

Amyda cartilaginea (Boddaert 1770) –
Asiatic Softshell Turtle, Southeast Asian Softshell Turtle

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SUMMARY. – The Asiatic Softshell Turtle, *Amyda cartilaginea* (Family Trionychidae), is a large species (total carapace length up to 850 mm) showing considerable variation in coloration over its wide range in tropical Southeast Asia. A recent genetic analysis suggests *A. cartilaginea* may be a species complex consisting of three species level clades with several subspecies. The turtle inhabits most types of aquatic habitats, from hill streams to rivers and swamps. It is an opportunistic omnivore with a preference for animal food. No comprehensive study of its reproductive biology exists; published observations suggest that females lay multiple clutches throughout the year with most nests being laid in the dry season, with clutch size ranging 3–28 eggs. Incubation period depends on microhabitat conditions and may last from 2–4.5 months. *Amyda cartilaginea* is a popular food animal; it is intensively exploited and appears frequently in the Asian food trade. Although some populations are in decline, the species still appears moderately abundant, at least at some sites. Several populations occur in protected areas. Specific conservation actions for heavily exploited populations appear to be overdue. Continued unregulated and unreported international trade would undoubtedly further threaten the species and careful monitoring of this trade is necessary.

DISTRIBUTION. – Bangladesh, Brunei Darussalam, Cambodia, India, Indonesia, Laos, Malaysia, Myanmar, Singapore, Thailand, Vietnam. Broadly distributed in Southeast Asia from extreme eastern Bangladesh and India through Indochina to Borneo and the large continental islands of Indonesia. Records from Yunnan, China, and east of Wallace’s line (e.g., Lombok, Sulawesi) very likely represent introduced individuals.

SYNONYMY. – *Testudo cartilaginea* Boddaert 1770a, *Gymnopus cartilaginea*, *Trionyx cartilagineus*, *Aspidonectes cartilagineus*, *Potamochelys cartilagineus*, *Amyda cartilaginea*, *Amyda cartilaginea cartilaginea*, *Testudo membranacea* Blumenbach 1779 (*nomen dubium*), *Testudo boddaerti* Schneider 1787 (*nomen novum*), *Trionyx boddaerti*, *Testudo striata* Suckow 1798 (*partim, nomen novum*), *Amyda javanica* Schweigger in Geoffroy Saint-Hilaire 1809, *Trionyx javanicus*, *Tyrse javanica*, *Aspidonectes javanicus*, *Trionyx stellatus javanica*, *Aspilus javanicus*, *Potamochelys javanicus*, *Trionyx stellatus* Geoffroy Saint-Hilaire 1809 (*nomen novum*), *Potamochelys stellatus*, *Trionyx cariniferus* Gray 1856, *Aspilus cariniferus*, *Trionyx carinifera*, *Trionyx ornatus* Gray 1861, *Aspilus ornatus*, *Ida ornata*, *Amyda ornata*, *Amyda ornata ornata*, *Aspilus punctulatus* Gray 1864, *Trionyx phayrei* Theobald 1868, *Aspidonectes phayrei*, *Trionyx jeudi* Gray 1869, *Trionyx ephippium* Theobald 1875, *Trionyx phayrii* Boulenger 1889 (*nomen novum*), *Amyda phayrii*, *Trionyx trinilensis* † Jaekel 1911 [Pleistocene], *Trionyx nakornsrithammarajensis* Nutaphand 1979, *Amyda nakornsrithammarajensis*, *Trionyx cartilagineus nakorn* Nutaphand 1990 (*nomen novum*), *Trionyx cartilagineus nakorn*, *Amyda cartilaginea maculosa* Fritz, Gemel, Kehlmaier, Vamberger, and Praschag 2014.

SUBSPECIES. – None currently recognized here, but see alternative taxonomy below.

STATUS. – IUCN 2015 Red List: Vulnerable (VU A1cd+2cd, assessed 2000); TFTSG Draft Red List: Vulnerable (VU, assessed 2011); CITES: Appendix II.

Taxonomy. – The Asiatic Softshell Turtle was originally described as *Testudo cartilaginea* by Boddaert (1770a); however, as indicated by Bour and Dubois (1983), Boddaert (1770b, 1772) also used various other names and Latin variations on the name for this species. The type

description was based on a single specimen of unknown origin; R. Webb and R. Bour indicated that MNHN 4150 is almost certainly the specimen described by Boddaert (see Bour et al. 1995; Bour 2007). Important synonyms include *stellatus* Geoffroy Saint-Hilaire 1809, *javanicus* Schweigger



Figure 1. Subadult *Amyda cartilaginea* from the Cardamom Mountains, southwest Cambodia. Photo by David Emmett.

in Geoffroy Saint-Hilaire 1809, *cariniferus* Gray 1856, *ornatus* Gray 1861, *phayrei* Theobald 1868, *jeudi* Gray 1869 (see Anderson 1871), and *nakornsrihammarajensis* Nutaphand 1979.

Van Dijk (1992) suggested that there might be a clear pattern to the geographical distribution of color variants of what is here treated as a single species. He recognized three color phases: Boddaert's type is typical of the widespread yellow-spotted lowland form; *Trionyx ornatus* Gray 1861 (illustrated in Gray 1861: Plate V) is the first available name for an "arrow-head form" of the Mae Klong and Mekong River basins; and the third type, referred to as a "saddle-shape form," is an unnamed taxon from Borneo and Sumatra. This third pattern was described as "wing-like" in specimens from western Borneo (Auliya 2000).

Fritz et al. (2014) have argued that *A. cartilaginea* actually represents a species complex and they have begun a revision of what we continue to treat as a single species

for the purposes of this conservation biology account. Their genetic analyses have suggested the existence of three major clades within the complex. Using the sister group of *Amyda*, *Nilssonina*, as a yardstick, the authors argued for the recognition of three species: an unnamed form from the north coast of Borneo, *A. cartilaginea* restricted to the islands of the Sunda shelf, and *A. ornata*, which they resurrected for the mainland forms. Within *A. cartilaginea* they recognized two subspecies, the nominal form *A. c. cartilaginea* from Java and the southeast side of Borneo, and a new subspecies, *A. c. maculosa* Fritz, Gemel, Kehlmaier, Vamberger, and Praschag 2014 from Sumatra and western Borneo. This new subspecies is the "saddle-blotched" form recognized by previous authors (Smith 1931; van Dijk 1992; Auliya 2000) (see Figs. 5 and 8). This pattern was also observed in specimens from northern Borneo (K. Jensen, in litt. to Auliya, 2015): "all except three of the 26 live specimens photographed [from



Figure 2. Adult *Amyda cartilaginea*, Dokhtawady River, Myanmar. Photo by Gerald Kuchling.



Figure 3. Adult *Amyda cartilaginea*, Dokhtawady River, Myanmar. Photo by Gerald Kuchling.



