್ತು ಅರೆ ನಿತ್ಯಹರಿದ್ವರ್ಣ ಕಾಡುಗಳಲ್ಲಿ ಕಂಡುಬರುತ್ತವೆ. ಈ ಜಾತಿಯ ಆಮೆಗಳಲ್ಲಿ ಗಂಡು ಮತ್ತು ಹೆಣ್ಣುಗಳು ಬೇರೆ ಬೇರೆ ಬಣ್ಣವನ್ನು ಹೊಂದಿವೆ. ಇವುಗಳಲ್ಲಿ ಗಂಡುಗಳ ತಲೆ ಕಡು ಗುಲಾಬಿ, ಅಥವಾ ಹಳದಿ ಅಥವಾ ಕಪ್ಪು ಬಣ್ಣವನ್ನಿರುತ್ತದೆ. ಹೆಣ್ಣುಗಳಲ್ಲಿ ಅವುಗಳ ತಲೆಯ ಮೇಲೆ ತೆಳು ಗುಲಾಬಿ ಬಣ್ಣದ ಗೆರೆ ಇರುತ್ತದೆ. ಇವುಗಳ ಮೊಟ್ಟೆಯಿಡುವ ಮುಂಗಾರಿನಲ್ಲಿ ಅಂದರೆ ಜುಲೈನಿಂದ ಅಕ್ಟೋಬರ್ ತಿಂಗಳಲ್ಲಿ ಸರಿಯಾ 1-3 ಸಣ್ಣ ಮೊಟ್ಟೆಯನ್ನಿಡುತ್ತವೆ. ಅವಾಸಸ್ಥಾನದ ಮಾರ್ಪಾಡು ಹಾಗೂ ಛಿದ್ರೀಕರಣವು ಈ ಆಮೆಗಳ ವಿನಾಶಕ್ಕೆ ಬಹುಮುಖ್ಯ ಕಾರಣವಾಗಿದೆ.

ಗುರುತಿಸುವಿಕೆ : ಇದು ಸಣ್ಣ ಮೃದುವಾದ ಚಿಪ್ಪಟೆಯಾದ ಮೇಲ್ಚಿಪ್ಪನ್ನು ಹೊಂದಿದೆ. ಗಂಡುಗಳು ಎದ್ದುಕಾಣುವಂತಹ ಬಣ್ಣವನ್ನು ಹೊಂದಿರುತ್ತದೆ.

ಸ್ಥಾನಮಾನ : IUCN ಕೆಂಪು ಪಟ್ಟಿಯ ಪ್ರಕಾರ ವಿನಾಶದ ಅಂಚಿನಲ್ಲಿರುವ ಪ್ರಾಣಿ 'ಎಂಡೇಂಜರ್ಡ್' (Endangered) ಎಂದು ಗುರುತಿಸಲ್ಪಟ್ಟಿದೆ. ಭಾರತದ ವನ್ಯಜೀವಿ (ಸಂರಕ್ಷಣೆ) ಕಾಯಿದೆ ಪ್ರಕಾರ ಇದು ಶೆಡ್ಯೂಲ್ ರಲ್ಲಿರುವ ಪ್ರಾಣಿ.

ಪರಿಚಯಿಕೆ : ಕೇರಳ, ಕರ್ನಾಟಕ ಮತ್ತು ತಮಿಳುನಾಡು ರಾಜ್ಯಗಳಲ್ಲಿರುವ ನಿತ್ಯಹರಿದ್ವರ್ಣ ಕಾಡುಗಳಲ್ಲಿ ಮಾತ್ರ ಕಂಡುಬರುತ್ತದೆ.

