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SPECIES DIVERSITY AND CONSERVATION OF TURTLES OF WESTERN THAILAND[1]

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ABSTRACT

At least 11 and possibly up to 16 species of native turtles still inhabit the Mae Klong basin and adjacent minor drainages. Among these are several rare species. The high number of genera, 10 to 15, may make it the world's most diverse turtle community. The western Thai population of the Striped Giant Softshell was recently recognised as a full independent species, *Chitra chitra.* This adds another spectacular species to Thailand's list of endemic fauna. The occurrence of *Lissemys scutata* in some streams in the Thai-Myanmar border region is a first country record for Thailand.

The small population of the Striped Giant Softshell, *Chitra chitra,* endemic to the Mae Klong basin, is severely affected by hunting and water pollution. The giant *Pelochelys bibroni* softshell became extinct in the Mae Klong and Chao Phraya River basins in recent decades. The majority of animals of *Hieremys annandalii* and *Malayemys subtrijuga* world-wide live in Thailand, which therefore has a major responsibility to safeguard their future. The Yellow Tortoise *(Indotestudo elongata)* is still widely distributed in the hills of western Thailand; however, its populations appear to have crashed in the last 10 to 15 years and nowadays it is nowhere common. The Black Tortoise *(Manouria emys)* seems restricted to a few areas of evergreen forest and is rare in these. Such is also the case for the Impressed Tortoise *(Manouria impressa)* whose distribution in western Thailand and elsewhere is highly localised.

Exotic turtle species, specifically the Chinese Softshell *(Pelodiscus sinensis)* and the Redeared terrapin *(Trachemys scripta elegans),* were introduced to Thailand in recent years. These species have a proven potential to disrupt native turtle populations. Their establishment in the wild should be prevented.

The creation of large, deep reservoirs is detrimental to tortoises, forcing them out of their riverside forests. Deep reservoirs do not benefit aquatic turtles either, because they offer little or no suitable habitat or food. The release of turtles into reservoirs and other places should be carefully monitored. Only suitable species that naturally occur in the river basin and can tolerate the highly unusual habitat conditions presented by a large reservoir, should be released. Ideally, parental turtle stock should be collected from the river basin where the captive-bred offspring will be released.

Several turtle species are effectively protected in wildlife sanctuaries in the area. Nevertheless, even here they are at some risk from habitat alteration, collection for consumption and other threats. Forest fires are a major detrimental factor in the survival of tortoise populations. Fires are also a negative influence on aquatic turtles and the ecosystem as a whole. We believe that natural resource managers should make every effort to limit or exclude fires from forest sanctuaries. Some turtle species do not inhabit protected areas and remain at risk from hunting and habitat destruction despite legal protection.

[1]Dedicated to the memory of Mr. Galong Kamsri and Mr. Boontiang Jomjak, our friends at Khao Nang Rum.

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We suggest that several turtle species should receive conservation attention; upgraded listings, enforcement of existing legal protection, and active conservation projects may be required for some species. Designating and protecting sanctuaries which incorporate extensive floodplain wetlands would be of great value for the survival of lowland aquatic species. Raising environmental consciousness and stimulation popular appreciation of Thailand's rich natural heritage are essential.

INTRODUCTION

Relatively few studies have been carried out on the biology of tropical reptiles and amphibians; hardly any of these concern Asian tortoises or terrapins, which are truly forgotten and ignored creatures. Basic information on the turtles of Thailand, and Asia, is still scarce and mainly concerns taxonomy. Thailand is one of few countries world-wide with more than 25 species of turtles, but with ever-increasing habitat destruction, hunting and human settlement, many species are disappearing and may become extinct before we have the chance to study and conserve them.

In mainland Southeast Asia, encompassing Myanmar, the Indo-Chinese Peninsula, the Malay Peninsula and southern subtropical China, more than 67 species of turtles occur. New species are still being discovered and described. Thailand lies in the area of contact between the Indian, Eastern Palearctic and Sundaic faunal regions and consequently shelters a rich assembly of turtle species: a total of 31 turtle species, specifically, 3 or 4 tortoises, 14 freshwater hardshells and 5 or 6 softshells, 5 marine species and 2 introduced exotics, have been reported from Thailand; some species occurring in adjacent areas may eventually be confirmed from Thailand. Although not all these taxa are currently accepted as full independent species or native to Thailand, the 26 recognised species confirmed to inhabit the kingdom are one-tenth of the world's total of about 260 turtle species. The 21 currently-recognised native freshwater and terrestrial turtle species belong to no fewer than 19 genera in 4 families.

Our knowledge of the turtles of Thailand and adjacent regions started with the efforts of 19th century explorers and collectors like THOMAS CANTOR (1847), HENRI MOUHOT (1864), WILLIAM THEOBALD (1868, 1876) and JOHN ANDERSON (1879, 1889), who collected in parts of Thailand or studied species occurring in Thailand while based in nearby countries. Based on their data, ALBERT GÜNTHER of the British Museum published the first checklist of Thai herpetofauna in 1860; in this he noted a single turtle species among the 23 species of herpetofauna. With the establishment of political, economic and cultural links, some western scientists made Thailand their temporary or permanent home. Among these were several with a great interest in reptiles, who made notable contributions to the knowledge of Thailand's herpetofauna. STANLEY S. FLOWER (1896, 1899) noted 23 turtles among 184 reptile species he collected in Siam; MALCOLM A. SMITH (co-founder of the Natural History Society of Siam) wrote major reviews of the reptiles of tropical Asia, from Pakistan to Hong Kong and Singapore (SMITH, 1930, 1931, 1935, 1943); RENÉ BOURRET was based in Hanoi in the 1930's and studied the herpetofauna of French Indochina and beyond. EDWARD H. TAYLOR visited Thailand extensively in the 1960's, reporting on his studies in separate monographs about Thai amphibians (1962), lizards (1963), snakes (1965) and turtles and crocodiles (1970). Museum-based zoologists contributed major

monographs reviewing various aspects of turtle biology (BOULENGER, 1889, 1890; SIEBENROCK, 1902, 1909; DE ROOIJ, 1915; IVERSON, 1986, 1992; GAFFNEY & MEYLAN, 1988; ERNST & BARBOUR, 1989; DAS, 1991).

Wirot Nutphand was the first native researcher to collect and present information about reptiles and amphibians; his English-language monograph *The Turtles of Thailand* (1979) is still the most widely used turtle book in Southeast Asia. JARUJIN NABHITABHATA (1989) and THUNYA CHAN-ARD (CHAN-ARD & NABHITABHATA, 1986) continue to make significant contributions on the distribution and ecology of Thailand's herpetofauna. Many valuable observations on species of Thai turtles have been published scattered in numerous local, regional and international journals by professional herpetologists and dedicated turtle hobbyists from around the globe.

Despite these efforts, the need for thorough investigation of the biology of the turtles of Thailand remains. The general ranges of nearly all species are understood (SMITH, 1931; TAYLOR, 1970; NUTPHAND, 1979; PRITCHARD, 1979; IVERSON, 1986, 1992); even so, the complete, accurate, recent distributional range is known for few species, since there has never been a comprehensive survey of the whole of the kingdom. Moreover, virtually nothing is known about population status, trends and exploitation levels of many of these turtles (*Manouria impressa, M. emys, Notochelys platynota, Melanochelys, trijuga, Pyxidea mouhotii, Dogania subplana,* and others). Such information is a first requirement for sensible conservation strategies. The limited information we have for some species suggests that many are disappearing fast (e.g., *Chitra chitra, Heosemys spinosa, Batagur baska, Callagur borneoensis* (GROOMBRIDGE, 1982; IUCN T & FTSG, 1989)). Similarly, elementary natural history data exist for most species, but detailed information is lacking. Of community ecology, we know nothing. Finally, we can only guess at the impact of introduced exotic species such as *Trachemys scripta elegans* and *Pelodiscus sinensis.*

In our efforts, we aim to address these inadequacies. Unfortunately, it is impossible to deal with all species over the whole country in a short period. Therefore, we expected that by concentrating our efforts in a region where most of the Thai species occur, we could make a significant contribution to the knowledge and conservation of the turtles of Asia. The specific objectives of the study reported in this paper were: to determine the species richness of the turtle fauna of western Thailand; to investigate population size, population structure, and geographical distribution range of each species; to examine the extent and importance of direct human exploitation of turtles, and of human-induced habitat alterations, on the viability of western Thai turtle populations; and to establish which species occur in populations of viable size within the boundaries of Thung Yai Naresuan and Huai Kha Khaeng Wildlife Sanctuaries and other protected areas in western Thailand. We also collected information on natural history which was or will be incorporated in other papers.

METHODS

Turtle Names and Species

In this study we follow the American usage of turtle names and call every member of the order Testudines (or order Chelonia, a widely-used name derived from Greek, Testudines

is the Latin word for the same group) a "turtle". Specific groups of turtles are often referred to by other names: "tortoises" are the completely terrestrial species of the family Testudinidae, while the word "terrapin" is often used for hardshelled aquatic species, generally with the inherent meaning that they are edible. In the English common names employed, "turtle" can be replaced by "tortoise" or "terrapin" where appropriate, or vice versa. Appendix 2 lists full scientific and English vernacular names, and Appendix 4 presents Thai names.

Nomenclature generally follows IVERSON (1992), who provided references to original descriptions, type specimen numbers and type localities, except for *Chitra chitra* Nutphand, 1986. Exhaustive synonymies are available in SMITH (1931), BOURRET (1941), and TAYLOR (1970). The taxonomic status of the Stripe-necked Terrapin *Geoemyda tcheponensis* (Bourret, 1941) remains uncertain and is presently under study by Iverson, van Dijk & Das; while it is certain that this form belongs in the genus *Cyclemys,* its status relative to *C. dentata* (Gray, 1831) is subject to debate. In this paper we include this form with *C. dentata,* as was done previously (MCDOWELL, 1964; DAS, 1991). The Brown Tortoise *Testudo nutapundi* Reimann, 1979 *in* NUTPHAND (1979) is universally regarded as synonymous with *Manouria emys phayrei* (Blyth, 1853) (see review by MOLL, 1989). Following the studies by MEYLAN (1987) and VAN DIJK (1992), we consider *Trionyx nakornsrithammarajensis* Nutphand, 1979 a synonym of *Amyda cartilaginea* (Boddaert, 1770). these and other nomenclatural changes are listed in Appendix 3.

Readers interested in reviews of morphology and natural history of particular species should consult the works by BOULENGER (1889), DE ROOIJ (1915), SMITH (1931), BOURRET (1941), TAYLOR (1970), PRITCHARD (1979), ERNST & BARBOUR (1989), SWINGLAND & KLEMENS (1989 [tortoises only]), DAS (1991 [for the species ranging into India]), and the forthcoming *Conservation Biology of Freshwater Turtles,* edited by Pritchard and Rhodin; coloured illustrations of nearly all species can be found in NUTPHAND (1979), and IVERSON (1992) presents well-documented distribution maps for all species.

Geographical Coverage of the Study

For this study, we consider western Thailand to encompass the whole of the Mae Klong River Basin, some minor areas drained by the Mae Nam Moei (a Salawin tributary), and some small tributaries of otherwise Burmese rivers. Described in another way, it is the whole Thai section of the Dawna Hill Range from 17°N southwards to 14°N, together with the lowlands along the Mae Klong River. Politically, the area includes parts or all of Tak, Kamphaeng Phet, Nakhon Sawan, Uthai Thani, Kanchanaburi, Ratchaburi and Samut Songkhram Provinces. The location of the study area is depicted in figure 1 and in more detail in figure 2.

By Asian standards, the Mae Klong is a rather small river system, originating in the hills of Tak Province and meeting the Gulf of Thailand at Samut Songkhram, a distance of about 380 km and draining an area of over 30,000 sq. km. The basin is entirely within the political boundaries of Thailand, stretching from 16° 26'N to 13° 06' North and 98° 12'E to 100° 00' East. The Khwae Yai and Khwae Noi form most of the river system. These two rivers join at Kanchanaburi City, and from there downstream the river is named Mae Nam Mae Klong, or Kanchanaburi or Ratburi River in some of the English literature.

The Khwae Noi, on the western side of the basin, was dammed in its upper regions to create Khao Laem Reservoir. On the Khwae Yai, the Srinagarind Reservoir stretches from the dam at Si Sawat northwards for almost 90 km; plans for a second Khwae Yai reservoir, at the Nam Chon area inside Thung Yai Naresuan Wildlife Sanctuary, were cancelled for environmental reasons. The construction of these large reservoirs has fundamentally altered the Khwae Yai and Khwae Noi Rivers: formerly, they were swift-running, clear-water rivers with great seasonal differences in water flow. They are now reduced to turbid discharge channels for the reservoirs. The reservoirs do not release water continually, but only during the hours of peak electricity demand, in the late afternoon and early evening. The small Tha Thung Na Reservoir was constructed a few km downstream from Srinagarind Dam to store this pulse and release the water gradually to the Khwae Yai; this prevents the strong daily water level fluctuations experienced in the Khwae Noi.

Forest still covers most of the basin's upper regions. Hill tribe people have inhabited the area to some extent, but the socio-political history of the area spared it from wholesale destruction. Huai Kha Khaeng Wildlife Sanctuary and adjacent Thung Yai Naresuan WS were gazetted in the early 1970's. Stretching from 14° 56'N to 15° 48'N and from 99° 20'E to 99° 28'E, they cover an area of over 6,200 sq. km. In 1992, UNESCO declared the joint sanctuaries a World Heritage site. They form the core of a cluster of adjoining wildlife sanctuaries, national parks, non-hunting areas and reserved forests which stretch over a total area of about 12,000 sq. km. along the Myanmar (Burmese) border, making it the largest single area of forest left in Thailand.

Downstream from Kanchanaburi, the Mae Klong flows through lowland regions which have experienced intensive settlement in recent decades. Due to the combined effects of conversion of forests to agricultural regions, mainly wet rice paddies, and the different topology, the landscape and its flora and fauna are radically different from the regions of the Khwae Yai and Khwae Noi.

Names and boundaries of cities, administrative divisions, countries and geographical features are employed as in current popular usage and do not reflect any socio-political opinion of the authors. Spelling of local names follows the official transliteration used locally, or is the most accurate approximation of spelling and pronunciation in the original language.

Survey Methods

By far the most effective method of discovering which turtle species occur in any area in Thailand is to visit villages, roadside eating places, temples, ferry crossings, national park checkpoints, any place where people are. Asking people about turtles is certain to unleash a flow of stories of past turtle encounters and captures. The species referred to can usually be identified by showing photographs of various species. We used this kind of information for guidance only, to identify promising areas to be explored more thoroughly. To the credit of these people, the turtle species which they claimed to occur locally could usually be confirmed in some way.

