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"The status and distribution of freshwater crabs [Indo-Burma Region of Asia]"

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Chapter 6. Freshwater crabs of the Indo-Burma hotspot: diversity, distribution, and conservation

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6.1 Overview of the freshwater crab fauna of the Indo-Burma hotspot

Freshwater crabs are among the most important invertebrates inhabiting Asian inland waters and these large and conspicuous crustaceans are present in almost all freshwater habitats from mountain streams to large lowland rivers and smaller water bodies (Yeo *et al*. 2008). The present work focuses on the freshwater crabs of the biodiversity hotspot that is centred in the Indo-Burma region that lies in five countries: Thailand, Cambodia, Viet Nam, Lao Peoples Democratic Republic (Lao PDR), and the eastern part of Myanmar. A small portion of Malaysia (the northwestern states of Perlis and Kedah) falls within the southern tip of the Indo-Burma region (Figure 1.1); however, this contributes only four species (one endemic) to the region's richness, representing less than 5% of the country's freshwater crab fauna, as such Malaysia will be excluded from our discussions of country level patterns in this paper. Specifically, the Indo-Burma region as considered here extends from the Salween eastwards, and includes the Thai peninsula, coastal basins in Myanmar, Thailand, and Indochina, and the major river basins (Mekong, Chao Praya, Hong and Da, Mae Klong), excluding the Chinese parts of these river basins.

The number of species of freshwater crabs found in the Indo-Burma hotspot has grown steadily as the number of revisionary taxonomic studies in this part of Asia has increased (Rathbun 1902, 1904, 1905; Alcock 1909, 1910; Balss 1914, 1918, 1923; Bott 1966, 1968, 1970; Ng 1988, Ng and Naiyanetr 1993, 1995; Yeo and Ng 1997, 1998, 1999, 2003, 2004, 2005, 2007, 2010; Yeo *et al*. 1999, Yeo and Naiyanetr 1999, 2000, 2010; Ng and Yeo 2001, Yeo 2004, 2010; Yeo and Naruse 2007, Yeo *et al*. 2008, Ng *et al*. 2008, Naiyanetr and Yeo 2010, Naruse *et al*. 2011). These works have resulted in the description of large numbers of new species and new genera. The revisions at the family-level have included the revalidation of the subfamily Potamiscinae of the Potamidae Ortmann, 1896, to include all east Asian potamids, including those in the Indo-Burma hotspot (Yeo and Ng 2003), and the reassignment to the Gecarcinucidae Rathbun, 1904 of all species formerly assigned to the Parathelphusidae following the synonymy of these two families, with priority going to the Gecarcinucidae (Klaus *et al*. 2009).

In biogeographical terms the Indo-Burma hotspot lies in the Oriental zoogeographical region, an area that includes India, southern China, and Southeast Asia as far east as Wallace's line (Yeo *et al*. 2008). The Oriental region is the most taxonomically

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diverse part of the world with over 900 species of freshwater crabs in 154 genera and two families, totals that are markedly higher than those of the faunas of the Neotropical region (50 genera, 298 species, two families) and the Afrotropical region (18 genera, 133 species, two families) (Yeo *et al*. 2008, Cumberlidge *et al*. 2009).

The Indo-Burma hotspot hosts 182 known species of freshwater crabs in 55 genera and two families, the Gecarcinucidae (45 species, ten genera) and the Potamidae (136 species, 45 genera) (Ng *et al*. 2008, Yeo *et al*. 2008, Cumberlidge *et al*. 2009). This fauna is more diverse than previously assumed, and there are many more species still to be discovered. The freshwater crab genera of the Indo-Burma hotspot is highly endemic at the country level – 92% of the potamid species, and 76% of the gecarcinucid species endemic (Yeo *et al*. 2008, Cumberlidge *et al*. 2009).

6.1.1 Biogeographic patterns

The Indo-Burma hotspot shows a distinct north-south latitudinal trend that corresponds to the broader regional trend reported by Yeo and Ng (2003), whereby potamids dominate over gecarcinucids in the north, but gecarcinucids dominate over potamids in the south. For example, in China the ratio of potamids:gecarcinucids is 91:9, but this ratio changes further south, and is 73:27 in Indochina, and 51:49 in Peninsular Malaysia (Yeo and Ng 1998). In the Indo-Burma hotspot dealt with here, the Potamidae constitute approximately 75% of the known fauna, with the Gecarcinucidae making up the remaining 25%. In the northern part of this region gecarcinucids are poorly represented in Myanmar and Lao PDR (only 9% and 12%, respectively) but become increasingly more dominant in Viet Nam and Thailand (23% and 33%, respectively). In Cambodia the gecarcinucids are the dominant fauna (and no potamids are known from this country), but the figures for this country are almost certainly an artefact of under-collection (Yeo and Ng 1998). Further to the south of the Indo-Burma hotspot, in the Malay Peninsular and insular Sundaic Southeast Asia, the number of species of gecarcinucids increases and easily exceeds the number of species of potamids (Ng 1988). This dominance is already hinted at within the small portion of Peninsular Malaysia that falls within the Indo-Burma hotspot, with three out of the four species occurring there being gecarcinucids.

Freshwater crabs are found in all major habitat types in the Indo-Burma hotspot including floodplains, swamps, lakes, moist forest rivers, highland and mountain systems, large lakes, and large river rapids. Species diversity is highest in the rivers and streams of the major river basins, especially those that flow through lowland rainforest and drain forested highlands. Because of their widespread representation in Indo-Burma's aquatic ecosystems, freshwater crabs are also represented in most of the regions' freshwater ecoregions (for example, tropical and subtropical floodplain rivers and wetland complexes, montane freshwaters, tropical and subtropical upland rivers, tropical and subtropical coastal rivers, and large river deltas) (Thieme *et al*. 2005, Abell *et al*. 2008). However, with only a few exceptions, there is no close correlation between freshwater crab distribution patterns and freshwater ecoregion boundaries found in the Indo-Burma hotspot. The only instances where freshwater crab distribution coincides with ecoregion boundaries are those species that have a restricted distribution.