ಸ್ಥಳೀಯ ಹೆಸರುಗಳು : ಕನ್ನಡ : ಬೆಟ್ಟದ ಆಮೆ, ತುಳು : ಕುಂಡೆ ಆಮೆ, ತಮಿಳು : ವೆಂಗಳ ಆಮೈ, ಮಲಯಾಳಂ : ಚುರೆಲ್ ಆಮ, ಕಾಡರ್ : ಸೆಂಗಾನಿ ಆಮೈ, ಕಾಣಿ : ಅಯನಿ ಇಲೈಯರ್ ಆಮೈ, ಕೊಂಗಿ ಕನ್ನಡ, ಮೂತಲ್ ಆಮೈ

ಈ ಆಮೆಯ ಇರುವಿಕೆಯ ಬಗ್ಗೆ ಮಾಹಿತಿ ದೊರೆತರೆ ಅಥವಾ ಈ ಪ್ರಾಣಿಯನ್ನು ನೋಡಿದರೆ ದಯವಿಟ್ಟು ಈ ಕೆಳಗೆ ಕೊಟ್ಟಿರುವ ವಿಳಾಸಕ್ಕೆ ಪತ್ರ ಬರೆಯುವ ಮೂಲಕ ಅಥವಾ ದೂರವಾಣಿಯ ಮೂಲಕ ನಿಮ್ಮಲ್ಲಿರುವ ಮಾಹಿತಿ ಮಾಹಿತಿ ಪಡೆಯಲು ಸಂಪರ್ಕಿಸುತ್ತೇವೆ.

ചുരലാമ (cane turtle) ഏതാണ്ട് 139 മില്ലി മീറ്റർ വരെ വളർച്ചയെത്തുന്ന ചെറിയ ആമകളാണ് ചുരലാമകൾ. നല്ലൊരു ശതമാനവും ഇവയുടെ പ്രധാന ആഹാരം നത്തകളെ, പ്രാണികൾ, മണ്ണിര, പഴങ്ങൾ എന്നിവയാണ്. നിത്യഹരിത വനങ്ങളിലും., അർദ്ധ നിത്യഹരിത വനങ്ങളിലും, 10 മുതൽ 800 മീറ്റർ വരെ ഉയരമുള്ള പ്രദേശങ്ങളിലാണ് ഇവയുടെ വാസം. ആൺ, പെൺ ചുരലാമകൾ വ്യത്യസ്തമായ വർണ്ണങ്ങളിലുള്ളവരാണ്. ആണാമകളുടെ തലയ്ക്ക് കടുത്ത പിങ്ക്, മഞ്ഞയോ, കറുപ്പോ നിറമായിരിക്കും. എന്നാൽ പെണ്ണാമകളുടെ തലയിൽ ഒരു തെളിഞ്ഞ പിങ്കുവര വരയെ ഉണ്ടാവൂ. ഒരു സമയം 1 മുതൽ 3 വരെ മുട്ടകളിടും., ആവാസവ്യവസ്ഥയുടെ രൂപാന്തരണവും, വിഘടനവും, ഇവരുടെ നിലനിൽപ്പിന് ഭീഷണിയാകുന്നു

തിരിച്ചറിയൽ ചെറിയ പരന്ന പുറംതോടും, ആകെയുള്ള തലയിലെ ചുവന്ന നിറവും, വളരെ തിരിച്ചറിയാൻ സഹായകരമാണ്

IUCN റെഡ് ലിസ്റ്റിൽ ഇവയെ ഉൾപ്പെടുത്തിയിരിക്കുന്നത് വംശനാശഭീഷണി നേരിടുന്ന ഗണത്തിലാണ്. അതുപോലെ തന്നെ ഇന്ത്യൻ വന്യ ജീവി സംരക്ഷണ നിയമത്തിന്റെ കീഴിൽ ഷെഡ്യൂൾ ഒന്നിലുൾപ്പെടുന്നു

പശ്ചിമഘട്ടത്തിന്റെ മാത്രമായ കേരള, കർണ്ണാടക, തമിഴ്നാട് എന്നി സംസ്ഥാനങ്ങളിലാണിവയെ സാധാരണയായി കണ്ടുവരുന്നത്.

പ്രാദേശിക നാമങ്ങൾ: മലയാളം - ചുരലാമ, തമിഴ് - വെങ്കലാമൈ, കന്നട - ബെട്ടാട, തുളു - കുണ്ടെ ആമെ, കാടർ - സെങ്കണി ആമൈ, കാണി - അയനി ഇലയൻ ആമ, കൊങ്കണി ആമ, മോട്ടയിൽ ആമ

നിങ്ങൾ ഇതിനെ കാണുകയോ ഇതിനെപ്പറ്റി കേൾക്കുകയോ ചെയ്തിട്ടുണ്ടെങ്കിൽ ദയവായി താഴെക്കൊടുത്തിരിക്കുന്ന മേൽവിലാസത്തിൽ ബന്ധപ്പെടുക. ഞങ്ങൾ ഉടൻതന്നെ നിങ്ങളുമായി ബന്ധപ്പെടുന്നതാണ്.

