

Population status and conservation of the Critically Endangered Burmese Star Tortoise *Geochelone platynota* in central Myanmar

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Abstract The Critically Endangered Burmese star tortoise *Geochelone platynota* is endemic to the dry zone of central Myanmar. Although quantitative assessments are lacking, populations are believed to be in decline throughout its limited range due to over-collecting for international markets. We conducted star tortoise surveys during 2000–2001 at two sites in central Myanmar: Minzontaung Wildlife Sanctuary, a protected area established in 1998–1999, and Myaleik Taung, an area recently proposed for protected status. *G. platynota* populations of global conservation significance were found at both sites. Because tortoises are protected by local

religious beliefs and commercial collecting is so far non-existent, the Sanctuary and Myaleik Taung offer excellent prospects for star tortoise conservation. The Sanctuary is well patrolled, protected from wildfires, and access is rigorously controlled. Recommended conservation actions at Myaleik Taung include management of live-stock grazing, prescribed burning, and elimination of fuelwood cutting.

Keywords Burmese star tortoise, dry zone, *Geochelone platynota*, Myanmar, nat worship, tortoise conservation.

Introduction

The Burmese star tortoise *Geochelone platynota* is endemic to the dry zone of central Myanmar (Moll, 1989), and is categorized as Critically Endangered on the IUCN Red List and listed on Appendix II of CITES (Bhupathy *et al.*, 2000; IUCN, 2002; CITES, 2003). *G. platynota* is one of the least studied of all living tortoises; its distribution within the dry zone remains ill defined, few recent locality records are available, and virtually nothing is known concerning the current conservation status or ecology of wild populations (Groombridge, 1982; Moll, 1989; van Dijk, 1997; Platt *et al.*, 2000). Significant numbers of

G. platynota are illegally exported from Myanmar to international food, medicinal, and pet markets, and the high demand for living tortoises is encouraging over-exploitation of wild populations (Das, 1997; Platt *et al.*, 2000). Van Dijk (1997) speculated that *G. platynota* populations are declining due to over-collecting and habitat destruction, but noted that quantitative survey data on which to base conservation decisions are unavailable. Platt *et al.* (2001) found that *G. platynota* in Shwe Settaw Wildlife Sanctuary had been driven to near-extinction by subsistence and commercial harvesting, and considered the future of this population to be tenuous at best. There are no conservation assessments from elsewhere in Myanmar, and population surveys have been accorded high priority (Groombridge, 1982; Moll, 1989; Das, 1997; van Dijk, 1997; Platt *et al.*, 2000). Here we present data on the occurrence and status of hitherto unreported populations of *G. platynota* at Minzontaung Wildlife Sanctuary and Myaleik Taung in central Myanmar, and provide conservation recommendations based on our findings.

Study area

Minzontaung Wildlife Sanctuary and Myaleik Taung are located within the dry zone of central Myanmar, a semi-arid region formed by the rain shadow of the Arakan Yoma Mountains (Fig. 1). The dry zone experiences a tropical monsoonal climate with a wet season extending from late June to October followed by a prolonged dry season from late October to June (Scott, 1989; Terra, 1944). Annual precipitation in the dry zone is 50–100 cm

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Received 12 July 2002. Revision requested 14 January 2003.

Accepted 16 June 2003.