Figure 4. Adult *Amyda cartilaginea* in captivity in Java, Indonesia. Photo by Mark Auliya.

northern Borneo] had a saddle shape of black spots on the forward area of the carapace. Those with saddles also had a medial, black streak near the posterior of the carapace and circles or blotches near the margins made of smaller black spots. These patterns could also be seen on the preserved specimens from the Sarawak Museum. All but one of these animals had the black saddle, black streak near the posterior of the carapace and the circles of blotches on the carapace.”

Amyda ornata (Gray 1861) has priority for the mainland species level clade recognized by Fritz et al. (2014). Within this clade, the authors recognized three subspecies: the nominal form, *A. o. ornata*, from Laos and Cambodia; *A. o. phayrei*, new combination, for the form that is so far known from Thailand, Myanmar, and trade material from Yunnan; and a currently unnamed form from Bangladesh. These authors correctly argued that their work should increase conservation concern for *A. cartilaginea* (*sensu lato*) as it actually represents multiple taxonomic entities. However, incomplete geographic sampling in key areas and the likelihood of further taxonomic adjustment suggest that full incorporation of this developing taxonomy into this account would be premature.



Figure 5. Adult *Amyda cartilaginea*, Anjungan, West Kalimantan, Indonesia. Photo by Mark Auliya.

Hypotheses on the relationships of *A. cartilaginea* have changed since the work of Meylan (1987) who considered *A. cartilaginea* most closely related to *Chitra* and *Pelochelys*. Van Dijk (1992) believed it to be congeneric with *Nilssonina formosa* and closely related to the Indian *Aspideretes* (now *Nilssonina*) species. Molecular studies generally agree with the latter arrangement, placing this species in a clade that consists of a paraphyletic Pelodiscini (*sensu* Meylan 1987) plus a monophyletic Aspideretini (Engstrom et al. 2004; Liebing et al. 2012; Fritz et al. 2014).

Description. — *Amyda cartilaginea* is a large softshell turtle with a bony disc length to 403 mm (Annandale 1912). Total leathery carapace length (CL) has been reported to be up to 700 mm (Smith 1931; Mumpuni and Riyanto 2010), 750 mm (Nutaphand 1979), 830 mm (van Dijk *in* Cox et al. 1998) and 850 mm (Mardiastuti 2008); specimens of 1000 mm have been reported but remain unconfirmed (Kusrini et al. 2014). Mass of large individuals has been reported as up to 35 kg (Nutaphand 1979), 44 kg (Mardiastuti 2008), 65 kg (Kusrini et al. 2009), and over 70 kg (Thai newspaper clipping, 1993). Information retrieved from interviews report on individuals weighing as much as 105 kg (West Kalimantan) and 140 kg (East Kalimantan) at exporters' premises; however, due to the specimens' large size, they were sold on the domestic market. The remarkable 140 kg individual was witnessed by a large number of people; however, no hard evidence can be provided (Mardiastuti 2008; Mardiastuti *in litt.* to Auliya, 2014).

The carapace of this species usually consists of 9 neural bones, with the first two fused, and 8 pairs of costals with the last pair unreduced (Meylan 1987). In addition to the standard trionychid pattern of pits in the carapacial bones, small individuals of *Amyda* also show a rather distinctive presence of a few sinuous longitudinal bony ridges stretching across several pleural bones. The plastron has five (sometimes poorly developed) callosities and very



Figure 6. Adult *Amyda cartilaginea*, Loagan Bunut National Park, Sarawak, Malaysia (Borneo). Photo by Karen A. Jensen.

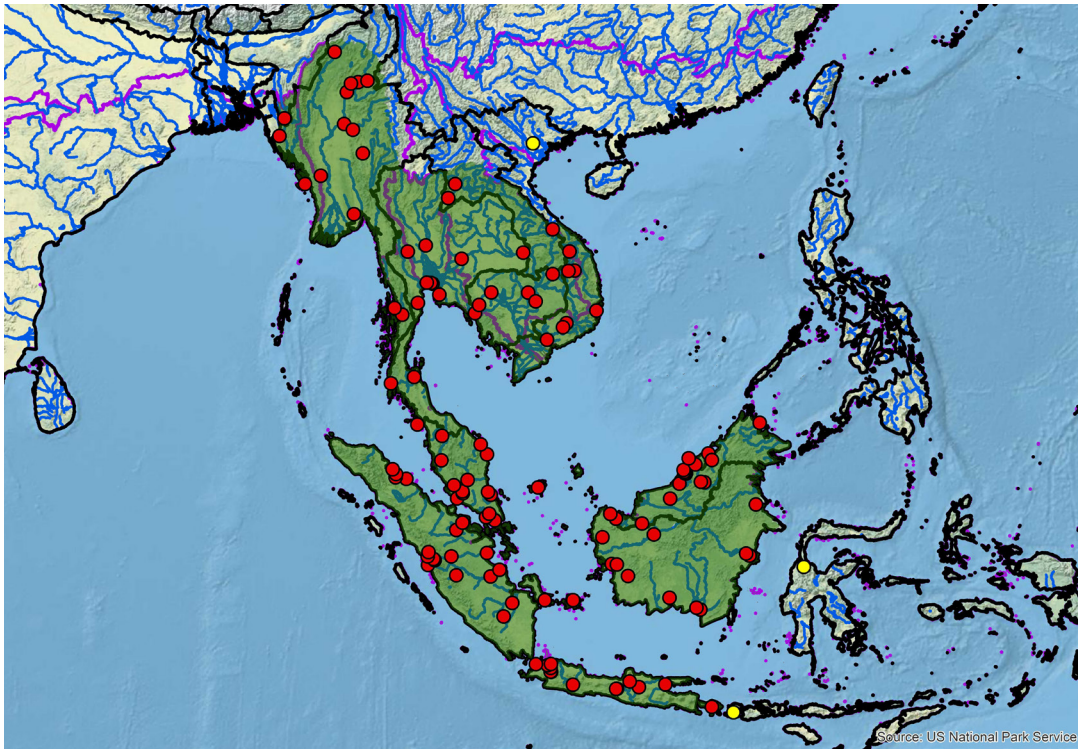


Figure 7. Distribution of *Amyda cartilaginea* in Southeast Asia. Purple lines = boundaries delimiting major watersheds (level 3 hydrologic unit compartments – HUCs); red dots = museum and literature occurrence records based on Iverson (1992) plus more recent data, and the authors’ personal data; yellow dots = presumed introduced specimens; green shading = projected historic native distribution based on GIS-defined level 8 HUCs constructed around verified localities and then adding HUCs that connect known point localities in the same watershed or physiographic region, and similar habitats and elevations as verified HUCs (Buhlmann et al. 2009; TTWG 2014), and adjusted based on authors’ subsequent data.

long epiplastra in contact or narrowly separated from each other on the midline. There is a strong median ridge on the symphysis (Smith 1931; Taylor 1970; Meylan 1987).