Most freshwater crabs are nocturnal scavengers or opportunistic predators, and some species have economic and ecological importance (Yeo *et al*. 2008). For example, some species are rice field pests, some are a source of protein for people, and other species have medical importance serving as the second intermediate host of the parasitic human lung fluke, *Paragonimus*. Some species of freshwater crabs also serve as bio-indicators of ecosystem disruption, some are threatened by collection for the aquarium trade, and some are even conservation icons, such as the Thai Royal crabs: *Phricotelphusa sirindhorn* (LC), *Indochinamon bhumipol* (EN), and *Thaiphusa sirikit* (LC).

6.2. Conservation status

The conservation status of 173 Indo-Burma's known freshwater crab fauna was assessed as part of the global study by Cumberlidge *et al*. (2009) using the IUCN Red List Categories and Criteria at the global scale (IUCN 2003) and individual species assessments are available through the IUCN Red List website (www.iucnredlist.org). The conservation assessments of nine species, mainly recently described taxa, are in progress and are considered provisional. The Cumberlidge *et al*. (2009) study included information from specialists and as many literature sources as possible from the Oriental region, including national Red List assessments that focused on Viet Nam, Malaysia (Ng and Yeo 2007), Japan (Naruse 2008), and Sri Lanka (Bahir *et al*. 2005).

The results reveal current high levels of threat, with 26 (34%) of the assessed extant species for which sufficient data are available considered Threatened (Table 6.2, Figure 6.1). There was insufficient information to assess the status of 98 species, which

Indochinamon dangi, a recently described species of freshwater crab from northern Thailand, has not yet been formally assessed against the IUCN Red List Categories. © Darren C.J. Yeo

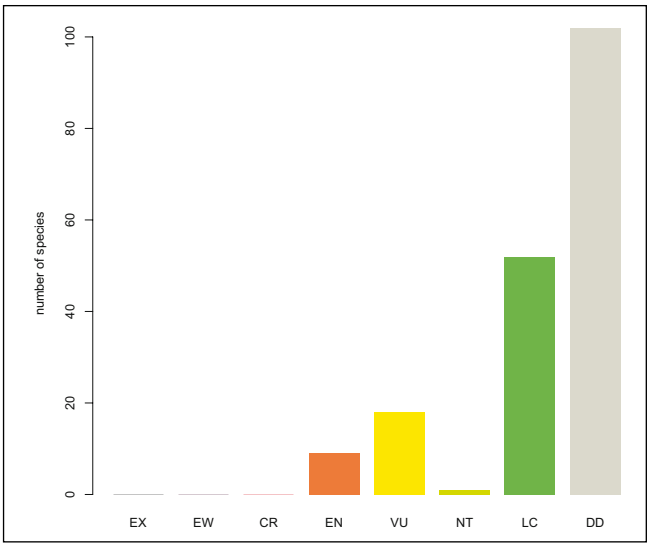
Table 6.1 The 27 species of freshwater crabs found in the Indo-Burma hotspot that are threatened with extinction. * Indicates provisional Red List Category based on draft assessment.

Family GECARCINUCIDAE		Family POTAMIDAE	
Heterothelphusa fatum Ng, 1997	VU	*Doimon doichiangdao* (Naiyanetr & Ng, 1990)	EN
Mekhongthelphusa kengsaphu Naiyanetr & Ng, 1995	VU	*Doimon doisutep* (Naiyanetr & Ng, 1990)	EN
Mekhongthelphusa tetragona (Rathbun, 1902)	VU	*Indochinamon bhumibol* (Naiyanetr, 2001)	EN
Phricotelphusa limula (Hilgendorf, 1882)	VU	*Indochinamon cua* (Yeo & Ng, 1998)	VU
Phricotelphusa ranongi Naiyanetr, 1982	VU	*Indochinamon dangi* Naruse, Nguyen & Yeo 2011	VU*
Salangathelphusa anophrys (Kemp, 1923)	EN	*Indochinamon guttum* (Yeo & Ng, 1998)	VU
Sayamia maehongsonensis (Naiyanetr, 1987)	VU	*Indochinamon mieni* (Dang, 1967)	VU
Sayamia melanodactylus Ng, 1997	EN	*Indochinamon villosum* (Yeo & Ng, 1998)	EN
Siamthelphusa holthuisi Naiyanetr & Ng, 1991	EN	*Iomon luangprabangense* (Rathbun, 1904)	VU
Stelomon erawanense Naiyanetr, 1992	VU	*Iomon nan* (Ng & Naiyanetr, 1993)	EN
Stelomon kanchanaburiense (Naiyanetr, 1992)	VU	*Nemoron nomas* (Rathbun, 1904)	VU
Thaksinthelphusa yongchindaratae (Naiyanetr, 1988)	EN	*Pupamon phrae* (Naiyanetr, 1984)	VU
		Stoliczia panhai Ng & Naiyanetr, 1986	VU
		Stoliczia perlensis (Bott, 1966)	VU
		Tiwaripotamon edostilus Ng & Yeo, 2001	VU

Table 6.2 The number of assessed freshwater crabs in the Indo-Burma region under each IUCN Red List category.

IUCN Red List Category	Number of species
Extinct	0
Extinct in the Wild	0
Critically Endangered	0
Endangered	9
Vulnerable	17
Near Threatened	0
Least Concern	49
Data Deficient	98
Total	**173**

Figure 6.1 The number of extant freshwater crab species for which sufficient data exist under each IUCN Red List Category in the Indo-Burma region.



were categorised as Data Deficient (DD) due to a lack specimens, and locality and population data (Cumberlidge *et al*. 2009, D.C.J. Yeo *pers. comm*. 2012). However, if all Data Deficient (DD) species also prove to be threatened, the level of threat could be as high as 72%. No species are currently thought to be Extinct or Extinct in the Wild.