Cane turtle (*Vijayachelys silvatica*) is a small forest turtle, growing up to 139 mm in length. It is omnivorous and feeds on molluscs, insects, earthworms and fruits. It is found in evergreen and semi-evergreen forest between 10-800 m above sea level. Males and females of the species have different colouration. The males have dark pink or yellow or black head, while the female has faint pink line on the head. It mates during monsoon (July to October) and lay 1-3 small eggs. Habitat alteration and fragmentation poses major threat to the cane turtle. Identification: small with a malleable, almost flat upper shell; males with a prominent head colouration. Status: IUCN Red list: Endangered; India's Wildlife (Protection) Act: Schedule I. Distribution: Known only from the Western Ghats, in the state of Kerala, Karnataka and Tamil Nadu. Vernacular names: Tamil: Vengala amai, Malayalam: Churrel aama, Kannada: Bettadh/Bettada amae, Thulu: Kunde amae, Kadar: Sengani amai, Kanis: Ayani ilaiyan amai, Sengkannan, Mootal amai.

If you have seen or heard about this tortoise anywhere in your area, please write or contact us at the address given below and we will get in touch with you soon

Contact: Karthikeyan Vasudevan, Wildlife Institute of India, P.O. Box 18, Chandrabani, Dehradun 248001, Uttarakhand, India
Phone: 0135-2640111 to 115; email: turtle&tortoise@wii.gov.in
Photos and map: V. Deepak

Appendix:2

இந்தியாவில் மட்டும் காணப்படும் ஆமைகள்

ഇന്ത്യയിൽ മാത്രം ജീവിക്കുന്ന ആമകൾ

ಭಾರತಕ್ಕೆ ಸೀಮಿತವಾದ ಆಮೆಗಳು

India's Endemic Turtles

Locality records

[illegible]

[illegible]

[illegible]

Leith's softshell (*Nissonia leithii*) is a large fresh water turtle found in rivers and reservoirs. It grows up to 630 mm and is completely aquatic. It feeds on fishes, crabs, mosquito larvae and fresh water molluscs. It nests during mid June, clutch size is unknown. The eggs measure 30-31 mm. Hatchlings have 4-6 prominent ocelli on the carapace. Adults have a prominent orange marking on the upper jaw. In most of its range, the species is hunted and consumed. It is threatened due to river alteration and pollution. Identification: It has a low carapace. Nostrils in front of the head are prominent and the front of shell has many wart like projections. Status: IUCN Red list - Vulnerable; India's Wildlife (Protection) Act - Schedule IV. Distribution: Known only from Peninsular India. Major Rivers in the state of Andhra Pradesh, Kerala, Karnataka and Tamil Nadu; and in some rivers of Maharashtra and Orissa. Vernacular names: Tamil: Parisal amai, Seravi amai, Thoni amai. Kannada: Pale poo. Telugu: Nadi tabelu.

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Appendix:3

இந்தியாவில் மட்டும் காணப்படும் ஆமைகள்

ಭಾರತಕ್ಕೆ ಸೀಮಿತವಾದ ಆಮೆಗಳು

ഇന്ത്യയിൽ മാത്രം ജീവിക്കുന്ന ആമകൾ

India's Endemic Turtles

Locality records

திருவாங்கூர் ஆமை (Travancore tortoise) ஒரு பெரிய காட்டு ஆமை. அது 330 மி.மீ வரை வளரக்கூடியது. அது அதிகளவில் மலைக்காடுகளில் 450-850 மீ கடல் மட்ட உயரத்தில் காணப்படும். ஆண் ஆமைகள் இனச்சேர்க்கையின் போது ஒன்றோடு ஒன்று மோதிக்கொள்ளும். பெண் ஆமைகள் மண்ணில் ஒரு சிறிய குழி தோண்டி அதில் முட்டையிடும், ஒன்று முதல் ஐந்து முட்டைகள் வரை இடும். ஆமைகுஞ்சுகள் 55-60 மி.மீ நீளம் வரை இருக்கும். இவ்வகை ஆமைகள் அதிகளவில் வேட்டையாடப்படுகின்றன. அது மட்டுமில்லாமல் காட்டுத்தீ, வாழிடம் நாசக்கேடு மற்றும் வாழிடம் துண்டாதல் மூலமாக இவ்வினம் அழியும் அபாயத்தில் உள்ளது.