Coloration of the carapace of young individuals is grayish brown or black, sometimes with an olive tint. It can be uniform or dotted with yellow, and usually has a few black spots, broad radiating streaks, or star-shaped marks, arranged over the midline and extending laterally. These black marks are sometimes outlined with yellow (Smith 1931; Taylor 1970; Nutaphand 1979; van Dijk 1992). Juvenile specimens from West Kalimantan have been described

as olive with yellow-centered black marks anteriorly with one distinct larger black mark having a “wing-like” pattern (Auliya 2000) (see Fig. 8). This pattern has been described as a “black transverse band on the back” and was illustrated by De Rooij (1915:329).

The plastron is uniform white, pale gray or pale olive, and may show cloudy dark areas. The head bears some large yellow spots dorsally and laterally that are usually reduced posteriorly. Some individuals have fine yellow dots on the face, head, and neck; in others, the yellow flecks on the top and sides of the head fuse into



Figure 8. Two juvenile *Amyda cartilaginea* from Tanjung Lasa, West Kalimantan, Indonesia. Photos by Mark Auliya.



Figure 9. *Amyda* habitat from Loagan Bunut National Park, Sarawak, Malaysia (Borneo). Photo by Karen A. Jensen.



Figure 10. Habitat of *Amyda cartilaginea* at Loagan Bunut National Park, Sarawak, Malaysia (Borneo). Photo by Karen A. Jensen.



Figure 11. Habitat of *Amyda cartilaginea*, the upper Chindwin River, Myanmar. Photo by Gerald Kuchling.



Figure 12. Habitat of *Amyda cartilaginea*, Dokhtawady River, Myanmar, with a local *Amyda* trap (*). Photo by Gerald Kuchling.

elongated streaks (Fig. 1 *in van Dijk* 2000). Limbs usually bear fewer distinct spots.

In the adult, carapacial spotting disappears entirely, although frequently large black marks remain, however, these are less distinct because the background color darkens. The yellow spots on the top and sides of the head become less distinct with age, and the intervening spaces become darker, resulting in a black reticulation on an olive ground color. The nape region is blackish and the sides of the neck occasionally have yellow tubercles. The chin and throat become whitish or grayish with age. Smith (1931) noted that the plastron is white in males and gray in females. Retention of yellow spots on the carapace by some individuals appears to be the basis for the description of *Trionyx nakornsrihammarajensis* Nutaphand 1979. Males have longer, heavier tails and appear to reach larger sizes than females. For general accounts that include descriptions, see also Manthey and Grossmann (1997), Lim and Das (1999), and Auliya (2007).

Distribution. — This species occurs naturally from easternmost Bangladesh and India (Mizoram), east to Vietnam and south across Malaysia and Indonesia at least as

far as Bali and Borneo. It appears to have been introduced to areas beyond this natural range. There are records from extreme eastern Mizoram in India (Pawar and Choudhury 2000) and extreme southeastern Bangladesh (Rahman et al. 2015), most of Myanmar (Burma) (e.g., Iverson 1992; Kuchling 1995; Kuchling et al. 2004; Platt et al. 2000, 2005, 2007, 2012), Thailand (e.g., van Dijk and Palasuwan 2000; Amornsakchai et al. 2000; Pauwels et al. 2002, 2003; Nabhitabhata and Chan-ard 2005; Duengkae 2011), Cambodia (e.g., Daltry and Dany 2000; Stuart and Platt 2004; Som et al. 2006; Bezuijen et al. 2008, 2009; Platt et al. 2008; Schmidt and Theilade 2010; Hartmann et al. 2013), the Mekong drainage area of Laos (e.g., Stuart and Timmins 2000; IUCN 2013) and the plains between Xe Kong and Xe Pian rivers (Davies et al. 2006) and Khammouan Province in Laos (Stuart and Platt 2004), central and south Vietnam (e.g., Nguyen and Ho 1996; Farkas and Ziegler 2002; Nguyen et al. 2009), the Malay Peninsula and offshore islands (e.g., Grismer et al. 2006), Singapore (Yong 1990), and the continental shelf islands of Sumatra (e.g., Bleeker 1857; de Rooij 1915; Teynié et al. 2010; Sentosa et al. 2013), Java, (e.g., de Rooij 1915; Whitten et al. 1996),

Borneo (e.g., Bleeker 1857; de Rooij 1915; Inger and Tan 1996; Auliya 2004, 2006; Kusriani et al. 2009), Bali (e.g., McKay 2006), and smaller Indonesian islands (e.g., Leong et al. 2003).

The species has also been reported from Lombok, Indonesia, but this island is not on the Sunda continental shelf, and its natural occurrence there is questionable. The species was more recently reported from Sulawesi; however, it is strongly presumed that all records from this island represent animals that have been introduced through trade activities (Koch et al. 2008). The species is also considered to have been introduced in Hong Kong, but without evidence of a breeding population (Lau et al. 2000), and this may also be the case for a few specimens from southwestern Yunnan, China (Kuchling 1995; Fritz et al. 2014).

The possible occurrence of *A. cartilaginea* in the region of Hanoi in northern Vietnam, as speculated by Petzold (1963), is highly unlikely, as noted by Farkas and Ziegler (2002), and no northern Vietnamese localities for the species are given by Nguyen et al. (2009). Petzold (1963) hypothesized that several large softshells he saw in Hoan Kiem lake in Hanoi might be *A. cartilaginea* (rather than *Rafetus swinhoei* which did occur there), and he saw one specimen of the species in the University of Hanoi Zoological Laboratory (but not from Hoan Kiem). If indeed *A. cartilaginea* occurred in Hanoi, it was probably introduced or trade-related, and we treat it as such at this time.

Habitat and Ecology. — *Amyda cartilaginea* appears to be a generalized aquatic species being most abundant in lowland lentic waters, such as swamps, ponds, and oxbow lakes adjacent to large rivers (Ernst and Barbour 1989). Smith (1931) found that it “inhabits chiefly muddy slow-flowing rivers, but also ascends hill streams for a considerable distance.” In fact, all records of the species in northeastern India were made in hill streams with rocky substrate (Pawar and Choudhury 2000). Annandale (1912) reported that it occurs in mountain streams in Arakan (Myanmar). The softshell in Inle Lake (part of the Salween system in Shan State, Myanmar) at an altitude of 900 m (Annandale 1918) was confirmed to be *A. cartilaginea* by Platt et al. (2004).