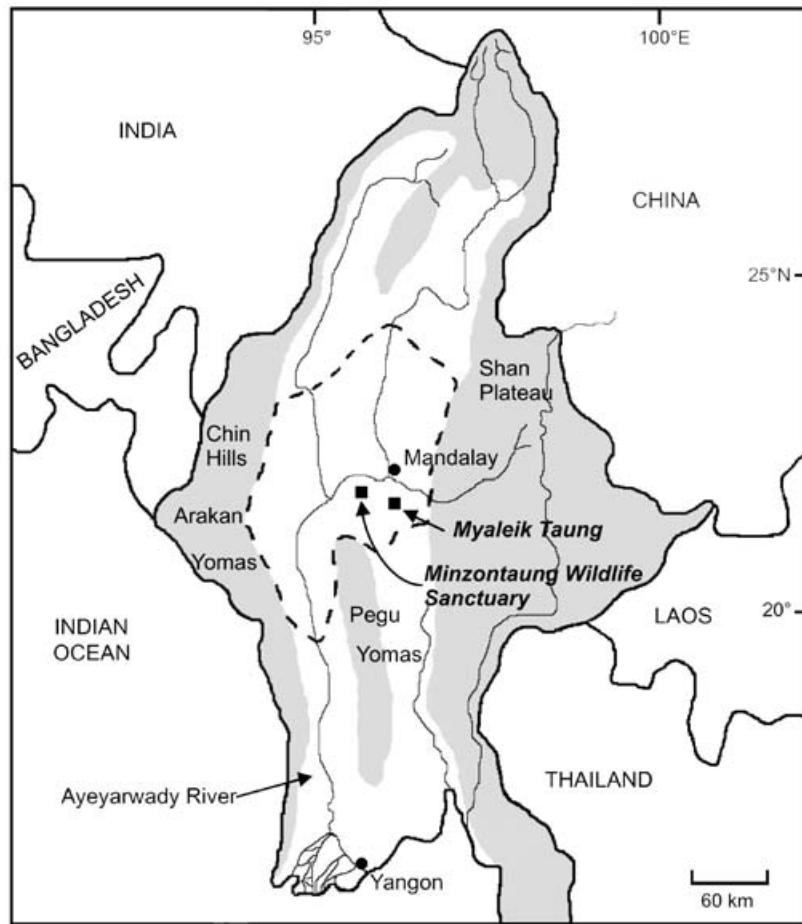


Fig. 1 Map of Myanmar showing the location of Minzontaung Wildlife Sanctuary and Myaleik Taung. The approximate extent of the dry zone is denoted by the dashed line. Hill ranges and mountains are indicated by shading.

(Terra, 1944); the two areas are encompassed by the 40 inch (76 cm) rainfall isohyet of Stamp & Lord (1923). The dry zone experiences high diurnal temperatures during the dry season (maximum = 43°C), and low nocturnal temperatures during the 'winter' months (January–February; minimum = 4°C) (FAO/UNDP, 1982).

Minzontaung Wildlife Sanctuary is approximately 60 km south-west of Mandalay in Nwahtogyi Township, Myingyan District, Mandalay Division. The sanctuary was established in 1998–1999 for the protection of Eld's deer *Cervus eldi thamin* and comprises 2,260 ha. The topography is dominated by Minzon Taung, an isolated hill with a maximum elevation of 398 m. The surrounding terrain is 200–225 m above sea level and generally flat except for some deep ravines. There are no permanently flowing streams in the Sanctuary and there is no surface water during most of the year. The vegetation resembles the Thorn Forest and Thorn Scrub associations described by Stamp & Lord (1923). Dominant trees include *Acacia catechu*, *A. leucophlorea*, *A. arabica*, *Tectona hamiltoniana*, *Terminalia oliveri*, and the exotic *Prosopis juliflora*. Dense grasses *Grewia microcos*, *Diectomis fastigata* and *Apluda mutica* occur in open areas. Patches of *indaing* forest

dominated by *Tectona hamiltonii*, *Xylia dolabriformis*, *Dipterocarpus* spp. and clumps of bamboo *Dendrocalamus strictus* are found on the upper slopes of Minzon Taung. The area comprising the Sanctuary was largely deforested prior to its establishment, but vegetation is regenerating and average canopy height exceeds 4 m. The sanctuary is surrounded by agricultural land and little natural vegetation remains outside the sanctuary boundaries.