இனம் கண்டறிதல் : தலையின் பின் முதுகோட்டில் சிறிய செதில் இருக்காது ஓட்டின் முதுகெலும்பு பாகத்தில் இரண்டாவதாக வரும் ஓடுதான் ஆமையின் உயரமான பகுதி ஆகும்.

தகுதி : ஐ.யு.சி.என் (IUCN) ரெட் லிஸ்ட் - வல்னரபல். இந்திய வனவிலங்கு (பாதுகாப்பு) சட்டம் - செட்யூல் IV.

பரவியிருத்தல் : தமிழகம், கேரளம் மற்றும் கர்நாடகா மாநிலங்களில் மேற்கு தொடர்ச்சி மலைப்பகுதியில் மட்டும் காணப்படுகிறது.

வட்டார மொழிகள் : தமிழ் : பெரிய ஆமை, கல் ஆமை, காடர் : வெங்கல ஆமை, கன்னடம்: பெட்ட ஆமே, குட்டே ஆமே, காடு ஆமே. மலையாளம் : சூரல் ஆமா.

இவ்வின ஆமையை உங்கள் பகுதியில் பார்த்தாலோ, கேள்விப்பட்டாலோ தயவு செய்து கீழ்க்கண்ட முகவரிக்கு தெரிவிக்கவும். நாங்கள் கண்டிப்பாக உங்களை தொடர்புக் கொள்வோம்.

ಟ್ರಾವಂಕೋರ್ ಆಮೆ (Travancore tortoise): ಕಾಡಿನಲ್ಲಿ ಜೀವಿಸುವ ಒಂದು ದೊಡ್ಡ ಆಮೆ. ಇದು 330 ಮಿ.ಮೀ.ನಷ್ಟು ಬೆಳೆಯುತ್ತದೆ. ಇದು ಮುಖ್ಯವಾಗಿ ಹುಲ್ಲು ಮತ್ತು ಸಸ್ಯಗಳನ್ನು ತಿನ್ನುತ್ತದೆ. ಇದು ಮೃದ್ವಂಗಿಗಳು, ಕೀಟಗಳು, ಸತ್ತು ಕೊಳೆಯುತ್ತಿರುವ ಪ್ರಾಣಿಗಳು, ಶಿಲೀಂಧ್ರಗಳು ಮತ್ತು ಹಣ್ಣುಗಳನ್ನು ಸಹ ತಿನ್ನುತ್ತದೆ. ಇದು 450–850 ಮೀ. ಸಮುದ್ರಮಟ್ಟದಿಂದ ಎತ್ತರದಲ್ಲಿರುವ ಗುಡ್ಡ ಪ್ರದೇಶದ ಕಾಡುಗಳಲ್ಲಿ ಕಂಡು ಬರುತ್ತದೆ. ಸಂತಾನೋತ್ಪತ್ತಿಯ ಸಮಯದಲ್ಲಿ ಅಂದರೆ ನವೆಂಬರ್‌ನಿಂದ ಮಾರ್ಚ್‌ವರೆಗೆ ಗಂಡು ಆಮೆಗಳು ತಮ್ಮ ಚಿಪ್ಪಿನಿಂದ ಗುದ್ದಿ ಹೋರಾಡುತ್ತವೆ. ಇವುಗಳು ನೆಲದಲ್ಲಿ ಸಣ್ಣದಾದ ಗುಂಡಿಯನ್ನು ಮಾಡಿಕೊಂಡು ಅಲ್ಲಿ 50–60 ಮಿ.ಮೀ. ಗಾತ್ರದ ಮೊಟ್ಟೆಗಳನ್ನು ಇಡುತ್ತವೆ. ಇದನ್ನು ಬೇಟೆಯಾಡುತ್ತಾರೆ, ಹಾಗೂ ಕಾಡ್ಗಿಚ್ಚು, ಆವಾಸಸ್ಥಾನದ ನಾಶ ಮತ್ತು ಆವಾಸಸ್ಥಾನದ ಛಿದ್ರೀಕರಣದಿಂದಾಗಿ ಈ ಪ್ರಾಣಿಯು ಅಪಾಯದ ಅಂಚಿನಲ್ಲಿರುವ ಭೀತಿ ಇದೆ.