In northern and western Thailand, *A. cartilaginea* inhabits quiet areas of streams up to altitudes of 400–600 m. Nutaphand’s (1979) *T. nakornsrihammarajensis* was said to occur only in flowing waters or streams, and to be reluctant to leave the water. In Thailand, where much suitable habitat was long ago converted to agriculture and development, *A. cartilaginea* inhabits rivers, reservoirs, ponds, canals, and ditches. In western Sumatra (Kerinci Seblat National Park) a juvenile specimen was recorded at night in a slow-moving stream edged by sand banks (Kurniati 2007). The species often occupies numerous water bodies

in disturbed habitat, e.g., agroecosystems near and within human settlements (see Kusriani et al. 2014). Chan-ard (1992) encountered the species in the acidic waters of a peat swamp forest in peninsular Thailand. All specimens found at Loagan Bunut National Park (Sarawak) occurred in acidic backwaters off of the lake (K. Jensen, in litt. to Auliya, 2015). Chai Kuh Shin (pers. comm. to EOM) reported that the species is frequently found resting on the bottom of shallow (30–120 cm), muddy water in swamps, swampy forest, river swamps, ponds, and monsoon drainage systems in plantations. He considered it rare in primary forest. Moll (unpubl. data) has found this species in large rivers to small streams, freshwater swamps, a small lake, and ditches in an oil palm plantation. B.H. Kiew (pers. comm. 1991 to EOM) reported that it is absent from estuaries, in contrast to Boulenger (1912), de Rooij (1915), and Moll (1980). In East Kalimantan, turtle collectors report finding the species in cavities below the riverbank; occasionally up to 12 individuals occupy a single cavity (Kusriani et al. 2009).

Few objective data are available on activity cycles. This species spends long periods buried in bottom substrate but can be active at any time of day or night, although activity seems to peak at dawn and dusk. Jensen and Das (2008a) suggested that this species is more active in overcast weather and during heavy rains compared to new moon phases, which may indicate that darkness reduces activity levels in *A. cartilaginea*. Basking was observed on a cool February morning in Bangkok (PPvD, unpubl. data).

Amyda cartilaginea is said to feed on a variety of aquatic arthropods, mollusks, fish, and amphibians (Taylor 1970; Nutaphand 1979). Moll and Khan (1990) reported that this species is an opportunistic omnivore, and that animal foods included clams, snails, prawns, snakes, and fish, but that it is not unusual to find fruits and seeds comprising 70 to 90% of the digestive tract contents. Plant material were also observed in stomach contents and feces (Jensen and Das 2008b). Chai Kuh Shin (pers. comm. 1991 to EOM) made similar observations on Malaysian *A. cartilaginea*, listing “aquatic animals, such as fishes, prawn, and snails, and insects such as a grasshopper” as items in the diet. He added that they eat wild fruits, particularly rubber tree seeds. In Pahang Province, Malaysia, it was observed feeding on crabs (Smedley 1932). In hill streams in the upper Mae Klong basin, western Thailand, this species consumes mainly small freshwater crabs, while further downstream in the main river’s lowland regions dragonfly larvae form an important food source for juveniles (van Dijk 1992). Similarly, a specimen from Java (ZMA 10882) regurgitated mainly dragonfly larvae after capture (PPvD, unpubl. data). Observations in West Sumatra in Jambi Province revealed that individuals associated with rice

fields mainly preyed on snails such as *Pomacea canaliculata* (Mumpuni et al. 2011; Ginting 2012), an invasive species widely considered as an agricultural pest in Southeast Asia (Chaichana and Sumpan 2014).

Natural predators on *Amyda* include smooth otter and tiger (Moll and Khan 1990). Predators on eggs include monitor lizards, crows, snakes, eagles, wild pigs, and humans (Jasmi 1986).

Data on population densities are scarce, also due to the aquatic and secretive behavior of the species. However, some information from Indonesia is available; with densities reported of 0.66 specimens/km (Kusrini et al. 2009) and 16 individuals/km river (Mumpuni et al. 2011). An area density index of 21 individuals/ha was provided for a population in a peat swamp (Mumpuni et al. 2010). These figures can provide a rough index, as field methods applied were not standardized (Kusrini et al. 2014). Data on a population of *A. cartilaginea* from East Kalimantan demonstrated a shift towards small-sized individuals, comprising 3.7% hatchlings, 50.9% juveniles, 33.6% subadults and 11.8% adults (n = 161) (Kusrini et al. 2009).

Maturation, Clutch Frequency, and Size Dimorphism. — Nutaphand (1979) claimed that under favorable conditions females can mature in 20 months (but see Gramentz 1992, who considered that this pertained to animals kept under unnatural conditions). Mumpuni and Riyanto (2010) reported on a 2-yr old female of 300 mm CL. In Jambi province, Sumatra, the smallest sexually mature females were reported to be between 285–324 mm CL, with a body mass between 2.2–3.19 kg (Mumpuni and Riyanto 2010; Ginting 2012), suggesting that females may reproduce at age 2 yrs. Males may attain a larger size than females; the two largest males measured by Moll (unpubl. data) were 650 and 660 mm CL. The largest female was 490 mm CL. Three females between 315 and 350 mm and two males of 300 and 350 mm, dissected by Moll, were immature. Another male of 510 mm may also have been immature.

Nesting Season and Nesting Behavior. — The nesting season coincides with the dry and hot season in Thailand, from February to July, with a peak in April (Nutaphand 1979; Khonsue, Thirakhupt, and van Dijk, unpubl. data). In northern Sumatra, nesting is said to occur from November to January (van de Bunt 1990). In Malaysia, the nesting season is reported to extend from January to March (Jasmi 1986); however, Kiew (1987) reported this species to emerge at night onto sandbanks in the Sungai Endau River in Malaysia, during the dry period between July and September. In Central Java egg clutches were found throughout the year, i.e., January, May and June, and August to November (Kopstein 1938).

Nutaphand (1979) reported that nesting occurs in the late afternoon or evening, in damp sandy areas close to the water. Similar observations were made by W. Khonsue

(pers. comm. to PPvD), who observed four nesting emergences between 1500 and 2000 hrs at the temple pond of Wat Prayoon, Bangkok. Smith (1931) observed that the eggs are deposited in holes in mud banks. Locals in East Kalimantan also reported nesting sites below organic material between tree buttresses (Kusrini et al. 2009). Single nests were recorded beside an irrigation channel next to a paddy field below a Kapok tree (*Ceiba pentandra*) (Mumpuni et al. 2011), while another nest covered by grass was located ca 1.9–4.5 m from a pond (Kusrini et al. 2007). Oviposition sites were described in more detail by Kopstein (1938), who noted that several clutches were found along the Kali Elo River near Magelang town in central Java. They were located about 3 m from the water line and were dug about 20 cm deep into the river sand.

