# Chapter 3

# Materials and Methods

## 3.1 Study Area

Huai Kha Khaeng Wildlife Sanctuary (HKK) was established in 1972. This sanctuary occupies the western area of Uthai Thani Province at 15°.00 - 15°.50 N and 99°.00 - 99°.19 E (Figure 1.) with an area about 2,800 square kilometers. HKK was announced a Natural Property to the World Heritage list in 1991 by UNESCO. Khao Nang Rum Wildlife Research Station (KNR) was established in 1976 and is located in the eastern part of HKK. (Figure 1.)

HKK comprises many hills oriented from the north to the south. Most of the study area ranges in elavation from 400-600 m. The Huai Kha Khaeng stream is the main waterway of this sanctuary. Vegetation in the area encompasses approximately is a mosaic of four forest types, as described in Bhumpakkapun et al. (1985), Stott (1986), and Thitathamakul (1985). These forest types are:

1. Mixed deciduous forest. Comprising 35% of the study area , this forest type is found primarily on moderately sloping and flat areas near streams. It is dominated by tree genera such as *Lagerstroemia, Terminalia, Dalbergia, Bombax, Pterocarpus, Cratoxylon, Vitex, Schleicher, Grewia,* and *Dillenia*. The tallest trees range to 20-30 m high, with a middle level canopy at 10-20 m. Ground cover, consisting of shrubs and creepers such as *Viburnum, Ixora, Harrisonia*, and *Congea*, averages 70% (range: 5-100%), and is often dense in rainy season but more open when fires sweep through in dry season.

2. Dry deciduous dipterocarp forest. This forest has a more open canopy, with a soil floral composition indicative of an artificial subclimax