Usually, some evidence will be brouht forward. When asked about turtle shells, some can often be produced, and in a few cases we managed to purchase live tortoises intended for a special dinner. Rural people nearly always keep the plastron of a tortoise, because

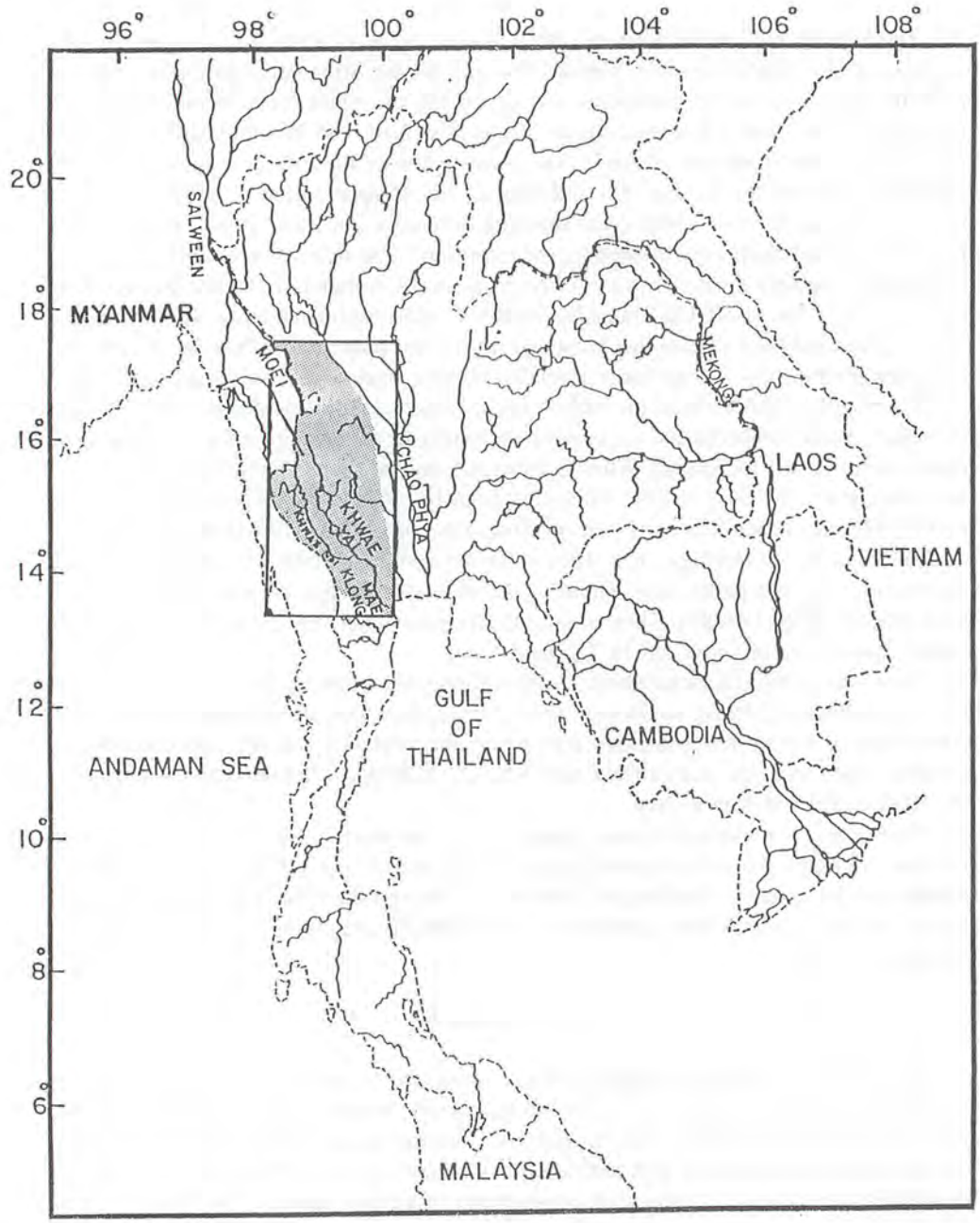

Figure 1. Map of S.E. Asian rivers; the area surveyed for this study is shaded.

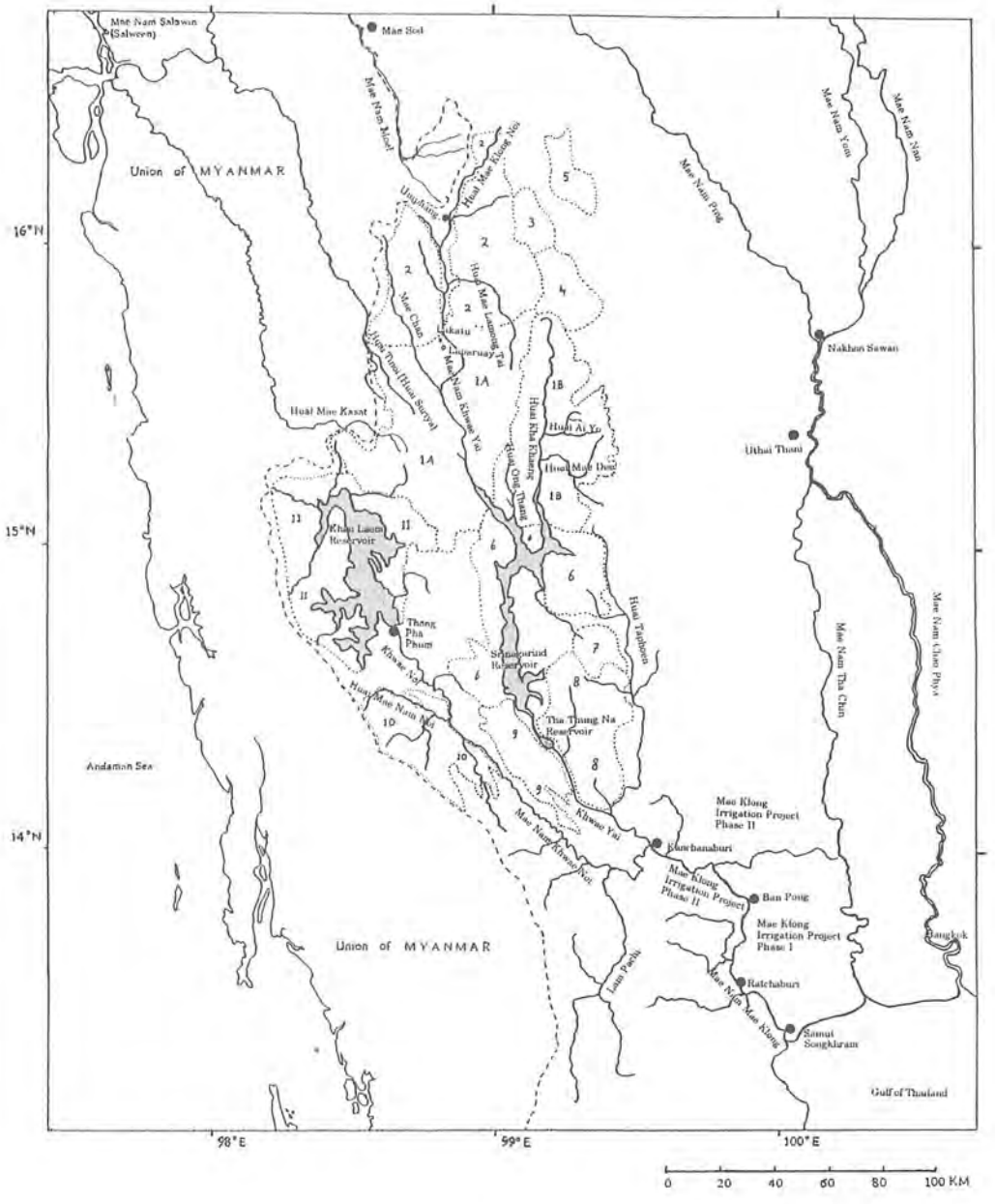

Figure 2. Locations of the rivers, reservoirs, wildlife sanctuaries, national parks and major cities in the study region. Dashed line is the Thai - Myanmar border, dotted lines indicate boundaries of protected areas. Legend to parks and sanctuaries : 1A. Thung Yai Naresuan W.S.; 1B. Huai Kha Khaeng W.S.; 2. Umphang W.S.; 3. Klong Larn N.P.; 4. Mae Wong N.P.; 5. Khao Sanam Prieng W.S.; 6. Srinagarind N.P.; 7. Chalerm Rattanakosin N.P.; 8. Salak Pra W.S.; 9. Erawan N.P.; 10. Sai Yoke N.P.; 11. Khao Laem N.P.

these plastra are utilised in traditional Chinese medicine and therefore have monetary value, often as much as the meat value of the animal. Consequently, plastra are kept until a travelling wholesaler (or visiting scientist) appears to buy them. People sometimes keep carapaces and non-tortoise plastra as ornaments or curiosa, but often throw them away. Helpful rural people relocated several turtle shells from the rubbish areas behind their houses. Such shells are occasionally complete shells, usually separated carapaces and plastra, and sometimes a handful of broken, half-decayed bone fragments. We collected such shells and other inanimate specimens whenever possible, noting their origin and other information provided. All these specimens, sometimes nothing more than a single bone of a large turtle, could be identified to species by comparing with museum specimens.

We are aware that purchasing turtles or shells from villagers increases the market demand for the animals. However, we feel justified to obtain specimens in this way because:

1. Turtle exploitation is directly linked to the number of human-turtle encounters. Nowadays, very few people actively seek out turtles; instead, most animals are found during other activities such as tending crops or collecting mushrooms, bamboo shoots or other forest products. Such animals are taken and kept at home, alive, until a suitable occasion to consume the animal arrives. If we arrive on an obviously once-off visit before that occasion and purchase the tortoise for a small sum (equivalent to the price of a chicken, providing the same or greater amount of meat), it does not encourage people to go out and look for more tortoises, nor does it deprive people of a good meal.
2. We take the opportunity to talk to villagers about turtles, and we stress the need for turtle conservation and limiting exploitation. This is usually well understood, since people themselves have noticed that turtles become more scarce every year.
3. The live specimens thus obtained from outside wildlife sanctuaries (at the time when trade was still legal) are kept in captivity to form the nucleus for a future captive breeding program. Only animals from the same geographical region are kept together.
4. Rural people consider most shell specimens useless; for us, shells not only prove species occurrence, but also provide a wealth of information on population structure and exploitation.

We studied live specimens and their habitat by observing and searching forests, streams and ponds, usually inside wildlife sanctuaries. For terrestrial tortoises, the technique is simple: we checked all likely hiding places, among accumulated leaves, between tree buttresses, near rocks or fallen trees, etc., when walking through various types of forest. The path taken could be either a random path from one likely hiding place to the next promising spot, or a straight-line transect where a strip of forest floor is completely searched. The first method proved more successful. For aquatic species, collecting technique consisted of wading through streams and probing likely hiding places among tree roots, undercut banks, accumulated leaves and areas with soft, sandy or muddy bottoms, using a stick, hands or feet. We paid particular attention to areas where turtle footprints showed on the banks, or where remains of food indicated that turtles were present. Turtle tracks can be unmistakable in the right substrate (such as recently washed fine silt), but many faint indications proved to record the activities of squirrels, rats, otters and crabs. Once located, turtles were captured by hand, a simple action for hardshells but a less reliable and sometimes risky method when dealing with softshells. Fyke traps, spring-door small

mammal traps baited with fresh fish, chicken or tinned fish, and other passive methods of capture were tried in several localities but proved unsuccessful for aquatic turtles. We normally released live turtles at the place of capture after keeping them in captivity for a while to collect faecal samples, parasites, etc., and to measure and photograph. Most animals were given a long-term mark by clipping or filing a scute corresponding to a numerical code. Some animals which could be recognised easily by their scars were not marked.

We anticipated doing population assessment by various methods, depending on conditions: The capture-mark-recapture method, where captured animals are marked and released, allows calculation of total population size based on the proportion of marked animals among later groups of captured animals. This is the method of choice, but requires many captures at different times in the study. For the absolute area count method, an area is marked off and every single possible hiding place is examined, therefore yielding the exact number of animals inhabiting the area of known size. To be accurate, this requires that no animals move into or out of the study plot while the count takes place; the practicalities of searching every nook and cranny limit the area that can be searched in one day. One can also search a strip of forest floor of fixed width (depending on how many people move side-by-side) and as long as the day's work allows. Density of aquatic turtles inhabiting streams can be assessed from the number of turtles found per km of stream. Finally, one can randomly search likely hiding places and get a relative measure of turtle abundance from the average number of man-hours searching required to find an animal of a particular species.

We extensively measured all specimens, taking basic measurements like carapace length (CL), carapace width (CW) and plastron length (PL) for shells, and up to 50 additional body measurements, plus weight, for live specimens. We noted any other potentially useful information on colouration, habitat, activity, gender, etc. Ectoparasites such as leeches or ticks were collected when present and preserved in alcohol or formalin for further laboratory study. Usually a faecal sample was obtained, either by direct irritation of the turtle which often provokes defecation as a defence mechanism or by keeping the animal in a clean plastic basin filled with water; after one or two days the faecal sample could then be sieved out. All live specimens, habitats, food items and other interesting features were recorded on colour transparencies (Kodak Ektachrome 100). Nearly all inanimate specimens obtained in this study are kept at Chulalongkorn University; a few were donated to other Thai collections. Visits to several natural history museums afforded opportunities to compare western Thai specimens with others from different areas of the distribution range, and to study lesser-known Southeast Asian species. Specimens collected, observed or otherwise included in this study are noted in Appendix 1.

RESULTS

Overview of Species Occurrence

The occurrence of the various turtle species observed in this study, including well-documented museum specimens, is mapped in figures 3 to 5 and detailed in Appendix 1.