Clutch Size. — Several authors have reported remarkably small clutch sizes in this species. Kopstein (1938) provided clutch size data of provisionally 10 clutches (81 eggs) from central Java, ranging from 5 to 18 eggs. He noted that he could not verify whether all eggs that locals brought to him on varying dates did in fact originate from one female, but confirmed that three different clutches contained 8 eggs each. At nine nesting sites in western Java, clutches ranged between 3 and 17 eggs (Kusrini et al. 2007), while at a breeding facility in Indonesia, clutches of ten nests ranged between 11 and 19 eggs (Susanti 2013). Nutaphand (1979) claimed that *Amyda* females in Thailand (possibly based on captive animals) laid 3 or 4 clutches per year, with clutch size varying from 7 to 30 eggs. Moll (1979) reported a clutch size of 5–7 eggs; and Bourret (1941) recorded 4–8 eggs per clutch for *Amyda* from the Mekong Delta. According to turtle collectors in East Kalimantan, clutch size may vary between 20 and 50 eggs (Kusrini et al. 2009). However, Moll (unpubl. data) dissected a 10 kg female from Kedah, Malaysia, during November that contained 14 shelled eggs with an average greatest diameter of 34.6 mm, plus 26 old corpora lutea, 19 follicles of 24–25 mm diameter, and 18 follicles of 18–20 mm. These data suggest that this female might have produced at least four clutches that year, including some with larger clutch sizes. Similarly, the observation of different-sized follicles in six dissected specimens led Mumpuni and Riyanto (2010) to the conclusion that more than one nesting season occurs. A female that was collected in late February (southern Mizoram, India) contained 18 ovarian eggs (Pawar and Choudhury 2000). Jasmi (1986) reported finding a nest of 28 eggs at Kuala Tahan, Taman Negara, Malaysia, and Kiew (1987) reported a nest containing 24 eggs from the Sungai Endau River, Malaysia.

Clutch Size Relative to Body Size. — Although Nutaphand (1979) suggested that the number of eggs per clutch increased from 6–10 in smaller females to 20–30 in larger ones, some available data do not support a con-

sistent positive correlation between body size and clutch size. Khonsue (pers. comm. to PPvD) noted that at Wat Prayoon, Bangkok, a female of 475 mm CL, weighing 17 kg, laid a clutch of 5 eggs (clutch mass 132 g, average egg mass 26.45 g), but two other females of 415 and 400 mm CL with masses of 10 and 12 kg respectively, each laid a clutch of 8 eggs (clutch masses 198 and 218 g, average egg masses 24.75 and 27.25 g); and a female of 360 mm CL with a mass of 7 kg laid a clutch of 11 eggs (clutch mass 230 g, average egg mass 20.9 g). A female of 460 mm CL contained 16 eggs (Mumpuni and Riyanto 2010). One possible explanation for these observations is that some large females may partition a large clutch into several separate nests during one egg-laying period. Furthermore, mature females may lay multiple clutches over the nesting season that vary in clutch size. At this stage it is not possible to ascertain whether captive and wild specimens display the partitioning of larger clutches into few smaller ones.

Egg and Hatchling Size. — Smith (1931) observed eggs measuring 30–40 mm in diameter while Bourret (1941) reported egg diameters between 24 and 33 mm. Kopstein (1938) described egg diameters between 24 and 37 mm, predominantly ranging from 30–33 mm and an egg mass averaging 15.4 g (81 eggs). In Bangkok, Thirakhupt and van Dijk (unpubl. data) found spherical, hard-shelled eggs from several clutches with a diameter of 32–39 mm (average 34.25 mm, $n = 32$) and a mass of 21–29 g (average 23.9 g, $n = 32$). Kopstein (1929) reported finding 8 spherical eggs with diameter 32–34 mm in a 15 cm deep nest cavity about 10 m away of a small stream at the end of October 1926 at Maloja, near Tasikmalaja in West Java; these eggs hatched between 9 and 13 February 1927, 78–85 days later; hatchlings varied in size from 42 to 49 mm CL and 34 to 40 mm carapace width (CW). Four hatchlings from Thailand measured 37–48 mm CL, 33–41 mm CW, 28–35 mm plastron length (PL); the mass of 8 hatchlings ranged from 12–17 g (Thirakhupt and van Dijk, unpubl. data). Hatchlings in central Java ranged from 42–49 mm CL and 34–40 mm CW (Kopstein 1938). Susanti (2013) reported hatchlings between 40 and 51 mm CL, with a body mass between 9 and 17 g.

Incubation Period. — Reported incubation periods are variable. Jasmi (1986) reported that five hatchlings in Malaysia emerged from a clutch of 28 eggs after 61 days in a styrofoam box at ambient temperature. However, natural nests appear to take longer. Eggs collected from nesting sites in Bangkok took 74 days or more to hatch at 28°C (Kitana 1997) and a clutch observed by Kopstein (1929) hatched after 78–85 days. Kopstein (1938) also reported on two clutches that hatched after 135 and 139 days, and Bourret (1941) reported that incubation lasts as long as 135–140 days. In artificially incubated clutches, hatching was observed between 95 and 102 days (Susanti 2013).



Figure 13. *Amyda cartilaginea* and *Dogania subplana* collected for the consumption trade in Sambas, West Kalimantan, Indonesia. Photos by Mark Auliya.

Population Status. — Historically, this was an abundant species throughout its range. Smith (1931) found *A. cartilaginea* to be common in central Thailand, frequently met with in the Chao Phrya River in the vicinity of Bangkok. It is still one of the most abundant turtle species in Thailand despite considerable hunting pressure. It is not rare in the wild and there is a regular supply to the markets, although as early as 1992 the supply in peninsular Thailand was no longer as plentiful as it was in the 1970s (W. Nutaphand, pers. comm. 1992 to PPvD). Bourret (1939, 1941) found it to be the most common freshwater turtle in watercourses at low and moderate elevations in southern Indochina.

Annandale (1912) considered the species to be common in the Malay peninsula, and D. Sharma (pers. comm. 1991 to EOM) considered it “presently out of danger in Malaysia.” However, given current hunting pressures at that time (see below), Chai Kuh Shin (pers. comm. 1991 to EOM) suggested that there was “a need for a certain amount of control [in Malaysia], otherwise, the species may be endangered in 10–15 years.” Populations in northern Borneo (Sarawak) may be under severe pressure due to the consumption by indigenous peoples combined with trade and the increased access to previously inaccessible areas from logging roads (K. Jensen, in litt. to Auliya, 2015). To date, the population

Table 1. Live individuals of *Amyda cartilaginea* reported as exported from Indonesia to international destinations 2005–13. Numbers in parentheses are import figures reported by the destination country for that year. Shipments to China of 7,900 kg of carapaces in 2005 and 6,000 kg of meat in 2006 are not included in these figures. Source: UNEP-WCMC 2014.

Year	Hong Kong	China	Singapore	Other Countries	Total
2005	18,640	2,850	2,127	2,494	26,111
2006	19,497		6,585	583	26,665
2007	9,988		14,825	1,897	26,710
2008	8,837 (12,093)		14,985 (23,124)	1,375	25,197
2009	8,600 (12,042)		14,157 (22,688)	2,443	25,200
2010	7,109 (8,909)	2,748	14,832 (19,827)	415	25,104
2011	4,382 (4,118)	3,966	15,970 (20,883)	446	24,764
2012	1,087 (1,383)	3,378	20,447 (22,950)	319	25,231
2013			(24,040)		

status and level of exploitation of the species has not been assessed in Malaysia (see below).