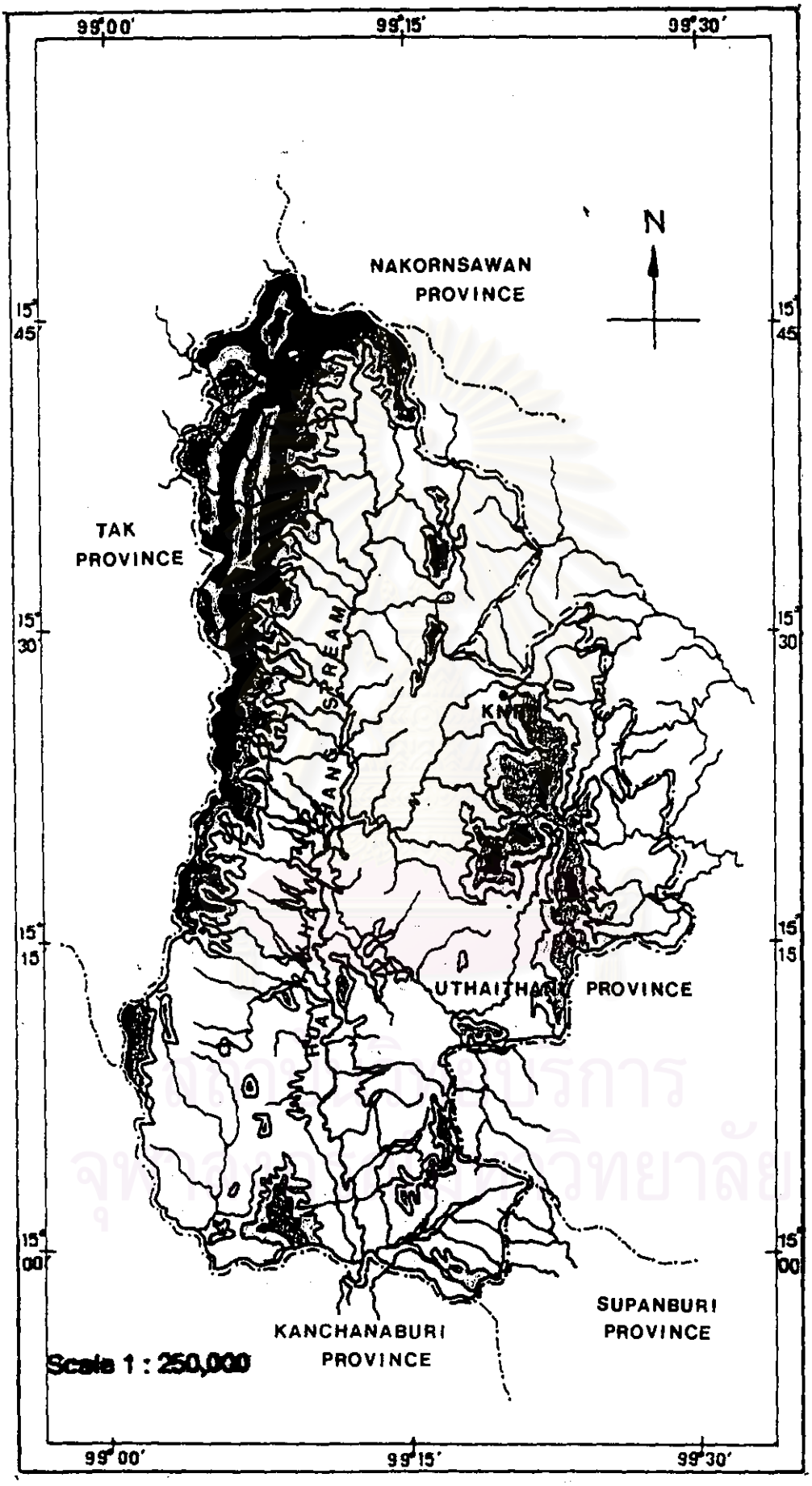



Figure 1. Map of Huai Kha Khaeng Wildlife Sanctuary

community maintained by annual fires as described by Stott (1986). Comprising 23% of the study area, this forest type was interspersed with mixed deciduous forest, often making distinctions between the two types difficult. Dominant tree genera included *Shorea, Dipterocarpus, Terminalia, Lithocarpus, Lagerstroemia* and *Eugenia* with a top canopy level 20-30 m high, and a lower level 10-15 m high. Ground cover averages 80% (range : 45-100%), covered in the rainy season by grasses such as *Schemia* and *Imperata*. In dry season, the ground was often bare due to fire.

3. Dry evergreen forest. Comprising 35% of the study area, this relatively dense forest type is found on both sloping ground above 600 m, and along permanent waterways from 400- 600 m. In the study area this forest type occurred mostly at low elevations along the waterways. Major tree genera at lower elevations included *Paranephelium, Hopea*, and *Dipterocarpus*; at elevations 600-1000 m, tree genera included *Polyalthia, Dipterocarpus*, and *Bacaurea*; at elevations 800-1000 m, tree genera included *Cinnamomum* and *Musa*. Ground cover in this forest type consists mainly of seedling and annuals averaging 47% (range: 5-100%) and was dense only in gap areas.

4. Hill evergreen or lower montane rainforest. This forest type comprises 7 % of study area and is found only over 1000 m on the top of Khao Khieo Mtn. It was dominated by trees of family Fagaceae such as *Quercus, Lithocarpus*, and *Castanopsiss.*

The climate type of HKK is a combination of tropical and subtropical climate. The average minimum temperature is 20° C and the average maximum temperature is 30° C. The rainy season starts from May until October, and the dry season from November until April. The average temperature is 24.4° C. The hottest month is April whereas the coldest is January. The average rainfall is 1,500 mm/year. The maximum rainfall