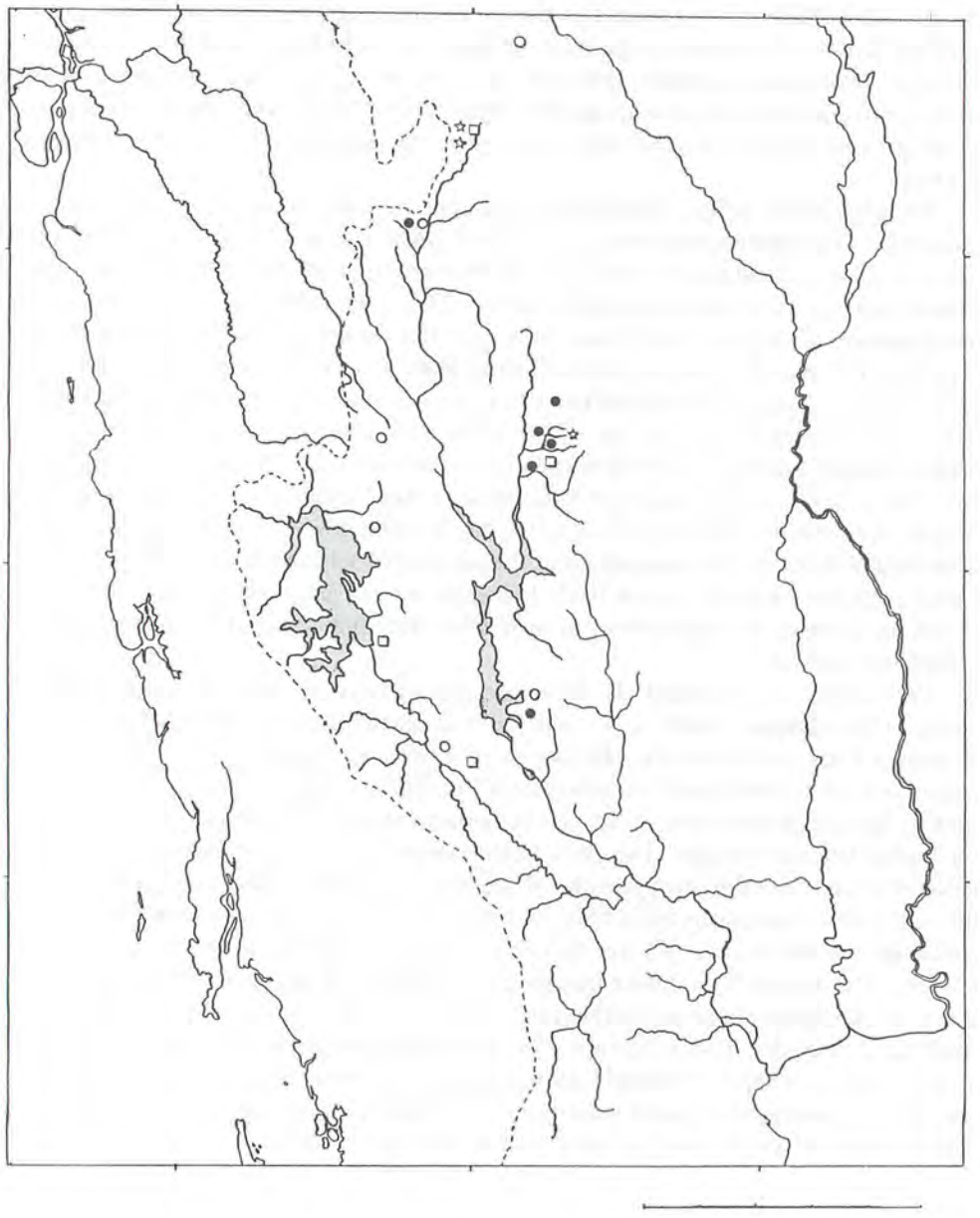

Figure 3. Occurrence of tortoises in western Thailand.
●, ○ : *Indotestudo elongata;* ■, ❑ : *Manouria emys;* ★, ☆ : *Manouria impressa.*
Solid symbols denote living specimens found in the wild, open symbols denote specimens seen in captivity or markets and preserved (museum) specimens. See figure 2 for names of geographical features.

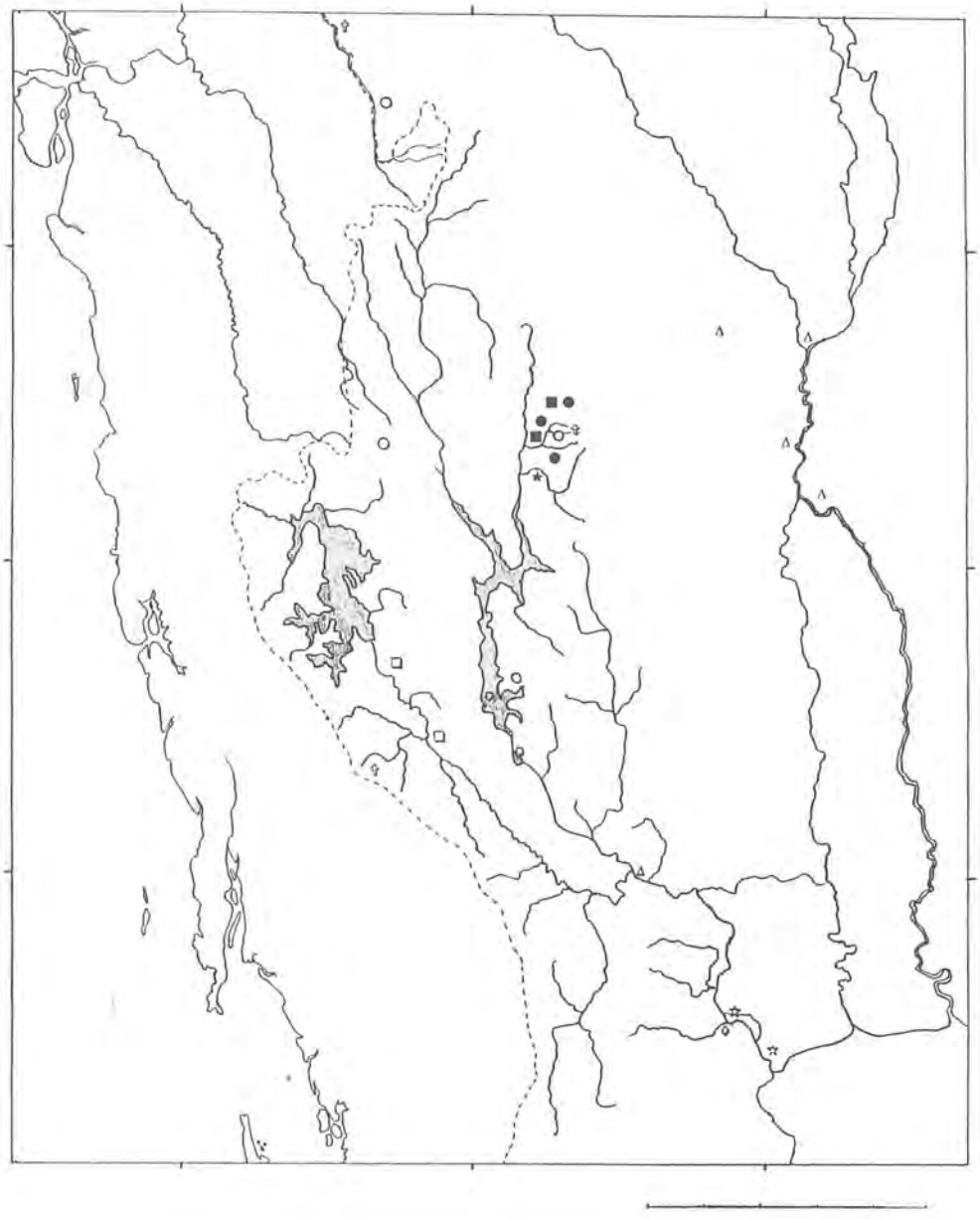

Figure 4. Occurrence of freshwater hardshelled turtles in western Thailand.
●, ○ : *Cyclemys dentata;* ■, ❑ : *Heosemys grandis;* ★, ☆ : *Cuora amboinensis;* ▲, Δ : *Malayemys subtrijuga;* ♦, ◇ : *Hieremys annandalii;* ↟, ⇧ : *Platysternon megacephalum;* ➡, ⇨ : *Batagur baska & Callagur borneoensis;* ■, ❑ : *Manouria emys* (combined). See also legends of figs. 2 and 3.

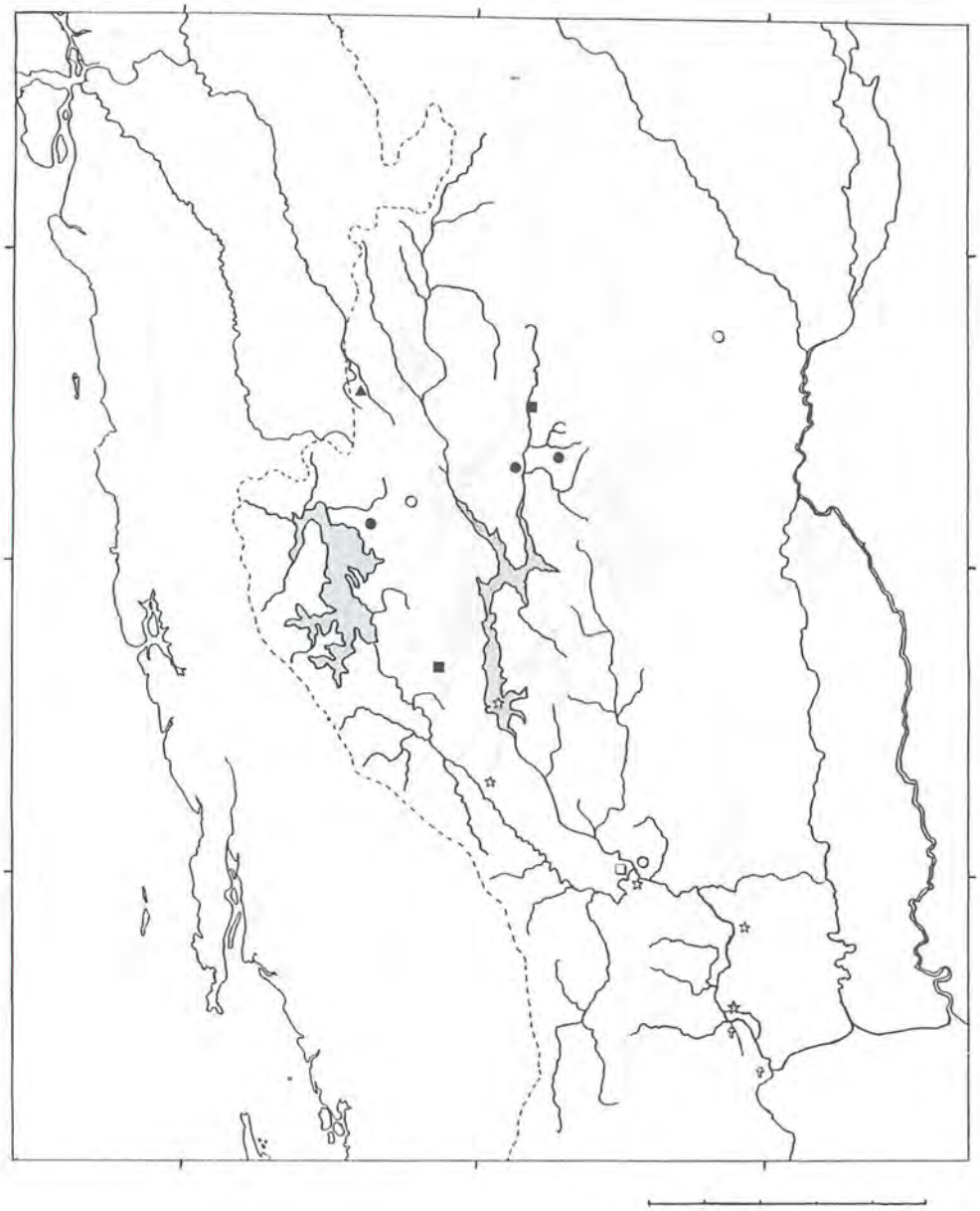

Figure 5. Occurrence of softshelled turtles in western Thailand.
●, ○ : *Amyda cartilaginea;* ★, ☆ : *Chitra chitra;* ■, ❑ : *Dogania subplana;* ▲, Δ : *Lissemys scutata;* ↟, ⇧ : *Pelochelys bibroni.* See also legends of figs. 2 and 3.

The Yellow Tortoise, *Indotestudo elongata,* is by far the most widespread turtle species of western Thailand, occurring in nearly all areas surveyed except cool high forests and deforested areas. In contrast, *Manouria emys* and *M. impressa* occur only localised in patches of undisturbed evergreen forest. *M. emys* still occurs in several places, while *M. impressa* appears restricted to the hill forests of Tak Province and possibly Khao Khieo in Huai Kha Khaeng WS. The latter two species are often confused by non-herpetologists.

The Stream Terrapin, *Cyclemys dentata,* occurs in most streams in forested hill areas of the area surveyed, but is absent from large rivers and lowland waters. We found the Giant Asian Pond Terrapin, *Heosemys grandis,* in a few places ranging from the middle reaches of hill streams down into major lowland river sections. Ricefield Terrapins, *Malayemys subtrijuga,* were observed in several markets in the agricultural regions along the main rivers; we were presented with a single shell from an animal found in a small watercourse in the Chao Phraya lowlands of Nakhon Sawan Province. Huai Kha Khaeng sanctuary staff photographed a single Asian Box Turtle, *Cuora amboinensis,* in deciduous hill forest near Khao Ban Dai; other Asian Box Turtles were observed in temple ponds in the lower Mae Klong basin. A few Yellow-headed Temple Turtles, *Hieremys annandalii,* also lived in these temple ponds. A few hundred juvenile *Batagur baska* and *Callagur borneoensis* terrapins are known to have been released into Srinagarind and Tha Tung Na Reservoirs, but we obtained no evidence of their survival.

Only spoken reports suggest the continuing occurrence of the Big-headed Turtle, *Platysternon megacephalum,* in western Thailand; we noted indications of this unmistakable long-tailed animal in the Mae Nam Moei-Salawin region of Tak Province, and in the stream coming down from Khao Khieo in Huai Kha Khaeng WS, part of the Mae Klong. There are old museum specimens (MCZ 29535, NHMB 8416) from Me Taw, Tak Province, and Sai Yoke, Kanchanaburi Province, respectively, attesting to the species' occurrence.

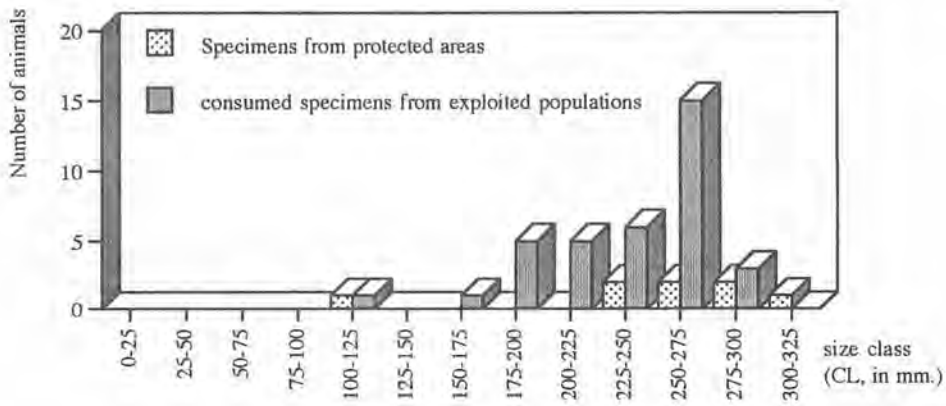

Figure 6. Size distribution of Yellow Tortoises *(Indotestudo elongata)* observed in protected areas, and size of tortoises exploited for human consumption.

The Common Asiatic Softshell, *Amyda cartilaginea,* occurs widely in most rivers and streams in western Thailand, although predominantly in slow-flowing lowland waters. *Dogania subplana* apparently restricts itself to the rocky-gravelly middle reaches of hill streams; this essentially Malayan species appears to reach its northernmost distribution in the Mae Klong basin. The Striped Giant Softshell, *Chitra chitra,* occurs only in the broad, deep sections of the Mae Klong Basin, from the reservoirs to Ratburi. *Pelochelys bibroni* was documented from the lower Mae Klong, from Ratburi to the estuary and beyond, but seems to have gone extinct in recent decades. The Burmese Flapshell Turtle, *Lissemys scutata,* inhabits the Gyaing-Ataran River system of Tenasserim, whose upper branches (Huai Mae Kasat, Huai Suriya) originate just inside Kanchanaburi Province.

We found no evidence of the (continuing) occurrence of *Heosemys spinosa, Melanochelys trijuga, Pyxidea mouhotii, Siebenrockiella crassicollis, Nilssonia formosa* or *Pelochelys bibroni* in the survey area; all these species have been recorded in western Thailand at one time or another.