Of the 73 species assessed in the Indo-Burma hotspot, 98 were found to be Data Deficient, of the other 75 species 49 species are Least Concern (LC) (65%), and 26 are threatened (35%) (Table 6.2). The 49 LC species comprised 26 species of potamids in 14 genera, and 23 species of gecarcinucids in seven genera, and most of these live in rivers, marshy lowlands, or mountain streams in the forested parts of the region (Cumberlidge *et al*. 2009). Twenty-six (37%) of the 75 species for which there was sufficient data were listed in one of two threatened categories, either as Endangered (EN) (four species of gecarcinucids plus five species of potamids) or Vulnerable (VU) (six species of gecarcinucids plus 11 species of potamids), but none were assessed as Critically Endangered (CR) or as Near Threatened (NT). No species of freshwater crabs from the region have been confirmed Extinct (EX) or Extinct in the Wild (EW). However, it should be noted that a species cannot be formally assessed as Extinct until exhaustive surveys have been carried out.

6.3 Patterns of species richness

The five countries that lie in the Indo-Burma hotspot collectively have a rich, highly diverse, and distinctly recognisable freshwater crab fauna with a high proportion of species endemic to this region (Cumberlidge *et al*. 2009: Table 2. Distribution data used here have been derived from all available specimen records but are still likely to be incomplete. Although many of the species

Described in 2011 from Phong Nha, Quang Binh Province central Viet Nam, *Indochinamon phongnha*, is still to be formally assessed for the IUCN Red List. © Darren C.J. Yeo

are quite well studied, there are still some that are known only from either the type locality or from just a few records, and in these cases further collections are necessary to ascertain their actual distributions. The available data indicate that the composition of the freshwater crab fauna in the Indo-Burma hotspot is not uniform, changes from region to region, and varies with ecosystem, aquatic drainage basins, and vegetation cover. For example, freshwater crabs are found in all of the major ecosystems in this region, but are noticeably more abundant in the rainforest, especially in highland regions (Cumberlidge *et al*. 2009). Species diversity appears to depend on vegetation cover and the availability of water, with the highest number of species occurring in rainforest ecosystems, especially in highland areas, and the fewest in lowland ecosystems.

The taxonomic diversity is highest in Thailand (107 species, 36 genera, two families), which is both the most species rich and most diverse country in the region. Next are Viet Nam (44 species, 18 genera, two families) and Myanmar (23 species, 16 genera, two families) while the diversity is lower in Lao PDR (17 species, 10 genera, two families), and lowest diversity is in Cambodia (two species, two genera, one family). Distribution patterns considered

Demanietta khirikhan (LC), known from northern Prachuap Khiri Khan and Phetchaburi Provinces in southern Thailand. © Tan Heok Hui

at the genus level indicate that although each of these five countries has genera with species that are found in more than one country, the vast majority of genera have species that have a restricted distribution. In the region as a whole, 19 out of 182 species have a distribution that encompasses more than one country. *Indochinamon* is found in four countries in the region (all except for Cambodia), *Esanthelphusa* is found in Thailand, Lao PDR, and Viet Nam, *Phricotelphusa* is found in Thailand, Myanmar and Cambodia, *Somanniathelphusa* is found in Viet Nam, Myanmar and Cambodia, and *Eosamon* is found in Thailand, Viet Nam, and Myanmar. In addition, the potamid genera *Hainanpotamon, Iomon, Pudaengon, Demanietta, Kanpotamon, Neolarnaudia, Quadramon, Stelomon, Thaiphusa, Pilosamon, Rathbunamon,* and *Villopotamon* and the gecarcinucid genera *Heterothelphusa, Mekhongtelphusa,* and *Sayamia* are all found in two countries in the region. In contrast, the vast majority of genera (35) that are found in the Indo-Burma hotspot have a relatively restricted range and are endemic to a particular country.

6.3.1 All freshwater crab species: interpretation of distribution patterns

The most speciose genera found in the Indo-Burma hotspot are *Siamthelphusa* and *Demanietta* (nine species each); *Esanthelphusa* and *Eosamon* (each with eight species); *Thaipotamon* (with seven species), and *Phricothelphsa* (six species). All species of *Siamthelphusa* are found only in Thailand, except for *S. nan* which is also found across the border in Lao PDR. Six species of *Siamthelphusa* are relatively well known and were assessed as LC (*S. acutidens, S. improvisa, S. paviei, S. retimanus, S. transversa,* and *S. variegata),* while three species have a restricted distribution and were either assessed as DD (*S. faxoni* and *S. nan*) or as EN (*S. holthuisi*). The nine species of the potamid genus *Demanietta* are found only in Thailand, except for *D. tritrungensis* and *D. thagatensis*, which are also found across the border in Myanmar. Seven species of *Demanietta* are relatively well known and were assessed as LC (*D. huahin, D. khirikhan, D. lansak, D. nakhonsi, D. renongensis, D. suanphung,* and *D. tritrungensis*), while two species (*D. manii* and *D. thagatensis*) were regarded as DD. Six of the eight species of the Thai gecarcinucid genus *Esanthelphusa* are relatively well known and were assessed as LC (*E. chiangmai, E. denchaii, E. dugasti, E. fangensis, E. nimoafi* and *E. phetchaburi*), while two species have a restricted distribution and were assessed as DD (*E. prolatus* and *E. nani*).

