

**A Conservation Assessment of the Critically Endangered
Burmese Star Tortoise in Chatthin Wildlife
Sanctuary, Myanmar**

Steven G. Platt, Win Ko Ko, and Nay Win Kyaw

**Wildlife Conservation Society - Myanmar Program
No. 12, Nanrattaw St., Kamayut Township,
Yangon, Myanmar**



Report to:

**Wildlife Conservation Society
2300 Southern Boulevard
Bronx, New York 10460-1099
USA**

14 July 2018

Executive summary

The Burmese Star Tortoise (*Geochelone platynota*) is a critically endangered species endemic to the dry zone of central Myanmar. By the early 2000s, *G. platynota* was considered “ecologically” extinct in the wild, although captive-breeding efforts underway within Myanmar make the possibility of “biological extinction” exceedingly remote. A national action plan developed at a workshop in 2012 recommends restoring viable wild populations of Burmese Star Tortoises within every protected area in the historic range of this endemic species. Reintroduction of captive-bred tortoises from in-country assurance colonies is the lynchpin of this conservation strategy. Currently, successful reintroduction efforts are underway at Minzontaung and Shwe Settaw wildlife sanctuaries. Located in the dry zone of Sagaing Region, Chatthin Wildlife Sanctuary (CWS) is ranked as a high-priority potential reintroduction site in the National Action Plan. As a first step in the reintroduction process, we conducted a survey of CWS during June 2018 with the following objectives: 1) determine if remnant populations of *G. platynota* persist in the sanctuary, 2) determine if other species of turtles occur within the protected area, 3) assess the potential for reintroducing captive-bred *G. platynota* to the sanctuary, 4) define any threats faced by turtle populations, and 5) collaborate with the Myanmar Forest Department to develop a tentative reintroduction plan.

Our survey confirmed the past occurrence of *G. platynota* within CWS. Most reported encounters with *G. platynota* occurred 25-40 years ago, but at least one tortoise was found as recently as 2012. Nonetheless, *G. platynota* appears to be biologically, or at least functionally extinct within the sanctuary and surrounding areas. The primary drivers of local extinction appear to be long-term, chronic subsistence hunting, commercial hunting for the local bushmeat trade, and to a lesser extent, habitat destruction by agriculturalists. Interestingly, tortoise populations in CWS seem to have collapsed well before the demand for *G. platynota* from high-end international pet markets became the primary driver of extinction. In addition to *G. platynota*, we documented the occurrence of five other species of chelonians in CWS: Yellow Tortoise (*Indotestudo elongata*), Asian Leaf Turtle (*Cyclemys fusca*), Burmese Flapshell Turtle (*Lissemys scutata*), and two larger softshell turtles, most likely the Asian Giant Softshell Turtle (*Amyda cartilaginea*) and Burmese Peacock Softshell Turtle (*Nilssonina formosa*).

Owing to high-quality deciduous forest habitat, seemingly effective enforcement measures designed to protect Eld’s Deer, and available infrastructure, we consider the reintroduction of captive-bred *G. platynota* to be a feasible management option for the sanctuary. To this end, we provide a set of management recommendations for a reintroduction program. We also recommend establishing an assurance colony of *G. platynota* in the deer pen currently under construction at San Myaung Camp, provided certain management issues are addressed beforehand.

Table of Contents

	<u>Page</u>
Executive summary	2
Introduction	4
Chatthin Wildlife Sanctuary	5
Methods	7
Results and Discussion	8
Burmese Star Tortoise	8
Specimens examined	8
Conservation status within CWS	8
Traditional ecological knowledge and ethnoherpetology	12
Other chelonians	16
Conservation recommendations	17
Eld's Deer enclosure	19
Acknowledgements	23
Literature cited	23
Appendix 1	26
Appendix 2	34
Appendix 3	36
Appendix 4	38

Cover photograph: Captive Burmese Star Tortoises (*Geochelone platynota*) eagerly consuming mushrooms in an enclosure at Shwe Settaw Wildlife Sanctuary. Both humans and tortoises competitively vie for the bountiful mushroom crop at Chatthin Wildlife Sanctuary.

Introduction

National parks, wildlife sanctuaries, and other protected areas often figure prominently in successful species conservation strategies (Stohlgren et al. 1994; Bruner et al. 2001). Protected areas can safeguard habitats for the long-term maintenance of biodiversity while at the same time serving as baselines against which biological and ecosystem change can be measured (Stohlgren et al., 1994). In order to realize these objectives, protected area managers require species inventories, accurate assessments of conservation status, and an understanding of existing and potential anthropogenic threats (Tuberville et al., 2005). Such information is essential for effectively targeting conservation efforts, formulating management policies, prioritizing research, and designing appropriate monitoring protocols, especially where cryptic, rare, and threatened species are concerned (Stohlgren et al., 1994; Tuberville et al., 2005). Unfortunately, such information is lacking for most protected areas in Myanmar owing to a lack of financial and technical resources available to park managers.

The Burmese Star Tortoise (*Geochelone platynota*) is a critically endangered species endemic to the dry zone of central Myanmar. High demand, first from food and traditional medicine markets in southern China, and later by global pet markets led to precipitous population declines during the late 1990s, and by the early 2000s, *G. platynota* was considered “ecologically” extinct in the wild (Platt et al., 2011). Despite the imperiled status of wild populations, WCS and TSA technical support to conservation-breeding efforts in Myanmar resulted in a remarkable increase in the captive population (Platt et al., 2017). At the time of this writing (July 2018), >15,000 Burmese Star Tortoises are held at three captive-breeding facilities (Lawkanandar, Minzontaung, and Shwe Settaw wildlife sanctuaries) in Myanmar. Given this reservoir of captive animals, “biological extinction” of the Burmese star tortoise is now extremely unlikely.

In late 2012, a national workshop was convened in Bagan and attended by NGO and government personnel responsible for Star Tortoise conservation in Myanmar. This working group produced a National Star Tortoise Action Plan with the stated objective of restoring the Burmese Star Tortoise as a functional species in dry zone landscapes (Platt et al., 2014). To this end, the action plan recommends reestablishing viable wild populations of Burmese star tortoises within every protected area in the historic range of this endemic species. Reintroduction of captive-bred tortoises from in-country assurance colonies is the lynchpin of this conservation strategy (Platt et al., 2014, 2017). Currently, reintroduction efforts are underway at Minzontaung and Shwe Settaw wildlife sanctuaries (Platt and Platt, 2017).

Chatthin Wildlife Sanctuary (CWS) is located in the dry zone of Sagaing Region and considered suitable habitat for *G. platynota* (Platt et al., 2014), which probably historically occurred in the area, although verified records are lacking (reviewed by Platt et al., 2011). Chatthin Wildlife Sanctuary is ranked as a high-priority site for the reintroduction of captive-bred star tortoises in the National Action Plan (Platt et al.,

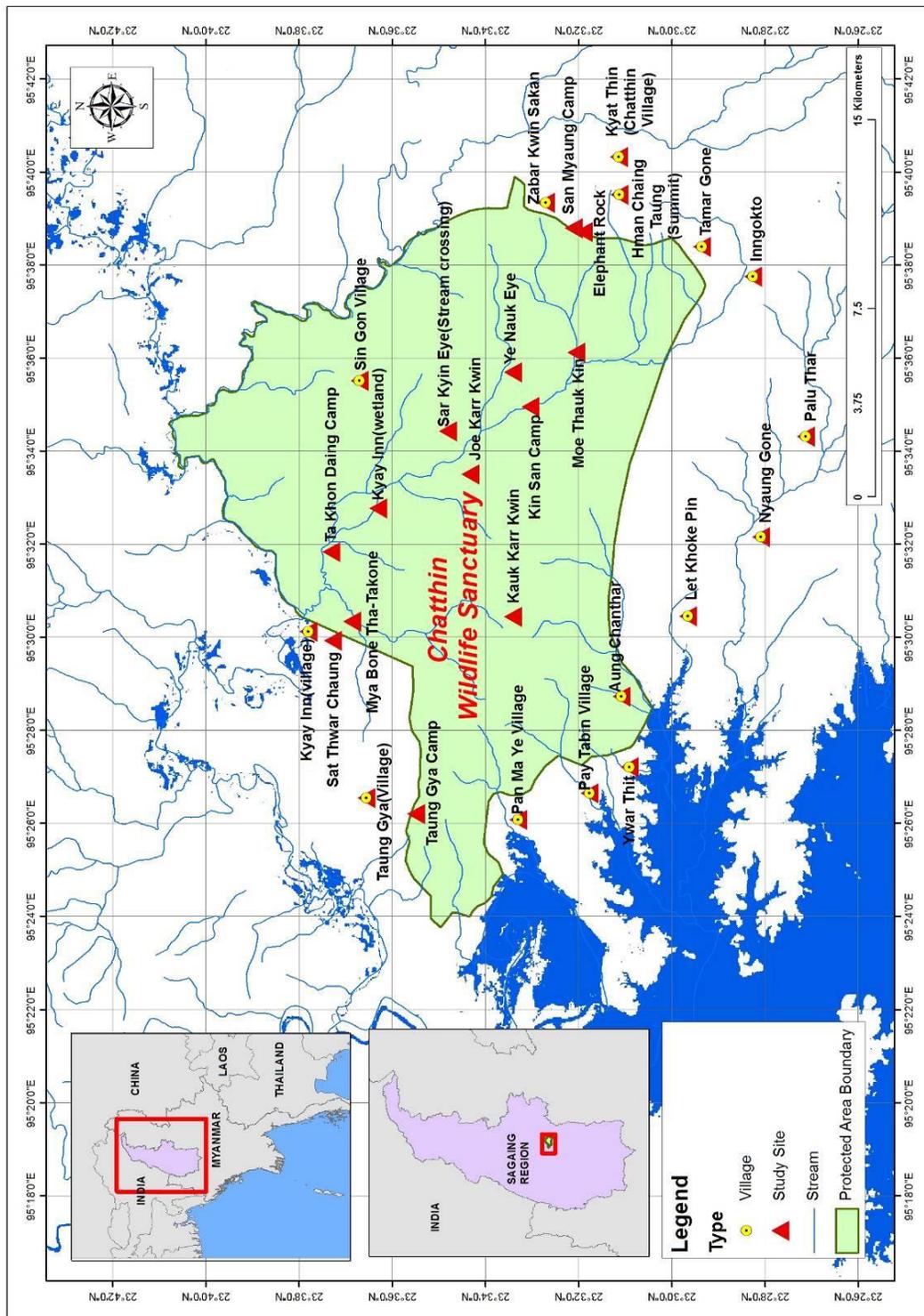
2014). As a first step in the reintroduction process, we conducted a survey of CWS during June 2018 with the following objectives: 1) determine if remnant populations of *G. platynota* persist in the sanctuary, 2) determine if other species of turtles occur within the protected area, 3) assess the potential for reintroducing captive-bred *G. platynota* to the sanctuary, 4) determine any threats facing turtle populations, particularly illegal hunting and habitat destruction, and 5) collaborate with the Myanmar Forest Department to develop a tentative reintroduction plan for the sanctuary. Herein we summarize the results of our survey. A detailed, annotated trip itinerary and expedition gazetteer is provided in Appendix 1 and 2, respectively. Locality-based records for reptiles (other than chelonians) encountered during fieldwork are given in Appendix 3 and vegetation sampling is detailed in Appendix 4.