Umphang and Mae Sod

Nearly all the forested areas of Tak Province visited are part of Umphang WS, Klong Larn NP and Lan Sang NP or designated reserved forests (figure 2). The original vegetation in this area was evergreen hill forest, but depressingly little forest remains; most of the area is now covered by a patchwork of agricultural fields, tall grass savannahs, original forest, second growth or sometimes bare earth in places where the land is eroded beyond recovery. Hunting and collecting still occurs by both Thai and hill tribe people, although not near Forest Department stations. Here collection by outsiders is successfully deterred, but staff occasionally supplement their meagre rations with wild-caught protein, be it fish, frogs or tortoises.

In Umphang town and places along the roads, we obtained shells of several species of turtles. Most shells were from Yellow Tortoises *(Indotestudo elongata),* probably because these are most likely to be encountered during people's daily activities. It was rather surprising to find shells of three Impressed Tortoises *(Manouria impressa)* and four Black Tortoises *(Manouria emys)* at two separate but close localities near or inside Umphang WS. Nobody was aware of the occurrence of *Melanochelys trijuga* in the area, even though Umphang is the type locality of *Melanochelys trijuga wiroti.* We observed or collected no turtles at Klong Larn NP or Lan Sang NP; park staff told us that Yellow Tortoises and Stream Terrapins *(Cyclemys dentata)* are moderately common while occasionally Black or Impressed Tortoises are sighted. The upper Mae Klong Noi, which eventually becomes the Khwae Yai, apparently harbours no softshells, Stream Terrapins or Big-headed Turtles *(Platysternon megacephalum).*

Mae Nam Salawin Basin (Salaween River)

Our survey also brought us to a few areas drained by the Mae Nam Moei, which is part of the Mae Nam Salawin system. At Ban Sareeraj, Tak Province, we obtained one shell of a Stream Terrapin *(Cyclemys dentata);* this specimen originated from a small Moei tributary. According to various informants, Stream Terrapins and Bigheaded Turtles

(Platysternon megacephalum) occur in the area, while softshells are hardly ever seen, neither in nature nor in the markets.

Mae Nam Chao Phraya Basin

Several areas surveyed are part of the Chao Phraya drainage basin. We obtained the shells of one Ricefield Terrapin *(Malayemys subtrijuga)* and two Common Softshells *(Amyda cartilaginea)* at Ban Na Bot, Nakhon Sawan Province. These specimens originated from Klong Mae Wong, a small stream near Klong Larn National Park. Klong Mae Wong flows towards the Ping River, where *Malayemys* is abundant. At settlements near or inside reserved forests on the Chao Phraya slopes of the western hills we obtained several shells of Yellow Tortoises *(Indotestudo elongata).* Before its designation as a national park, villagers regulerly hunted for softshells in the streams of the Khlong Larn area and collected tortoises in the forests. They do this no longer, partly because of enforcement of park boundaries, but also because turtle stocks have already been depleted beyond profitability.

Huai Kha Khaeng Wildlife Sanctuary

Huai Kha Khaeng WS comprises nearly the entire drainage basin of the stream with the same name (*Huai* means stream or small river in Thai). This main stream flows down the centre of the sanctuary from north to south for about 110 km before entering Srinagarind Reservoir. It is an area of hills covered by a mosaic of different forest types, mainly Dry Evergreen Forest, Mixed Deciduous Forest and Deciduous Dipterocarp Forest, with local areas of savannah grassland, montane vegetation, and regenerating abandoned agricultural fields. Deciduous Dipterocarp forest is an impoverished fire-climax vegetation type that occurs on poor soils and is dominated by three or four tree species; individual trees are often spaced well apart, their crowns not forming a closed canopy. Consequently, the forest floor is bright and dry, allowing a ground cover of grass and herbaceous plants. Large mammals graze on this, then retreat to the coolness of evergreen forest to rest and ruminate. Every valley contains its own stream, ranging in depth from a few cm to a meter or more depending on season and location. Small streams on hillsides are usually colder than 20°C, while the Huai Kha Khaeng in its lower reaches regularly exceeds 30°C. Galleries of Dry Evergreen Forest, containing a rich species mixture of large trees, line the watercourses even in areas dominated by Deciduous Dipterocarp Forest.

The climate is seasonal: the rainy searson, with almost daily heavy showers, lasts from July to October. This is followed by a dry season, lasting from November to February, when hardly any rain falls. In mid-winter, dawn air temperatures may approach freezing in elevated areas. In the hot season, from March to June, air temperature rises to over 40°C, and only occasional light rain falls. Huai Kha Khaeng WS lies in the rain shadow of the Dawna mountain range and only receives about 1500 mm of rainfall each year; consequently, most of the numerous small streams dry out during the hot season. Because of the annual leaf fall and parched undergrowth, forest fires are a regular occurrence. Fire moves in from the surrounding agricultural areas and is almost uncontrollable once present. During the 1992 dry season, fire swept through most of Huai Kha Khaeng WS. Subsequent rain and young growth masked most of the effects when we visited in June.

Khao Nang Rum Research Station is situated on the watershed divide between Mae Klong and Chao Phraya: most of the streams in its vicinity flow south-westwards to the Huai Kha Khaeng–Khwae Yai, but some streams to the north are part of the Huai Thap Salao system, a tributary of the Chao Phraya. During our walks through the surrounding forest and streams we encountered Yellow Tortoises *(Indotestudo elongata), Cyclemys dentata, Heosemys grandis* and Common Softshells *(Amyda cartilaginea).* Museum specimens and photos reliably record the occurrence of the tortoises *Manouria emys, Manouria impressa* and the softshell *Dogania subplana* in the immediate vicinity. The report of a Big-headed Turtle, *Platysternon megacephalum,* at Huai Chang Tai's eastern fork (Mr. Tassanate Petkong, pers. comm. 1991) remains unconfirmed, but an expedition onto the slopes of Khao Khieo could well confirm the occurrence of this species.

One particular day's searching (June 23, 1992) provided an indication of turtle population density: within 48 hours of very heavy rain, which caused flooding and thus wiped out all animal tracks in the stream beds, we searched the watercourses of Huai Pong Pai and subsequent Huai Chang Tai downstream to the confluence with Huai Ai Yo, then followed the latter upstream. Total stream length searched was about 8 km, all good turtle habitat. We found a total of 8 sets of unmistakable turtle tracks, presumed to represent one Orange-headed Giant Terrapin *(Heosemys grandis),* two Softshells *(Amyda cartilaginea),* and three to five Stream Terrapins *(Cyclemys dentata).* Some sets of *Cyclemys* tracks occurred fairly close together and probably represented single individual turtles. Obviously, this indicates a very low average density of turtles per km of stream, per species and overall. On the other hand, turtles may congregate in numbers at a particularly attractive site: Mr. Theerapat Prayurasiddhi (pers. comm. 1992) observed four turtles, from his description probably two *Heosemys grandis* and two *Cyclemys dentata,* feeding together under a single streamside fig tree at the confluence of Huai Ai Yo and Huai Chang Tai.

Khao Ban Dai Ranger Station is located in the heart of Huai Kha Khaeng WS, at the confluence of the Huai Mae Dee coming from the east and the Huai Kha Khaeng from the north. The Huai Kha Khaeng then flows another 50 km south before reaching Srinagarind Reservoir. At Khao Ban Dai, the Huai Kha Khaeng flows through a wide valley, its sandy banks mostly overgrown with tall reeds at the time of our visit in July. Although not much rain had fallen in the weeks before our visit, water flow was considerable: the joint streams had an estimated average flow speed of 1-2 m/s with a volume flow rate in the order of tens of m^3/s. In practice, this translates into a stream about 10 m wide on average with often waist-deep water and a current strong enough to make going upstream difficult. Coarse sand covers most of the bottom, but there are occasional areas with polished rocks. Water temperature varied around 30°C.

Along the stream is a wide gallery of evergreen forest, bordered by Deciduous Dipterocarp forest. Our party of four searched the streams for two days, one day going upstream on Huai Kha Khaeng, the next day going downstream. We captured one Common Softshell *(Amyda cartilaginea)* and observed three Water Monitors *(Varanus salvator),* one small Reticulated Python *(Python reticulatus),* three Green Peafowl, and many large mammal tracks including elephant and tapir. Mr. Boonchu Thongnamchai, station chief of Khao Ban Dai Station, found a Box Terrapin *(Cuora amboinensis)* walking in deciduous dipterocarp forest in January 1993. Mr. Ronglarp Sukmansaung and co-workers encountered several Yellow Tortoises *(Indotestudo elongata)* during surveys of elephant transects in

Figure 7. Mixed deciduous forest on the hills south of Khao Nang Rum Research Station, Huai Kha Khaeng Wildlife Sanctuary, typical habitat of the Yellow Tortoise, *Indotestudo elongata.*

Figure 8. The upper reaches of Khlong Kor (Huai Ai Yo): gentle yet appreciable fall of the narrow valley floor, the stream bed scattered with rocks and boulders. *Dogania subplana* and *Cyclemys dentata* typically inhabit this type of stream.

Figure 9. The valley of Huai Kha Khaeng at Khao Ban Dai: a wide, nearly level valley showing the seasonally flooded sand banks, opportunistic vegetation and gallery evergreen forest. The stream is home to *Amyda cartilaginea, Heosemys grandis* and *Cyclemys dentata;* the tortoises *Indotestudo elongata* and *Manouria emys* occur in the forest beyond.

deciduous and bamboo forest. Apart from these species, according to the people stationed at Khao Ban Dai, the Orange-headed Giant Terrapin *(Heosemys grandis)* and the Stream Terrapin *(Cyclemys dentata)* occur in the various streams in the area, while the Black Tortoise *(Manouria emys)* occurs in the evergreen gallery forest. The workers' foreman, a reliable source of information, said that the Striped Giant Softshell *(Chitra chitra)* does not occur in the Huai Kha Khaeng: all local softshells have a row of tubercles at the front of the carapace, characteristic of *Amyda* softshells but unlike *Chitra.*

Ong Thang Ranger Station lies on the southern boundary of Huai Kha Khaeng WS, on a promontory overlooking Srinagarind Reservoir. Founded in 1988, it has considerably strengthened conservation efforts in this area. The Huai Ong Thang, which lends its name to the station, is a small stream that used to join the Khwae Yai just south of the station; the reservoir's raised water level has now flooded its last km, leaving a twisted ribbon of nearly stagnant, murky water sandwiched between sheer rock cliffs and very steep sides of high sediment banks. In a few places, groups of a particular tree species grow in the flooded area, creating a mangrove-like impression. After travelling up this flooded canyon for about one km, one reaches the original stream bed. Initially this is very muddy, since the water here flows no longer fast enough to wash silt downstream. Further up is a stretch of soft sand with a few gravel banks, also a few 100 m long. Gravel then becomes

Figure 10. The Khwae Yai a few miles south of the Srinagarind Dam. The river is still inhabited by *Amyda cartilaginea, Chitra chitra* and *Heosemys grandis;* the tortoise *Indotestudo elongata* has been hunted to local extinction in the surrounding hills while *Manouria emys* cannot tolerate the destruction of the original evergreen forests and their replacement with bamboo.

Figure 11. *Indotestudo elongata,* Elongated Tortoise or Yellow Tortoise; juvenile animal, with a carapace length of 112 mm, in natural habitat.

Figure 12. *Manouria emys*, Asian Giant Tortoise. Adult animal, carapace length about 40 cm.

Figure 13. *Manouria impressa*, Impressed Tortoise; adult animal from Chiang Mai province, carapace length 24 cm.

Figure 14. *Cyclemys dentata*, Stream Terrapin, Asian Leaf Terrapin; adult animal, carapace length 174 mm, from near Khao Nang Rum R.S., Huai Kha Khaeng W.S.

increasingly dominant and coarse until eventually, about 2 km from the reservoir itself, the stream bed cuts into the underlying clay, loosening stones, which move downstream with the current or accumulate on the inside banks of curves. We thoroughly searched these last 2 km of Huai Ong Thang. Fish are abundant, mostly cyprinids up to 20 cm. Tracks indicated that otters, barking deer, bovines and small carnivores forage here, but most of the footprints were left by humans and their dogs. There was no trace of the presence of any turtle species, no tracks on the shore, no muddy stones scraped by claws or sandy areas disturbed by burrowing softshells. Because of the steep banks and sparse streamside vegetation, few hiding places exist for semi-aquatic turtle species like *Cyclemys dentata, Heosemys grandis* or *Cuora amboinensis.* Rangers apparently had never encountered tortoises in the surrounding forests.

Thung Yai Naresuan Wildlife Sanctuary

Thung Yai Naresuan WS encompasses most of the Khwae Yai above Srinagarind Reservoir (the Khwae Yai's upper stretches flow in Umphang WS), the Mae Chan, and several streams of the Salawin and other mainly Burmese drainage systems. The vegetation is generally more open than that of Huai Kha Khaeng WS. Our only visit to Thung Yai Naresuan WS concentrated on the area surrounding Songthai Ranger Station, near Huai Songthai. We searched areas of Deciduous Dipterocarp and Mixed Deciduous forest, streams and stream banks, and confirmed the occurrence of Yellow Tortoises *(Indotestudo elongata)* and Stream Terrapins *(Cyclemys dentata).*

Huai Tinoi (also known as Huai Thi Mu or Huai Suriya) and Huai Mae Kasat are small rivers in the western part of Thung Yai Naresuan WS. The former is a tributary to the Gyaing River, the latter is part of the Ataran River system; both flow across the border into the Tenasserim lowlands and join the Salawin estuary. Several Burmese endemic species, turtles and others, inhabit those regions. Mr. Kittipong Jarutanin showed us a Flapshell Turtle, *Lissemys scutata,* which a commercial softshell collector caught in a stream bordering, or just within, Thung Yai WS. This species is widespread in Myanmar (Burma), including lowland Tenasserim (Theobald, 1867-8), but has not been reported from Thailand before. While its occurrence in (probably) Huai Mae Kasat has not been confirmed beyond reasonable doubt, this specimen, and subsequent specimens apparently from the same Thai stream, argue for the inclusion of *Lissemys scutata* on the list of native Thai turtle species. We ourselves confirmed that *Cyclemys dentata* occurs in Huai Tinoi, and *Indotestudo elongata* in the surrounding evergreen forest.

Thung Yai Naresuan WS contains some wetlands towards its northern boundary. Apparently it is unknown whether or which turtles inhabit lake Lakatu or the seasonally flooded Laparuay basin enclosed by Triassic limestone mountains. The area was too remote to be included in our survey, but we hope to visit these areas eventually.