This species is currently considered to be uncommon in Singapore, mainly as a result of over-exploitation for consumption (Lim and Chou 1990; Lim and Lim 1992). Residents from the Mekong River in Laos reported that nowadays most individuals captured were much smaller compared to those in previous years (IUCN 2013). In Sumatra results of interviews conducted with traders along the trade chain (hunters to large-scale collectors) indicated a decline in local populations (Kurniati 2008). On Java *A. cartilaginea* has been depleted due to various anthropogenic impacts on the species' natural habitat (Mardiastuti 2008).

Threats to Survival. — *Amyda cartilaginea* faces threats throughout its range. It is still actively hunted for food wherever it occurs. Although some smaller animals are collected for the pet trade and there are also impacts due to habitat loss, exploitation for food, primarily for Chinese markets, appears to be the most significant threat. Data on levels of exploitation vary geographically and temporally but some recent accounts report levels of harvest are measured in tons. Based on the biology of this species, this is likely to be unsustainable (but see Mardiastuti 2008:11). The threats to this species are enumerated below on a geographical basis.

In Indonesia, softshells continue to be intensively hunted and stocks appear significantly depleted. Van de Bunt (1990) reported that 65,000 kg of softshell meat was legally exported from Sumatra in 1988; this was likely all or nearly all *A. cartilaginea*. According to Walter (1990), it was estimated that up to 50 tons of softshells

(mainly *A. cartilaginea*) was traded across the border from Kalimantan to Sarawak annually, and harvest locations predominantly refer to the Danau Sentarum National Park (DSNP) in West Kalimantan. As a result, since the late 1990s, populations of the Asiatic Softshell Turtle have been overexploited in parts of the DSNP (see also Widmann et al. 2009). A monitoring program designed to assess *A. cartilaginea* densities on the border of DSNP revealed that the wild population had collapsed in 2010–11. In one study area at the border of the park, no recaptures were recorded. In the lower reaches of the Sungai Leboyan only two recaptures were recorded. This is also reflected in the price increase seen in Pontianak (capital of West Kalimantan). In two years, the price per kilo doubled from 30,000 to 60,000 IDR (3.3–6.7 US\$) (Widmann, in litt. to Auliya, 2011).

Exporters established in Medan (North Sumatra) and Riau Province supply large numbers of *Amyda* to China and Hong Kong for the meat trade. Few data are available on the level of export to these markets but traders consulted in Medan in September 1999, reported that 3–5 tons of live *A. cartilaginea* left Medan for China on a daily basis (Shepherd 2000; Nijman et al. 2012).

Export trade volumes from Indonesia are available for years subsequent to the inclusion of this species in CITES Appendix II in 2005 (Table 1). Data are for live animals of wild origin and suggest that as many as one-quarter million live *A. cartilaginea* have been exported from Indonesia since 2005. An Indonesian association for the consumption trade of turtles and softshelled turtles (Asosiasi Pengusaha Kura-kura dan Labi-labi Konsumsi Indonesia, APEKLI) was established in 2009, and as a result, an annual export quota was disseminated to the 18 members of that association. The larger the specimens, the higher the profit, therefore traders preferably collect and sell larger specimens, but also do not necessarily refuse to buy smaller specimens, even if the annual quota limits are surpassed (Kus-rini et al. 2014). Export numbers declared by Indonesia do not necessarily match the corresponding numbers declared as imported by the recipient country, as a shipment may be permitted for export one year but not actually be shipped and received until the next year. While the total export quantities reported by Indonesia closely match the annual export quota (27,000 during 2005–07, 25,200 from 2008 onwards), the consistent reporting of higher import numbers by Singapore (and less consistently by Hong Kong) and claims of unpermitted, undeclared and thus unreported shipments (Asian Turtle Conservation Network 2006) suggest that actual trade volumes may be significantly higher (see also Lau et al. 1996; Cheung and Dudgeon 2006; Zhou and Jiang 2008). Mardiastuti (2008) provided data on the numbers of *A. cartilaginea* that enter the pet trade from Indonesia.

In Laos, this species is the most common softshell turtle available in markets (Stuart 1999). Duckworth et al. (1999) gave this species their highest ranking for threat in Laos due to harvest and trade. In Phnom Penh, Cambodia, the species is sold in Chinese restaurants for 40–50 US\$ per kg (Emmett 2009).

In Malaysia, a survey of markets, dealers, and temples by one of us (EOM) during 1989–90 suggested moderate levels of exploitation. It was the fourth most frequently encountered turtle in markets but appeared to be the most popular food turtle among the Chinese population in Malaysia. It appeared to be less common than during a similar survey undertaken during the 1970s. Chai Kuh Shin (pers. comm. 1991 to EOM) reported that in Malaysia it is “extensively collected by Orang Asli natives and sold to Chinese for food. Populations in areas regularly hunted by natives are becoming exhausted. [The hunters] sometimes organize big hunting parties to hunt in new and distant areas.” He also reported that natives sold their catches for 5–8 Malaysian Ringgit (1.5–2.5 US\$; rate from 2013) per kg, and that there were collectors in almost all native villages. Sharma (1999) reported on meat prices of *A. cartilaginea* in Kuala Lumpur, estimating the “weekly sale of meat” at 350–560 Malaysian Ringgit (135–215 US\$), which represents about 10 kg of turtle per day, at the rate given above. In Sarawak, “nearly all indigenous people” hunt the species for food (Jensen and Das 2006), and it is considered to be the most expensive bush meat, selling for between 10–25 Malaysian Ringgit per kg (2.5–8 US\$) (Jensen and Das 2008c). Declared exports of *A. cartilaginea* from Malaysia since the species’ inclusion in CITES comprise 5500 live animals of wild origin to China in 2004, and 10,000 live animals from the wild to China in 2005; 50 live animals, declared as captive bred, to Taiwan in 2007; and 200 live animals of wild origin to China in 2009 (UNEP-WCMC 2014).

In Myanmar, the history of softshell exploitation extends back to the 19th century (Theobald 1868). More recently, a trader in Myanmar reported that in 1999 he purchased 480 kg per month, while in 2000 his purchase shrunk to 110 kg per month (Platt et al. 2000). This species appears to have suffered severe declines in the Inle Lake (Myanmar) since the onset of the commercial harvest through increased demands created by Chinese markets (Platt et al. 2004).

In Thailand, Taylor (1970) reported that this species was common in shops in Bangkok where smaller individuals were generally available. In the early to mid-1990s live, whole frozen, or butchered animals (at 150–200 Thai Baht = US\$ 6–8 per kg including organs and bones), and prepared softshell curry, were all available in the Bangkok weekend market. Several upscale Bangkok restaurants still serve softshell turtle. Its novelty value and perceived health

benefits sustain a constant demand for softshells for consumption. In rural areas, softshells and other wild animals are an important protein source for local peasants.