Chatthin Wildlife Sanctuary

Chatthin Wildlife Sanctuary (Map 1) is located in Sagaing Region approximately 160 km northwest of Mandalay and consists of approximately 268 km² of dry zone habitat (Beffasti and Galanti, 2011). The local climate is strongly seasonal and linked to monsoonal cycles and mountain rain-shadow effects. The area experiences a pronounced wet season (late May to mid-October) followed by a prolonged dry season during which rainfall is minimal; April is the hottest month and February the coldest (Sen Roy and Kaur, 2000; Myint Aung et al., 2004).

Chatthin Wildlife Sanctuary (CWS) was established in 1941 by the British Colonial Administration by combining two adjacent blocks of reserved forests as a wildlife reserve for Eld's Deer (*Recervus eldii*) (Salter and Sayer, 1983). Following independence, CWS was included in a timber production area and heavily logged through the 1970s. As part of this activity a logging railroad and network of trails was constructed to facilitate the extraction of timber from the sanctuary (Myint Aung et al., 2004).

CWS is characterized by extensive secondary *Indaing* forest which covers approximately 90% of the sanctuary (Zug et al., 1998; Myint Aung et al., 2004; Beffasti and Galanti, 2011). *In* (*Dipterocarpus tuberculatus*) is a major component of the *Indiang* forest in CWS (Zug et al., 1998); other species are listed in Appendix 4. Canopy height varies according to logging history, and ranges from 8 to 15 m (Zug et al., 1998; Appendix 4). Canopy coverage likewise varies between 30-70% (Zug et al., 1998). Much of the forest is characterized by a relatively open understory of grasses and forbs with scattered shrubs. Tree regeneration (mainly root sprouts) is abundant in the understory. Anthropogenic and natural fires are common during the dry season (November – May) and maintain the open structure of the forest. Small grasslands that appear edaphic in nature are scattered throughout the sanctuary. A large lake (Kyay In) is found along the northwestern edge of the sanctuary. Three villages with surrounding agricultural lands are encompassed by the sanctuary boundaries and continued encroachment is recognized as a serious threat that continues to erode forest cover (Beffasti and Galanti, 2011). Other threats include illegal logging, subsistence and



Map 1: Map of Chatthin Wildlife Sanctuary and adjacent areas showing localities mentioned in text.

commercial hunting of wildlife, collection of plants, and unauthorized burning (Beffasti and Galanti, 2011).

Methods

We conducted fieldwork in CWS from 5-22 June 2018 (Appendix 1). During this period we traveled on foot through the sanctuary and its associated buffer zone; ox- and buffalo-drawn carts were used to transport camp equipment and supplies. We visited villages within and adjacent to the sanctuary and conducted semi-directed, open-ended interviews (Martin, 1995; Huntington, 1998, 2000; Gilchrist et al., 2005) of hunters, farmers, and other knowledgeable individuals regarding the local occurrence and natural history of *G. platynota* and other turtles, hunting and collecting methods, levels of exploitation. Such individuals are recognized as an excellent source of information on local chelonians (Thirakhupt and van Dijk, 1994; Platt et al., 2004). We also queried informants on Traditional Ecological Knowledge (TEK; defined as “the cumulative body of knowledge concerning the relationship of organisms to one another and their environment, empirically acquired, and passed down by oral tradition”; Berkes *et al.*, 2000; Huntington, 2000) and ethnoherpetology (broadly defined as “the relationships between human culture and reptiles”; Alves *et al.*, 2012). Interviews were conducted by single native-Burmese speaker also fluent in English, and later translated into English and transcribed.

In accordance with the format of semi-directed and open-ended interviews, we asked each informant a series of questions that included standard questions prepared in advance and others that arose during the course of conversation. We guided the discussion, but the direction and scope of each interview was allowed to follow the participants’ train of thought (Huntington, 1998). Semi-directed interviews are more of a conversation than a typical question and answer session, and rather than rigidly adhering to a set of prepared questions, the interview provides an opportunity for collecting and discussing unanticipated information (Huntington, 2000; Gilchrist et al., 2005). Our questions focused on the past and present occurrence of turtles, local ecological knowledge about these species, folk taxonomy, exploitation, fishing practices, and potential threats. We used a photographic guide to Myanmar Turtles (Platt et al., 2012) supplemented by a collection of representative shells to facilitate species identification and match vernacular names to scientifically recognized taxa.

During interviews, we also asked to examine any turtle shells or living turtles that might be available in villages. We measured straight-line carapace length (CL) and plastron length (PL; measured from base of anal notch) with a tape measure, and then photographed each specimen. Body mass was generally given in Viss, a measure unique to Myanmar. We converted Viss to Kg as 1 viss = 1.6 kg. We determined geographic coordinates (India-Bangladesh Datum) and elevation with a Garmin® GPS76. Place names are in accordance with a national gazetteer currently being compiled. Transcripts and summaries of interviews are contained in field notes archived in the Campbell Museum, Clemson University, Clemson, South Carolina, USA.

Results and Discussion

We interviewed 127 people at 16 villages and encampments during this survey (Table 1). Our informants included 98 males and 29 females who ranged in age from 20 to 93 years-old (Table 1). Most of our informants were males owing to the fact that hunting, farming, and fishing are male-dominated activities. Most female informants with a knowledge of tortoises encountered these animals while collecting mushrooms in the forest. Based on information provided by these informants, we documented the occurrence of six species of chelonians in CWS; *Geochelone platynota*, *Indotestudo elongata*, *Cyclemys fusca*, *Lissemys scutata*, and two larger softshell turtles (most likely *Amyda cartilaginea* and *Nilssonina formosa*). Our findings are summarized below.

Burmese Star Tortoise (*Geochelone platynota*)

Specimens examined

We examined three specimens of *G. platynota* during this survey confirming the past occurrence of this species in CWS and augmenting information provided by local informants (Figure 1-2). The first specimen was a carapace from a small juvenile without an associated plastron. The CL of this specimen measured 109 mm and four annuli were counted on a coastal scute. This tortoise was collected near Mya Bone Tha – Takone Village in 2012. The second and third specimens were examined in Kyat Thin Village, although collected elsewhere. The second specimen was a carapace from a large adult (CL = 290 mm), and like the first, lacked an accompanying plastron. Without a plastron, determining sex was impossible; > 20 annuli were present on the costal scutes. This tortoise was originally collected from the vicinity of Kin San Camp sometime before 2000 by a hunter now residing in Taung Gya Village. The third specimen was an intact shell (carapace and plastron) owned by a local merchant. The merchant obtained the shell >25 years ago from a relative who worked for the timber company then extracting logs from CWS. However, the specific provenance of the specimen is unknown. The CL and PL of this shell measured 320 and 235 mm, respectively. Lack of a plastral concavity indicated the tortoise was a female. Although the CL this specimen exceeds the maximum size of most *G. platynota* (Platt et al., 2011), the carapacial annuli were worn and indistinct; consequently only 12-13 could be counted.

Conservation status within Chatthin Wildlife Sanctuary

Our interviews of numerous local informants confirmed the past occurrence of *G. platynota* in CWS. Most reported encounters with *G. platynota* in CWS and adjacent areas occurred 25-40 years ago. Any tortoise (both *G. platynota* and *Indotestudo elongata*) encountered by villagers was invariably collected for food. Perceptions of historic abundance varied among our informants and are probably influenced by individual hunting skills and time-effort expended searching for tortoises. One hunter stated that at least one tortoise could be found per day “about 30 years ago” (circa 1990) while another individual recalled taking only 3-4 tortoises annually during the same

Table 1: Summary of interviews conducted in Chatthin Wildlife Sanctuary and adjacent villages (8-21 June 2018).

Date	Location	Male	Female	Total	Notes
8-Jun-18	Kin San Camp	1	0	1	Mushroom collector
9-Jun-18	Kin San Camp	2	0	2	Hunters
10-Jun-18	Kin San Camp	2	0	2	Hunters
10-Jun-18	Sin Gon Village	14	8	22	Farmers
13-Jun-18	Kyar Inn Village	8	0	8	Farmers/fishermen
13-Jun-18	Sat Thwar Chaung	8	1	9	Farmers/elderly woman
15-Jun-18	Taung Gya Camp	2	0	2	Hunters
16-Jun-18	Pin Ma Ye	12	2	14	Farmers
16-Jun-18	Pay Tabin	9	0	9	Farmers
17-Jun-18	Ywar Thit	7	0	7	Farmers
17-Jun-18	Aung Chanthar	15	11	26	Farmers
18-Jun-18	Takone	0	1	1	Shopkeeper
18-Jun-18	Nyaung Gone	1	0	1	Retired Forest Department staff
19-Jun-18	Palu Thar	7	0	7	Farmers
19-Jun-18	Inngokto	5	6	11	Farmers
20-Jun-18	Tamar Gone	2	0	2	Farmers
21-Jun-18	Kyat Thin	2	0	2	Townsmen
21-Jun-18	Zabar Kwin Sakan	1	0	1	Farmer
Total		98	29	127	



Figure 1: Carapace of a juvenile Burmese Star Tortoise (*Geochelone platynota*) harvested by villagers near Mya Bone Tha – Takone in 2012. Despite the small body size (CL = 109 mm), this tortoise was eaten by villagers.



Figure 2: Two *Geochelone platynota* shells examined in Kyat Thin. The tortoise (CL = 290 mm) above was harvested near Kin San Basecamp sometime prior to 2000. The specimen below was harvested in Chatthin Wildlife Sanctuary > 25 years ago.

period. Other informants not actively seeking tortoises reported finding only 1-2/year, usually while searching for mushrooms, tending free-ranging cattle and water buffalo, or gathering medicinal plants and other non-timber forest products. Regardless, most individuals – based on either personal experience or hearsay from others – considered *G. platynota* to be “common” as recently as the 1980s and early 1990s.

Our informants reported few post-2000 observations of *G. platynota*. A shopkeeper reportedly encountered a group of eight juveniles in streamside vegetation near Mya Bone Tha – Takone Village during 2000. Based on the reported body size, the tortoises in this group were small juveniles rather than hatchlings. The reason for this unusual grouping is unknown, but the riparian vegetation may have provided a mesic refuge for the young tortoises, which are vulnerable to desiccation under extreme dry season conditions. The last verifiable record of *G. platynota* in the study area is the small specimen (CL = 109 mm) described above that was collected near Mya Bone Tha – Takone Village in 2012. The CL of this specimen is consistent with a young juvenile perhaps 2-3 years old. Therefore, breeding adults must have persisted in the area until at least 2009 or 2010. However, the recent dearth of reported encounters strongly suggests that although a few isolated individuals might remain, *G. platynota* is almost certainly functionally extinct within CWS and areas bordering the sanctuary.