Khao Laem, Srinagarind and Tha Thung Na Reservoirs

We visited nearly all villages and other other places of habitation around Khao Laem Reservoir. At Thong Pha Poom, the site of the Khao Leam Dam, we measured a total of 14 live Black Tortoises *(Manouria emys),* which people had collected from island refugia

when the upper Khwae Noi valley was flooded to create Khao Laem reservoir. At other places around Khao Laem Reservoir, we obtained specimens of the Yellow Tortoise *(Indotestudo elongata)* and the softshell *Amyda cartilaginea.*

In addition to our visit to Ong Thang Ranger Station, we also visited several settlements along the southern part of Srinagarind Reservoir, but did not see any turtles. A fish wholesaler on the reservoir told us that softshelled turtles are sometimes captured; these include occasional rare animals of 70 to 90 kg, an obvious reference to *Chitra chitra.* This species was reported from Srinagarind Reservoir before: a *Chitra* specimen presently preserved at Chulalongkorn University was captured somewhere above Srinagarind Dam (V. Taechachareonsukchera, pers. comm.). Several years ago an enormous softshell got tangled in the safety net that prevents flotsam from reaching the hydro-electric turbines at the Srinagarind power station. It was said to be so large that its shell spread over the sides of the pickup truck in which it was transported after capture (S. Amonratanasareegul, pers. comm.).

Probably because these reservoirs are geologically recent features, created in the 1970's, the composition of their flora and fauna is still developing. Some species which originally inhabited the Khwae Yai River may have adapted to the standing water, others retreated to the tributaries, and several became extinct. The Fisheries Department introduced several species of fish and turtles in an effort to improve the productivity of these water bodies. It proved difficult to obtain data on exactly which species have been released, and even fewer data are available concerning numbers of released animals. Two turtle species that we know were released are the Mangrove Terrapins *Batagur baska* and *Callagur borneoensis.* In September 1992, one- and two-year old juveniles were sent from the Fisheries Department's Satun Freshwater Fisheries Development Centre at La-ngu, Satun Province, to be released at Srinagarind Reservoir. Other consignments of these two species have in the past been released at Tha Tung Na Reservoir, on the Khwae Yai just below Srinagarind, and in other still water bodies. Softshells may also have been released at times.

Khwae Noi, Khwae Yai and Mae Klong—the Large Rivers

We visited nearly all human habitations accessible by car along the Khwae Yai and Khwae Noi north of Kanchanaburi City. Our field work included a few days of fyke-trapping in the Khwae Noi, without results. From villagers we obtained several shells of various turtle species, mainly Yellow Tortoises *(Indotestudo elongata)* but also some *Amyda cartilaginea* and *Dogania subplana* softshells, a *Cyclemys dentata* carapace and fragments of the carapace of a *Heosemys grandis.* Also, we purchased a live female Yellow Tortoise, and a *Dogania subplana* softshell originating from a stream in the hills between the two river valleys.

At the market of Kanchanaburi City, usually several dozen Ricefield Terrapins *(Malayemys subtrijuga)* were offered for sale. In November 1991, we purchased skulls of several Common Softshells *(Amyda cartilaginea)* and the remains of a single *Dogania.* According to the vendor, several different softshell species, collected in the region, pass through her hands; most of these are *Amyda,* 5 to 10% are *Dogania,* and occasionally a *Chitra* appears. Also, very rarely, a species not a hardshell but also unlike a normal

softshell is brought by a collector from the far upstream regions. This could be a reference to *Lissemys scutata.* Few other markets visited in Kanchanaburi, Ratchaburi and Samut Songkhram provinces offered turtles for sale; vendors said that the occasionally sell some sofshells, and some Ricefield Terrapins could usually be obtained. During the hot season (March-June), few turtles are traded because of the increased mortality.

Remarkably, during our numerous visits to these lowland areas, we never obtained evidence of the occurrence of the Black Marsh Terrapin *(Siebenrockiella crassicollis),* and we found *Hieremys annandalii* and *Cuora amboinensis* terrapins only in the turtle ponds of temples in Ratchaburi and Samut Songkhram. The origin of these animals is uncertain. Based on known habitat preference and general distribution, we had expected to encounter these species more often.

During our visit to the Mae Klong estuary and mangrove forests south of Samut Songkhram, we found that this area is no longer inhabited by turtles. Local fishermen told us that 20 years ago softshells were not rare in the area, but they had not seen or caught them in the last 5-8 years. They described these softshells to us as having a shell 30-40 cm long, and with no distinct proboscis. The animals inhabited the main river mouth and the mudflats out at sea, but did not venture into the mangrove forest channels. This description and known habits suggest that *Pelochelys bibroni* was the species concerned.

Summary of Habitat Selection

The geographical distribution of the various turtle species is of course dependent on the distribution of their preferred habitat, which in turn depends on the complex interaction between elevation, precipitation and other geological and climatic factors giving rise to the development of certain vegetation types. Additionally, the influence of humans on turtle distribution has been considerable and continues to increase, exerting both indirect pressures on turtle occurrence by altering the environment and directly by hunting and collecting.

The turtles of western Thailand inhabit four major habitat types, forests, hill streams, shallow lowland water bodies, and large rivers and esturaries. Nearly all species are restricted to just one or two of these macrohabitat types.

Forest provides home to the three tortoise species: the Yellow Tortoise *Indotestudo elongata* favours rather open, dry forests, the Black Tortoise *Manouria emys* prefers moist evergreen forests, and the Impressed Tortoise *Manouria impressa* occurs limited to certain hill areas. The Asian Box Terrapin *Cuora amboinensis* leads a semi-terrestrial life and can be found well away from water.

Small, sometimes seasonal, clear and cool hill-streams are the exclusive habitat of the Big-headed Turtle *Platysternon megacephalum,* the Hillstream Softshell *Dogania subplana* and the Stream Terrapin *Cyclemys dentata.* Within streams, *Platysternon* and *Dogania* restrict themselves to the boulder-strewn upper reaches on the hill slopes. Several species that normally occur in lower, warmer areas also ascend into the sandy regions of these streams; such species include the Giant Pond Terrapin *Heosemys grandis,* the Common Softshell *Amyda cartilaginea,* the Box Terrapin *Cuora amboinensis* and apparently also the Flapshell Turtle, *Lissemys scutata.*

Lowland shallow waters, like ponds, ditches, swamps, canals, khlongs and wet rice-fields, are the main habitat of the Ricefield Terrapin *Malayemys subtrijuga,* Temple

Terrapin *Hieremys annandalii,* Box Terrapin *Cuora amboinensis,* Black Marsh Turtle *Siebenrockiella crassicollis* and Flapshell Turtle *Lissemys scutata.* This environment also offers suitable conditions to the Giant Pond Terrapin *Heosemys grandis* and Common Softshell *Amyda cartilaginea.*

Finally, large rivers are the only habitat of the giant softshells *Chitra chitra* and *Pelochelys bibroni,* the latter frequently inhabiting the estuary and coastal areas as well. Some *Amyda cartilaginea, Heosemys grandis* and perhaps *Hieremys annandalii* inhabit large rivers as well as smaller waters.

Western Thailand illustrates that hill areas and associated watershed divides pose significant barriers for the distribution of aquatic turtles: *Malayemys subtrijuga* appears unable to ascend streams and remains restricted by the eastern Chao Phraya flanks of the hills in the Khlong Larn region; *Dogania subplana* is apparently unable to cross overland from the upper Khwae Yai or Huai Kha Khaeng into Chao Phraya or Salawin headwaters; and *Lissemys scutata* remains limited to the Huai Suriya-Huai Mae Kasat region, even when Mae Klong streams are within easy reach of this wandering species. Why *Chitra chitra* remains restricted to the Mae Klong, apparently unable to reach the nearby and connected Tha Chin and Chao Phraya rivers, remains a biogeographical mystery. In contrast, the terrestrial tortoises appear little affected by watershed divides: Yellow Tortoise occur over the whole general area, while the *Manouria* tortoises occur in patches of suitable habitat irrespective of drainage basins.

A special case of habitat selection and species community development is presented by the turtle fauna inhabiting reservoirs. Reservoir turtles are a subset of the turtle community inhabiting the original river and its tributaries before damming, those species that can adapt to the new conditions; in addition, other species may establish themselves after human introduction.

The turtle fauna of the Khao Laem and Srinagarind Reservoirs at this time seems to be fully derived from the original river inhabitants, because only the riverine species *Amyda cartilaginea* and *Chitra chitra* have been reported to occur in the reservoirs. Species that inhabit the margins of natural standing waters, such as *Cuora amboinensis, Malayemys subtrijuga, Siebenrockiella crassicollis, Hieremys annandalii* and *Heosemys grandis,* appear to be absent so far.

Seasonality of Turtle Encounters

Although the climate of western Thailand is highly seasonal, we found little indication that turtle capture is linked to either temperature or rainfall. There are a few circumstances that contribute to increased encounters between humans and turtles, leading to increased exploitation levels. Many rural folk told us that tortoises are more active and more easily found during the early wet season. Another peak in tortoise exploitation comes at the time that a particular forest mushroom appears. This mushroom comes out at an unpredictable period, lasting only about one week, after the wet season, and is much appreciated by humans and tortoises. Tortoises encountered during humans' intensive searches for mushrooms are usually taken and end up as turtle in mushroom sauce. A third peak of tortoise collection occurs after the hot season forest fires, when all leafy cover is burnt away and tortoises are easily seen. Our own experiences did not show any strong seasonal

Figure 15. *Heosemys grandis,* Giant Asian Pond Terrapin or Orange-headed Giant Terrapin; adult female, 34.2 cm carapace length, from Huai Kha Khaeng W.S.

Figure 16. *Cuora amboinensis,* Asian Box Turtle; adult female, 22 cm, CL, from Khao Ban Dai, Huai Kha Khaeng W.S.
Photo by Mr. Boonchu Thongnumchai.

Figure 17. *Malayemys subtrijuga.* Rice-field Terrapin, adult female, with a carapace length of about 15 cm.

Figure 18. *Lissemys scutata,* Flapshell turtle. Adult animal from Western Thailand with a carapace length of 17 cm.

Figure 19. *Chitra chitra,* Southeast Asian Narrow-headed Softshell Turtle. Captive-raised animal from Mae Klong parentage, total carapace length about 35 cm.

Figure 20. *Amyda cartilaginea,* Common Asian Softshell Turtle; young animal (108 mm) from Huai Kha Khaeng W.S.

Figure 21. *Dogania subplana,* Hill-stream Softshell; adult animal, total carapace length 19.4 cm, from a small stream in the hills between the Khwae Yai and Khwae Noi.

Figure 22. *Platysternon megacephalum,* Bigheaded Turtle, adult animal from Phu Luang W.S., northern Thailand. CL 172 mm. Note: figure 22-26 include species which may occur in western Thailand but have not been confirmed.

Figure 23. *Pelochelys bibroni,* Asian Giant Softshell Turtle. Adult, about 55 cm total shell length.

Figure 24. *Hieremys annandalii,* Yellow-headed Temple Terrapin, adult male, about 40 cm carapace length.

Figure 25. *Melanochelys trijuga,* Indian Pond Turtle; animal from Mandalay, Myanmar, carapace length about 23 cm.

Figure 26. *Siebenrockiella crassicollis,* Black Marsh Turtle. Adult of about 17 cm CL.

Figure 27. *Trachemys scripta elegans,* Red-eared Terrapin, adults of 18-25 cm carapace length. This species is native to North America. Note: figures 27-30 include species known or suspected to have been introduced into western Thailand.

Figure 28. *Pelodiscus sinensis,* Chinese Softshell turtle, adult of 18 cm shell length. Native to China, Taiwan, Japan and nearby regions.

Figure 29. *Batagur baska*, Mangrove Terrapin. Juvenile of about 10 cm, the size at which some of these animals are released. The species formerly occurred in estuaries from India to Sumatra.

Figure 30. *Callagur borneoensis*, Painted Terrapin. A juvenile animal of about 9 cm. This species is native to estuaries of the Malay region.

aspect to frequency of turtle encounters; at the various times that we were in the field we noticed no significant differences in the number of man-hours searching required per turtle.

Population Estimates

Due to the low number of animals captured, population assessment by the capture-mark-recapture method was not possible. Absolute area count is impossible in a situation where the presumed home range and daily activity radius exceed the area that can be searched thoroughly and completely in one day, even by a team of people. Streams allowed some assessment of density per km of stream, but even in the limited strip of stream bed plus banks a group of people can search not much more than one km per day, so that animal movements again influence the data. Therefore, under natural circumstances in wildlife sanctuaries in western Thailand, the best density indication is the number of man-hours or, more appropriately, man-days searching required to find one animal. In other areas, it is impossible to quantify population densities; the only possible description is in terms like "abundant, rare or extremely rare", based on the frequency of obtaining shells and on interviews with rural folk. Such data are far from satisfactory, but in the absence of better data, even crude estimates are valuable for conservation assessments. Conservation biology remains a crisis management discipline where one has to take decisions based on a fraction of the rigid, conclusive data that pure science would demand (SOULÉ, 1986).

The only species for which population data could be gathered was the Yellow Tortoise, *Indotestudo elongata.* Area searches around Khao Nang Rum, in Huai Kha Khaeng WS, indicate a density in the order of one individual tortoise per square km of suitable habitat, or less. Perhaps significant was the fact that the largest tortoise observed inside a protected area was larger than any of the tortoise shells seen in settled areas, though specimens from settled areas outnumbered specimens from sanctuaries four-fold in our sample (see fig. 6).

DISCUSSION

Turtle Species Diversity

Several authors have presented reviews and checklists of the turtles of Thailand, usually indicating where in the country the various species occur (GÜNTHER, 1860; FLOWER, 1896, 1899; BOULENGER, 1889, 1890, 1912; SMITH, 1916, 1930, 1931; BOURRET, 1941; TAYLOR, 1970; NUTPHAND, 1979; NABHITABHATA, 1989). With the exception of Iverson's unpublished database, none of the checklists specifies exact sources of information, and unquestioning repetition of previous information has occurred. Re-examination of the material on which checklists and secondary literature are based sometimes leads to different identifications of the specimens concerned and thus affects the composition of the list. Scientific studies constantly improve our understanding of phylogenetic relationships, and nomenclature and resultant checklists change accordingly. Based on literature review, we expected to find a maximum of 15 currently recognised native turtle species in the Mae

Klong Basin of western Thailand.

In this study, we confirmed the natural, continued occurrence of the following 10 turtle species in the Mae Klong Basin: *Indotestudo elongata, Manouria emys, Manouria impressa, Cuora amboinensis, Cyclemys dentata, Heosemys grandis, Malayemys subtrijuga, Amyda cartilaginea, Chitra chitra* and *Dogania subplana.* In addition, the Flapshell turtle *Lissemys scutata* occurs in a minor drainage area just west of the Mae Klong system. This includes one species *(Lissemys scutata)* previously unrecorded from Thailand, while we could not confirm the occurrence of some other species previously reported from western Thailand. We believe that our list may still be incomplete.

The occurrence of the Giant Softshell *Pelochelys bibroni* in the Mae Klong Basin is adequately proven by old museum records (e.g., BMNH 1921.4.1.179, 1974.2952, MCZ 29490, 29491 Ratburi River), and indicated by the reports of softshells in the Samut Songkhram estuary region. Its continued presence, however, is doubtful. *Platysternon megacephalum* has been reported from Huai Kha Khaeng WS, Sai Yoke and the upper streams of the Khwae Yai in Tak Province, and Salawin tributaries in Tenasserim; despite very few voucher specimens, we consider that this species is quite likely to inhabit parts of the Mae Klong Basin, but probably in very low numbers. *Hieremys annandalii* and *Siebenrockiella crassicollis* are lowland species which occur in adjacent areas of the Chao Phraya basin and in peninsular Thailand. The absence of these species from our list of species encountered (except some *Hieremys* in temple ponds in Samut Songkhram) is most likely a result of recently decreased populations following agricultural land development.