Bong Heang Kiew (pers. comm. 1991 to EOM) suggested that dam projects, which cause the loss of breeding habitat, are also a threat. In Thailand, on the other hand, *A. cartilaginea* appears to have taken advantage of habitat alterations associated with wet rice culture, inhabiting irrigation and drainage canals in considerable populations (van Dijk 1992). Modern agricultural practices, including increasing pesticide and fertilizer usage, combined with increasingly severe droughts in central Thailand, could be detrimental to these populations. The species was frequently encountered in the international pet trade. Small specimens were regularly exported from Bangkok until 2002.

Vietnam reported a total of 300 live animals exported in 2010, and another 300 in 2011; all these animals were recorded as originating from captive-breeding facilities (UNEP-WCMC 2014).

Overall, the consumption trade appears to be the most serious threat to the species over its global range. This conclusion is based on the volume of trade and the number of seizures of illegally traded *A. cartilaginea* reported by CITES and other published reports (e.g., Jenkins 1995; Lehr 1997; Samedi and Iskandar 2000; Shepherd 2000; Kadoorie Farm and Botanic Garden 2004; Nijman et al. 2012; TRAFFIC Bulletin Seizures and Prosecutions 2013). For example, the CITES trade database reports 180,966 live *Amyda* exported from source countries from 2005 to 2011, of which nearly 99% were wild caught. The majority (99.5%) originated from Indonesia; only 0.5% was from Malaysia and Vietnam. This trade is thought to serve food markets and not the pet trade. The CITES trade database (2013) reported the importation of 196,896 live *Amyda* from 2005 to 2011. These animals were reportedly imported at Singapore (55.4%), Hong Kong (33.1%), and China (11.4%). In addition, the species is also valued in the traditional medicine trade with Southeast Asian populations supplying markets in China (see Chen et al. 2009).

Conservation Measures Taken. — The IUCN Red List (2015) categorizes *A. cartilaginea* as Vulnerable (VU A1cd+2cd), evaluated in 2000 (Asian Turtle Trade Working Group 2000). This assessment needs updating; a draft assessment by the IUCN Tortoise and Freshwater Turtle Specialist Group in 2011 assessed the species as still being Vulnerable (TTWG 2014). The species is listed on Appendix II of CITES.

Protected Areas. — The species has been recorded in protected areas from the following range states.

Bangladesh: Sangu-Matamuhuri Reserve Forest (Rahman et al. 2015).

Brunei Darussalam: Ulu Temburong National Park (Das 2007).

Cambodia: Ream National Park (McFarlane et al. 2005), Virachey National Park (Emmett et al. 2007), Central Cardamom Protected Forest (Som 2004).

India: Ngengpui Wildlife Sanctuary, southern Mizoram (Pawar and Choudhury 2000).

Indonesia: Kerinci Seblat National Park, West Sumatra (Kurniati 2007), Leuweng Sancang Nature Reserve and Rawa Danau Nature Reserve, West Java (Samedi and Iskandar 2000), Kerumutan Baru Nature Reserve and Giam-Siak Kecil Wildlife Reserve, Riau, and Berbak National Park, Sumatra (Samedi and Iskandar 2000), Danau Sentarum National Park, West Kalimantan, Pleihari Martapura Wildlife Reserve, South Kalimantan (Walter 2000; Samedi and Iskandar 2000), Bukit Batikap Protection Forest, Central Kalimantan (Berkel et al. 2012), Gunung Palung National Park, West Kalimantan (MIA S 2015).

Laos: in several National Biodiversity Conservation Areas, i.e., Nam Et, Phou Xang He, Nakai-Nam Theun, Xe Kong Plains in Xe Pain, Phou Xiang Thong and Ban Nongpin in Xe Pian (Stuart 1999).

Malaysia: Ulu Muda Forest Reserve, Kedah (Norsham et al. 2005), Taman Negara National Park (Moll and Khan 1990), Temengor Forest Reserve, Hulu Perak (Lim et al. 1995), West (Peninsular) Malaysia, Loagan Bunut National Park and Gunung Mulu National Park, Sarawak (Jensen and Das 2006, 2008a).

Myanmar: Htamanthi Wildlife Sanctuary (Kuchling et al. 2004), Inle Lake Wildlife Sanctuary (Platt et al., 2004), Lake Indawgyi Wildlife Sanctuary (Kuchling et al. 2006).

Singapore: Nee Soon Swamp Forest, Central Catchment Nature Reserve (Yong 1990).

Thailand: Huai Kha Khaeng Wildlife Sanctuary, Thung Yai Naresuan Wildlife Sanctuary, and Khao Laem National Park (van Dijk 1992; Thirakhupt and van Dijk 1995; Chan-ard and Nabhitabhata 1986).

Vietnam: Cat Tien National Park (TCEP 2000).

Amyda cartilaginea is protected or regulated under a variety of international and national laws. It was included in CITES Appendix II at the 13th Conference of the Parties (Bangkok, Thailand, October 2004), which came into effect in January 2005; all range countries are Party to CITES. The European Union has included *A. cartilaginea* in Annex B of the European Wildlife Trade Regulations since 22 August 2005, and suspended imports of wild-origin animals from Indonesia since September 2008 (Commission Regulation (EC) No. 811/2008).

The Wildlife Protection Act (1983) of Brunei Darussalam excludes *A. cartilaginea* as a protected species.

Cambodia enacted sub-decree 123 A.N.Kr.B.K on Identification of Threatened Fisheries Species and its Production, on 12 August 2009. This sub-decree prohibits the collection and trade of listed species, which includes *A. cartilaginea* as well as several other freshwater turtle species.

India suspended commercial exports of wild-collected specimens of native species on 31 May 1999, which remains in force to this date (CITES Notification 1999/39).

Indonesia established an export quota of 27,000 animals for each of the 3 years 2005–07, and reduced this to 25,200 for 2008 and subsequent years; this quota remains in effect at this time (<http://cites.org/sites/default/files/common/quotas/2014/ExportQuotas2014.pdf>; accessed 4 September 2014). The quota is divided in allocations for different purposes: since 2008 the export quota has generally been subdivided with about 1800 to 3600 individuals with weight under 3 kg for the pet trade, and the remaining 21,600–23,400 for consumption purposes. Indonesia also prohibits the harvest of wild specimens that have a body mass between 5.5 and 13.5 kg (Mardiastuti 2008).

In Laos, *A. cartilaginea* is placed in Category II of the 2008 Wildlife and Aquatic Law, that refers to managed species (hunting is permitted in the non-breeding season) not threatened by extinction.