Myaleik Taung is approximately 22 km south-east of Mandalay along the Dokhtawady River (also known as the Myitnge) in Sinkgaing Township, Kyaukse District, Mandalay Division. It is a sandstone mountain in the western foothills of the Shan Plateau with a maximum elevation of 744 m (Chibber, 1933). The original vegetation of Myaleik Taung was probably Than-Dahat Forest (Davis, 1964), but today the lower slopes are deforested as a result of fuelwood cutting. Wildfires are common during the dry season and we found signs of recent (2001) burning even near the summit. Dense bamboo *D. strictus* brakes, an anthropogenic formation resulting from tree removal and repeated burning (Davis, 1964) now cover most of the mountain (Plate 1). The



Plate 1 Bamboo brake at the base of Myaleik Taung. This photograph was taken during March 2001 at the height of the annual dry season. Note the lack of foliage and ground cover.

Forest Department recently proposed the designation of 3,240 ha of Myaleik Taung as the Myaleik Taung (Kwenahpa Taung) National Star Tortoise Sanctuary. The Dokhtawady River Valley below Myaleik Taung was settled in the early 1970s and is now densely populated. The composition of the original vegetation is somewhat speculative, but British military maps dating from World War II label the Dokhtawady Valley as “dense jungle, mainly bamboo” (Sheets 93 C1 and C5 issued by Survey Headquarters, Burma Command, November 1944), and Searle (1928) describes this area as “Bamboo Forest”. The river valley has since been converted to agricultural fields, and cultivation extends to the base of Myaleik Taung. Cotton, corn, and beans are the principal crops, and livestock graze in fallow fields. Agricultural fields are separated by narrow hedgerows of bamboo and thorn scrub (Plate 2), and small clumps of brush are scattered throughout, especially on rocky patches that cannot be tilled.



Plate 2 Agricultural habitat in the Dokhtawady River floodplain below Myaleik Taung. Star tortoises frequently utilize small hedgerows between fields as cover.

Methods

Field surveys were conducted at Minzontaung Wildlife Sanctuary from 18 November to 5 December 2000 and during 13–19 June 2001. Searchers varied from one to 14 and were accompanied by 1–9 local hunting dogs. Surveys were conducted at Myaleik Taung over 20–23 March and 22–30 June 2001. Searchers varied from two to nine and were accompanied by 2–4 local hunting dogs. Surveys at both sites were conducted during the morning (06.00–09.00) and late afternoon (16.00–18.30). Search effort was quantified as the number of man- and dog-hours required to locate one tortoise, and was used as a measure of relative abundance (Stubbs *et al.*, 1984; Klemens & Moll, 1995).

Tortoises captured in the Sanctuary were taken to base camp and released the following day at the capture site. Tortoises found at Myaleik Taung were measured in the field and released immediately, in accordance with the desires of villagers. Captured tortoises were marked by notching a unique series of marginal scutes (Cagle, 1939). The straight-line carapace length (CL) of each tortoise was measured with tree calipers. The sex of large juvenile and adult tortoises was determined based on differences in shell and tail morphology (Platt *et al.*, 2001). We interviewed local villagers to obtain information on religious beliefs and exploitation of tortoises. Any available shells were measured, sexed if possible, and photographed.

Results

Minzontaung Wildlife Sanctuary

Twelve (10 individuals and two recaptures) and five (four individuals and one recapture) captures of *G. platynota* were made during field surveys in November 2000 and June 2001, respectively (Table 1). Although the upper slopes of Minzon Taung were searched, all captures occurred in the surrounding lowlands. Both Buddhist monks living near the summit and villagers assert that *G. platynota* does not occur on Minzon Taung. Three additional tortoises were found by sanctuary rangers, three shells were obtained from a nearby village, and another was found in the Sanctuary. We also examined 13 *G. platynota* recently captured in the Sanctuary and held in an enclosure at Sanctuary headquarters. Our total sample consisted of 19 males and 11 females, a small juvenile and three shells lacking plastrons that could not be reliably sexed. The mean (± 1 SD) carapace length was 13.6 ± 4.3 cm (range = 4.0–25.0 cm; $n = 34$); our sample was dominated by small to intermediate sized tortoises (Fig. 2).