Some species occurring in adjacent regions could occur in western Thailand but have not been confirmed from nature so far. Juvenile specimens of *Melanochelys trijuga* were found in a market at the Thai-Myanmar border and described as a new subspecies, *Melanochelys trijuga wiroti* (Reimann *in* NUTPHAND, 1979). NAKHASATHIEN & STEWART-COX (1990) listed the species as occurring in Thung Yai-Huai Kha Khaeng, but this was based on an identification of a photographed animal which PPvD later re-identified as *Cyclemys dentata.* Considering the confirmed natural occurrence of this species just across the mountains in Tenasserim and elsewhere in Myanmar, and its habit of wandering far from permanent water, the occurrence of this species in Thailand is a distinct possibility. *Pyxidea mouhotii* is a small, cryptic species with a scattered, apparently disjunct distribution in Vietnam, Laos, southern China, northern Myanmar and north-eastern India. It has never been verified to occur in Thailand, but it might occur in hill areas of northern or western Thailand. The Burmese Peacock Softshell, *Nilssonia formosa* (formerly *Trionyx formosus*), inhabits the Irrawaddy, Sittang and (probably) lower Salween Rivers in Myanmar, and could well occur in the Mae Nam Salawin or its tributaries (Mae Nam Moei, Mae Nam Yuam) in north-western Thailand. However, *Amyda cartilaginea* has also been reported from the Salawin drainage basin, and the distribution and ecological separation of these two morphologically extremely similar species is not at all clear at this moment. The alleged occurrence of *N. formosa* (alternatively reported as *Trionyx hurum*) in peninsular Thailand and Malaysia, as reported by CANTOR (1874) and subsequent checklist compilers, is almost certainly based on misidentification of *A. cartilaginea. Nilssonia formosa* can be recognised by the four large, round, bold black spots arranged symmetrically on its carapace, and minor skeletal features (VAN DIJK, 1992, 1993).

Commercial cultivation of two exotic turtle species, the Red-eared Slider *Trachemys*

scripta elegans for the pet trade and *Pelodiscus sinensis,* for consumption, is still expanding. It is only a matter of time before populations of these two adaptable, opportunistic species establish themselves in the wild in western Thailand.

In conclusion, from our results and the above discussion, we argue that at least 10, and possibly up to 15 species, belonging to 9 to 14 genera in 3 or 4 families, occur naturally in the Mae Klong Basin; one more species, *Lissemys scutata,* occurs in the upstream Thai section of a Burmese river system. By any standard, this is a very high species diversity. Several compatible reasons can be suggested to explain this high diversity. The varied topography and diverse biotic environment create many opportunities for ecological separation, permitting many species to coexist. During Pleistocene times, the area may have been one of three Southeast Asian Evergreen Forest refugia (EUDEY, 1980). The region is also part of the contact zone between the Malayan, the Indo-Burmese and Chinese faunas, facilitating establishment of species from three large species pools. The turtle fauna of Thailand as a whole has predictable affinities mainly to the Malayan realm (16 species shared with the total turtle fauna of 18 species in the Malay Peninsula and western Archipelago) and the Indo-Burmese region (14 species shared out of 36, 6 to 8 of these being Indian invaders, the others essentially Southeast Asian species that range into Myanmar and north-eastern India). Surprising is the limited influence of the southern region of the Eastern Palæarctic, Thailand sharing only 3 species with the rich turtle fauna of about 22 species in Northern Vietnam, Laos and southern China.

Endemic Turtle Species

Traditionally, the paradoxical view was held that Thailand, with its great turtle species richness, is not home to any endemic turtle species. This was true within the political boundaries of Thailand, a result of human historical processes rather than a discrete physio-geographical entity, but does not reflect the great biogeographical importance of Thailand.

Ignoring taxa described last century from a single specimen and subsequently synonymised or recognised to be widely distributed, the first two species described as endemic to Thailand after the major reviews by BOULENGER (1889), SMITH (1931) and BOURRET (1941) were *Trionyx nakornsrithammarajensis* and *Testudo nutapundi.* Both are now considered junior synonyms of wider-ranging species. With the description of *Chitra chitra* Nutphand, 1986, as a full, scientifically recognised species (VAN DIJK, THIRAKHUPT & WEBB, in press), Thailand obtained its first unequivocal endemic turtle species, restricted to the Mae Klong basin.

A second type of endemic species is presented by species that have the centre of their distribution in Thailand. This group includes *Hieremys annandalii, Malayemys subtrijuga* and to a lesser extent *Heosemys grandis* and *Manouria impressa.* Each of these species occurs in adjacent, geographically similar areas of adjacent countries, i.e. Cambodia, the Mekong delta in Vietnam, Tenasserim in Myanmar, or northern parts of peninsular Malaysia. The occurrence of *Malayemys subtrijuga* in Java is probably a result of human introduction (DAMMERMAN, 1929). As such, these species are not endemic within the political boundaries of Thailand, but they are restricted to a limited physio-geographical area centred on Thailand. Populations of these species are usually very small at the limits of their distribution, so that in effect up to 95% of individuals of these species live in

Thailand. As such, Thailand has a major responsibility for the world-wide conservation of these species.

Exotic Species

A different group of species of special conservation interest are those introduced by humans to regions where they do not occur naturally. No longer part of the biological and environmental interactions and controls of their native habitat, they will either quickly disappear, or establish themselves successfully in the new area. In the latter case they may seriously disturb the balance of the ecosystem by consuming resources, preying on native species or interfering with natural predator-prey interactions.

In Thailand, two species of exotic turtles are present in large numbers in captivity, and some individuals have made their way into the wild already. Hatchlings of the Red-eared Slider Turtle *(Trachemys scripta elegans)* from the southern United States are widely available in markets and pet-shops. Babies grow quickly, and when they become larger these smelly, quick-biting animals are usually released in the nearest pond, canal or river. Here they grow more mature, and are well able to reproduce in Thailand's favourable climate. Some of these animals have found their way into the wild, as confirmed by an animal found in Rangsit (N. Srinarumol, pers. comm. 1992). The Chinese Softshell *(Pelodiscus sinensis)* has in recent years become quite popular in Thai aquaculture (KAMNEUNG, 1989), due to its greater fecundity and smaller living-space requirements compared with native *Amyda cartilaginea* softshells. Although cultured mainly for export for consumption, a lively trade in babies as pets exists. Many of these will die, but many will survive; due to their extremely aggressive behaviour, these "pets" will quickly be liberated "back to nature". Like the Slider, the Chinese Softshell survives and reproduces very well in tropical climates. Several Chinese Softshells have been seen in Bangkok ponds, but in contrast to the very visible Slider Turtles which spend most of their time basking in the sunshine, the presence of the shy Chinese Softshells can only be established after very careful, patient observation together with a large dose of luck.

Almost certainly, consignments of turtles released to relieve overcrowding in city ponds will contain large proportions of these exotic species, sufficient to establish reproducing populations at the site of release. Theoretically, it is only a matter of time before these species follow the example of the Water Hyacinth *(Eichornia crassipes),* Tilapia cichlids, or any of the numerous other introduced species which spread through Thailand's waterways. The effect of such introduced species on what is left of the natural ecological balance, and specifically the effect of these two turtle species on native turtle species, cannot be predicted; we do know that introduced Slider Turtle populations in southern France, Israel, South Africa, Californa and elsewhere have caused declines in the populations of native species.

All we can do to stop this threat, apart from a major public awareness campaign against the release of animals and the suffering it causes when such animals are first captured to supply the demand, is to remove exotic turtles from protected natural areas and, if animals need to be released, to make sure that only suitable animals originating from populations of native species occurring elsewhere in the same river basin are released. This will require careful inspection of any consignment of turtles proposed to be released

in a national park or other protected area.

Turtles in Reservoirs

Introduction of fish and turtle species to reservoirs is a standard practice carried out by the Fisheries Department to improve reservoir productivity. This practice, however, is not without controversy. Another source of released turtles and other animals is from private people who release one or a few animals to gain merit, in accordance with Buddhist beliefs. Over time, numerous animals are released into ponds, canals and other waters. Certain temples are famous for their turtle ponds, attracting more releases. Many of these animals die of disease or lack of suitable food, but enough survive to create serious overcrowding. One method to relieve this problem is to collect part of such an overcrowded population and release the animals in apparently suitable habitat. But while release at such sites would benefit the individual turtles, the influx of park turtles may upset the ecological balance by competing excessively with native turtles, and because many pond turtles are actually exotic species. We therefore strongly oppose such dumping of unwanted animals. We are aware of at least one large shipment of mixed turtles, including exotic Red-eared Sliders, that was brought from Bangkok and released at Kaeng Krachan Reservoir.

Juveniles of the Mangrove Terrapins *Batagur baska* and *Callagur borneoensis* were shipped from the Fisheries Department's Satun Freshwater Fisheries Development Centre at La-ngu, Satun Province, to be released at various bodies of still water all over Thailand. These sites include Srinagarind and Tha Thung Na Reservoirs on the Khwae Yai, Bung Borapet near Nakhon Sawan, in Chiang Rai Province, at Rajjaprabha Reservoir in Surat Thani Province, and at Bang Na Ra Reservoir in Narathiwat Province. The rationale for releasing these species in reservoirs is obscure to us. Both species inhabit estuarine conditions in nature, in the rivers and creeks of peninsular Thailand. The reservoirs listed above are totally unsuitable as habitat, as there is no adequate supply of appropriate vegetable food, the water temperature and chemistry are very different from the natural habitat, and no suitable nesting sites are available, should the animals manage to reach maturity. Whether the reason for releasing these species is to improve the productivity of the reservoirs or to be of conservation benefit for the turtle species, it is of dubious value.

Almost certainly, other turtle species have also been consciously released into the reservoirs on a medium or large scale. In the absence of definite data, we can guess that *Amyda cartilaginea* softshells and perhaps other species such as the Chinese Softshell *Pelodiscus sinensis* and the Ricefield Terrapin *Malayemys subtrijuga* have been released. Hopefully, the stock for such releases was collected in the lower regions of the Mae Klong Basin so that no external genetic material was introduced to the basin. However, at least one softshell collected near Khao Laem Reservoir (CUMZ[R] 1992.0405.1) is conspicuously different from normal Mae Klong *Amyda* softshells and is identical to the peninsular colour form of *A. cartilaginea.*

We strongly urge that guidelines for the release of turtles into the wild be drafted or reviewed, giving due consideration of the suitability of the species to the prospective site of release, and the impact of the introduced species on the native animals already present.

An intriguing question is whether large, deep reservoirs are suitable habitat for turtles

at all. The first consideration would be that a large water body should provide large areas of habitat for aquatic or amphibious animals, and therefore, reservoir creation should be beneficial to amphibious turtles (TONGKASAME & TORRANIN, 1990: part IV, page 3-100). However, by examining in detail the habitat conditions in a reservoir, we arrive at a different conclusion. Firstly, turtle population size and density are determined by the available area of substrate in shallow water, not by total water volume. Very few turtles use deep, open water. In the original river, turtles inhabit the shallows along both banks of the main river, as well as its tributaries. When we calculate the area in a reservoir where the water is shallow enough that a turtle can rise to the surface to breathe without difficulty, we arrive at a total area that is actually less than the area suitable for turtles in the original river and its now-flooded tributaries. Then there is the structure of this littoral zone. In a river and tributaries, this shallow zone generally has a gently-sloping bottom profile, and is followed by a flood-plain with rich vegetation adapted to annual flooding, where turtles can find abundant food. In a reservoir, the littoral zone is steep, often subject to strong wave action, and the annual change in water level of 5 m or more cannot be tolerated by any plant species: aquatic plants dry out, dry land or emergent swamp vegetation is drowned and starved of light. The only vegetation in reservoirs are floating plants (Water Hyacinth, *Eichornia crassipes*), aquatic Coontails (*Ceratophyllum* sp.) and a few reeds and creepers at the high-water line. This does not support much insect or other small aquatic life, and as a result, the entire littoral zone of a reservoir is barely usable for turtles.

A feature of deep reservoirs is the occurrence of thermal stratification, where a layer of warm water at the surface lies over the deeper, cooler water. At the boundary, the thermocline, no mixing of water occurs, effectively sealing the deep water off from the atmosphere. Decay processes use dissolved oxygen, but because no fresh oxygen becomes available below the thermocline, anaerobic and acidic conditions develop, creating conditions lethal to any aquatic creature. This situation persists for most of the year, but during the coldest month the surface layer cools below the temperature of the deep water. This leads to an exchange of aerated surface water with deep, anoxic water, creating local anoxic areas at the surface and mixing the entire surface layer with anoxic water. This leads to an acute and severe drop in dissolved oxygen content of the water inhabited by fish and other creatures, which is often severe enough to cause local fish-kills.

Similarly, the water released from the reservoir is a mixture of deep and surface water, so that the water in the river downstream from the dam is seriously deficient in dissolved oxygen for a long distance. For example, the Khwae Noi reaches normal levels of dissolved oxygen for a long distance. For example, the Khwae Noi reaches normal levels of dissolved oxygen (7-9 mg/1) only above Kanchanaburi, about 80 km downstream from Khao Laem Dam. Downstream the oxygen level drops again because of mixing with the outflow of Srinagarind Reservoir and, especially, the pollutants added to the water at Kanchanaburi City.

On balance, we conclude that large, deep reservoirs provide little suitable habitat or food for aquatic turtles and are detrimental compared to the original river situation. TONGKASAME & TORRANIN'S (1990: part IV, page 3-100) assertion that the creation of Khao Laem Reservoir would be beneficial to the turtle species they list *(Indotestudo elongata, Manouria emys, Heosemys spinosa)* is untenable. The rising water forced both tortoise species. (*I. elongata* and *M. emys*) out from the riverside forests, confining them to small

islands where they were quickly captured by humans. *Heosemys spinosa* does not occur anywhere near Khao Laem, its northernmost record being at Chumphon, 500 km further south.

Forest Fires and Management in Western Thailand

For a long time, fire was a popular forestry management tool. Annual burning of the leaf litter "cleaned" the forest and stimulated the growth of grass and other annual vegetation, upon which the large herbivores graze. Even if not started intentionally, fires frequently sweep into protected forests from adjacent agricultural areas.

More recently, however, the negative aspects of annual forest fires have become more clear. For example, RABINOWITZ (1990) described the effects of the instantaneous loss of vegetation cover and small prey items on the small carnivore community at Huai Kha Khaeng WS. The fires also cause long-term damage by promoting the replacement of evergreen forest with mixed deciduous forest and eventually the deciduous dipterocarp fire-climax forest type, a floristically poor forest type utilised by relatively few animal species. Recent research indicates that forest fires exert an especially heavy toll on fig trees (*Ficus* spp.) and other "keystone" tree species: although a single ground fire will not kill mature fig trees, they suffer damage at the lower trunk. They can recover from such damage, given sufficient time, but they cannot withstand fire cycles repeated at short intervals, as presently occurs when fires move from agricultural areas into the sanctuary every dry season (J. Grogan, pers. comm.). Fig trees fruit at unpredictable times, including the dry season, and form an extremely important source of food and moisture for many animals during the dry and hot seasons (TERBORGH, 1986). The selective removal of fruit trees threfore strains the whole ecosystem. Tropical deciduous forests in general are considered to be among the most severely threatened ecosystems world-wide (JANZEN, 1989).