Two of the eight Thai species of the potamid genus *Eosamon* are relatively well known and were assessed as LC (*E. boonyaratae* and *E. smithianum*), while six species have a restricted distribution and were assessed as DD (*E. brousmichei, E. hafniense, E. nominothuis, E. paludosum, E. phuphanense,* and *E. yotdomense*). Two of the six species of the Thai gecarcinucid genus *Phricotelphusa* are relatively well known and were assessed as LC (*P. deharvengi, P. sirindhorn),* while two species have a restricted distribution and were either assessed as VU (*P. limula,* and *P. ranongi*) or as DD (*P. aedes*). Three of the seven species of the Thai potamid genus *Thaipotamon* were assessed as LC (*T.*

chulabhorn, T. dansai, and *T. lomkao*), while four species have a restricted distribution and were assessed as DD (*T. holthuisi, T. siamense,*T. *smitinandi,* and *T. varoonphornae*).

6.3.2 Threatened species distribution patterns

Some 35% (26/75 species) of freshwater crabs from the Indo-Burma hotspot were assessed as being in one of two threatened categories (EN, VU) (Cumberlidge *et al*. 2009; Figure 6.1; Table 6.2). Most of these (20 species) are found in Thailand (11 species of gecarcinucids and nine species of potamids). There are five threatened species of potamids (but no gecarcinucids) found in Viet Nam, three threatened species of potamids (but no gecarcinucids) found in Lao PDR, and there are no threatened species found in Cambodia or in the part of Myanmar included in this study. Of the threatened species, ten were assessed as EN, of which eight are from Thailand (four gecarcinucids: *Salangathelphusa anophrys, Sayamia melanodactylus, Siamthelphusa holthuisi,* and *Thaksinthelphusa yongchindaratae)* and four potamids: *Tiwaripotamon edostilus, Doimon doichiangdao, Indochinamon bhumibol,* and *I. villosum*), one from Viet Nam (*Iomon nan*) and one from Lao PDR (*Doimon doisutep*). None of the species from Myanmar was assessed as EN. A further seventeen species were assessed as VU, of which 12 are from Thailand (seven gecarcinucids: *Heterothelphusa fatum, Mekhongthelphusa kengsaphu, M. tetragona, Phricotelphusa callianira, P. limula, P. ranongi,* and *Sayamia maehongsonensis*) and five potamids: *Nemoron nomas, Pilosamon guinotae, Pupamon phrae, Stelomon erawanense,* and *S. kanchanaburiense*), four from Viet Nam (four potamids: *Stoliczia panhai, Indochinamon dangi, Indochinamon guttum,* and *I. mieni*), and two potamids from Lao PDR (*Indochinamon cua* and *Iomon luangprabangensis*). No species were assessed as CR or as NT. The main threats to these species were identified as urban, industrial,

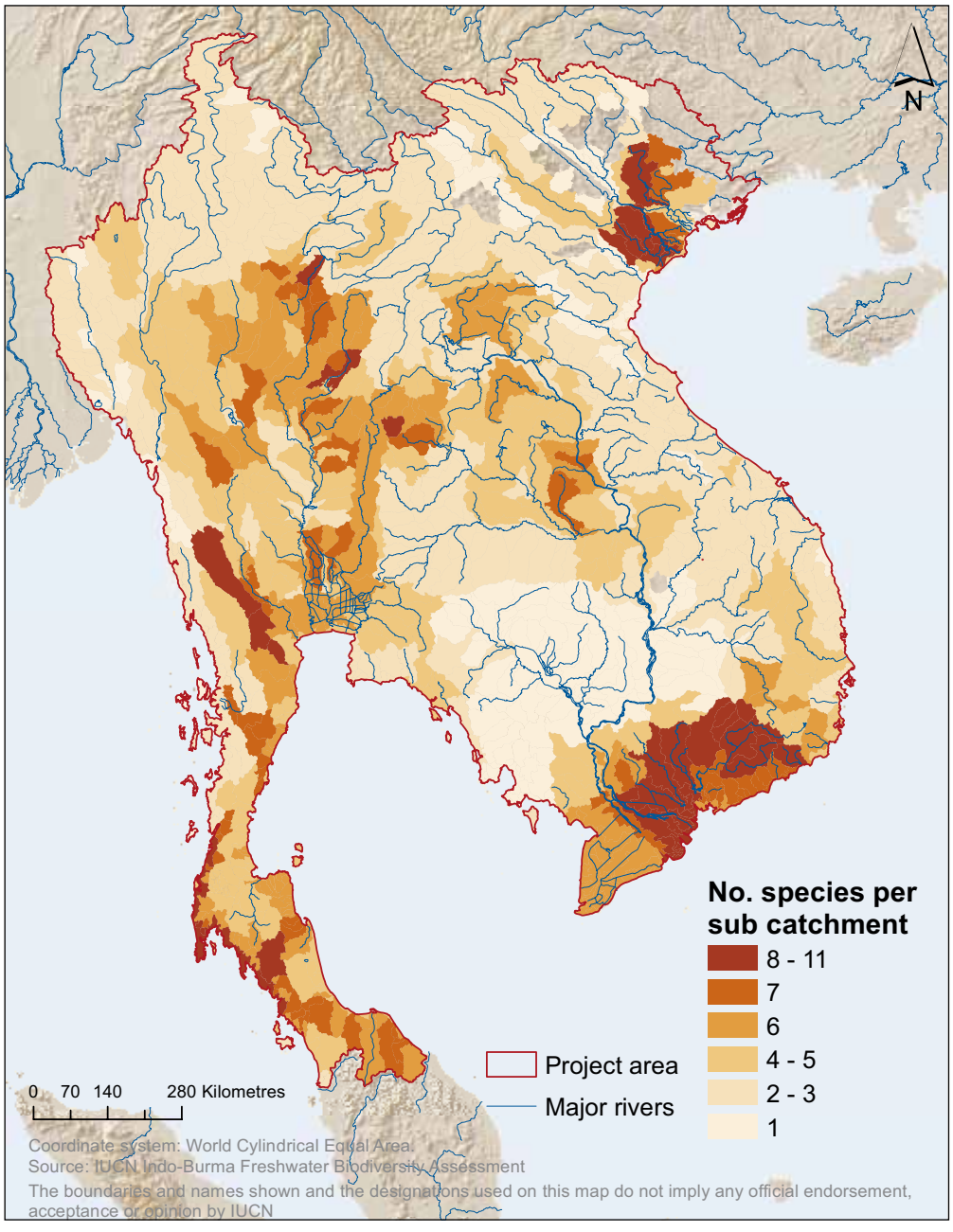


Figure 6.2 The distribution of freshwater crab species across the Indo-Burma hotspot.

and agricultural development and the associated aquatic habitat degradation and pollution.