The primary causes underlying the local extirpation of *G. platynota* in CWS and adjacent areas is two-fold. Foremost in importance was long-term chronic subsistence harvesting combined with commercial hunting for the local bushmeat trade. Rural villagers harvested most every tortoise encountered, even very small juveniles. Indeed, the smallest specimen we examined (CL = 109 mm) had been harvested for food. Even though most encounters with tortoises occurred opportunistically, the aggregate number collected must have been considerable. Moreover, several hunters we interviewed described organized tortoise hunts conducted many years ago in which hundreds of *G. platynota* and *I. elongata* were harvested and then sold for meat in local markets. Hunters typically entered the forest, established a basecamp, and then systematically denuded the surrounding area of tortoises. Dogs were often employed in these hunts and as expected, proved highly efficient in finding tortoises (see also Platt et al., 2003). Tortoises were returned to a central holding facility at the forest basecamp and later transported to area villages and sold in local markets. Because chelonian populations in general are unable to withstand even moderate levels of off-take (Brooks et al., 1991; Congdon et al., 1993), long-term subsistence harvesting coupled with intensive collecting for the local bushmeat trade no doubt sounded the death knell for *G. platynota* populations in CWS. Interestingly, tortoise populations in CWS seem to have collapsed well before the demand for *G. platynota* from high-end international pet markets became the primary driver of extinction. Several informants even expressed regret at having eaten tortoises in light of the current black-market value of *G. platynota*.

In addition to over-harvesting, habitat destruction undoubtedly played a significant role in the demise of *G. platynota* populations, especially in the Buffer Zone along the southern boundary of CWS. This area contained tracts of *Inn* Forest once inhabited by *G.*

platynota. However, upon completion of the Mu River Dam in the late 1990s, 57 villages were inundated and their inhabitants resettled along the southern boundary of the sanctuary. Ultimately, this resulted in widespread deforestation and conversion to agricultural lands and today much of the Buffer Zone consists of rice- and bean-fields with few significant tracts of tree cover remaining. What forest does remain is highly degraded and subject to continuing agricultural clearance, cattle grazing, exploitation for firewood production.

Our interviews suggest the former distribution of *G. platynota* was quite localized within CWS. Informants identified four general areas within the sanctuary where *G. platynota* formerly occurred: 1) *Kyauk Karr Kwin*, 2) *Ye Nauk Eye* (= Unclear Water Pond), 3) *Inn Palet*, and 4) Elephant Rock (GPS coordinates in Appendix 2). These areas are well-drained, slightly elevated sandy ridges characterized by relatively open deciduous forest with a high component of *Inn* (*Dipterocarpus tuberculatus*). The latter tree is considered an indicator plant for suitable *G. platynota* habitat within CWS. Understory plants in *G. platynota* habitat include various grasses and sprouts of regenerating trees (Figure 3). Natural and anthropogenic dry season fires are common and likely responsible for maintaining the open structure of *Inn* forest. Areas of CWS subject to wet season inundation are apparently avoided by *G. platynota*. Such areas are usually dry except during the wet season when 10-30 cm of water may remain standing for up to a week following heavy monsoonal rains. Flood-prone sites are typified by soils with a relatively high clay content, deciduous forest, and a dense understory of *Thek-kal*, a grass (scientific name yet to be determined) used locally as thatching (Figure 4).

Our informants stated that *G. platynota* once occurred sympatrically with *Indotestudo elongata* in *Inn* forest. However, in contrast to *G. platynota* which appears to exhibit very specific habitat preferences, *I. elongata* occurs (or once occurred) more widely, being found in most forest types in the sanctuary. Differing habitat preferences may in part explain the co-existence of the two species both in CWS and elsewhere (see Platt et al., 2001 for discussion of possible niche partitioning).

Traditional ecological knowledge and ethnoherpetology

Several vernacular names are locally applied to *G. platynota*, including *Mangyi Leik* (=Tamarind Turtle), *Pankyar Leik* (=Flower-striped Turtle), and *Seijo Leik* (=Oil Turtle). We speculate that *Mangyi Leik* refers to the streaks radiating from the yellow areola of each carapacial scute which bear a striking resemblance to structure and color of Tamarind (*Tamarindus indica*) flowers. *Pankyar Leik* is likewise thought to be a reference to Tamarind flowers. The vernacular name *Seijo Leik* is applied widely to *G. platynota* in central Myanmar and refers to the fact that carapaces of tortoises consumed as food are useful for dispensing sesame and peanut oils. Differences in the shell color of *G. platynota* can be quite pronounced (S.G. Platt, pers. obs.), and several informants attributed these to soil characteristics; tortoises found in areas of sandy soils are said to have lighter shells than those emanating from habitats with dark soils. One informant reported finding nests of *G. platynota* excavated in loose sandy soil beneath low shrubs.

The intact shells of dead tortoises found in the forest were assumed by informants to result from predation. Although direct observations are lacking, informants attributed predation to large cats (*Panthera pardis* and formerly *P. tigris*), which are said to “suck” the tortoise from the shell, leaving behind an intact shell.

Our informants provided a great deal of information on the natural diet of *G. platynota*. Although well-studied in captivity (e.g., Platt et al., 2017), the diet of *G. platynota* in the wild remains virtually unknown. According to our informants, a variety of fruits are consumed including *shar-zat* (*Agapetes adenobotrys*), *lin-yaw* (*Dillenia parviflora*), *te* (*Diospyros* sp.), *zinbyun* (*Dillenia pulcherrima*), *hman* (*Gardenia erythroclada*), and *ye mauk* (species yet to be determined). The succulent young foliage of *Dipterocarpus tuberculatus* is an important dry season food and possibly a source of moisture. Mushrooms are said to be an important component of the diet, especially during the early wet season and *G. platynota* reportedly consumes the same species of fungi that are avidly sought by humans. One hunter reported finding partially digested mushrooms in the stomach of a tortoise being butchered. Grass sprouting in the wake of dry season fires is also a preferred food item and tortoises reportedly visit mineral licks and consume mineral-laden soil.

Dry season fires of natural and anthropogenic origins are ubiquitous in deciduous forest habitats of central Myanmar and pose a potential threat to *G. platynota* (for fire-related mortality see also Platt et al., 2001). According to interviewees, tortoises avoid fires by seeking refuge in burrows constructed by other animals and subterranean cavities in termite mounds. Seasonal movement of tortoises into riparian vegetation was also reported; this micro-habitat is less apt to combust and would seem to confer some protection from dry season fires. Furthermore, if flames threaten, tortoises can move into the adjacent streambed where little fuel is available to carry a fire. One hunter described tortoises moving to sparsely vegetated gravel substrates during wildfires. Tortoises are also said to void copious amounts of urine on the ground at the approach of flames, thereby creating a small, very localized firebreak. Finally, tortoises often remain partially buried for much of the dry season, a behavior that exposes only the top of the carapace to passing flames during a wildfire and may explain the prevalence of fire-scars on the upper half of the carapace (Platt et al., 2015).

Hunters employed a variety of stratagems to harvest both *G. platynota* and *I. elongata*, the foremost being the use of trained hunting dogs to locate concealed tortoises. Most targeted hunting was carried out during the dry season, although tortoises are less active during this period. Hunters frequently set wildfires and captured tortoises fleeing before the flames. And by removing leaf litter and other ground debris, wildfires rendered concealed tortoises more visible to keen-eyed huntsmen. In the wake of fires, hunters carefully searched likely refugia such as hollow logs, animal burrows, and subterranean cavities in termite mounds that might shelter tortoises. Hunters also searched beneath certain trees for tortoises feeding on fallen fruits. In addition to targeted hunting, many tortoises were harvested when opportunistically encountered by



Figure 3: *Geochelone platynota* were formerly restricted to *Inn* (*Dipterocarpus tuberculatus*) forest in CWS. Note the relatively open canopy and understory of grass and tree sprouts.



Figure 4: Low-lying deciduous forest was avoided by *G. platynota*. Note the dense understory of *Thet-kal* (grass), an important local source of material for thatching.

villagers, usually while searching for mushrooms at the onset of the wet season (early June). One villager stated that tortoises insufficiently large to provide a meal for an entire family were left in the forest to mature with the expectation they would be harvested in the future.

Tortoises were at one time an important food source and widely consumed by rural villagers. However, several informants rated the taste of *G. platynota* meat as rather low, on par with the less palatable *Cyclemys fusca*, which is known locally as the “smelly turtle” owing to an associated strong odor. Our informants mentioned few other uses for *G. platynota* other than as a food resource. The carapaces of butchered turtles were sometimes used as scoops to dispense cooking oil or dried rice, hence the vernacular moniker of *Seijo Leik* (see above).

Other chelonians in CWS

Other chelonians reportedly occurring in CWS include Yellow Tortoise (*Indotestudo elongata*), Asian Leaf Turtle (*Cyclemys fusca*), Burmese Flapshell Turtle (*Lissemys scutata*), and two larger softshell turtles, most likely the Asian Giant Softshell Turtle (*Amyda cartilaginea*) and Burmese Peacock Softshell Turtle (*Nilssonina formosa*). The occurrence of *I. elongata* was confirmed during an earlier survey of CWS by Zug et al. (1998). Our interview data suggests *I. elongata* continues to persist in the sanctuary, albeit at very low levels, and the viability of these populations is doubtful. *Indotestudo elongata* remains subject to harvest, and mushroom collectors no doubt continue to encounter and harvest these tortoises. The meat is consumed locally and shells are sold for a minimal amount to itinerant merchants who regularly visit rural villages and ply their wares. We examined two carapaces (CL = 220 and 180 mm) from locally harvested *I. elongata* in Aung Chanthar on 17 June 2018. Zug et al. (1998) considering *I. elongata* extremely rare in CWS and found only a single small juvenile despite an intensive, months-long search.

Lissemys scutata appears widespread in anthropogenic wetland habitats surrounding CWS where it is regularly harvested for local consumption. We examined three living *L. scutata* during the survey. We captured the first specimen (CL = 160 mm) in a seasonal pond in the Kyauk Karr Kwin area (9 June 2018). A second specimen (CL = 190 mm) was obtained from a villager in Kyay Inn (14 June 2018). A third specimen (CL = 160 mm) was provided by a villager in Nyaung Gone. This turtle had been found crossing a footpath beside a small pond embedded in rice-fields about 1.0 mile from the village and later released near the point-of-capture. Our observations complement an earlier report of *L. scutata* in CWS (Zug et al., 1998).

Cyclemys fusca is also said to occur in the sanctuary, although we were unable to obtain specimens for verification. *Cyclemys fusca* was not reported by Zug et al. (1998). Two larger species of Trionychids were said by informants to occur in permanent creeks and lakes of CWS. Unfortunately, specimens to confirm these identifications were lacking and owing to a plethora of confusing vernacular names, we are unable to be

certain which species are actually present. Based on the physical descriptions provided by our informants, we consider it most likely the species being referred to are *Amyda cartilaginea* and *Nilssonia formosa*, neither of which was recorded during the earlier herpetological survey (Zug et al., 1998).