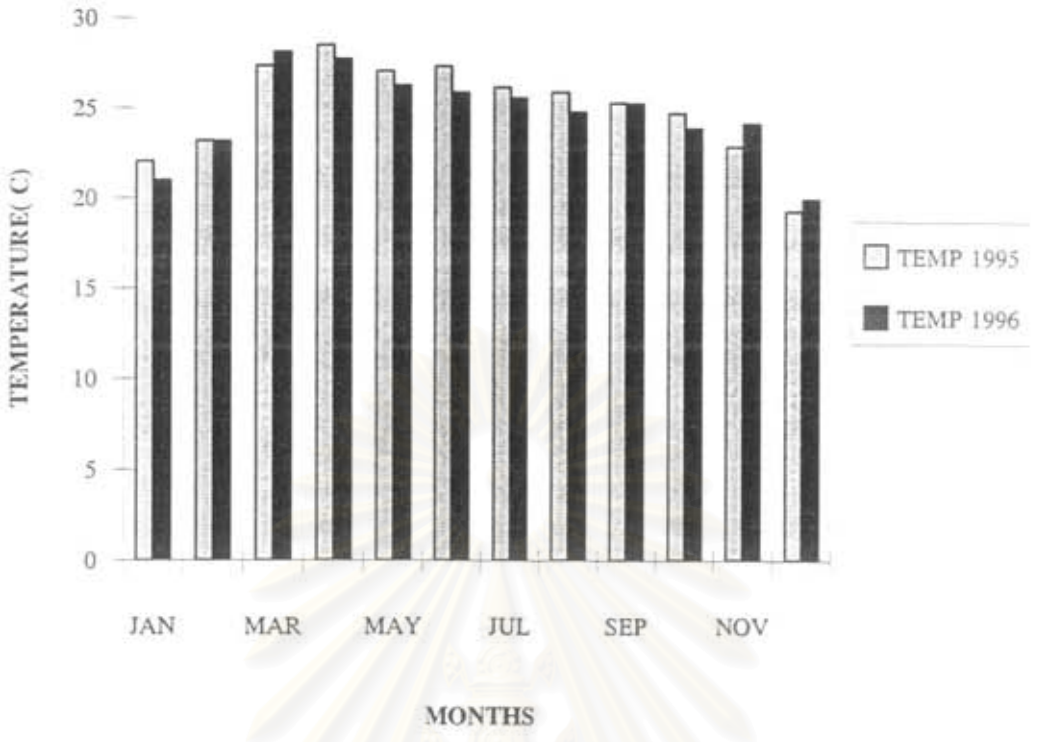



Figure 2. Average Temperature at KNR in 1995 and 1996.