Forest fires pose a significant threat to tortoises. Some tortoises are burnt to death in the accumulations of leaf litter in which they shelter during the dry season and others receive injuries to their shells and soft parts. Every year, several dead and subsequently scavenged Yellow Tortoises are found in recently burnt deciduous dipterocarp forest (Theerapat Prayurasiddhi, pers. comm.). Those tortoises that survive the fires have to cope with an absence of food and shelter from sun and predators, and the long-term fire-induced changes in the forest. Of course, juveniles are especially vulnerable to the effects of fire. The effects of forest fires on aquatic turtles are less obvious. However, the destruction of stream-side vegetation, the selective killing of important food trees, and the long-term changes of forest structure, soil runoff and water flow patterns would appear to be far from beneficial for aquatic turtles.

Turtle Populations and their Conservation

Size of Turtle Populations

When evaluating the results of our survey, we are forced to conclude that population densities (and by inference, total population sizes) of all turtle species in western Thailand are low to extremely low. This contrasts with older reports and the general expectation

that turtles, especially tortoises, are widespread and abundant; this expectation is reinforced by the herds of Yellow Tortoises *(Indotestudo elongata)* kept at the exceptional, well-publicised "Tortoise village" in north-eastern Thailand. Our habitat searches, including dozens of man-days spent searching large areas of forest floor, regular transects and many km of stream beds, indicate that tortoises occur at densities in the order of one per square km, and aquatic species in the order of one or at most a few animals per km of ecologically undamaged stream. Outside protected areas, even professional hunter-gatherers admit that it is no longer worth the effort to search for tortoises.

The very low densities of turtles found suggests that populations are well below the carrying capacity of the habitat for such passive vegetarians with low metabolic rates. For example, Mediterranean tortoises (*Testudo* spp.) reach densities of several per hectare of scrub forest, despite fires and occasional killing by humans. Indeed, at the low density observed in western Thailand, one wonders how prospective mates ever meet each other. Of course, it is conceivable that in our searches we only found less than, say, a tenth of the animals actually occurring in the particular area searched. We are convinced, however, that the observed density is real, not just a result of inefficient searching. Even if one does not find the tortoises themselves, one can infer their presence from tell-tale bite marks on leaves, mushrooms and fallen fruit. Such signs were extremely rare.

Low population density of turtles may be normal, however, as many aspects of their biology are suited to cope with the problems of infrequent encounters. The longevity of tortoises, probably in the order of several decades, and fertility continuing into old age, are examples. There are indications that male tortoises locate mates in the breeding season by olfactory means; once mated, sperm remains viable for several years, stored in the female's reproductive tract. Multiple clutches of eggs are often laid in a year, decreasing the chance of predation of any individual egg while increasing the chances of at least some hatchlings emerging at the time of optimal environmental conditions. Despite there adaptations, recruitment may still be occasional: GERMANO & BURY (1994) suggest that "recruitment in [North American] tortoises is low or non-existent until there is a combination of favorable factors every few years or perhaps decades. Juvenile cohorts probably occur when for 2 or more years conditions are optimal (e.g., normal to high precipitation), a conditon that is probably needed for the survival of eggs, hatchlings and young. Thus, uneven numbers of cohorts enter the population and in time compensate for adult losses. Such a pattern of survivorship is expected in environments such as deserts where weather is unpredictable and precipitation is spotty or low." While we doubt that the forests of western Thailand are as environmentally severe as the North American scrub-deserts inhabited by the *Gopherus* tortoises, it is quite conceivable that a similar recruitment pattern operates in the Yellow Tortoise. In any case, the increased incidence of forest fires lowers the chances of consecutive years of optimal vegetation. This in turn affects food availability and hatchling detection by predators, and this combined with direct fire mortality of juveniles will influence recruitment. Under these conditions, removal of reproductive adults (as occurs outside protected areas) sharply decreases the number of clutches laid in any particular year, and therefore the size of the juvenile cohort if conditions are favourable.

Population Structure

Only a few turtle species were found in sufficient numbers to draw conclusions about population structure with some certainty: The Stream Terrapin *(Cyclemys dentata)* occurs in healthy populations at least in Huai Kha Khaeng WS, with several juveniles and subadults testifying to successful reproduction and recruitment to this population, which also includes a strong representation by old, reproducing animals.

In contrast, only two juvenile Yellow Tortoises *(Indotestudo elongata)* were found, one inside a wildlife sanctuary. As figure 6 shows, the animals exploited outside protected areas are reproductively valuable mature animals and a few young adults, but include relatively few large (over 28 cm), old specimens. A posthatchling Black Tortoise *(Manouria emys)* butchered for consumption indicates that the general absence of juveniles among the shells collected does not always reflect a matter of selective collection to spare young ones. In any case, the exploitation of mature, reproducing animals of a slow-growing and late-maturing species with limited reproductive output inevitably leads to a population crash, as has apparently occurred in most areas of Thailand.

The Common Softshell, *Amyda cartilaginea,* is exploited whenever encountered and at any size. Nevertheless, its biology allows it to surmount modest levels of exploitation. By inhabiting nearly all types of waters, the species is certain to inhabit some inacessible areas from where depleted populations can be strengthened. Its habit of living in deep water, its cryptic lifestyle and impressive active defences like high swimming speed and especially its powerful jaws, used at the slightest provocation, all make manual collection difficult. In addition, a high growth rate, maturity at a comparatively young age, and fairly high annual egg production seem to guarantee recruitment under all but the most severe exploitation pressures.

Another species found in considerable numbers is the Ricefield Terrapin, *Malayemys subtrijuga,* which successfully inhabits human agricultural landscapes. It probably begins to reproduce at a size too small for general human consumption, so that small females can produce several offspring before being removed from the population. This hypothesis agrees with the observation that large females, over 15 cm LC, are frequently offered for sale for consumption but are quite scarce in the wild, compared to small females and males.

Conservation of Viable Populations

From the above sections it will be abundantly clear that nearly all western Thai turtle species are under unsustainable pressure from exploitation and habitat degradation in many areas. Moreover, Thailand is the main area of occurrence of several of these species, and safeguarding their future in Thailand means safeguarding their global survival.

Thailand's forested Wildlife Sanctuaries and National Parks do an effective job conserving the species that inhabit forested regions, although even here there are some problems with collection and forest fires. Because nearly every natural forest in Thailand is legally protected, turtle survival here depends on the prevention of poaching and optimum sanctuary management (which in the case of turtles means preventing and controlling forest fires). This by itself should be sufficient to sustain viable populations of forest-

inhabiting turtle species such as the three tortoises *Indotestudo elongata, Manouria emys* and *Dogania subplana.* Conservation action for turtle species with a marginal or presumed distribution into Thailand, such as *Lissemys scutata, Melanochelys trijuga* and *Pyxidea mouhotii,* can more effectively be directed towards the substantial populations in Myanmar, Laos or Vietnam.

Surveying and monitoring of populations should be carried out before any population or species can be considered "safe"; there can be no room for complacency. Particularly the status of the two *Manouria* species should be carefully monitored. The sad reality is that designating a forest as a protected area does not automatically provide effective protection for turtles or other species.

There are more serious problems for several Thai turtle species that do not inhabit forested areas, but instead occur in lowland wetlands and other generally unprotected and strongly altered habitats. Several of these species are not confirmed to inhabit areas which are safe from exploitation. This primarily applies to the species of limited distribution, such as *Chitra chitra, Hieremys annandalii* and *Malayemys subtrijuga,* and to a lesser extent to the more widespread species whose status in other countries is unknown. The latter group includes *Pelochelys bibroni, Lissemys scutata, Melanochelys trijuga* and *Siebenrockiella crassicollis.*

Virtually all wetlands and flood-plain areas in Thailand have been converted to agricultural areas. It appears that *Malayemys subtrijuga* and *Amyda cartilaginea* have actually profited from this, while some other species *(Siebenrockiella, Hieremys, Cuora amboinensis)* can utilise these regions to some extent. If these populations are not hunted beyond sustainability and somehow manage to avoid suffering from droughts and water pollution, they may survive here, but this is not very likely. For these species, a number of protected lowland swamps would be of immense conservation value, and to confirm that these turtle species occur at Bung Borapet and other sanctuaries would provide peace of mind.

This leaves the conservation requirements for Thailand's native turtle species accounted for, with five notable exceptions. The mangrove inhabitants *Batagur baska* and *Callagur borneoensis* are extinct in the wild in Thailand, being kept only at the Satun Freshwater Fisheries Development Station. Eventually, they may be successfully reintroduced to mangrove areas along the Andaman Sea and Gulf of Thailand coasts. *Hieremys annandalii* is a large species that is virtually restricted to Thailand; it is widely exploited, quite rare in the wild and not confirmed to occur in any protected natural areas. Captive breeding is quite successful and offspring produced, as well as surplus adults inhabiting temple ponds, could be recruited to establish or strengthen populations in suitable areas, with due precautions.

The large softshell *Pelochelys bibroni* inhabits the economically most valuable riverine areas, the estuaries and mid-river stretches. Here it is in close contact with humans and their pollutants, and as a result the species seems to have disappeared from the Chao Phraya (W. Nutphand, pers. comm.) and Mae Klong (this study). Elsewhere, the status of this species is little known but considered critical. The situation is similar for the endemic *Chitra chitra* softshell in the Mae Klong, where it is severely threatened by hunting, polluting, reservoir creation and other forms of habitat destruction and alteration. There is a slight chance that the species occurs in the upper Khwae Yai inside Thung Yai

Naresuan WS, but otherwise the species, though legally strictly protected, receives no practical protection and remains a main target of hunters and collectors. The importance of preserving viable populations of these species cannot be overestimated. *Chitra chitra,* occurring only in western Thailand, provides a unique biogeographical link with the Gangetic plain; the Thai population of *Pelochelys,* currently assumed to be part of the wide-ranging species *P. bibroni,* may in fact be a full species in a complex of several species ranging from India to New Guinea. Substantial efforts are required to offer these two giant softshell species a chance to survive into the next century.

Conservation Priorities

We can identify several priorities for conservation of the non-marine turtles of Thailand. First priority is the Striped Giant Softshell Turtle, *Chitra chitra,* whose entire known world population is under imminent threat of extinction. The second priority is for species at considerable risk of local or national extinction, whose status in other countries is rare or unknown: *Manouria impressa, Manouria emys, Pelochelys bibroni, Heosemys spinosa, Batagur baska,* and *Callagur borneoensis.* The third priority category should include those species not assumed to be in immediate danger in Thailand but of restricted distribution outside the country, or otherwise vulnerable. Occurrence of these species in viable populations inside wildlife sanctuaries and other protected areas should be established. This group includes *Platysternon megacephalum, Indotestudo elongata, Hieremys annandalii,* and *Malayemys subtrijuga.* Third priority should also be given to species at considerable risk of local or national extinction, but known to exist in reasonably substantial populations in nearby countries. *Lissemys scutata, Melanochelys trijuga, Notochelys platynota,* and *Pyxidea mouhotii* fall into this group. Finally, the fourth priority group should include those species for which no additional, specific conservation action is deemed necessary at this moment, but whose status requires continued monitoring: *Amyda cartilaginea, Dogania subplana, Cuora amboinensis, Cyclemys dentata, Heosemys grandis, Siebenrockiella crassicollis.*

The preceding are conservation priorities for Thailand. Several of the above species, notably *Manouria impressa, Platysternon megacephalum, Callagur borneoensis,* and *Batagur baska,* were long ago recognised to be among Thailand's most endangered species (NUTPHAND, 1979; HUMPHREY & BAIN, 1990; GROOMBRIDGE, 1982; MOLL, 1985; TISTR, 1991). Internationally, several studies have identified threats and conservation requirements of turtles. Several species are listed under the Convention on International Trade in Endangered Species and Species Products (CITES). The IUCN Red Data Book (GROOMBRIDGE, 1982) is another internationally recognised database of endangered species. The IUCN Tortoise and Freshwater Turtle Specialist Group (IUCN T&FTSG, 1989) gave a best-possible assessment of conservation priorities for non-marine turtles worldwide; species were given first, second or third priority status (or no action required), and active conservation projects were noted. The various ratings for Thai species are presented in Table 1.

Conservation action can take many forms. All native Thai turtle species except *Amyda cartilaginea* are officially protected by the 1992 Wildlife Conservation Act, prohibiting capture, possession and trade. This is a great step forward, but it is not yet fully enforced

Table 1. Current conservation listings of Thai non-marine Turtle species.

Species	CITES	Red Data Book 1988	T&FTSG APR 1989	Remarks
Indotestudo elongata	II	K	1	
Manouria emys	II	K	3	
Manouria impressa	II	K	1	
Batagur baska	I	E	1, X	
Callagur borneoensis	-	E	1, X	
Cuora amboinensis	-	-	-	
Cyclemys dentata	-	-	3	
Cyclemys tcheponensis	-	-	-	
Heosemys grandis	-	-	-	
Heosemys spinosa	-	-	1	
Hieremys annandalii	-	-	-	Proposed APR2
Malayemys subtrijuga	-	-	3	
Melanochelys trijuga	-	-	-	
Notochelys platynota	-	K	3	
Pyxidea mouhotii	-	-	3	
Siebenrockiella crassicollis	-	-	-	
Trachemys scripta	-	-	-	Exotic species
Platysternon megacephalum	-	-	3	
Amyda cartilaginea	-	-	3	
Chitra chitra	not yet recognised		*	Proposed APR1
Dogania subplana	-	-	3	
Lissemys scutata	-	-	-	
Pelochelys bibroni	-	-	3	
Pelodiscus sinensis	-	-	-	Exotic species

Red Data Book categories: E = Endangered, K = insufficiently known (presumed threatened); IUCN T&FTSG Action Plan Ratings: 1 = known threatened species in need of conservation action, 2 = species of restricted distribution in need of status investigation, 3 = other species requiring conservation projects and/or status surveys, X = species which have received or currently receiving conservation action.

in the countryside, where we found that nobody was aware of this protection status. Controls on the collection of forest produce in protected areas should be tightened. Effective protection of known turtle nesting sites has considerable potential. Captive breeding can be used as a management tool to strengthen or reintroduce depleted populations, but its long-term success will depend on habitat integrity. With adequate legal protection in effect, successful conservation action for Thai turtles, and other creatures, will depend above all else on increased public awareness of the value and beauty of Thailand's Natural Heritage.

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Appendix 1. Turtle Records from Western Thailand

Key to abbreviations:

BMNH	British Museum of Natural History, London SW7 5BD, England.
CUMZ(R)	Chulalongkorn University Museum of Zoology, Reptile Collection, Bangkok 10330, Thailand.
CUMZ(R,P)	Photographic section, Chulalongkorn University Museum of Zoology, Reptile Collection, Bangkok 10330, Thailand.
HKKWS	Huai Kha Khaeng Wildlife Sanctuary, Uthai Thani & Tak Province, Thailand.
KNR-HKK	Khao Nang Rum Research Station Museum, Huai Kha Khaeng W.S., Uthai Thani Province, Thailand.
KP	Kanchanaburi Province, Thailand.
MCZ	Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts 02138, U.S.A.
NHMB	Naturhistorisches Museum Basel, Switzerland.
TNRC	Thai National Reference Collection, Thailand Institute of Scientific and Technological Research, Bangkok 10900, Thailand.
TP	Tak Province, Thailand.
TYNWS	Thung Yai Naresuan Wildlife Sanctuary, Kanchanaburi and Tak Provinces, Thailand.
UTP	Uthai Thani Province, Thailand.