ಗುರುತಿಸುವಿಕೆ : ಈ ಆಮೆಯಲ್ಲಿ ಕತ್ತಿನ (ತಲೆ) ಮೇಲಿನ ಸ್ಕ್ಯೂಟ್ ಇರುವುದಿಲ್ಲ ಮತ್ತು ಬೆನ್ನುಹುರಿಯ ಜೊತೆ ಇರುವ ಎರಡನೇ ಸ್ಕ್ಯೂಟ್ ಮೇಲ್ಭಾಗ ಚಿಪ್ಪಿನ ತುದಿಯಲ್ಲಿರುತ್ತದೆ.

ಸ್ಥಾನಮಾನ : IUCN ಕೆಂಪು ಪಟ್ಟಿಯ ಪ್ರಕಾರ ಇದು 'ವಲ್ನರಬಲ್' (Vulnerable) ಎಂದು ಗುರುತಿಸಲ್ಪಟ್ಟಿದೆ. ಭಾರತದ ವನ್ಯಜೀವಿ ಸಂರಕ್ಷಣಾ ಕಾಯಿದೆಯ ಪ್ರಕಾರ ಇದು ಶೆಡ್ಯೂಲ್ IV ರಲ್ಲಿರುವ ಪ್ರಾಣಿ.

ಹಂಚಿಕೆ: ಈ ಆಮೆಗಳು ಕೇರಳ, ಕರ್ನಾಟಕ ಹಾಗೂ ತಮಿಳುನಾಡು ರಾಜ್ಯಗಳಲ್ಲಿರುವ ಪಶ್ಚಿಮ ಘಟ್ಟದ ಕಾಡುಗಳಿಗೆ ಸೀಮಿತವಾಗಿದೆ.

ಸ್ಥಳೀಯ ಹೆಸರುಗಳು : ಕನ್ನಡ – ಬೆಟ್ಟ ಆಮೆ, ಗುಡ್ಡೆ ಆಮೆ, ಕಾಡು ಆಮೆ, ಮಲಯಾಳಂ – ಚುರ್ರೆಲ್ ಆಮ, ತಮಿಳು– ಪೆರಿಯ ಅಮೈ, ಕಲ್ ಅಮೈ, ಕಾಡಾರ್ – ವೆಂಗಳ ಅಮೈ.

ಈ ಆಮೆಯನ್ನು ನೋಡಿದರೆ ಅಥವಾ ಆಮೆ ಇರುವ ಬಗ್ಗೆ ನಿಮ್ಮ ಸ್ಥಳದಲ್ಲಿ ಮಾಹಿತಿ ದೊರೆತರೆ, ದಯವಿಟ್ಟು ಈ ಕೆಳಗೆ ಕೊಟ್ಟಿರುವ ವಿಳಾಸಕ್ಕೆ ಬರೆದು ಅಥವಾ ದೂರವಾಣಿಯ ಮೂಲಕ ತಿಳಿಸುವಿರಿ. ನಂತರ ನಾವು ನಿಮ್ಮೊಂದಿಗೆ ಇದರ ಬಗ್ಗೆ ಮಾಹಿತಿ ಪಡೆಯಲು ಬಹುಬೇಗ ಸಂಪರ್ಕಿಸುತ್ತೇವೆ.

തിരുവിതാംകൂർ ആമ (Travancore tortoise) 330 മില്ലി മീറ്ററോളം വലുപ്പമുള്ള കാട്ടാമകളാണ് തിരുവിതാംകൂർ ആമകൾ. നത്തക്ക, പ്രാണികൾ, കൂണുകൾ, പഴങ്ങൾ തുടങ്ങിയവയെ എല്ലാം ഭക്ഷണമാക്കുമെങ്കിലും, ഇവയുടെ പ്രധാനാഹാരം പുല്ലുകളും ചെടികളുമാണ്. 450 മുതൽ 850 മീറ്റർ വരെ ഉയരമുള്ള മലമ്പ്രദേശങ്ങളിലാണ് ഇവയെ സാധാരണയായി കാണുന്നത്.