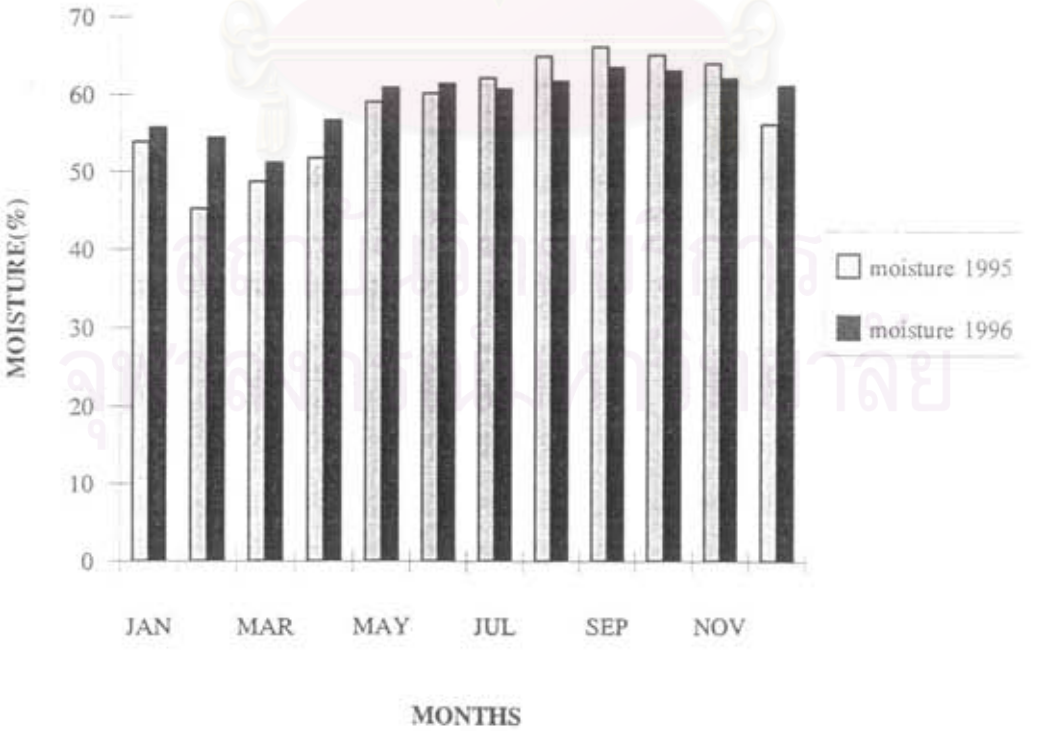



Figure 3. Average Relative Humidity at KNR in 1995 and 1996.

occurs in September and October while the minimum occurs in December and the number of days having rainfall is 113 to 151 day/year (Prayurasiddhi, 1992).

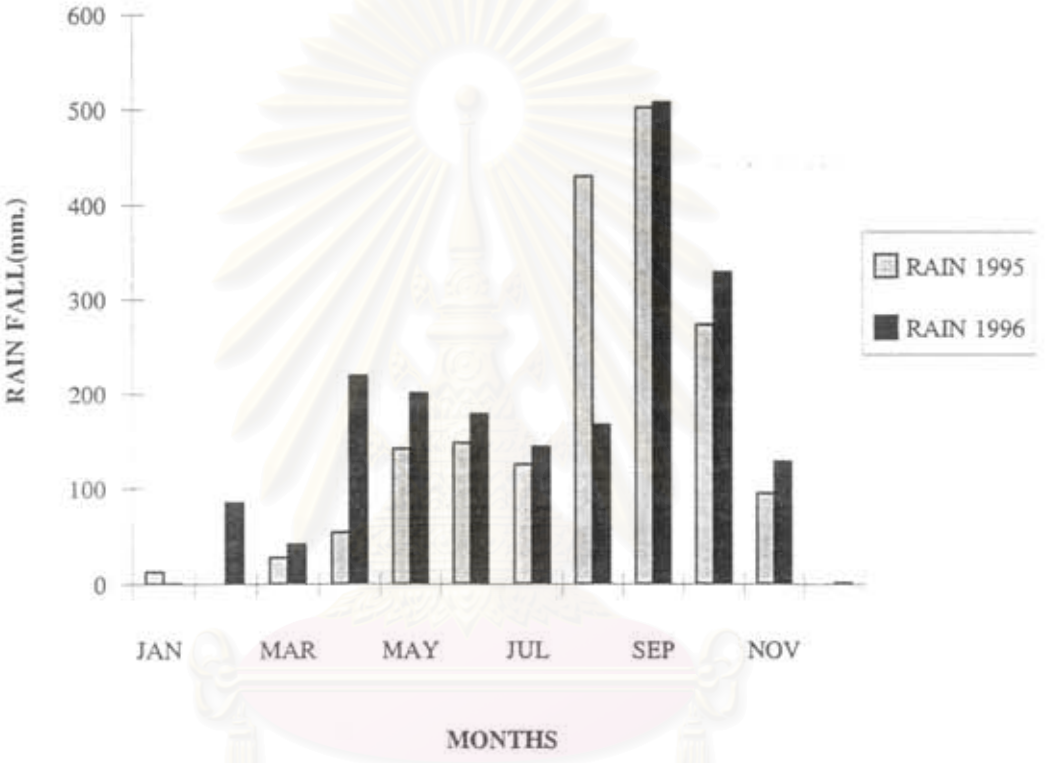



Figure 4. Total rainfall at KNR in 1995 and 1996.