6.3.3 Restricted range species

Excluding DD species, 29 species have a restricted range (<20,000 km^2), and are irregularly distributed throughout the region (Figure 6.4). The limited distributions of these species are not simply a product of omission errors stemming from a lack of knowledge or under collection. These species are specifically recorded, through many surveys conducted over the years, as being absent in localities where they may have been expected to occur. Any disruption to the habitats of these species (either from development, pollution, or political unrest) could have serious consequences given that these restricted range species have been assessed as Threatened. Any species with a restricted range is potentially vulnerable to extreme population fragmentation and could suffer a rapid decline and even extinction in a relatively short time should dramatic changes in land-use suddenly affect its habitat. It is therefore of immediate concern that 29 of the 75 crab species that could be assessed are known from distribution ranges of less than 20,000 km^2 (and some of these have an estimated range of 5,000 km^2 or less). Despite the dangers of population fragmentation current population levels of stenotopic species assessed as LC or NT were estimated to be stable because they have been collected recently and there are no identifiable immediate threats that would impact the health of those streams and endanger their long-term existence. The reasons for the restricted ranges of the stenotopic species are largely unknown, but it is thought likely that they have speciated relatively recently in response to isolation in a specialised (marginal) habitat or through island colonization, rather than their being the remnant populations of formerly widespread species now in decline (Cumberlidge *et al*. 2009).

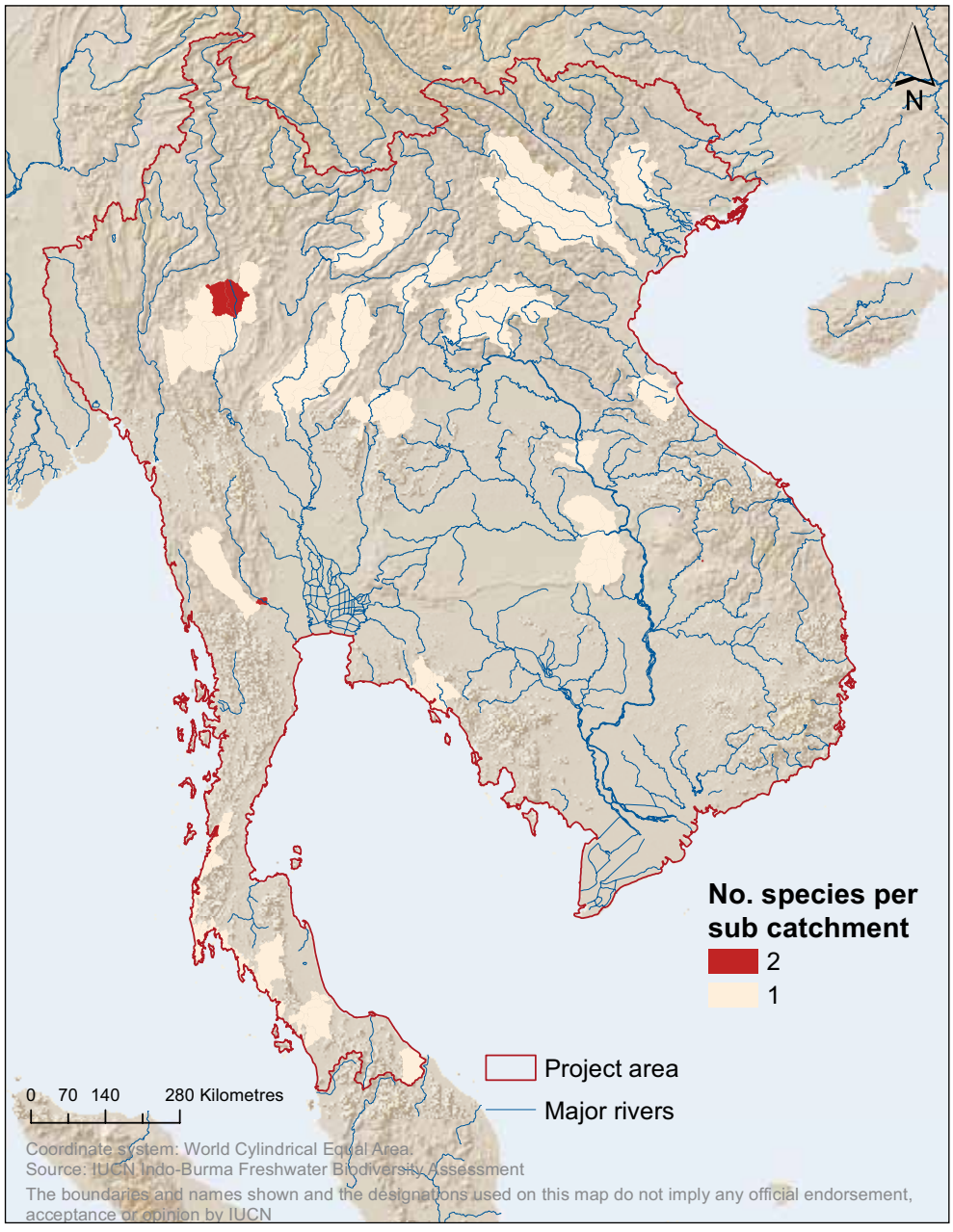


Figure 6.3 The distribution of threatened freshwater crab species in the Indo-Burma hotspot.