Conservation recommendations

Our survey indicates that while *G. platynota* once occurred within CWS, populations are now either reduced to extremely low levels or completely extirpated. Nonetheless, owing to the high-quality deciduous forest habitat, seemingly effective enforcement measures designed to protect Eld's Deer, and available infrastructure, we consider the reintroduction of captive-bred *G. platynota* to be a feasible management option for the sanctuary. Below we provide a set of management recommendations for such a reintroduction program. The successful Star Tortoise reintroduction programs at Minzontaung and Shwe Settaw wildlife sanctuaries served as the template for these recommendations. Our recommendations should not however, be considered absolute; some modifications will no doubt be necessary to address issues and concerns that are unique to CWS.

To briefly summarize, below we out-line a four-stage process with the ultimate objective of restoring a viable wild population of *G. platynota* in CWS. Security is of paramount concern and must first be addressed through public awareness and education coupled with intensive law enforcement patrolling. Habitat must then be assessed and specific target areas for reintroduction identified. A soft-release program using animals produced at in-country assurance colonies will the return tortoises to the wild. Finally, an on-going monitoring program will be necessary to determine the dispersal and survival of released tortoises. Modifications and changes can be made during any phase of the project if deemed necessary.

1. Conduct an assessment of the communities adjacent to (and in some cases within) CWS. These assessments should be designed to provide a better understanding of the conservation impacts of villages on the sanctuary and information on potential threats to reintroduced Star Tortoises. Such information is critical for tailoring public education programs to address specific conservation issues in targeted communities. Some information on local communities (e.g., demographics and impact assessment) is available from Friends of Wildlife (FOW), gathered as part of an Eld's Deer conservation project
2. Conduct public education and awareness campaigns in the communities in and around CWS. These campaigns will be modelled on similar campaigns conducted in communities adjacent to other wildlife sanctuaries where Star Tortoises have been reintroduced. Education campaigns should focus on different age cohorts (school children and adults) within the village. Local village leaders, and especially school teachers should play an active role in

these programs. Moreover, the participation of local Buddhist monks greatly enhances the likelihood of successful interactions with communities. Finally, community visits provide an excellent opportunity to identify individuals interested in serving as Community Conservation Cadres (CCCs).

3. Conduct training workshop for CWS staff and villagers interested in serving as CCC. Subjects covered during the workshop will include basic chelonian biology, law enforcement patrolling skills (SMART Patrolling), radio-telemetry and post-release monitoring skills, and tortoise husbandry and care. A written exam will be administered at the conclusion of the workshop to facilitate the selection of CCCs. Each person selected to participate in the project will receive a modest monthly stipend. CCCs provide a direct link between local communities and the conservation project.
4. Investigate specific areas of Star Tortoise habitat within CWS and assess the suitability of each as a potential reintroduction site. Particular attention must be given to security issues (e.g., proximity to sanctuary boundaries and villages, prevalence of unauthorized intruders, recent deer poaching incidents, etc.), existing infrastructure (buildings and permanent camps), and logistic arrangements (e.g., current staff levels, availability of water in the dry season, access, and ease resupply). A single reintroduction site will then be selected based on these criteria.
5. Construct three 1-ha pre-release acclimation pens and semi-permanent security basecamp (including watch tower) at the reintroduction site using locally sourced materials. These pens should encompass an area of high-quality natural forest and grassland habitat. Three shallow concrete pools should be installed in each pen to supply water to tortoises during the dry months. Each pen can accommodate 100-150 subadult tortoises depending on the availability of natural forage in the pens.
6. Assemble a group of ca. subadult (4- to 5-years-old) captive-reared *G. platynota* from stock currently held in the assurance colonies of Lawkanandar, Minzontaung, and Shwe Settaw wildlife sanctuaries. This group should consist of approximately equal numbers of male and female tortoises, or with a modest female bias. Once selected, the group should undergo a rigorous health assessment by the WCS/TSA wildlife veterinarian to minimize the risk of exposing existing wild populations of *Indotestudo elongata* to novel pathogens that might emanate from the assurance colonies. (Note: This is strictly a precautionary measure. Previous health assessments have yet to identify any serious pathogenic threats in the assurance colonies.). Each tortoise selected for release should be implanted with a microchip for permanent identification. Additionally, a unique

configuration of marginal scutes should be notched, and identification numbers and Buddhist icons tattooed on the carapace of each tortoise. VHF transmitters should be attached to a subset of the group to allow post-release monitoring with radio telemetry. The number of transmitters deployed will depend on funding availability; 20-40 transmitters should be sufficient.

7. Upon completion of the health assessment and marking, tortoises should be transferred from the assurance colonies to CWS and liberated in the acclimation pens. At this juncture, the tortoises are symbolically “donated” to a local monastery, blessed by the *Pongyi*, and then released into the pen. The release is often accompanied by a ceremony involving local villagers, village leaders, and government officials. These ceremonies imply tacit government endorsement for the project, high-light local participation (e.g., CCCs), and serve to further increase public awareness.
8. Tortoises will remain in the holding pens for about 12 months, with release timed to coincide with the termination of the annual wet season (ca. November). Supplemental feeding may prove necessary while tortoises are held in the pens, depending on the availability of natural forage. Security at the acclimation pens must be provided on a 24-7 basis to deter evil-doers who seek to purloin tortoises. Roving law enforcement patrols should secure the surrounding area in anticipation of eventual release. At the conclusion of the 12-month holding period, panels will be removed from the perimeter fence, and tortoises allowed to self-liberate.
9. Regular monitoring with radio-telemetry must be conducted to determine post-release dispersal and survival. Monitoring should be as intensive as permitted by the available resources. Furthermore, monitoring should be coupled with aggressive law enforcement patrols to deter poaching. Heightened levels of vigilance must be maintained during the early wet season when hordes from the surrounding villages enter the sanctuary to legally harvest the abundant mushrooms (Figure 5). Chance encounters with released tortoises might be a strong temptation for opportunistic theft. Therefore, it will be crucial to saturate the forest with enforcement personnel during this period.

Eld’s Deer enclosure at CWS

An enclosure is currently being constructed at San Myaung Camp to house an unspecified number of captive Eld’s Deer for viewing by eco-tourists visiting the sanctuary (Figure 6). The pen is being built in close proximity to cabins designed to accommodate tourists. During our survey, we were asked to assess the suitability of the deer pen for housing a group of captive *G. platynota*. The deer pen encompasses about 5-acres of deciduous forest habitat on the lower slope of a large hill mass. The site is near Elephant Rock, an area reputed to have formerly been inhabited by *G. platynota*. The pen consists of a low (ca. 90 cm high) brick and concrete wall topped by a high chain link

fence. At least two large gates will provide access to the pen. The habitat within the pen appears suitable for *G. platynota*; soils are well-drained, a layer of low ground cover (grass and tree sprouts) provides sufficient cover for tortoises, and adequate levels of shading are provided by the tree canopy. Furthermore, the pen seems largely escape-proof with the only point of concern being the gates. These had not yet been erected during our visit so we are unable to make specific design recommendations; however, even small gaps between the gate and lower frame could allow tortoises to escape from the pen. Although the Eld's Deer inhabiting the pen pose no danger to the tortoises, trampling and grazing of the vegetation will deprive tortoises of forage and cover. Therefore, the number of deer housed in the enclosure should be kept to a minimum. If these caveats can be addressed, the pen appears to be a suitable facility for housing a small assurance colony of captive-bred tortoises. Establishing an assurance colony in the deer pen would serve three purposes: 1) allow an evaluation of captive-reared tortoises under semi-natural conditions typical of CWS and provide insight into issues that might arise during an actual reintroduction, 2) produce offspring for head-starting and eventual reintroduction into the sanctuary, and 3) play an important role in public education and conservation awareness.



Figure 5: Chance encounters with hordes of mushroom who legally enter the sanctuary at the onset of the wet season pose a potential threat to any reintroduced tortoises. Heightened vigilance will be required by law enforcement staff during this period to guard against theft.





Figure 6: A deer pen currently being constructed in CWS could also house an assurance colony of *Geochelone platynota*. Except for the gates, the pen appears capable of containing tortoises and encompasses 5-acres of dry forest habitat.

Acknowledgements

We thank the Minister of the Ministry of Environmental Conservation and Forestry, Director General and Deputy Director General of the Planning and Statistics Department of the Ministry of Environmental Conservation and Forestry, Director General and Deputy Director General of the Forest Department and the Director of NWDC for granting us permission to conduct this survey. The assistance and hospitality of U Min Swe (Warden of CWS) was most appreciated. We are grateful for the field assistance provided Win Zaw Lhon and the staff of CWS. Funding for this project was provided by the Andrew Sabin Family Foundation. U Than Myint, U Saw Htun, Colin Poole, Rick Hudson, and Kalyar Platt were instrumental in insuring the success of our field work. We also thank Deb Levinson for assistance with obtained much needed literature, Lewis Medlock and Thomas Rainwater for thoughtful commentary on an early draft of this report, and U Kyaw Zay Ya for preparing our map

Literature Cited

- Alves, R.R.N., K.S. Vieira, G.G. Santana, W.L.S. Vieira, W.O. Almeida, W.M.S. Souto, P.F.G.P. Montenegro, and J.C.B. Pezzuti. 2012. A review of human attitudes towards reptiles in Brazil. *Environmental Monitoring and Assessment* 184: 6877-6901.
- Berkes, F., J. Colding, and C. Folkes. 2000. Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications* 10: 1251–1262.
- Beffasti, L. and V. Galanti. 2011. Myanmar Protected Areas: Context, Current Status, and Challenges. Instituto Oikos and BANCA, Ancora Libri, Milan, Italy. 86 pp.
- Brooks, R.J., G.P. Brown, and D.A. Galbraith. 1991. Effects of a sudden increase in natural mortality on a population of common snapping turtle (*Chelydra serpentina*). *Canadian Journal of Zoology* 69:1314-1320.
- Bruner, A. G., R. E. Gullison, R. E. Rice, G. A. B. da Fonesca. 2001. Effectiveness of parks in protecting tropical biodiversity. *Science* 291:125-128.
- Congdon, J.D., A.E. Dunham, and R.C. van Loben Sels. 1993. Delayed sexual maturity and demographics of Blanding's turtle (*Emydoidea blandingii*): implications for conservation and management of long-lived organisms. *Conservation Biology* 7:826-883.
- Gilchrist, G., M. Mallory, and F. Merkel. 2005. Can local ecological knowledge contribute to wildlife management? Case studies of migratory birds. *Ecology and Society* 10:20-31.