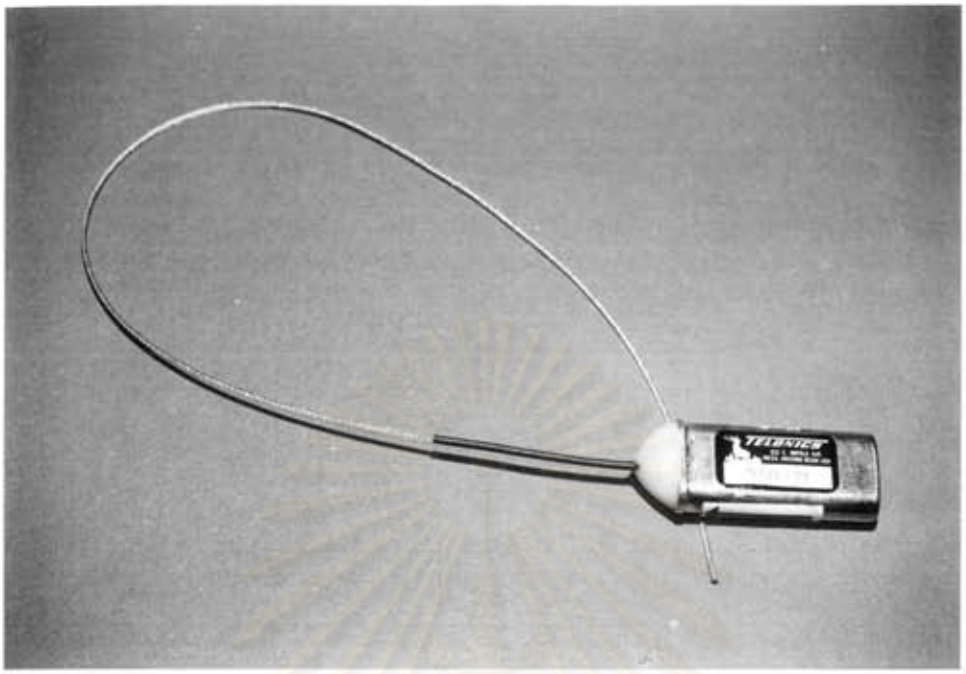
## 3.2 Materials

3.2.1. Radio-telemetry equipments

1. Transmitters (Figure 5) used in this study were ;

- CPH 2H, S2 (Telonics, Inc), Transmitter weight 12-15 g, 6 months operation, Temperature sensor (S2) included.

- MOD 080, S2 (Telonics, Inc), Transmitter weight 34-36 g, 12 months operation, Temperature sensor (S2) included.



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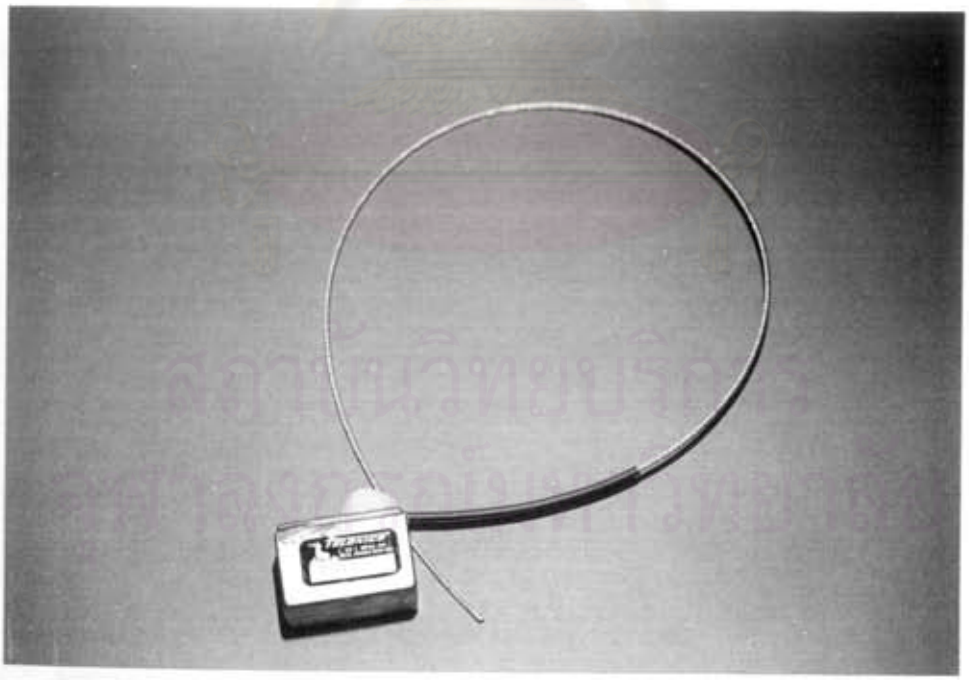