6.3.4 Data Deficient species

Ninety-eight (57%) of the 173 species assessed were judged to be DD (Table 6.1). Forty-seven DD species (five gecarcinucids and 42 potamids) are from Thailand, 19 DD species (all potamids) are from Myanmar, 29 DD species (six gecarcinucids and 23 potamids) are from Viet Nam, 11 DD species (all potamids) are from Lao PDR, and one DD species (a gecarcinucid) is from Cambodia (Figure 6.5). The high proportion of DD species reflects the general lack of specimens available, a scarcity that continues to fuel uncertainty about the distribution of these little-known species (Cumberlidge *et al.* 2009). It is of great concern that in many cases these DD species have not been found in recent years. These species have been listed as DD in view of the absence of recent information on their distribution ranges, habitat, ecological requirements, population size, population trends, and long-term threats (Cumberlidge *et al.* 2009). It is also of concern that many of these species are known only from a few individuals collected many years ago, and that no new specimens have been found recently. The DD status is also assigned where there is insufficient information either on their taxonomic distinction, or where they are known from either only one or only a few localities and the full range

Pudaengon arnamicai, a Data Deficient species known only from the type specimens collected at Pakse in southern Lao PDR. © Darren C.J. Yeo

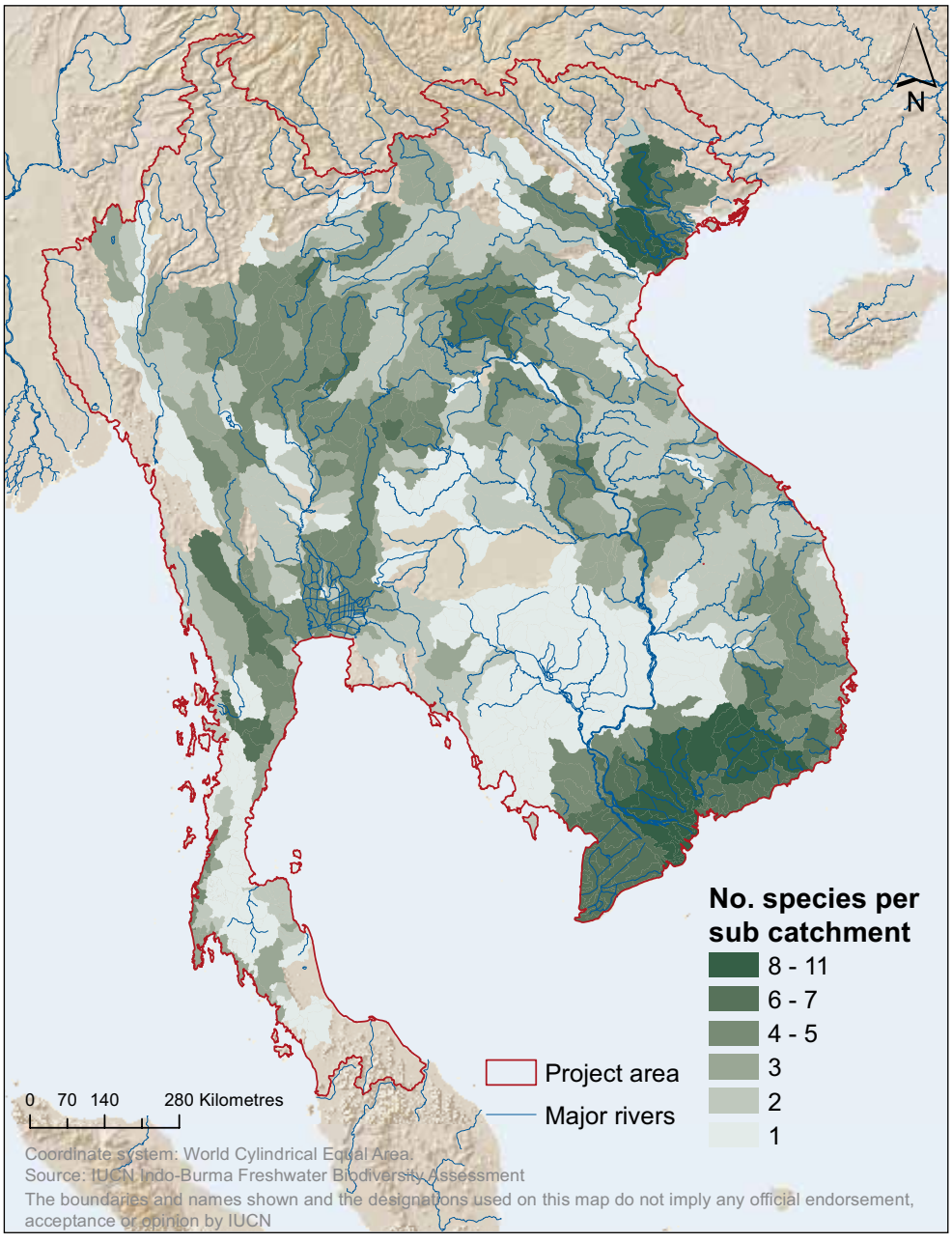


Figure 6.4 The distribution of freshwater crab species with severely restricted distributional ranges in the Indo-Burma hotspot.

extent is uncertain. It is possible that in some cases the DD status may be due to under-sampling but, as mentioned above, this is not thought to be the case for many of the DD species. Further research is needed on all of these species because, at least, they may prove to be restricted range endemics vulnerable to habitat loss.

6.4 Major threats

The main threats to the freshwater crabs from the Indo-Burma hotspot include water pollution, urban, industrial, and agricultural development, and habitat loss and deforestation resulting from human population and urban and agricultural expansion.