- Huntington, H.P. 1998. Observations on the utility of the semi-directed interview for documenting traditional ecological knowledge. *Arctic* 51:237-242.
- Huntington, H.P. 2000. Using traditional ecological knowledge in science: methods and applications. *Ecological Applications* 10:1270-1274.
- Leviton, A.E., G.R. Zug, J.V. Vindum, and G.O.U. Wogan. 2008. Handbook to the dangerously venomous snakes of Myanmar. California Academy of Sciences, San Francisco, California. 122 pp.
- Martin, G.J. 1995. *Ethnobotany: A methods manual*. Chapman Hall, London. 268 pp.
- Myint Aung, Khaing Khaing Swe, Thida Oo, Kyaw Kyaw Moe, P. Lemigruber, T. Allendorf, C. Duncan, and C. Wemmer. 2004. The environmental history of Chatthin Wildlife Sanctuary, a protected area in Myanmar (Burma). *Journal of Environmental Management* 72:205-216.
- Platt, K., S.G. Platt, Lay Lay Khaing, Thin Thin Yu, San San Nwe, Win Ko Ko, Khin Myo Myo, Kyaw Moe, Me Me Soe, Tint Lwin, N. Chansue, and K. Charapum. 2014. Star tortoise handbook for Myanmar: Conservation status, captive husbandry, and reintroduction. Proceedings of a Workshop, Bagan, Myanmar. Privately Printed, Yangon, Myanmar. 90 pp.
- Platt, K., S.G. Platt, Win Ko Ko, Khin Myo Myo, Kyaw Moe, and Me Me Soe. 2012. Photographic guide to the freshwater turtles and tortoises of Myanmar. Privately printed, Yangon, Myanmar. 54 pp.
- Platt, S.G., Kalyar, and T.R. Rainwater. 2004. Inle Lake turtles, Myanmar with notes on Intha and Pa-O ethnoherpetology. *Hamadryad* 29:5-14.
- Platt, S.G. and K. Platt. 2017. Progress continues in the fight to save Myanmar's critically endangered turtles. *Turtle Survival* 2017:38-43.
- Platt, S.G., K. Platt, Lay Lay Khaing, Thin Thin Yu, Shwe Htay Aung, San San New, Me Me Soe, Khin Myo Myo, Win Ko Ko, Swan Htet Naing Aung, and T.R. Rainwater. 2017. Back from the brink: *Ex-situ* conservation and recovery of the critically endangered Burmese Star Tortoise (*Geochelone platynota*) in Myanmar. *Herpetological Review* 48:570-575.
- Platt, S.G., Saw Tun Khaing, Win Ko Ko, and Kalyar. 2001. A tortoise survey of Shwe Settaw Wildlife Sanctuary, Myanmar, with notes on the ecology of *Geochelone platynota* and *Indotestudo elongata*. *Chelonian Conservation and Biology* 4:172-177.
- Platt, S.G., Thanda Swe, Win Ko Ko, Kalyar Platt, Khin Myo Myo, Thomas R. Rainwater, and D. Emmett. 2011. *Geochelone platynota* (Blyth 1863) – Burmese

Star Tortoise, Kye Leik. Conservation Biology of Freshwater Turtles and Tortoises: A compilation project of the IUCN Tortoise and Freshwater Turtle Specialist Group. Rhodin, A.G.J., P.C.H. Pritchard, P.P. van Dijk, R.A. Samure, K.A. Buhlman, J.B. Iverson, and R.A. Mittermeier (eds.). Chelonian Research Monographs 5:57.1-57.9.

Platt, S.G., K. Platt, Win Ko Ko, Khin Myo Myo, Me Me Soe, B.D. Horne, and T.R. Rainwater. 2015. *Manouria emys* (Asian Brown Tortoise). Fire scarring. Herpetological Review 46:83-85.

Salter, R.E., and J.A. Sayer. 1983. Kyatthin Wildlife Sanctuary draft management plan. FAO Rangoon, Field Document 6/85. 49 pp.

Sen Roy, N. and S. Kaur. 2000. Climatology of monsoon rains of Myanmar (Burma). International Journal of Climatology 20:913-928.

Smith, M.A. 1931. The fauna of British India, including Ceylon and Burma. Vol. 1. Loricata and Testudines. Taylor and Francis, London.

Stohlgren, T. J., J. F. Quinn, M. Ruggiero, and G. S. Waggoner. 1994. Status of biotic inventories in US national parks. Biol. Conserv. 71:97-106.

Thirakhupt, K. and P.P. van Dijk. 1994. Species diversity and conservation of turtles in western Thailand. Natural History Bulletin of the Siam Society 42:207-259.

Tuberville, T. D., J. D. Willson, M. E. Dorcas, and J. W. Gibbons. 2005. Herpetofaunal species richness of southeastern national parks. Southeast. Nat. 4:537-569.

Zug, G.H., Htun Win, Thin Thin, Than Zaw Min, Win Zaw Lhon, and Kyaw Kyaw. 1998. Herpetofauna of the Chattin Wildlife Sanctuary, north-central Myanmar, with preliminary observations of their natural history. Hamadryad 23:111-120.

Appendix 1: Annotated trip itinerary (4 to 28 June 2018). Place names in accordance with topographical maps issued by Government of Myanmar or local usage. Distance walked determined with Garmin GPS 76 or estimated with pedometer (ca. 2000 steps = 1.0 mile); asterisk denotes distance estimates based on pedometer.

-
- 4 June Travel by road from Yangon to Mandalay arriving ca. 1800 hr. Meet with Tint Lwin in early evening and discuss recent developments in captive-breeding of *Batagur trivittata* at Yadanabon Zool.
- 5 June Visit Yadanabon Zoological Gardens in Mandalay, inspect *Batagur trivittata* breeding enclosure, and unearth eggs and hatchlings from artificial sandbank. To date in 2018, 95 hatchlings have been produced at this assurance colony. Leave Mandalay (ca. 1000 hr) and drive north, stopping in Shwebo for lunch. Continue north to Kanbalu and visit administrative headquarters of Chattin Wildlife Sanctuary (arrive ca. 1600 hr). Meet with warden and then continue north to Forward Operating Base in Chattin Village. Meet with staff and discuss planned survey. **Weather** = scattered rainstorms along road to Kanbalu, but clearing in late afternoon.
- 6 June Hire water buffalo cart and together with motorcycles, transfer supplies and gear from Chatthin Village to Kin San Camp. Before leaving Chatthin, police arrive at camp to question us regarding security concerns. Phone Than returns to Yangon in vehicle. WKK, NWK, and SGP walk to Kin San Camp arriving ca. 1400 hr (distance = 6.8 miles rather than the reputed 8.0 miles). Meet many villagers harvesting mushrooms along the trail. **Weather:** Downpour in early morning and intermittent light showers throughout day; cloudy and overcast, but clearing in late afternoon.
- 7 June Hike from Kin San Camp to Moe Thauk Kin (= Flooded Field), an area where villagers reportedly found *Geochelone platynota* in the past. Interesting habitat consisting of low-lying semi-permanent wetlands surrounded by open, sparse dry forest with closely cropped grass. Approximately 2.0 miles from camp. Return to camp for lunch and rustication. Deploy two camera traps at mineral licks used by Eld's Deer in afternoon. **Weather:** Intermittent light rain through the morning and into mid-afternoon; cloudy and overcast but clearing in late afternoon.
- 8 June Heavy rains in morning forced cancellation of plans for long-distance hike to potential Star Tortoise habitat. Spent morning in camp reading and attending to various tasks. Interrogated a mushroom collector that wandered into camp and gleaned interesting information regarding local folk knowledge of turtles. After lunch made lengthy ambulatory circuit to visit Ye Nauk Eye (=Unclear Water Pond) and collect memory cards from

two camera traps deployed yesterday. Returned to camp ca. 1600 hr for brief respite. Hiked into forest to East of Kin San Camp in late afternoon (ca. 1700-1820 hr). **Weather** = Heavy rain beginning before dawn and continuing until ca. 1030 hr. Cloudy and overcast for remainder of day with distant rumblings of thunder.

- 9 June Interview two huntsmen that visited our camp before breakfast this morning. One hunter had extensive first-hand experience with *Geochelone platynota*. Depart Kin San Camp (ca. 0900 hr) and hike westward along old logging railroad to Kauk Karr Kwin, an area reputed to have once been inhabited by *Geochelone platynota*. Consume rations and capture *Lissemys scutata* at small pond in forest; photograph and release turtle. Inspect habitat at Kauk Karr Kwin, which is an open Dipterocarpus forest with grass understory and seemingly suitable for *G. platynota*. Return to Kin San Camp along abandoned railroad arriving ca. 1610 hr (distance walked = 11.10 miles). Three female Eld's Deer each accompanied by a fawn encountered during our hike; also numerous trackways. Rest briefly at camp and then walk to nearby mineral lick and recover memory card from camera trap; captured series of images showing nocturnal visit by female and young Eld's Deer. **Weather:** Rain before dawn, cloudy-overcast and clear throughout the day, brief downpour in late evening. Hot (high ca. 85F) and humid throughout the day.
- 10 June Interview two hunters that visited our camp this morning. Spend most of morning hiking from Kin San Camp to Sin Gon (=Elephant Head) Village, arriving ca. 1215 hr (distance = 5.3 miles). Much of hike took place during heavy rain and over sodden trail as we were beset upon by deer flies. Meet community leaders and conduct group interview rank-and-file villagers. Eat lunch with villagers and then visit elderly hunter and spouse (93 and 92 years-old, respectively). Glean very useful information regarding historic occurrence and distribution of *Geochelone platynota* in Chatthin Wildlife Sanctuary. Leave village and return to camp over same route arriving ca. 1820 hr. **Weather:** Intermittent rain throughout day, at times heavy.
- 11 June Team stands down for rest and resupply. NWK accompanies foraging party to Kyat Thin to replenish exhausted food stocks and arrange for bullock cart transport tomorrow. SGP remains in camp to attend to various administrative and reporting tasks. Heavy downpour at mid-day restricts outdoor activity. SGP bird-watching in late afternoon. Recover memory cards from both camera traps. **Weather:** Intermittent showers throughout day with torrential downpour at mid-day.
- 12 June Leave Kin San Camp (0830 hr) and hike to Ta Khon Daing Camp, arriving ca. 1330 hr after walking 7.6 miles. Much of hike was through

beautiful deciduous forest with some very large trees, especially in vicinity of Ta Khon Daing Camp. Set-up camp and consume lunch. Search for birds and other wildlife in late afternoon, returning to camp when heavy rain threatened (ca. 1800 hr). **Weather:** Cloudy and overcast with light rain throughout the day, and mild temperatures (high ca. 80F).