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Figure 5. Transmitters for tortoise

a. Model CPH

b. Model MOD


Figure 6. Receiver


Figure 7. Digital data processor

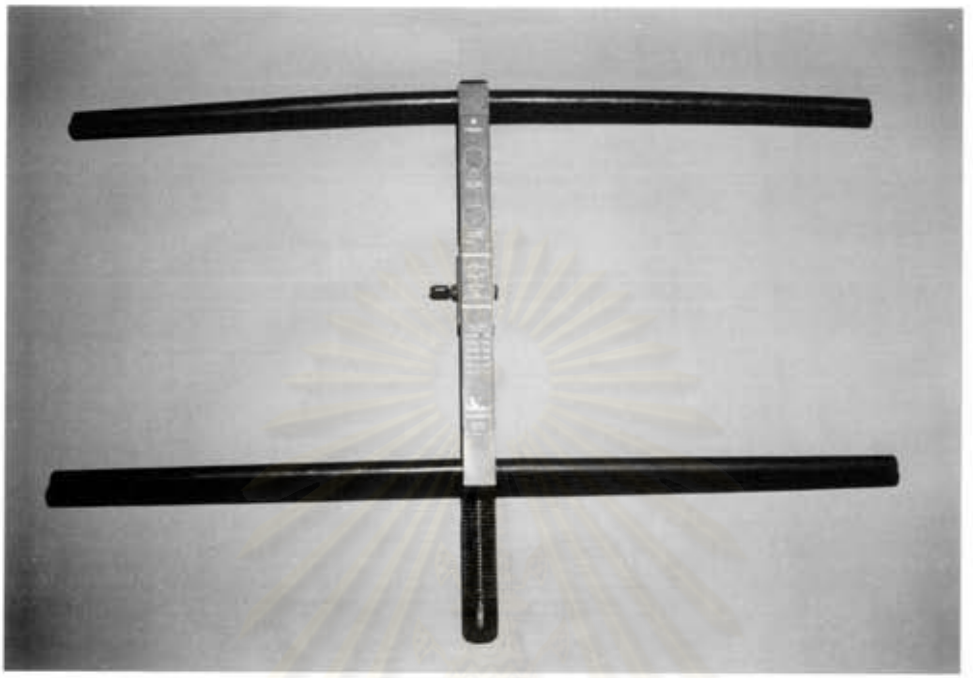

Figure 8. Antenna

- MOD 080, LP (Telonics, Inc), Transmitter weight 34-36 g, 18 months operation.

- MOD 080, S2, SGB (Telonics, Inc), Transmiter weight 34-36 g, 12 months operation, Temperature sensor (S2) and Motion sensor included.

- MOD -125, S2 (Telonics, Inc), Transmitter weight 47-53 g, 18 months operation, Temperature sensor (S2) and Motion sensor included.

2. Telonics TR 2 (148 - 150 MHz) Receiver (Figure 6)

3. TDP 2 Advanced Digital Data Processor (Figure 7) (Telonics, Inc), processes audio output from the receiver to provide a display of signal strength and interpulse period, allowing accurate processing of temperature and motion data.