6.4.1 Habitat destruction

Threats to the endemic species include habitat destruction in the form of deforestation driven by timber extraction, mining, increasing agriculture, the demands of increasing industrial development, the alteration of fast flowing rivers for the creation of hydroelectric power, and the drainage of wetlands for farming and other uses. Destruction of the forests in many parts of the Indo-Burma hotspot is further exacerbated by logging roads that provide access to remote and previously undisturbed parts of the forest. Other threats that result in deforestation and habitat destruction include political unrest and refugee movements that are often accompanied by deforestation and soil erosion that contributes environmental damage to freshwater ecosystems. Potential future threats to aquatic communities in rivers associated with cities and towns in the Indo-Burmese region include pollution by sewage and industrial and general waste. Some agricultural pesticides used by farmers may prove to be lethal to freshwater crabs but more research needs to be carried out. All of the above factors combine to increase the overall level of threat to range-restricted endemic species, and the careful management of Asia's forests and water resources in the future will have the biggest impact on their long-term survival.

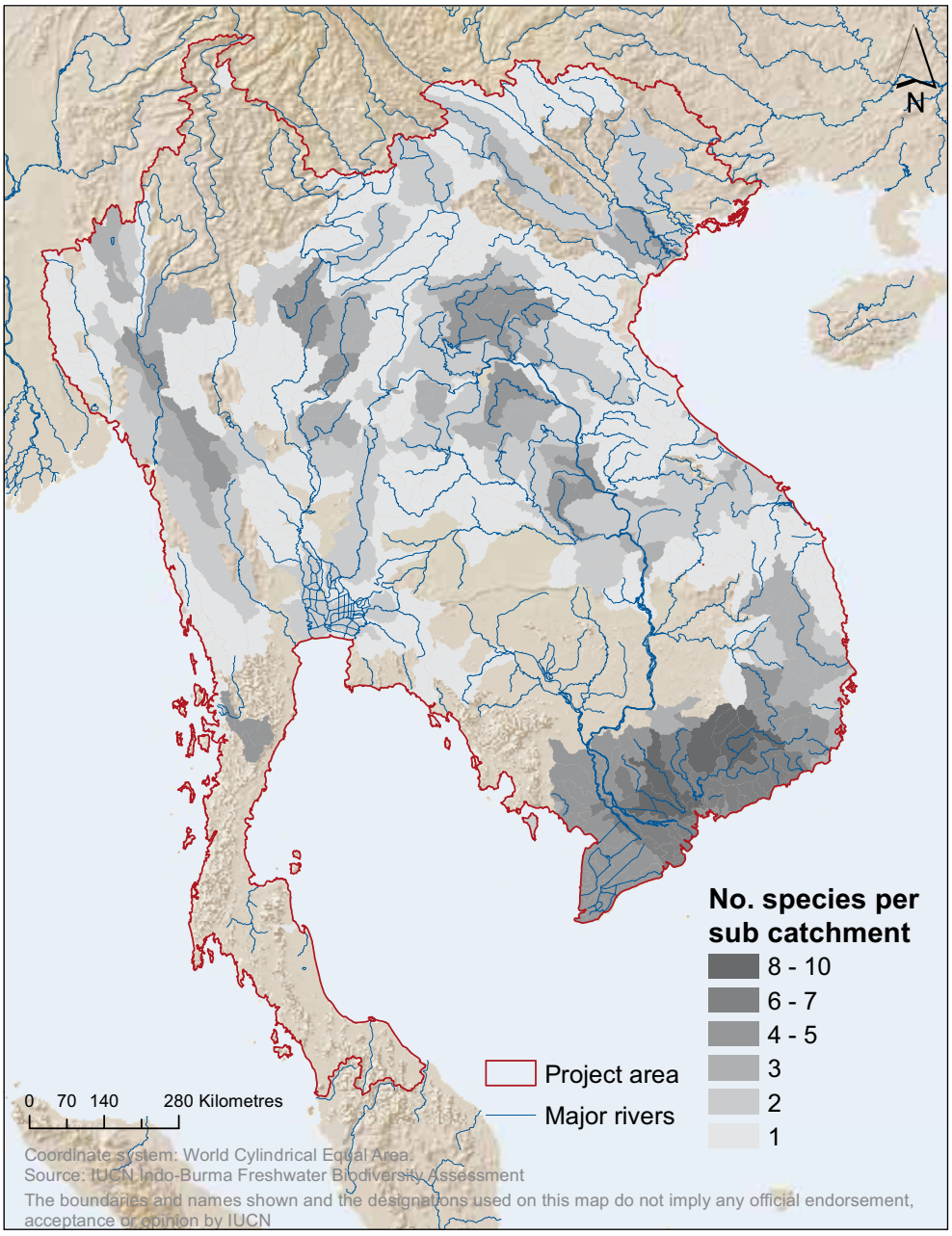


Figure 6.5 The distribution of Data Deficient freshwater crab species across the Indo-Burma hotspot.

Waterfall habitat for freshwater crabs in Thailand. © Darren C.J. Yeo

6.4.2 Pollution

Pollutants from mining activities for diamonds, gold, bauxite, and iron ore, and from organic wastes from leaking sewage systems in urban areas in Asia can accumulate in rivers and other freshwater bodies. These pollutants impact freshwater crab populations because they are benthic feeders that ingest other invertebrates and detritus that may contain high levels of contaminants. Immediate attention should be given to the improvement of the water quality in these areas not least because the bioaccumulation of metals in crabs could pose an increasing problem for the health of people that may eat them.