- 13 June Travel by boat from Ta Khon Daing Camp to Kyay Inn Village and interview headman and rank-and-file villager. Hike ca. 2 miles over an atrocious road slippery with mud to Sat Thwar Chaung, eat lunch, and then conduct interview with small group of villagers. Learned from villagers that Sat Thwar Chaung was founded 254 years ago (circa 1764). After completing interviews, hiked from Sat Thwar Chaung to Ta Khon Daing Camp via a roundabout track leading through beautiful deciduous forest with some large trees. Arrive in camp ca. 1600 hr and make brief late afternoon foray into nearby forest to search for birds. **Weather:** Overcast and cloudy with intermittent light showers throughout the day, and mild temperatures (high ca. 80F).
- 14 June Conducted boat-borne reconnaissance of Kyay Inn (0900-1100 hr); observed four Comb Ducks which are said by villagers to nest in this wetland. Returned to camp where most of team remained for the rest of the day. SGP searched for birds behind Ta Khon Daing Camp (1130-1230 hr), returned to camp for lunch and brief rest, and then spent remainder of afternoon hiking trails in the surrounding forest. Notable bird observations include Yellow-capped Woodpeckers, White-rumped Falcon, and Common Woodshrikes feeding fledgling Oriental/Eurasian Cuckoo. Returned to camp ca. 1820 hr. Local fishermen brought adult *Lissemys scutata* into camp; measured and released in Kyay Inn (wetland). **Weather:** Cloudy and overcast, but little rain.
- 15 June Assembled gear and loaded bullock cart before breakfast and left Ta Khon Daing Camp shortly thereafter. Hiked to Sat Thwar Chaung and thence to Taung Gya (distance not recorded). After a brief respite in Taung Gya we continued down the road for about 1.5 miles to Taung Gya Camp at boundary of Chatthin Wildlife Sanctuary. Interviewed a large group of villagers, police (including an obnoxious drunkard), and Forest Department staff. Two elderly villagers were only useful sources and provided a wealth of historical information. Another group from a nearby village was scheduled to arrive in mid-afternoon, but failed to appear. About 1600 hr I made a bird-watching foray into an area of mixed deciduous forest and farmland returning to Taung Gya Camp ca. 1800 hr. **Weather:** Cloudy and overcast with fleeting glimpses of sun, but no rain; hot (high ca. 80F) and very humid.

- 16 June Arise early (ca. 0500 hr) after spending a tiring night listening to drunks ramble, people hold cell phone conversations, and an early rising wench who seemed intent on waking the camp. Consume breakfast, load ox cart, and leave Taung Gya Camp (0730 hr). Hike about 3 miles to Pan Ma Ye Village and conduct interview. Little useful information gleaned from interviewees. People in this village were formerly fishermen dwelling along the Mu River and translocated to current location 17 years ago to remove them from the dam impoundment. Villagers remain focused on fishing and rice farming and rarely enter the forest except to clear land, hence their unfamiliarity with tortoises. Bird-watching in rice-fields near Pan Ma Ye after lunch (ca. 1300-1400 hr), and then return to village and rest. In late afternoon hike about two miles east to Pay Tabin Village and interview group of villagers concerning local occurrence of tortoises. One individual proved especially knowledgeable and related some interesting information. Hike back to Pan Ma Ye arriving near-dusk and establish bivouac. **Weather:** Cloudy and overcast in morning, clearing and sunny after lunch; with no clouds afternoon was a scorcher (high ca. 85F) and very humid.
- 17 June Load bullock cart before breakfast and after eating, hike to Pay Tabin Village, have tea and continue walking. Reach Ywar Thit about 0930 hr and conduct large group interview. Little useful information gleaned from the crowd. Continue walking to Aung Chanthar and interview another group of villagers, including an elderly (80 year-old) man known locally as the "Tortoise Master" who unfortunately was able to recall little of his earlier hunting career. Examined *Lissemys scutata* shell and two *Indotestudo elongata* carapaces before continuing our hike. By this time the sun had risen to full strength, little shade was available (having been destroyed by villagers), and the walking was brutal. Arrived at Let Khoke Pin ca. 1530 hr and make arrangements to stay for the evening. Examined a very small *Geochelone platynota* carapace that originated from a village to the east of Let Khoke Pin, which we intend to visit in the morning. Total distance walked ca. 9.0 miles. **Weather:** Cloudy and overcast until ca. 0930 hr, sun for rest of day, extremely hot (high ca. 95F) and humid.
- 18 June Loaded bullock cart, ate breakfast, and left Let Khoke Pin. Hiked about three miles to Mya Bone Tha – Takone, an amalgamation of four different villages displaced by dam construction about 20 years ago. Spoke with woman who encountered a group of eight small *G. platynota* near the village many years ago. Hiked from Mya Bone Tha – Takone to Nyaung Gone through a devastated landscape almost devoid of trees. This area was formerly part of the Buffer Zone of Chatthin Wildlife Sanctuary until cleared by translocated villagers and converted to rice fields and wasteland. Nary a tree remained standing for miles! Walking through this treeless landscape was exhausting given the heat, humidity, and lack of

shade. Reached Nyaung Gone, interviewed a retired Forest Department staff who resided at Kin San Camp from 1986-2011. Ate lunch and passed the heat of day before continuing our journey. Measured *Lissemys scutata* obtained from villager and later released the turtle in a nearby Chaung. Left Nyaung Gone ca. 1430 hr and hiked to Palu Thar. Encountered a group of White-throated Babblers (ca. 6 birds) along the way to Paul Thar. These birds are apparently rare in the greater Chatthin area and the liaison officer has observed them only once before. Arrive at Palu Thar and met village headman. Walk to nearby monastery, meet two residents monks, arrange to stay the night, and establish bivouac in spacious out-building. Total distance walked ca. 10 miles. **Weather:** Clear, very hot (high temperature ca. 95F), and extremely humid.

19 June Conduct interview of villagers in Palu Thar after breakfast; only two of the seven individuals seemed to know much about tortoises. Later in the morning we hosted a primary school group and provided an instructional talk on turtles and turtle conservation. Left Palu Thar ca. 1000 hr and hiked to Inngokto, arriving ca. 1230 hr. Our route lead through a mosaic of open Ricefields, scrubby pasture, and young second-growth deciduous forest. In one area we passed through abandoned farmland that was choked with regenerating *In* trees that were 3-4 meters tall and reportedly only two years old. Conducted interview in Inngokta (1530-1630 hr) and gleaned a surprising amount of new information about *Lissemys scutata*. Spent the remainder of the afternoon birding in ricefields surrounding the village. This proved to be one of the most diverse ricefield ecosystems that I have yet visited. Returned to village just before dusk to update field notes. **Weather:** Cloudy-overcast to partly cloudy, hot (high temperature ca. 95F), and very humid.

20 June Leave Inngotke (ca. 0700 hr) and hike to Tamar Gone, a distance of only about 2 miles. Search for birds in rice-fields and wetlands along trail, encountering several interesting species including White-bellied Minivet, Burmese Bushlark, and White-throated Babbler. Arrive at Tamar Gone ca. 0800 hr and wait while village headman rounds up suitable interviewees. Conduct interviews and leave village, walking through more rice-fields and wetlands to forested Buffer Zone of Chatthin Wildlife Sanctuary. Hike through small agricultural fields and arrive at Chatthin ca. 1100 hr. Rest after lunch and update field notes. Went bird-watching in rice-fields north of Kyat Thin along the railroad tracks. Unfortunately the local police commander got wind of my plans and assigned one of his men to accompany me. Together we walked about 2.0 miles N of Kyat Thin and returned along same route. The area traversed was mostly fallow and active rice-fields with a belt of scrub along the railroad tracks. Several noteworthy species were encountered including White-throated Babbler, Burmese Bushlark, Red-wattled Lapwing, and Intermediate Egret.

Returned to Kyat Than ca. 1800 hr. **Weather:** Cloudy-partly cloudy-clear and extremely hot (high temperature ca. 95F) and humid; light shower at 1330 hr that scarcely wet the ground.

- 21 June After breakfast we visited shop owner in Kyat Thin who has a large carapace of a Star Tortoise collected in the sanctuary (Taung Gya) about 20 years ago. Photographed and measured this shell and learned of another. Sought out this person who had an even larger shell, this one an intact carapace-plastron. Measured and photographed this shell and returned to sanctuary head-quarters. Along the way we chanced upon a large rookery of Cattle Egrets and Little Egrets nesting in gardens in town. Estimate the rookery contains as many as 150 nests, about 30% of which are those of Little Egrets with the remainder belonging to Cattle Egrets. Collected our gear at headquarters and then hiked to San Myaung Camp, conducting an interview along the way. We inspected a deer pen being constructed for Eld's Deer near San Myaung Camp. After lunch at San Myaung Camp we hiked through nearby rice-fields to Zabar Kwin Sakan where we interviewed a farmer who had taken Star Tortoises in past years. After completing the interview we hiked back to San Myaung Camp, took a brief tea break, and continued on to Kyat Thin. **Weather:** Cloudy to clear, very humid and hot in the afternoon (high temperature ca. 95F).
- 22 June Final day of fieldwork at Chatthin Wildlife Sanctuary. Hiked to monastery at base of Hman Chain Taung and hiked to summit (elevation = 1250 ft). Climb proved to be rather brief (ca. 45 minutes) and although steep in places, fairly easy. Summit is characterized by large boulders with scattered trees. Collected vegetation data for last three plots on our return down the mountain. Also visited pagoda on lower summit above monastery. Walked into village to eat lunch and returned to Forest Department Basecamp on edge of town. Assemble gear in preparation of return to Mandalay tomorrow. Went bird-watching in late afternoon in rice-fields surrounding Kyat Than. Walked about 2.0 miles north of town and returned along same route. **Weather:** Cloudy in morning, clear and hot in afternoon with a brief shower (high temperature ca. 90F).
- 23 June Left Kyat Thin early (0700 hr) and traveled by road to Mandalay, arriving ca. 1330 hr. Rendezvoused with Tint Lwin at 1600 hr and after a confab at our favorite Tea Shop near zoo, we rounded up two keepers and drove a short distance north of Mandalay to Sin Kwar Gyi village, which is home to Wa So Monastery where large numbers of wading birds roost and nest. I last visited the monastery in November 2015 when large numbers of Glossy Ibis were roosting on the grounds. Today we saw few Glossy Ibis, but found almost 200 nests of Little Egrets. Also, nesting were Intermediate Egrets (< 10% of rookery) and Cattle Egrets (about 20 nests). The Little Egrets and Intermediate Egrets were nesting in the many

Borassus palms on the monastery grounds. The Cattle Egrets were nesting in a Tamarind tree about 100 ft north of the perimeter wall surrounding the monastery. We remained at monastery until near-dusk and then returned to Mandalay.