4. Telonics RA 2A(148-150 Mhz) Antenna (Figure 8), two-element handled Yagi-type

3.2.2 Camera and films

3.2.3 GPS ( Global Positioning System )

3.2.4 Thermometer

3.2.5 Hygrometer

3.2.6 Spring balance (1 kg & 5 kg)

## 3.3 Study Methods

3.3.1 Radio - telemetry technique

For shy or elusive animals, and those too small to carry conspicuous color tags or other visible markers, radio tracking is often the only way to collect data systematically on behavior and some aspects of demography. (Kenward, 1987)

Many countries now allocate a frequency band of 150 KHz-2 MHz. for wildlife radio tags. In this study, the frequencies 148 - 150 MHz. were used to avoid interference with other studies using the 150-152 MHz. band in progress at KNR.

A transmitter is a device which is attached to a target animal to transmit a radio signal. An antenna and a receiver were used for finding and receiving the radio signal from transmitters on each tortoise. Each study tortoise had a transmitter which looked like a piece of rubber (Figure

a b

Figure 9. Two-types of transmitter attachment

a. Antenna on carapace

b. Antenna free on ground

5.) attached to its carapace. The weight of a transmitter was less than 5 % of a tortoise 's body weight. This study used transmitters that can identify the surrounding temperature of the study animals by changes in the interpulse period. Some special transmitters could tell both the surrounding temperature and movement of a study animal; only two of these transmitters were used in this study, because they were very expensive. In this study, a Digital Data Processor was used to distinguish the strength of radio signals by displaying numbers, representing signal strength, on the LCD. The strongest radio signal indicates the direction of the target tortoise and was very helpful in locating these animals which are very difficult to find.

3.3.2 Attachment of Transmitters

After a wild tortoise was found in the forest, it was taken to the station to be measured and weighed. Its carapace was then cleaned up and a suitable transmitter with a weight of less than 5% of the tortoise's body weight was selected. The transmitter did not seem to have any apparent effect on the survival of the study animal as all tortoises showed seasonal weight increases.

The hind part of the carapace seemed to be the most suitable place for placing a transmitter since it would not easily catch on vegetation and stop forward movement. The fourth costal scute on the hind part of the carapace where the transmitter was specifically attached was the least worn of all the scutes. Epoxy-resin was used for attaching the transmitters except at the growing joints of the scutes where silicone was used instead.

The antenna of the transmitter was shielded with IV tubing before being fixed on the carapace(Figure 9a). Since it was often broken by

obstacles, later in the field work this method was adjusted by letting the antenna trail free on ground behind the tortoise (Figure 9b).

3.3.3 Collection of wild and captive Tortoises

Nine wild tortoises (4 adult males, 4 adult females and 1 immature male) were captured in the study area for this study by myself and with the help of staffs of KNR. Four captive tortoises were obtained from different locations in Thailand which had been in captivity for at least two years. Two of them designated SKR1 and SKR2, were captured from a dry dipterocarp forest at Sakarat Experimental Station, Nakorn Ratchasima Province. SKR1 and SKR2 were in captivity three months old and 3-4 years old, respectively. SNR9 was captured from a mix deciduous forest near Srinakarin Reservoir, Kanchanaburi Province and was in captivity for about two years. UNK10 was a captive tortoise donated from the Samutprakan Crocodile Farm and Zoo from an unknown location of origin and length of time in captivity. More details of wild and captive tortoises are presented in table 3.1.

3.3.4 Collection of Data

The study period was one year from June 1995 to May 1996 in order to collect field data for two seasons (wet and dry seasons). Every time a tortoise was found, the location was obtained by GPS and the type of habitat, the ambient temperature, the relative humidity, any behavior etc. were recorded. All tortoises were weighed once a month using a spring balance.