Table 1 Man- and dog-hours of searching, number of tortoises captured (including recaptures) and search effort (hours required to locate each tortoise) at Minzontaung Wildlife Sanctuary and Myaleik Taung, Myanmar.

	Minzontaung Wildlife Sanctuary			Myaleik Taung		
	November 2000	June 2001	Total	March 2001	June 2001	Total
Man-hours	718.5	331.3	1,049.8	46.5	247.5	294.0
Captures	3	2	5	2	9	11
Search effort	239.5	165.6	209.9*	23.5	27.5	26.7*
Dog-hours	246.7	185.9	432.6	8.0	134.7	142.7
Captures	9	3	12	1	21	22
Search effort	27.4	61.9	36.0*	8.0	6.4	6.5*

*Calculated by dividing total man- or dog-hours by total captures.

Myaleik Taung

Three and 30 (28 individuals and two recaptures) *G. platynota* were captured during field surveys in March and June 2001, respectively (Table 1), and two shells were found at Myaleik Taung. Of the total of 31, there were 17 females and 11 males, four neonates and a shell (posterior half of carapace missing) that could not be sexed. The mean (\pm 1SD) CL was 14.6 ± 6.8 cm (range = 4.2–27.8 cm; $n = 32$). Mean CL did not differ significantly ($P > 0.05$) between Minzontaung Wildlife Sanctuary and Myaleik Taung (CL measurements log transformed to meet assumptions of normality; $t_{(2),65} = 0.04$). Larger size classes were well represented in the sample (Fig. 2). Two females (CL = 27.8 and 26.2 cm) found at Myaleik Taung are the largest *G. platynota* we examined during 2 years of fieldwork (Plate 3).

Star tortoises were found in both natural and agricultural habitats; 20 (60.6%) were captured in bamboo brakes, 6 (18.1%) in fallow agricultural fields, and 7

(21.2%) in cultivated agricultural fields. Agricultural land is important tortoise habitat at Myaleik Taung; villagers frequently encounter *G. platynota* in fields and many of the tortoises we found were in close proximity to agricultural fields and probably move into fields to graze. We also noted numerous tortoise resting sites or 'forms' in hedgerows, which provide important cover in agricultural habitats.

Discussion

The size distribution of *G. platynota* in Minzontaung Wildlife Sanctuary is suggestive of a population in which decreased survivorship among the larger size classes is reflected in a higher proportion of juveniles and small adults (Robinson & Redford, 1994; Klemens & Moll, 1995; Close & Seigel, 1997; van Dijk, 1998). We speculate this is the result of low levels of chronic mortality from wildfires and opportunistic subsistence harvesting before the sanctuary was established. In