Those specimens marked with an asterisk (*) are museum specimens not examined by us.

Indotestudo elongata (Blyth, 1853): Amphoe Umphang, TP: CUMZ(R) 1992.0702.3-19, CUMZ(R, P)1992.0702.2; Ban na Bot, near Ping River: TP: CUMZ(R) 1992.0704.1-2; Huai Pong Pai, HKKWS: CUMZ(R, P) 1991.1208.4; vicinity of Khao Nang Rum R.S, HKKWS: CUMZ(R, P) 1991.1202.1, 1992.0706.2, 1993.1119.1 KNR-HKK unnumbered (4 specimens); Huai Tinoy, TYNWS: CUMZ(R) 1992.0414.2; Vicinity of Sangkhlaburi, KP: CUMZ(R) 1992.0405.1-6; Ban Nam Jone, Sai Yoke, KP: CUMZ(R) 1992.1108.1; Bong Tee Valley, Sai Yoke, KP: BMNH 1921.4.1.101*, MCZ 21580-3*; Tambon Chalae, KP: CUMZ(R) 1992.0414.1; Ban Mongkratae, KP: CUMZ(R) 1992.0620.1-10, CUMZ(R, P) 1992.0620.12.

Manouria emys (Schlegel & Müller, 1840): Ban Mae Klong Noi, TP: CUMZ(R) 1992.0703.3-6; Khlong Kor, HKKWS: TNRC F # UT 276; Amphoe Thong Pha Poom, KP: CUMZ (R, P) 1991.1115.1-8, 1992.0405.9-14; Bong Tee valley, Sai Yoke, KP: BMNH 1921.4.1.182* Sai Yoke, KP: MCZ 29513*

Manouria impressa (Günther, 1889): Ban Mae Klong Noi, TP: CUMZ(R) 1992.0703.1-2; Km 97 on Mae Sod-Umphang Highway, TP: CUMZ(R) 1992.0602.1; Khao Khieo, HKKWS?: KNR -HKK unnumbered (1 specimen).

Cuora amboinensis (Daudin, 1802): CUMZ(R, P) 1992.0917.1: near Khao Ban Dai ranger station, HKKWS.

Cyclemys dentata (Gray, 1831): Ban Sareerat, TP: CUMZ(R) 1992.0703.7; Huai Ai Yo (Khlong Kor), HKKWS: CUMZ(R, P) 1991.1119.2-3, 1992.0630.1; Huai Nam Sap, HKKWS: CUMZ(R, P) 1991.1119.4; Huai Chang Tai, HKKWS: CUMZ(R) 1991.1123.1, CUMZ(R, P) 1991.1205.1, 1991.1205.1, 1992.0705.1; vicinity of Khao Nang Rum R.S., HKKWS: KNR-HKK unnumbered (1 specimen); Tambon Chalae, KP: CUMZ(R) 1992.0414.2; Huai Tinoy, TYNWS: CUMZ(R) 1992.0414.5.

Heosemys grandis (Gray, 1860): Huai Nam Sap HKKWS: CUMZ(R, P) 1991.1119.5; Huai Pong Pai, HKKWS: 1991.1208.1, 1992.0706.2; Vicinity of KNR-HKK: CUMZ(R) 1992.0701.1; 1992.0706.3; Khwae Noi river, KP: CUMZ(R) 1991.1116.6; Sai Yoke, KP: MCZ 29515*.

Malayemys subtrijuga (Schlegel & Müller, 1844): Khlong Mae Wong, Nakhon Sawan province: CUMZ(R) 1992.0704.6; Kanchanaburi, Uthai Thani and Chai Nat city markets.

Platysternon megacephalum Gray, 1831: Me Taw, TP: MCZ 29535*; Sai Yoke, KP: NHMB 8416*

Amyda cartilaginea (Boddaert, 1770): Huai Ai Yo (Khlong Kor) HKKWS: CUMZ(R) 1991.1118.1, CUMZ(R, P) P1991 0125.1, P1991.1119.1; Vicinity of Khao Nang Rum, HKK: KNR-HKK unnumbered; Huai Kha Khaeng at Khao Ban Dai R.S., HKKWS: CUMZ(R, P) P1992.0716.1; Vicinity of Sangkhlaburi, KP: CUMZ(R) 1992.0405.7-8; Kanchanaburi city market: CUMZ(R) 1991.1116.3, CUMZ(R, P) P1991.1116.1, -2, -4; Khlong Mae Wong, Nakhon Sawan province: CUMZ(R) 1992.0704.4-5.

Chitra chitra Nutphand, 1986: Mae Klong River at Ratburi: BMNH 1926.12.16.1; Ban Pong, KP: BMNH 1921.4.1.197, 1974.2451; Srinagarind Reservoir, KP: CUMZ(R) 1991.0823.1; CUMZ(R) unnumbered (3 specimens): captive-hatched, Khwae Noi river, KP;

Dogania subplana (Geoffroy St. Hilaire, 1809): Tambon Chalae, KP: CUMZ(R) 1992.0414.3; 20 km East of Khwae Noi River, Amphoe Thong Pha Poom, KP: CUMZ(R) 1992.0221.1.; Kanchanaburi city market: PPvD 1991.1114.1.

Lissemys scutata (Peters, 1868): Kanchanaburi province, probably Huai Mae Kasat: CUMZ(R) unnumbered.

Pelochelys bibroni (Owen, 1853): Amphoe Muang, Ratburi Province: BMNH 1974.2452.

Appendix 2. Scientific and Vernacular English Names of Selected Asian Turtles.

Family Emydidae, subfamily Batagurinae	
Batagur baska (Gray, 1831)	Mangrove Terrapin
Callagur borneoensis (Schlegel & Müller, 1844)	Painted Terrapin
Cuora amboinensis (Daudin, 1802)	Asian Box Turtle
Cyclemys dentata (Gray, 1831)	Stream Terrapin
Heosemys grandis (Gray, 1860)	Giant Asian Pond Terrapin, Orange-headed Temple Terrapin
Heosemys spinosa (Gray, 1831)	Spiny Turtle
Hieremys annandalii (Boulenger, 1903)	(Yellow-headed) Temple Turtle
Malayemys subtrijuga (Schlegel & Müller, 1844)	Ricefield Terrapin, Snail-eating Turtle
Melanochelys trijuga (Schweigger, 1812)	Indo-burmese Pond Turtle
Notochelys platynota (Gray, 1834)	Flat-shelled Turtle
Pyxidea mouhotii (Gray, 1862)	Keeled Box Turtle
Siebenrockiella crassicollis (Gray, 1831)	Black Turtle
Trachemys scripta elegans (Wied, 1839)	Red-eared Slider, Red-eared Terrapin
Family Platysternidae	
Platysternon megacephalum (Gray, 1831)	Big-headed Turtle
Family Testudinidae	
Indotestudo elongata (Blyth, 1853)	Yellow Tortoise, Elongated Tortoise
Manouria emys (Schlegel & Müller, 1840)	Asian Giant Tortoise
Manouria impressa (Günther, 1882)	Impressed Tortoise
Family Trionychidae, subfamily Trionychinae	
Amyda cartilaginea (Boddaert, 1770)	Common Asiatic Softshell Turtle
Chitra chitra (Nutphand, 1986)	Striped Giant Softshell Turtle
Dogania subplana (Geoffroy St. Hilaire, 1809)	Hillstream Softshell Turtle
Pelochelys bibroni (Owen, 1853)	Asian or Frog-headed Giant Softshell Turtle
Pelodiscus sinensis (Wiegmann, 1835)	Chinese Softshell Turtle
Family Trionychidae, subfamily Cyclanorbinae	
Lissemys scutata (Peters, 1868)	Burmese Flapshell Turtle

Appendix 3. Recent Changes in the Nomenclature of Thai Turtles.

Previous name	Current name	Transferring Author
Chitra indica (part)	*Chitra chitra*	Nutphand, 1986
Chrysemys scripta	*Trachemys scripta*	Seidel & Smith, 1986
Cyclemys mouhotii	*Pyxidea mouhotii*	Sachsse, 1973
Damonia subtrijuga	*Malayemys subtrijuga*	Lindholm, 1931
Geochelone elongata	*Indotestudo elongata*	Bour, 1980; Crumly, 1984
Geochelone emys	*Manouria emys*	Bour, 1980; Crumly, 1984
Geochelone impressa	*Manouria impressa*	Bour, 1980; Crumly, 1984
Geoemyda grandis	*Heosemys grandis*	McDowell, 1964
Geoemyda spinosa	*Heosemys spinosa*	McDowell, 1964
Geoemyda tcheponensis	*Cyclemys dentata*	McDowell, 1964
Geoemyda trijuga	*Melanochelys trijuga*	McDowell, 1964
Lissemys punctata scutata	*Lissemys scutata*	Webb, 1982
Pseudemys scripta	*Trachemys scripta*	Seidel & Smith, 1986
Testudo elongata	*Indotestudo elongata*	Bour, 1980; Crumly, 1984
Testudo emys	*Manouria emys*	Bour, 1980; Crumly, 1984
Testudo impressa	*Manouria impressa*	Bour, 1980; Crumly, 1984
Testudo nutapundi	*Manouria emys phayrei*	Moll, 1989
Trionyx cartilagineus	*Amyda cartilaginea*	Meylan, 1987
Trionyx formosus	*Nilssonia formosa*	Meylan, 1987
Trionyx nakornsrithammarajensis	*Amyda cartilaginea*	Melyan, 1987; van Dijk, 1992
Trionyx sinensis	*Pelodiscus sinensis*	Meylan, 1987
Trionyx subplanus	*Dogania subplana*	Smith, 1931; Meylan, 1987

Appendix 4. Thai Names of Turtles.

Thai name	Phonetic	Meaning	Species
เต่าเหลือง	Tao Luang	Yellow Turtle/Tortoise	*Indotestudo elongata*
เต่าเพ็ก	Tao Pek	"Pek" bamboo Turtle	*Indotestudo elongata*
เต่าเทียน	Tao Tien	Wax Turtle	*Indotestudo elongata*
เต่าแขนง	Tao Khaneng	Small turtle, or Fragment Turtle (refers to scute pattern)	*Indotestudo elongata*
เต่าหกดำ	Tao Hok Dam	Black Six-legged Tortoise	*Manouria emys emys*
เต่าหกเหลือง	Tao Hok Luang	Brown Six-legged Tortoise	*Manouria emys phayrei*
เต่าเดือย	Tao Duey	Spur Tortoise	*Manouria impressa*
เต่ากระอาน	Tao Kra-arn	??	*Batagur baska*
เต่าจาน	Tao Charn	Plate Turtle	*Batagur baska*
เต่าหัวแดง	Tao Hua Daeng	Red-headed Turtle	*Callagur borneoensis*
เต่าจมูกแหลมบอร์เนียว	Tao Chamook Laem Borneo	Sharp-nosed Borneo Turtle	*Callagur borneoensis*
เต่าลายตีนเป็ด	Tao Lai Teen Ped	Striped Duck-foot Turtle	*Callagur borneoensis*
เต่าหับ	Tao Hab	Hinged Turtle	*Cuora amboinensis*
เต่าแดง	Tao Daeng	Brown Turtle	*Cyclemys dentata*
เต่าใบไม้	Tao Bai-Mai	Leaf Turtle	*Cyclemys dentata*
เต่าดำ	Tao Dam (W.-Thailand)	Black Turtle	*Cyclemys dentata*
เต่าห้วยคอลาย	Tao Huai Ko Lai	Stripe-necked Turtle (this name refers to the *tcheponensis* form)	*Cyclemys dentata*
เต่าหวาย	Tao Hwai	Rottan Turtle	*Heosemys grandis*
เต่าวัดหัวแดง	Tao Wat Hua Daeng	Orange-headed Temple Turtle	*Heosemys grandis*
เต่าหิน	Tao Hin	Rock Turtle	*Heosemys grandis*
เต่าจักร	Tao Chak	"Serrated" Turtle	*Heosemys spinosa*
เต่าบัว	Tao Bua	Lotus Turtle	*Hieremys annandalii*
เต่าหม้อ	Tao Moh	Pot Turtle	*Hieremys annandalii*
เต่าบึง	Tao Bueng	Swamp Turtle	*Hieremys annandalii*
เต่านา	Tao Na	Ricefield Terrapin	*Malayemys subtrijuga*
เต่าปากเหลือง	Tao Pak Luang	Yellow-lipped Turtle	*Melanochelys trijuga* spp.
เต่าทับทิม	Tao Tab-tim	Ruby Turtle	*Notochelys platynota*
เต่าจัน	Tao Chan	??	*Pyxidea mouhotii*
เต่าดำ	Tao Dam	Black Turtle	*Siebenrockiella crassicollis*
เต่าเหม็น	Tao Menh	Smelly turtle	*Siebenrockiella crassicollis*
เต่าแก้มขาว	Tao Gaam-Khao	White-cheeked Turtle	*Siebenrockiella crassicollis*
เต่าแก้มแดง	Tao Gaam Daeng	Red-cheeked Turtle	*Trachemys scripta elegans*
เต่าญี่ปุ่น	Tao Jipoon	Japanese Turtle	*Trachemys scripta elegans*
เต่าอังกฤษ	Tao Angrit	English Turtle	*Trachemys scripta elegans*
เต่าปูลู	Tao Pulu	??	*Platysternon megacephalum*
ตะพาบ (น้ำ)	Ta Pab (Nam)	(Water) Softshell Turtle	*Amyda cartilaginea*
ตะพาบสวน	Ta Pab Suan	Garden Softshell Turtle	*Amyda cartilaginea*
ปลาฝา (เหนือ)	Pla Fa (North)	Plate fish	*Amyda cartilaginea*
ตะพาบม่านลาย	Tapab Manlai	Striped Softshell	*Chitra chitra*
กริวลาย	Griu Lai	Striped Giant Softshell	*Chitra chitra*
กราวด่าง	Grau Dang	Dark-brown Giant Softshell	*Chitra chitra*

Thai name	Phonetic	Meaning	Species
ตะพาบแก้มแดง	Ta Pab Gaam Daeng	Red-cheeked Softshell	*Dogania subplana*
ตะพาบหับ	Ta Pab Hab	Hinged Softshell Turtle	*Lissemys scutata*
ตะพาบหัวกบ	Ta Pab Hua Kob	Frog-head Softshell Turtle	*Pelochelys bibroni*
กริวดาว	Griu Dao	Spotted Giant Softshell	*Pelochelys bibroni*
กราวเขียว	Grau Khieo	Olive-green Giant Softshell	*Pelochelys bibroni*
ตะพาบไต้หวัน	Ta Pab Taiwan	Taiwanese Softshell Turtle	*Pelodiscus sinensis*