Table 3.1 Yellow tortoises, *Indotsetudo elongata* used in this study at Khao Nang Rum Wildlife Research Station.

| Tortoise Number | Estimated age (years) | Weight of Transmitter (g) | Measurement of Tortoise at the start of study | | | | Month of releasing |
|---|---|---|---|---|---|---|---|
| | | | Carapace length (mm) | Plastron length (mm) | Weight (Kg) | Height (mm) | |
| SKR 1 ( c,m*) | 6 | 13.98 | 190 | 175 | 1.00 | 82 | Jan 1995 |
| SKR 2 ( c,m ) | ≤ 8 | 37.26 | 246 | 208 | 1.90 | 105 | Jan 1995 |
| SNR 9 ( c,f ) | >10 | 51.02 | 255 | 218 | 2.15 | 105 | Jan 1995 |
| UNK10 ( c,f ) | 20 | 51.19 | 261 | 226 | 2.20 | 106 | Jan 1995 |
| KNR 8 ( w,m ) | >20 | 52.18 | 271 | 212 | 2.25 | 105 | Jan 1995 |
| KNR 20 ( w,m ) | 10 | 39.71 | 206 | 183 | 1.10 | 89 | Jun 1995 |
| KNR 26 ( w,m) | >20 | 14.83 | 286 | 230 | 2.20 | 104 | Jun 1995 |
| KNR 37 ( w,m ) | >20 | 34.00 | 283 | 233 | 2.70 | 108 | Nov 1995 |
| KNR 5 ( w,f ) | >20 | 38.41 | 267 | 225 | 2.55 | 107 | Dec 1994 |
| KNR 14 ( w,f ) | >20 | 38.07 | 255 | 208 | 2.20 | 102 | Jun 1995 |
| KNR 19 ( w,f ) | 20 | 40.09 | 260 | 220 | 2.15 | 106 | Jun 1995 |
| KNR 36 ( w,f ) | >20 | 51.60 | 265 | 230 | 2.60 | 114 | Nov 1995 |
| KNR 53 ( w,m*) | ≤ 9 | 14.43 | 178 | 155 | 0.92 | 77 | Jan 1996 |

**Note** : c = captive, w = wild, m = male, f = female, m* = immature male, SKR = specimen from Sakaerat Experimental Station, Nakorn Ratchasima Province ; SNR = specimen from a forest near Srinakarin Reservoir, Kanchanaburi Province KNR = specimen from Khao Nang Rum, Uthai Thani Province; UNK = Unknown.

### 3.3.5 Home Range Check

Every tortoise was located 2 - 3 times a month, depending on the condition of the weather. Since the electronic receiving equipment was sensitive to humidity, rainy days were avoided.

### 3.3.6 Analysis of Data

The home range size of each individual was estimated by using the Minimum Convex Polygon method using programe home range developed by the University of Idaho (Ackerman et al, 1990). The differences in the median home range sizes between sexes and between captive and wild tortoises were analyzed using the Man-Whitney U-test. The differences in the median home range sizes between dry and wet season in males and females, captive and wild animals were analyzed using the Wilcoxon method pairs test.

### 3.3.7 Activity Check

Tortoises that lived not too far from the station were selected for study of their activities. KNR 8, SNR 9 and KNR14 were observed during a daytime period for a month, from late morning until before dusk. Observation during the nighttime for these three tortoises were not possible due to the risk of dangerous animals in the forest along the way back to the station. Tortoises (KNR19 & KNR20) which lived near the station could be checked for a 24 hour periods by motion sensors in their transmitters. However, these two tortoises could be studied for only a few months, because the radio signal of KNR20 disappeared and the transmitter of KNR19 was out of order and was sent back to the manufacturer in USA for repairing.

The differences in the median percentage of daytime activity between sexes and between captive and wild tortoises were analysed by using Mann-Whitney u test.

The differences in the median percentage of daytime activity in male and female tortoises between the wet and dry season were analysed by using Wilcoxon Matched pairs test.

The differences in average temperature and relative humidity during inactive and active period between sexes and between captive and wild tortoises were analyzed using t-test at confidence level of 95%

The differences in the average temperature and relative humidity in males and females between inactive and active were analysed by using F-test at 95 % confidence level.

The differences in ambient temperature and relative humidy at the point where the tortoises were found between sexes and between captive and wild tortoises were analyzed by using t-test at 95% confidence level.

3.3.8 Survival Check of Captive tortoises

Four captive tortoises were attached with transmitters and were released at Khao Nang Rum in late December, 1994. They were relocated and weighed at least once a month, similar to the wild tortoises.