6.4.3 Natural predators and competition with introduced species

A large number of Asian predators including yellow-necked otters, water mongooses, civets, kites, egrets, herons, giant kingfishers, monitor lizards, and crocodiles depend on freshwater crabs as vital components of their diet. This is because freshwater crabs are the largest macro-invertebrates in Asian aquatic ecosystems and form an integral part of the food chain (Cumberlidge *et al*. 2009). The ecological importance of freshwater crabs in food webs has been underlined in studies on African carnivores (Rowe-Rowe 1977, Butler and Marshall 1996, Somers and Purves 1996). Such studies in Asia are still lacking, but it is likely that freshwater crabs would also constitute part of the diet of aquatic or semi-aquatic predators in Asia as well. In addition, freshwater crabs are also ecologically important for nutrient cycling through their role as macro-decomposers or as shredders of leaf litter and other allochthonous nutrient inputs (Ng 2004, Yeo *et al*. 2010). Potential competitors of freshwater crabs in Asia that are ecologically similar include exotic freshwater crayfish that have been introduced and established in subtropical/temperate parts of Asia (for example, North American *Procambarus clarkii*) (Xu *et al*. 2006) as well as in equatorial/tropical areas (for example, Australasian *Cherax quadricarinatus*) via aquaculture and ornamental trade (Ahyong and Yeo 2007).

6.4.4 Taxonomic issues

The evolving taxonomy of freshwater crabs is likely to be a challenge for conservation planning in the future because some taxa currently assumed to be widespread and common may prove to be complexes of several distinct cryptic taxa each with specific ecologies and distributions requiring specific conservation actions. There are a number of species that are currently assessed as LC primarily on account of their wide distributional ranges, however the distribution patterns of these species consist of many relatively isolated subpopulations that show a great deal of morphological variation. Further investigations may show these species to be species complexes as was the case for African species (Daniels *et al*. 2002).

6.5 Research actions required

Significant areas of this vast and biodiversity rich region still remain insufficiently explored, given that 56% of all species found in the region are Data Deficient. New species of freshwater crabs are sure to be discovered if collection efforts in remote areas are intensified and taxonomic advances become more readily available in the form of identification keys. Cambodia stands out as a country that is seriously understudied and its current total of only two species is almost certainly an undercount, given the outstanding species richness of the surrounding countries, and abundance and diversity of aquatic habitats within the country. Although taxonomic knowledge has advanced considerably recently, and museum collections of freshwater crabs have improved, a great deal of work still needs to be done. There is a need for further surveys to discover new species, refine species distributions, define specific habitat requirements, describe

Freshwater crabs are harvested for food throughout the region and often found in markets. © Charles Pieters

Demanietta khirikhan male. © Darren C.J. Yeo

population levels and trends, and identify specific threats to Asia's important and unique freshwater crab fauna. It is vital to the health of these ecosystems that fishery managers consider measures that specifically include the conservation and sustainable use of local populations of river crabs.

6.6 Conservation recommendations

The biology and distribution patterns of the freshwater crabs of the Indo-Burma hotspot are becoming better known as are the potential threats to their long-term survival. With 26 (35%) species of the 75 non-DD species of freshwater crabs from the Indo-Burma hotspot currently assessed as being at risk of global extinction, the long-term survival of the continent's largely endemic freshwater crab fauna is a concern. Nevertheless, it is hoped that conservation recovery plans for threatened species will be developed for those species identified to be in need of conservation action through this Red List assessment process (Collen *et al*. 2008, Cumberlidge *et al*. 2009).

The conservation of many species of freshwater crabs depends primarily on preservation of areas of natural habitat large enough to maintain water quality. Although it is not yet known exactly how sensitive the freshwater crabs of the Indo-Burma hotspot are to polluted or silted waters, there is evidence from elsewhere in Asia that similar crabs are not likely to survive when exposed to these factors (Ng and Yeo 2007). Development, agriculture and exploitation of natural products are necessary realities in developing economies, but compromises may have to be made if freshwater crab species are not to be extirpated in the future. Judicious and careful use of resources is unlikely to cause species extinctions as long as water drainages are not heavily polluted or redirected, some forest and vegetation cover is maintained, and protected areas are respected (Cumberlidge *et al*. 2009).

Common species assessed as LC have a wide distribution in the rivers, wetlands, and mountain streams of the region and so far have proved to be relatively tolerant of changes in land-use affecting aquatic ecosystems. It is encouraging that these more adaptable species can persist in the already disturbed and visibly polluted parts of the lowland rivers and streams. The increasing loss of natural vegetation and pollution as a result of land development and agriculture are, however, likely to affect the lowland rivers in the long term, and many of the wholly aquatic species that live there could eventually be vulnerable. Even species assessed as LC could suffer catastrophic declines should there be abrupt changes in land development, hydrology, or pesticide-use regimes. It is not known how the highland taxa will cope with habitat disturbance and pollution but, considering their specialised habitat requirements, it is likely that most of these species will not adapt as readily as the more widespread lowland species. In many countries with a rapid pace of development, often only a fine line separates a species assessed as LC from one assessed as VU, or a VU species from one that is assessed as EN. Development projects could have a dramatic impact on species with specific habitat requirements and a restricted distribution. Conservation activities should therefore be aimed primarily at preserving the integrity of sites and habitats while at the same time closely monitoring key freshwater crab populations.

The 98 species of freshwater crabs from the Indo-Burma hotspot judged to be DD were assigned to this category primarily as the result of insufficient field surveys. The scarcity of available specimens is in some parts of the continent due to the long-term poor security situation, and as a result little is known of the habitat needs, population trends, or threats to these species. When more information has been gathered, it is expected that almost all DD species will have a relatively restricted distribution and be endemic to the river basin where they are found.

The conservation assessment of freshwater crabs in Asia (Cumberlidge *et al*. 2009) represents a first step toward the identification of threatened species within the region and toward the development of a conservation strategy for endemic species. The restricted range of many species, together with the on-going human-induced loss of habitat in many parts of the region, are primary causes of concern for the long-term survival of this fauna. Asia's freshwater crabs have a high degree of endemism with many species living in specialised habitats such as river rapids, lowland marshes, forested highlands, and islands. Additional research is recommended to determine the minimum effective size and design of protected areas for freshwater species such as crabs.

6.7 References

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