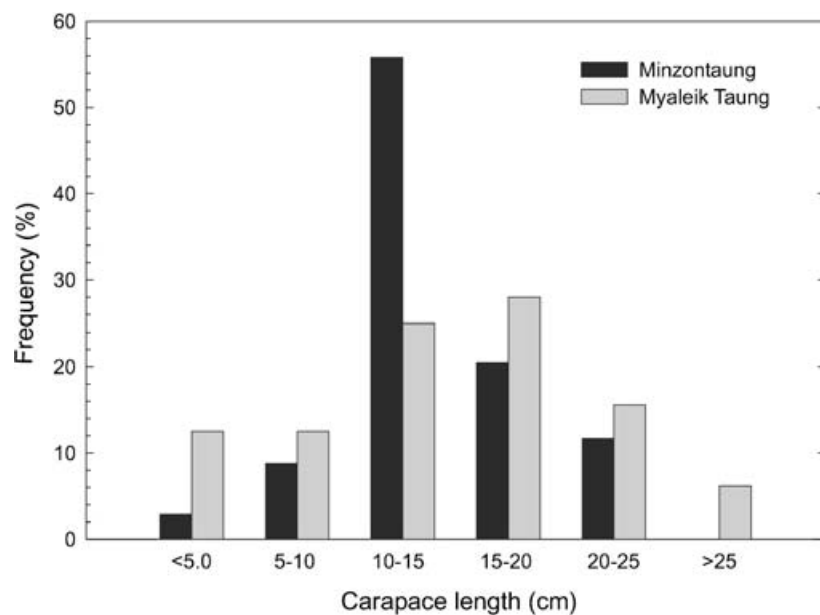


Fig. 2 Frequency distribution (%) of *Geochelone platynota* size classes from Minzontaung Wildlife Sanctuary ($n = 34$) and Myaleik Taung ($n = 32$).



Plate 3 Female star tortoise captured in a fallow cotton field near the base of Myaleik Taung during March 2001. This was the largest star tortoise (carapace length = 27.8 cm) found in two years of fieldwork.

contrast, large tortoises were frequently encountered at Myaleik Taung indicating that exploitation has been minimal.

The search effort required to find tortoises in the Sanctuary varied greatly between surveys; fewer man-hours and more dog-hours of searching were needed to find tortoises in June than in November (Table 1). This variation is difficult to explain, but was probably due to the differing abilities of searchers, including dogs. With the exception of ourselves, different people participated in each survey, and inter-observer bias in locating tortoises is significant (Freilich & LaRue, 1998). Likewise, different dogs were used in each survey, and hunting ability undoubtedly varies among individuals. In contrast, the same people and dogs participated in both surveys of Myaleik Taung and the search effort required to find tortoises was similar in the two months. At both Minzontaung Wildlife Sanctuary and Myaleik Taung dogs were more efficient at locating tortoises than people (Table 1), underscoring the value of dogs in studies of terrestrial chelonians. Similarly, Schwartz *et al.* (1984) used dogs to locate large numbers of *Terrapene carolina*, a cryptic terrestrial turtle in eastern North America.

Considerably more search effort was required to find tortoises at Minzontaung Wildlife Sanctuary than at Myaleik Taung, suggesting a difference in relative abundance. However, between-site comparisons of relative abundance are probably inappropriate for several reasons. Firstly, habitat differences between Myaleik Taung (open bamboo brakes with little ground cover and agricultural habitats) and the Sanctuary (impenetrable thorn scrub) undoubtedly biased results by affecting the probability of finding tortoises. Secondly, search effort at the Sanctuary was inflated by ineffectual surveys of the upper slopes of Minzon Taung, an area

where *G. platynota* apparently does not occur. Finally, a greater number of dogs were used at the Sanctuary, which theoretically should increase capture probabilities. However, our observations of hunting dogs suggest that when deployed in large packs, as at the Sanctuary, only one or two dominant animals actively search for tortoises while the remaining dogs follow idly until the quarry is found. Thus, using packs of hunting dogs only inflates the number of dog-hours without yielding a concomitant increase in the probability of finding tortoises. If search effort could be corrected to include only those dogs actually searching, the dog-hours required to find each tortoise at the Sanctuary would be considerably less than the reported value. In the future we recommend using dogs singly or in pairs.

Shell damage suggestive of fire injuries (Dodd *et al.*, 1997; Lambert *et al.*, 1998) were noted on 5 (15.6%) and 14 (42.4%) *G. platynota* from Minzontaung Wildlife Sanctuary and Myaleik Taung, respectively, and the two shells found at Myaleik Taung were probably from fire-killed tortoises. Uncontrolled wildfires were probably an important source of mortality prior to the establishment of the Sanctuary, but an effective fire management program has since been instituted. In contrast, wildfires are common at Myaleik Taung and may pose a threat to tortoises, especially smaller individuals. Elsewhere in tropical Asia uncontrolled wildfires often result in significant mortality to many turtle and tortoise populations, particularly among smaller size classes (Thirakhupt & van Dijk, 1994; Chan-ard *et al.*, 1996; Mitchell & Rhodin, 1996; Das, 1997; van Dijk, 1998).