- 24 June SGP remains in Mandalay to conduct further chelonian surveys along Dokhtawady River. Encounter several *Calotes mystaceus* in urban habitats of Mandalay. Transfer to hotel in "New Mandalay" (ca. 1300 hrs) and work on manuscript through much of afternoon. **Weather:** Partly cloudy to clear, humid, and hot (high temperature ca. 90F).
- 25 June Leave Mandalay and travel to villages along Dokhtawady River at base of Mya Leik Taung. Visit Thamanthar and interview hunter. Examined *Indotestudo elongata*. Visit Yatha Yar Village and locate shamaness who performed "Nat Ceremony" during our research in 2001 (see Platt et al., 2003). Interview several villagers who participated in earlier surveys. Returned to Thamanthar and spent much of afternoon searching for tortoises in scrub near village. Return to Mandalay in early evening. **Weather:** Cloudy and overcast with occasional sun, brisk breeze, and hot (high temperature ca. 85F).
- 26 June Arrived at Yatha Yar (ca. 0830 hr) with supplies for conducting a Nat Ceremony. Shamaness made the necessary preparations and performed the ceremony. Afterwards we hiked with hunters to base of Mya Leik Taung. We first visited a monastery where free-ranging tortoises reputedly were kept at large on the grounds. Then we hiked to a low ridge to inspect a site where a Star Tortoise was found in April 2017. From there we hiked through an area where Star Tortoise were found in 2001 and inspected habitat changes. We walked to point where road closely approached base of mountain and returned to village along road. After lunch we traveled by road upstream, stopping at several places to view the river. At Ye Wa Village we interviewed a group of fishermen concerning the possible occurrence of *Batagur trivittata*. We crossed the Dokhtawady River at Ye Wa and returned to Mandalay along north bank. A large DOR *Ptyas koros* was found along our route; the snake was measured and stomach contents (Button Quail) removed. We arrived in Mandalay ca. 1900 hr. **Weather:** Cloudy in morning, clear and hot in the afternoon with high temperature ca. 90F.
- 27 June Left Mandalay ca. 0920 hr and traveled to area south of Mya Leik Taung on Kyause Road. Rendezvoused with two hunters and spent about two hours inspecting habitat and searching for tortoises in area near transmission line corridor. Walked down the hill and met vehicle near a military checkpoint. Traveled to valley below and ate lunch in Yoe Yoe Lay. Afterwards we traveled a short distance to a community boat landing

at Sunye Inn where we hired a boat and made a brief excursion onto the lake; a nesting colony of Asian Golden Weavers was found in beds of *Nelumbo* that characterize shallow waters of the lake. Returned to Mandalay arriving ca. 1700 hr. **Weather:** Clear to partly cloudy, humid, and hot (high temperature ca. 90F).

28 June Left Mandalay ca. 0730 hr and traveled to Yetha Yar where we met group of hunters. Used dogs to search for tortoises along base of Mya Leik Taung. Found opening to what is said to be a very large underground cave that contains water (possibly a subterranean river). Followed base of mountain to Thamanthar Village. After lunch SGP walked back to Yetha Yar and met van for transport to Mandalay International Airport. Returned to Yangon ca. 1830 hr. **Weather:** Partly cloudy to clear, hot (high temperature ca. 95F), and dry (no recent rainfall).

Appendix 2: Expedition gazetteer: Geographic coordinates (latitude and longitude) and elevation (feet) of localities mentioned in the text. Place names in agreement with local usage; listed alphabetically in gazetteer. Geographic coordinates determined with Garmin GPS 76 (India-Bangladesh Datum).

Location	Latitude (N)	Longitude (E)	Elevation (feet)
Aung Chanthar	23°31'04.7''	95°28'43.8''	540
Elephant Rock	23°31'53.1''	95°38'43.3''	730
Hman Chaing Taung (Summit)	23°31'07.2''	95°39'31.5''	1250
Inngokto	23°28'15.2''	95°37'45.4''	643
Joe Karr Kwin	23°34'19.0''	95°33'30.9''	572
Kyauk Karr Kwin	23°33'24.1''	95°30'26.7''	630
Kyat Thin (Chatthin Village)	23°31'08.0''	95°40'20.2''	682
Moe Thauk Kin	23°32'03.1''	95°36'07.4''	570
Kin San Camp	23°33'02.1''	95°34'57.9''	592
Kyay Inn (village)	23°37'47.7''	95°30'07.5''	610
Kyay Inn (wetland)	23°36'17.7''	95°32'47.0''	560
Let Khoke Pin	23°29'38.7''	95°30'27.9''	660
Mandalay	21°56'03.0''	95°05'55.4''	250
Mya Bone Tha - Takone	23°36'51.4''	95°30'20.4''	564
Nyaung Gone	23°28'04.8''	95°32'09.6''	565
Palu Thar	23°27'07.1''	95°34'19.6''	568
Pan Ma Ye Village	23°33'17.8''	95°26'04.8''	716
Pay Tabin Village	23°31'45.7''	95°26'38.9''	540

San Myaung Camp	23°32'06.3''	95°38'48.1''	660
Sar Kyin Eye (stream crossing)	23°34'48.0''	95°34'26.5''	567
Sat Thwar Chaung	23°37'16.0''	95°29'56.3''	558
Sin Gon Village	23°36'41.7''	95°35'31.4''	596
Sunye Inn	21°41'16.4''	96°13'45.3''	320
Ta Khon Daing Camp	23°37'17.9''	95°31'50.7''	574
Tamar Gone	23°29'20.8''	95°38'24.4''	680
Taung Gya (village)	23°36'32.9''	95°26'33.2''	580
Taung Gya Camp	23°35'29.4''	95°26'12.2''	630
Thaman Thar	21°45'26.7''	96°17'41.4''	310
Wa So Monastery	22°02'12.9''	96°08'50.9''	285
Yatha Yar	21°48'36.4''	96°15'23.1''	300
Ye Nauk Eye	23°33'24.1''	95°35'42.3''	580
Ye Wa	21°41'18.8''	96°23'22.0''	374
Yoe Yoe Lay	21°40'47.5''	96°12'47.1''	323
Ywar Thit	23°30'54.0''	95°27'13.0''	650
Zabar Kwin Sakan	23°32'42.0''	95°39'21.1''	790

Appendix 3: Locality-based records of reptiles (other than chelonians) encountered during fieldwork in Chattin Wildlife Sanctuary (6 to 28 June 2018).

The herpetofauna of Myanmar remains poorly known; there is little recent information and much of the herpetological literature dates to the British Colonial Administration (e.g., Smith, 1931). With the exception of herpetofaunal inventories conducted in some protected areas by the Myanmar Forest Department in collaboration with the Smithsonian Institution (e.g., Zug et al., 1998), the country has not been studied in recent years, and even basic distributional and natural history information is lacking for most species (Leviton et al., 2008). Therefore, field observations of reptiles in Myanmar, particularly outside of protected areas are especially noteworthy. We here record opportunistic observations of reptiles made during fieldwork in central Myanmar during June 2018.

Tokay (*Gekko gekko*)

Tokay geckos were heard vocalizing in outbuildings at the Forest Department Forward Operating Base in Chattin Village (5 June 2018), Indiang Forest and buildings at Kin San Camp (6 June 2018), Indiang forest (23°33'28.3"N; 95°35'42.4"E; 580 ft; 8 June 2018), Village dwellings at Pin Ma Ye (16 June 2018), Let Khoke Pin (17 June 2018), and Inngokto (19 June 2018). Observed in outbuildings at Kin San Camp (9 June 2018) and DOR Tokay found in Kyay Inn Village (13 June 2018).

We found no evidence of commercial harvesting and our observations suggest Tokay geckos remain in natural and anthropogenic habitats in CWS. Elsewhere in Myanmar, Tokay geckos are subject to intense over-collecting for the traditional Chinese medicinal trade (Platt et al., *in review*).

Variable Lizard (*Calotes mystaceus*)

Single lizard basking on log structure in rice-field ca. 0.5 mile W of Pan Ma Ye Village (16 June 2018). Lizard was basking amidst a group of about 15 House Sparrows. Large male in Mya Bone Tha – Takone Village (18 June 2018). Lizard was in garden surrounding village tea shop and seemed unafraid of dogs lounging about, which likewise paid it little attention. Zug et al. (1998) consider *C. mystaceus* to be "uncommon" and largely restricted to agricultural habitats in the area around Chatthin Wildlife Sanctuary. Four lizards encountered at various locations in urbanized habitats of Mandalay (24 June 2018). *Calotes mystaceus* is apparently common in urbanized areas of the city. Single lizard flushed while searching for tortoises at base of Mya Leik Taung. Habitat was bamboo and scrub forest on lower slope of limestone hill (27 June 2018).

Bengal Monitor (*Varanus bengalensis*)

Monitor (TL ca. 600 mm) crossing Kyause Road, ca. 3.7 miles NE of Yoe Yoe Lay Village (21°43'23.3"N; 96°16'32.5"E; elevation = 800 ft). Habitat best described as scrub forest and bamboo growing on steep slope of limestone hills.

Wolf Snake (*Lycodon aulicus*)

Snake found in rotting, termite-ridden timbers of building at Kin San Camp. Reportedly common in CWS and our observation compliments earlier report from San Myaung Camp by Zug et al. (1998).

Appendix 4: Vegetation points sampled in Chatthin Wildlife Sanctuary (June 2018). Geographic coordinates determined with Garmin GPS 76 (India-Bangladesh Datum). At least four photographs taken at each site to show representative vegetation and forest structure. Photographs deposited with GIS Vegetation Mapping Team at WCS Headquarters in Yangon. Plants identified by Nay Win Kyaw and Win Zaw Lhon.

Point 1 (8 June 2018)

- **GPS Coordinates:** 23°33'33.9"N; 95°54'42.2"E.
- **Description:** Scattered trees, canopy ca. 50 ft. tall, open understory of grass and regenerating trees.
- **Dominant trees:** *Shorea siamensis* and *S. obtusa*, *Dalbergia fusca*, *Agapetes adenobotrys*.

Point 2 (8 June 2018)

- **GPS Coordinates:** 23°33'24.1"N; 95°35'42.3"E.
- **Description:** Sparse tree cover, canopy ca. 40 ft. tall, water-logged soil with closely cropped grass.
- **Dominant trees:** *Shorea siamensis* and *S. obtusa*, *Terminalia crenulata*, *Diospyros burmanica*, *Phyllanthus pomiferus*.

Point 3 (9 June 2018)

- **GPS Coordinates:** 23°33'26.1"N; 95°30'34.8"E.
- **Description:** Well-drained site, open canopy *In* forest with widely spaced trees, canopy 40-50 ft., grass understory.
- **Dominant trees:** *Dipterocarpus tuberculatus*, *Shorea siamensis* and *S. obtusa*, *Terminalia crenulata*, *Dalbergia fusca*, *Celtis cinnamomea*, *Agapetes adenobotrys*, *Bombax insigne*.

Point 4 (9 June 2018)

- **GPS Coordinates:** 23°33'25.5"N; 95°30'56.6"E.
- **Description:** Well-drained site, open canopy *In* forest with widely spaced trees, canopy 40-50 ft., grass understory with numerous *Dipterocarpus tuberculatus* (*In*) saplings.
- **Dominant trees:** *Dipterocarpus tuberculatus*, *Shorea siamensis*, *Aporosa macrophylla*, *Dalbergia fusca*, *Celtis cinnamomea*.

Point 5 (10 June 2018)

- **GPS Coordinates:** 23°35'27.7"N; 95°34'37.1"E.
- **Description:** Widely spaced trees with canopy to ca. 50 ft, understory of low grasses (ca. 30 cm), tree sprouts, and scattered Phoenix Palms on well-drained sandy substrate.

- **Dominant trees:** *Phyllanthus pomiferus*, *Terminalia crenulata*, *Terminalia chebula*, *Dipterocarpus tuberculatus*, *Dalbergia fusca*, *Kayea kunstleri*, *Cycus siamensis*, *Celtis cinnamomea*, *Shorea obtusa*.