മണ്ണിൽ ചെറിയ കുഴികൾ ഉണ്ടാക്കി അതിലാണിവ മുട്ടയിടുന്നത്. ഒരേസമയം 1 മുതൽ 5 വരെ മുട്ടകൾ ഇടാറുണ്ട്. മുട്ട വിരിഞ്ഞുവരുന്ന ആമക്കുഞ്ഞുങ്ങൾക്ക് ഏതാണ്ട് 55-60 മി.മീറ്ററോളം വലുപ്പമുണ്ടാകും. വേട്ടയാടൽ കൂടാതെ കാട്ടുതീ, ആവാസവ്യവസ്ഥയുടെ നശീകരണം, വിഭജനം എന്നിവയെല്ലാം ഇവയുടെ നിലനിൽപ്പിന് ഭീഷണിയാകുന്നു.

തിരിച്ചറിയൽ: തലയ്ക്ക് തൊട്ടുപിറകിലുള്ള പുറംതോടിൽ കാണപ്പെടുന്ന കട്ടി ചെറിയ കുറവാണ്. ആമയുടെ ഉയർന്ന ഭാഗമാണ് ഇവയെ തിരിച്ചറിയാൻ സഹായിക്കും.

IUCN റെഡ് ലിസ്റ്റിൽ വംശനാശഭീഷണി നേരിടുന്ന ഗണത്തിലാണ് ഇവയെ ഉൾപ്പെടുത്തിയിരിക്കുന്നത്. കൂടാതെ ഇന്ത്യൻ വന്യജീവി സംരക്ഷണനിയമത്തിന്റെ നാലാം പട്ടികയിൽ പെടുത്തിയിരിക്കുന്നു.

പ്രാദേശിക നാമങ്ങൾ: തമിഴ്- പെരിയ ആമൈ, കാടർ-വെങ്കല, കന്നട - ബെട്ട ആമെ, ഗുഡ്ഡെ ആമെ, കാട് ആമെ

നിങ്ങൾ ഇതിനെ കാണുകയോ ഇതിനെപ്പറ്റി കേൾക്കുകയോ ചെയ്തിട്ടുണ്ടെങ്കിൽ താഴെ കൊടുത്തിരിക്കുന്ന മേൽവിലാസത്തിൽ ബന്ധപ്പെടുക. ഞങ്ങൾ ഉടൻതന്നെ നിങ്ങളുമായി ബന്ധപ്പെടുന്നതാണ്.

Travancore tortoise (*Indotestudo travancorica*) is a large forest tortoise growing up to 330 mm. It primarily feeds on grasses and herbs. It also feeds on molluscs, insects, animal carcass, fungi and fruits. It occurs in hill forests at 450-850 m above sea level. Males combat by ramming their shell during their breeding season between November and March. It makes a shallow nest in the ground and lay 1-5 eggs. Hatchlings are 55-60 mm in size. The tortoise is hunted and it is threatened due to forest fires, habitat destruction and fragmentation. Identification: a scute right behind the head is absent and the second scute along the vertebral column is located at the highest point of the shell. Status: IUCN Red list - Vulnerable; India's Wildlife (Protection) Act: Schedule IV. Distribution: restricted to the Western Ghats, in the states of Kerala, Karnataka and Tamil Nadu. Vernacular names: Tamil: Periya amai, Kal amai, Kadas: Vengala amai. Kannada: Betta aame, Gudde aame, Kadu aame. Malayalam: Churrel aama.

If you have seen or heard about this tortoise anywhere in your area, please write or contact us at the address given below and we will get in touch with you soon

Contact: Karthikeyan Vasudevan, Wildlife Institute of India, P.O. Box 18, Chandrabani, Dehradun 248001, Uttarakhand, India
Phone: 0135-2640111 to 115; email: turtle&tortoise@wii.gov.in
Photos and map: V. Deepak

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