We found no evidence of commercial harvesting of *G. platynota* in either area, which is surprising given the high market value of living tortoises and the proximity of both sites to Mandalay, the centre of an extensive illegal wildlife trade and a major trans-shipment point for turtles destined for markets in southern China (Platt *et al.*, 2000). A few villagers living near the Sanctuary formerly harvested *G. platynota* on an opportunistic basis for food. We obtained two shells of recently collected tortoises, suggesting this practice continues, although villagers stated that it is not widespread. In contrast, according to villagers, harvesting at Myaleik Taung is non-existent. This is strongly supported by the ease with which we located tortoises, the prevalence of large adults in our sample, and the fact that tortoises occur in accessible, anthropogenic habitats such as bamboo/field ecotones, hedgerows and cultivated fields, areas where they would be unlikely to survive if subject to even infrequent harvest.

We attribute the continued survival of *G. platynota* at Myaleik Taung, and to a lesser extent at Minzontaung Wildlife Sanctuary, to protection conferred by the practice of nat worship. Nats are supernatural beings

believed to inhabit forests, fields and hills, and form the basis of elaborate local cults (Spiro, 1967). Nats are perceived as jealous overlords of their domain, harming those who fail to recognize their suzerainty, but at the same time protecting those who acknowledge their dominance by proper propitiation (Spiro, 1967). Villagers near the two areas believe that tortoises (both *G. platynota* and *Indotestudo elongata*) are protected by nats residing in Minzon Taung and Myaleik Taung, respectively. A person who harms or even unduly disturbs a tortoise faces retribution in the form of misfortune, sickness or even death. Prior to initiating our surveys we were requested to participate in ceremonies conducted by a shamaness who made offerings to the nats as evidence of our good intentions (Plate 4). Only after performing these ceremonies would local hunters agree to assist us in searching for tortoises. These beliefs are particularly strong near Myaleik Taung, where villagers requested that tortoises not be brought into the village for fear that bad luck would befall the community. We were also asked to reorient captured tortoises to the same direction as we found them, although the significance of this practice is unclear. Nat worship is ubiquitous throughout rural Myanmar and its use in tortoise conservation at other sites warrants exploration.

While there are probably as yet unidentified populations of *G. platynota* elsewhere in central Myanmar, those in Minzontaung Wildlife Sanctuary and Myaleik Taung are the only viable populations currently known and therefore of global conservation significance. Because local religious beliefs afford a high degree of protection and commercial poaching is so far non-existent both sites offer excellent prospects for star tortoise conservation. Although these areas are relatively



Plate 4 Shamaness at Myaleik Taung making an offering to supernatural beings known as nats prior to initiating our field survey. Villagers believe that tortoises are protected by nats inhabiting the mountain, and would not assist us until this ceremony was performed.

small, when given adequate protection, tortoises frequently occur at high densities and even small areas may support large populations (Mushinsky & McCoy, 1994; van Dijk, 1998; Freilich *et al.*, 2000; Hailey & Willemsen, 2000). Furthermore, the Sanctuary is well patrolled, wildfires are rare, and with the exception of a few herders, people rarely enter the sanctuary.