The legal protected status of *A. cartilaginea* in Malaysia is not quite clear. The species is included in Schedule II of Act 686 (International Trade in Endangered Species Act 2008), making its import and export and possession or trade of imported specimens subject to regulation, but this does not clarify the legal status of exploitation or possession of specimens of native origin. In some states protection is covered by fisheries laws, however, there is apparently little enforcement (Sharma and Tisen 2000; B.H. Kiew, pers. comm. to EOM). Malaysia used to permit significant export volumes (see Threats, above) but has greatly reduced its authorized exports since 2006. A zero quota for all of Malaysia was announced for wild-collected *Amyda* for 2007. The zero quota was then extended to all animals, parts and derivatives from Peninsular Malaysia during 2010–13, and was narrowed to all specimens of wild origin from Peninsular Malaysia during 2014, leaving the option open at times to export dead, frozen or otherwise processed specimens, and not restricting exports from Sarawak and Sabah.

Amyda cartilaginea has Protected status in Myanmar, by notification under the Protection of Wildlife, Wild Plants and Conservation of Natural Areas Law, 1994 (Kyaw Moe et al. 2002). Singapore protects all native wildlife species, including *A. cartilaginea*, from unlicensed collection, keeping or killing, under the Wild Animals and Birds Act, 1965, Chapter 351, while import and export of all CITES-listed species and populations is regulated under the revised Endangered Species (Import and Export) Act of March 2006.

In Thailand, *Amyda cartilaginea* was the last native turtle species to be included, in 2002, in an amendment to the Wild Animal Reservations and Protection Act (WARPA) of 1992, protecting its native populations from

all forms of exploitation and thus ending previously-permitted exploitation outside wildlife sanctuaries and national parks.

Vietnam has not included *A. cartilaginea* in its listings of protected species under Decrees 160/2013 ND-CP and 32/2006/ND-CP, leaving domestic exploitation unregulated.

Amyda cartilaginea was selected at the 23rd meeting of the CITES Animals Committee (AC 23, Geneva, April 2008) for evaluation in the Review of Significant Trade (RST); only Indonesia was requested to demonstrate its non-detriment finding [AC23 Sum. Rec. p.14], as Malaysia had imposed a zero export quota from 2007 onwards and no exports had been recorded from other Parties. Indonesia provided detailed information to the 24th meeting of the Animals Committee (AC24, Geneva, April 2009) on trade quantities, size limitations and usage of traded animals, but was unable to provide population estimates beyond considering this a common species. Demand for the species for consumption was increasing, while no registered breeders were on record in Indonesia (AC24 Doc. 7.4 (Rev. 1) p.6-7). At AC24 Indonesia was retained in the RST because no population estimates were available, the numbers exported were high and the export quota had recently been substantially increased (AC24 Summ. Rec. p.11). Accordingly, a detailed review of the species in Indonesia was prepared by UNEP-WCMC (2010: AC25-09-04A: pp.161-172) for consideration at the 25th AC meeting (Geneva, July 2011), where Indonesia provided additional information. Based on the available information, the Animals Committee considered declared trade quantities of *A. cartilaginea* from Indonesia as of 'Possible Concern' and recommended, among others, revision of the export quota and the establishment of a monitoring program (AC25 WG1 Doc.1: p.10). Indonesia replied ahead of AC26 (Geneva, March 2012) that it would comply with the recommendations (AC26 Doc. 12.2: p.2), and at its 27th meeting (Veracruz, Mexico, April 2014) the committee was informed that actions were ongoing (AC27 Doc 12.3 p.2). A few months later, the Standing Committee at its 65th meeting (Geneva, July 2014) was informed that the CITES Secretariat, in consultation with the Chair of the Animals Committee, had determined that the recommendations had been complied with, noting that a detailed monitoring program for *Amyda* (2013–17) was awaiting initiation and implementation (SC65 Doc.26.1 p. 9), and the species was accordingly removed from the Review of Significant Trade.

Conservation Measures Proposed. — Upgrading legal protection and banning hunting during the nesting season to promote reproductive output appear to be sensible measures to promote the likelihood of the healthy populations that would be needed to manage current utilization towards sustainability. However, additional restrictions and strict enforcement measures may be needed

to protect populations from intensely harvested river systems that currently show signs of overexploitation. We urge Indonesia to implement its planned monitoring program as a matter of urgency, and call on the involved institutions to publish the program's findings on an annual basis. There should be continued monitoring of international trade in this species as called for under Appendix II of CITES, and significant enforcement efforts made to combat illegal and undeclared offtake and trade. Detailed research on the natural history of the species, specifically habitat use, diet, growth, reproduction and population dynamics, in undisturbed natural habitat and in exploited populations, is highly desirable.

Captive Husbandry. — Although Smith (1931) reported that this species feeds freely in captivity and is not timid, and Bourret (1941) suggested that it is easily raised in captivity, there is little evidence for this species being successfully bred and raised in captivity. There have been some attempts to farm this species in Thailand (P. Youngprapakorn, pers. comm. to PPvD) and Singapore (Chou and Choo 1986); in both countries it proved more profitable to breed and raise imported *Pelodiscus sinensis* than the native *A. cartilaginea*. Farmers in Thailand favor *P. sinensis* to *A. cartilaginea* as the former matures and reproduces earlier (Anonymous 2003 in Thomson 2008). A strain of golden *A. cartilaginea* being developed by several Bangkok breeders promises to become quite popular among herpetoculturists. The commercial farming of *A. cartilaginea* is reported in southwestern Vietnam (Le 2007), but information on actual commercial breeding efforts and successes are elusive.

In Indonesia, there have been several attempts to establish captive breeding enterprises that must be considered unsuccessful. One attempt in western Java reported a hatching rate of only 5% (Kusrini et al. 2007). Mardiasuti (2008) reported there is no company registered to commercially breed the species in Indonesia and breeding this species on a commercial scale in Indonesia has not been successful and remains a challenge (Mumpuni 2011). The Indonesian turtle trade association (APEKLI) has encouraged members to establish breeding farms in Banten province of western Java; and one company, i.e., PT Ekanindya Karsa (known as a crocodile breeding facility) is evidently raising the offspring of six females and three males representing initial parent stock (Susanti 2013; Kusrini et al. 2014).

Current Research. — A phylogenetic study of the species was recently provided by Fritz et al. (2014). However, for reasons outlined above, it is believed that the phylogeny of *A. cartilaginea* is far more complex than presented there. It therefore is very likely that thorough examination of morphological traits and genetic identification of more populations based on larger sample sizes will contribute

to a more widely-agreed upon arrangement for the *Amyda* species complex and for names attributed to specific populations. These results may then trigger and implement regional conservation measures to secure viable populations of taxonomically distinct forms for the long-term.

The large volume of export of the species from Indonesia has prompted research institutions, universities, and authorities to initiate multiple studies in recent years (e.g., Kusriani et al. 2007, 2009; Oktaviani 2007; Mardiasuti 2008) with the sustainability of trade in the species being a major question. Efforts to assess population status and trends in Indonesia are planned or ongoing, with the intent to create a foundation for informed, sustainable management of the species.

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