Point 6 (10 June 2018)

- **GPS Coordinates:** 23°34'48.0"N; 95°34'26.8"E.
- **Description:** Riparian strip along seasonal watercourse (Chaung) with very large widely spaced trees, understory of tree sprouts, woody shrubs, and scattered clumps of *Dendrocalamus strictus* (bamboo).
- **Dominant trees:** *Chukrasia velutina*, *Terminalia crenulata*, *Kayea kunstleri*, *Dalbergia cultrata*, *Adina cordifolia*, *Dalbergia fusca*, *Dipterocarpus tuberculatus*, *Schleichera oleosa*, *Butea monosperma*.

Point 7 (12 June 2018)

- **GPS Coordinates:** 23°33'57.7"N; 95°33'59.6"E.
- **Description:** Widely spaced trees, open canopy (height ca. 40-60 ft), and understory of regenerating trees (sprouts) on sandy substrate.
- **Dominant trees:** *Dipterocarpus tuberculatus*, *Shorea obtusa*, *Shorea siamensis*, *Melanorrhoea usitata*, *Cycus siamensis*, *Dillenia parviflora*, *Celtis cinnamomea*, *Aporosa macrophylla*.

Point 8 (12 June 2018)

- **GPS Coordinates:** 23°34'19.0"N; 95°33'30.9"E.
- **Description:** Open canopy (height ca. 60-70 ft), widely spaced trees, with understory of regenerating trees (sprouts), short (ca. 1 ft) grass, and scattered clumps of bamboo (*Dendrocalamus strictus*).
- **Dominant trees:** *Lanea coromandelica*, *Adina cordifolia*, *Agapetes adenobotrys*, *Dalbergia cultrata*, *Chukrasia velutina*, *Shorea obtusa*, *Terminalia crenulata*, *Shorea siamensis*, *Cycus siamensis*, *Celtis cinnamomea*, *Dillenia parviflora*, *Kayea kunstleri*.

Point 9 (12 June 2018)

- **GPS Coordinates:** 23°35'24.7"N; 95°32'43.0"E.
- **Description:** Low-lying flood-prone site on heavy clay substrate; tall trees (to ca. 70 ft) with sparse understory, but many vines on trees.
- **Dominant trees:** *Terminalia crenulata*, *Chukrasia velutina*, *Butea monosperma*, *Adina sessilifolia*, *Adina cordifolia*, *Mitragyna parvifolia*, *Cycus siamensis*, *Kayea kunstleri*, *Albizia procera*.

Point 10 (12 June 2018)

- **GPS Coordinates:** 23°36'30.8"N; 95°32'13.1"E.
- **Description:** Low-lying forest with low canopy (ca. 40 ft), understory with dense "thatching grass" (species undetermined) on heavy clay substrate and abundant standing water.

- **Dominant trees:** *Dipterocarpus tuberculatus*, *Cycus siamensis*, *Kayea kunstleri*, *Melanorrhoea usitata*, *Gardenia sessiliflora*.

Point 11 (13 June 2018)

- **GPS Coordinates:** 23°36'11.1"N; 95°30'31.7"E.
- **Description:** Scattered large trees with open canopy (to 50 ft), understory of grass and much bare soil, well-drained sandy substrate.
- **Dominant trees:** *Dillenia parviflora*, *Cycus siamensis*, *Bauhinia malabarica*, *Kayea kunstleri*, *Dipterocarpus tuberculatus*, *Buchanania lanzen*, *Terminalia chebula*, *Celtis cinnamomea*, *Gardenia sessiliflora*.

Point 12 (13 June 2018)

- **GPS Coordinates:** 23°37'02.1"N; 95°31'30.0"E.
- **Description:** Widely spaced trees with low canopy (ca. 30-40 ft), understory with short grass (ca. 30 high) and scattered tree regeneration, on poorly drained sandy substrate.
- **Dominant trees:** *Dipterocarpus tuberculatus*, *Kayea kunstleri*, *Phyllanthus pomiferus*, *Terminalia chebula*, *Buchanania lanzen*, *Terminalia crenulata*, *Celtis cinnamomea*, *Bombax ceiba*, *Stereospermum suaveolens*.

Point 13 (13 June 2018)

- **GPS Coordinates:** 23°37'18.0"N; 95°31'46.7"E.
- **Description:** Widely spaced trees with high canopy (ca. 60-70 ft), dense understory of shrubs with some tree saplings on clay substrate.
- **Dominant trees:** *Dipterocarpus tuberculatus*, *Celtis cinnamomea*, *Dillenia parviflora*, *Dalbergia oliveri*, *Mitragyna rotundifolia*, *Aporosa macrophylla*.

Point 14 (14 June 2018)

- **GPS Coordinates:** 23°37'14.7"N; 95°31'49.5"E.
- **Description:** Closely spaced tall trees (canopy ca. 60-70 ft), some with vines, understory of tree sprouts growing on clay/sand substrate; some bare soil.
- **Dominant trees:** *Dipterocarpus tuberculatus*, *Cycus siamensis*, *Buchanania lanzen*, *Dillenia parviflora*.

Point 15 (16 June 2018)

- **GPS Coordinates:** 23°34'33.3"N; 95°26'37.4"E.
- **Description:** Disturbed site; scattered large trees (canopy height to 50 ft), understory choked with saplings (to 25 ft), on well-drained clay/sand substrate.
- **Dominant trees:** *Dipterocarpus tuberculatus*, *Melanorrhoea usitata*, *Dalbergia fusca*, *Kayea kunstleri*, *Cycus siamensis*, *Shorea obtuse*.

Point 16 (17 June 2018)

- **GPS Coordinates:** 23°31'05.7"N; 95°27'43.5"E.

- **Description:** Disturbed forest, no large trees remaining, profusion of saplings and smaller trees, canopy height to ca. 30 ft, with understory of grass and tree sprouts on heavy clay substrate.
- **Dominant trees:** *Phyllanthus pomiferus*, *Terminalia crenulata*, *Lanea coromandelica*, *Dillenia parviflora*, *Gardenia sessiliflora*, *Bombax insigne*, *Adina cordifolia*, *Agapetes adenobotrys*, *Shorea obtusa*, *Shorea siamensis*, *Stereospermum suaveolens*.

Point 17 (17 June 2018)

- **GPS Coordinates:** 23°30'35.0"N; 95°29'26.6"E.
- **Description:** Widely spaced trees, canopy height to ca. 50 ft, understory of scattered saplings and grass on sandy substrate.
- **Dominant trees:** *Dipterocarpus tuberculatus*, *Melanorrhoea usitata*, *Gardenia crythroclada*, *Terminalia chebula*, *Kayea kunstleri*, *Dalbergia fusca*, *Cycus siamensis*.

Point 18 (19 June 2018)

- **GPS Coordinates:** 23°27'36.6"N; 95°35'58.0"E.
- **Description:** Heavily disturbed site supporting young second-growth forest with no mature trees remaining; dense sapling regrowth (canopy 3-4 m high) with little understory vegetation other than scattered clumps of grass, accumulated leaf litter, and bare laterite soil.
- **Dominant trees:** *Dipterocarpus tuberculatus*, *Lanea coromandelica*, *Amoora rohiteska*, *Terminalia crenulata*, *Shorea siamensis*, *Shorea obtusa*, *Terminalia chebula*, *Gardenia obtusifolia*, *Dalbergia fusca*, *Buchanania lanzen*, *Melanorrhoea usitata*.

Point 19 (20 June 2018)

- **GPS Coordinates:** 23°30'03.0"N; 95°39'25.4"E.
- **Description:** Secondary "Mixed Deciduous Forest" with trees to ca. 40 ft. and dense understory of herbaceous vegetation and abundant bamboo (*Dendrocalamus strictus*) on lower slope of hill in Buffer Zone of Chatthin Wildlife Sanctuary.
- **Dominant trees:** *Terminalia chebula*, *Xylia xylocarpa*, *Melanorrhoea usitata*, *Dipterocarpus tuberculatus*, *Shorea siamensis*, *Shorea obtusa*, *Pterocarpus macrocarpus*, *Bridelia retusa*, *Buchanania lanzen*, *Lanea coromandelica*, *Terminalia crenulata*, *Dillenia parviflora*.

Point 20 (21 June 2018)

- **GPS Coordinates:** 23°31'55.0"N; 95°38'59.6"E.
- **Description:** Young forest on lower slope of hill (slope ca. 30%), closely spaced trees with canopy to ca. 50 ft and understory of tree sprouts and some herbaceous vegetation.
- **Dominant trees:** *Dipterocarpus tuberculatus*, *Melanorrhoea usitata*, *Gardenia crythroclada*, *Aporosa macrophylla*, *Cycus siamensis*.

Point 21 (21 June 2018)

- **GPS Coordinates:** 23°31'56.2"N; 95°38'52.9"E.
- **Description:** Young forest at base of hill, closely spaced trees with canopy to ca. 50 ft and understory of tree sprouts and some herbaceous vegetation.
- **Dominant trees:** *Dipterocarpus tuberculatus*, *Melanorrhoea usitata*, *Dalbergia oliveri*, *Xylia xylocarpa*, *Dillenia parviflora*.

Point 22 (21 June 2018)

- **GPS Coordinates:** 23°31'53.3"N; 95°38'43.5"E.
- **Description:** Second-growth deciduous forest of closely spaced trees on lower slope of hill (slope ca. 10%), canopy to 5-60 ft, with understory of grass and some tree regeneration (primarily sprouts). Plot encompassed within a 5-acre deer pen being constructed near San Myaung Camp.
- **Dominant trees:** *Dipterocarpus tuberculatus*, *Melanorrhoea usitata*, *Aporosa macrophylla*, *Xylia xylocarpa*, *Kayea kunstleri*, *Diospyros burmanica*, *Protium serratum*, *Dillenia parviflora*.

Point 23 (22 June 2018)

- **GPS Coordinates:** 23°31'18.2"N; 95°39'47.8"E.
- **Description:** Second-growth forest on lower slope of Hman Chaing Taung (elevation ca.800 ft); heavily disturbed by fuelwood cutting and few large trees remaining (canopy height to 40 ft); understory of shrubs and herbaceous vegetation; slope ca. 45°.
- **Dominant trees:** *Berrya ammonilla*, *Pterocarpus macrocarpus*, *Xylia xylocarpa*.

Point 24 (22 June 2018)

- **GPS Coordinates:** 23°31'07.2"N; 95°39'31.5"E.
- **Description:** Summit of Hman Chain Taung (elevation ca. 1250 ft); small trees (canopy height ca. 30-40 ft) growing amidst large boulders with open understory of herbaceous vegetation and tree sprouts.
- **Dominant trees:** *Dipterocarpus tuberculatus*, *Melanorrhoea usitata*, *Phyllanthus pomiferus*, *Shorea obtusa*, *Albizia procera*, *Kayea kunstleri*.

Point 25 (22 June 2018)

- **GPS Coordinates:** 23°31'14.3"N; 95°39'41.4"E.
- **Description:** Ridgeline on Hman Chain Taung (elevation ca. 940 ft) with low secondary forest of widely scattered trees (canopy height ca. 30-40 ft); understory choked with herbaceous vegetation and bamboo.
- **Dominant trees:** *Bombax insigne*, *Dalbergia fusca*, *Xylia xylocarpa*, *Berrya ammonilla*.