Myaleik Taung harbors the least disturbed and most significant *G. platynota* population yet identified in Myanmar. The recently proposed Myaleik Taung National Star Tortoise Sanctuary will be managed by the Nature and Wildlife Conservation Division of the Myanmar Forest Department. Management guidelines for the proposed sanctuary are currently unavailable but urgently required, as the area remains subject to livestock grazing, frequent wildfires, and fuelwood cutting. The effect of livestock grazing on tortoises represents a complex interaction between climate, vegetation, forage availability and grazing intensity that must be evaluated in a site-specific context (Kazmaier *et al.*, 2001). However, because livestock may compete with tortoises for grass (Oldemeyer, 1994), we recommend that grazing be regulated, although not necessarily eliminated, within the proposed sanctuary. Uncontrolled wildfires pose a direct threat to tortoises and therefore fire management must be part of any conservation plan. Rather than attempt to exclude fires from this naturally pyrogenic ecosystem (Stott, 1988), we propose that managed, low intensity prescribed burns be conducted annually by staff of the proposed sanctuary early in the dry season (October–November). Burning at this time mimics the natural fire regime and will reduce fuel loads, thereby lessening the probability of catastrophic wildfires later in the dry season, and will also stimulate the production of forage, particularly grasses for tortoises (Wharton, 1966; Landers & Speake, 1980; Stott, 1988; Rabinowitz, 1990). Moreover, mortality from light prescribed burning is rare; tortoises readily evade slow moving surface fires and those remaining buried under leaf litter are likely to sustain only minor scarring of the carapace (Ernst *et al.*, 1995; Russell *et al.*, 1999). We also recommend that fuelwood cutting be prohibited within the sanctuary because continued deforestation will lead to further soil erosion and degradation of watershed function. Because villagers depend on wood from Myaleik Taung, we strongly recommend the development of a community forestry programme funded by an international donor agency, but managed locally by staff of the proposed Sanctuary. Remedial actions could include establishing tree plantations on degraded or fallow agricultural land, and enrichment plantings on the lower slopes of Myaleik Taung and in hedgerows. In addition to supplying wood, the latter will also enhance cover for tortoises. We further recommend that periodic surveys to monitor

tortoise population trends be conducted within the two areas by Conservation Division personnel in collaboration with biologists from the Wildlife Conservation Society Myanmar Program. The same people and dogs should be employed in each survey to minimize possible sampling bias. Finally, personnel from both organizations should conduct educational programs in the surrounding villages to raise public awareness of tortoise conservation, explain the benefits of environmental services provided by protected areas, such as watershed protection, instill general conservation values, and foster a greater appreciation of Myanmar's natural history.

Acknowledgements

The Forest Department of Myanmar is thanked for granting us permission to visit Minzontaung Wildlife Sanctuary and Myaleik Taung. Logistic and field assistance was provided by U Saw Tun Khaing, U Than Myint and Daw Bibiana Chit (WCS Myanmar Program), U Myint Shwe, U Khin Maung Soe, Daw Hla Myo Tint, Daw Aye Aye Cho, and the staff of Minzontaung Wildlife Sanctuary, U Maung Chit (Yadanabon Zoological Gardens), U Phone Myint Aung (Yangon University), and the residents of Kywenahpa and Yawthaya Villages. We thank Peter Paul van Dijk for bringing Myaleik Taung to our attention. Critical references were supplied by Peter Paul van Dijk, Stephen Johnson, G.S. Hartman, Gabe Crabtree, and the librarians at Texas Tech University. Don Sutherland is thanked for providing references and thoughtful insights on fire management. Our manuscript was improved by comments from Indraneil Das and an anonymous reviewer.

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Biographical sketches

The authors are all involved with the Reptile Conservation Program of the Wildlife Conservation Society, which has been actively collaborating with governmental and academic institutions in Myanmar on various field research projects since 1999. The primary focus of the Program is to determine the conservation status of chelonians in Myanmar, with particular emphasis on endemic species such as the Burmese star tortoise, develop conservation programmes to protect chelonians from over-exploitation and habitat destruction, and curb illegal trade. In addition to an ongoing star tortoise conservation programme, the Program is currently conducting field research on other Critically Endangered chelonians, including the Arakan forest turtle *Heosemys depressa*, Burmese roofed turtle *Kachuga trivittata*, and peacock softshell turtle *Nilssonnia formosa*.