How EIA has furthered the conservation of endemic freshwater crabs in Hong Kong

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Introduction

Despite its small size, Hong Kong Special Administrative Region is home to three, potentially four, endemic crab species; *Somanniathelphusa zanklon, Cryptopotamon anacoluthon* and *Nanhaipotamon hongkongense*. The fourth species, *Nanhaipotamon aculatum*, is known from a single museum specimen and is not considered further here.

Somanniathelphusa zanklon is a tropical freshwater crab that occurs in a variety of lotic and lentic habitats and is currently considered an endemic to Hong Kong (Esser & Cumberlidge 2008a). It is listed under the Endangered category of the IUCN Red List due to a limited extent of occurrence (less than 5,000km^2) and probable decline in habitat quality from application of pesticides in rice fields (Esser & Cumberlidge 2008a). Under a local conservation assessment, the species is listed as being of Global Concern (Fellowes *et al.* 2002).

Cryptopotamon anacoluthon appears to be relatively stenotopic and is found in shaded shallow streams with clear or unpolluted, fast-flowing waters, rocky substratum, and leaf-litters, which serve as shelter and food (Ng & Dudgeon 1992). It is listed as Vulnerable under the IUCN Red List because it might be under long-term threat from rapid anthropogenic changes and also due to its limited distribution (Esser & Cumberlidge 2008b). Its published range under Esser & Cumberlidge (2008b) is limited to four locations, however it was considered to be fairly common and widespread in local unpolluted streams by Dudgeon & Corlett (2004). Locally, the species is listed as being of Potential Global Concern (Fellowes *et al*. 2002).

Nanhaipotamon hongkongense is listed as Least Concern on the IUCN Red List (Cumberlidge 2008). It published range under Cumberlidge (2008) is limited to three locations, though the range map shows the distribution extending outside of Hong Kong into neighbouring Guangdong, northwards up the Pearl River estuary and eastwards along the coast, though no supporting evidence or rationale for this suggested wider range was provided. IUCN stated that major threats to this species are habitat loss and pollution and that no conservation measures are known to be in place for this species, and incorrectly, that it is not found in a protected area

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Hong Kong has a large network of protected areas, Country Parks, comprising 40% of its land area of 1104 square kilometres, though these are usually at higher elevations, i.e. above 200m asl. However, there is much development pressure on unprotected areas and the peripheries of the Country Parks; many of these areas are at lower elevations and where topography is more conducive to development. In these lowland habitats there is an ongoing loss of wetland habitats and channelisation of lowland watercourses, with accompanying threats to a many fauna species (Hill 2011). Since *Somanniathelphusa zanklon* was largely considered to be predominantly a species of slower-flowing lowland watercourses with the other two crab species generally thought to be of faster-flowing hill streams at higher elevations, it was generally assumed that *S, zanklon* was the most threatened of the three taxa.

Whilst undertaking ecological surveys and assessments under Hong Kong's statutory Environmental Impact Assessment (EIA) process, it became clear to us that the status, distributions and habitat requirements of the three species was inadequately documented and that there was a paucity of published literature available to provide a baseline for the evaluation of the predicted severity of impacts on these species.

Since the statutory Environmental Impact Assessment (EIA) process was introduced in Hong Kong in 1998, EIA reports have been published online and are available for public view. In an effort to address the deficiencies described above, we reviewed all published EIA reports approved under the EIA system and produced three peer-reviewed papers on these freshwater crabs to help to guide assessment of potential direct and indirect impacts under the EIA Ordinance and to safeguard the future of these cryptic and little-known species. Here we posit that the data collected, evaluated and published under a statutory EIA process can be an important resource for conservation and assessment for biodiversity, particularly for those lesser-studied or less-glamorous taxa groups.

Methods

Hong Kong SAR has a robust EIA process and numerous developments requiring EIA studies have taken place in Hong Kong since its introduction with many concerning watercourses where freshwater crabs occur. Such EIA studies invariably require surveys of the streams that may be affected and survey data and findings are detailed in Ecological Impact Assessment section. These EIA reports are permanently and freely available for public inspection on a website maintained by the Environmental Protection Department (http://www.epd.gov.hk/eia/).

We reviewed all published EIA Reports for all projects across Hong Kong and records of *S. zanklon*, *C. anacoluthon* and *N. hongkongense* were. Key search words, included species names, along with singular species or genus name (to account for typographical errors or spelling mistakes) and also included terms such as 'crab', 'freshwater', 'aquatic' and 'invertebrate'.

Findings

A review of 126 EIA reports published between 2002 and 2017 was conducted. The review resulted in a significant increase in the number of locations from where these crabs were recorded increased significantly and their distributions also extended beyond previously published information (Table 1). Figures 1-3 shows the distribution of each of the crabs following the review process.

Table 1. Comparison between published IUCN data and findings from this Study

	Somanniathelphusa zanklon	***Cryptopotamon anacoluthon***	***Nanhaipotamon hongkongense***
IUCN			
Number of locations	2	4	3
Area of Occupancy	-	-	-
EIA Review			
Number of locations	41	25	34
Area of Occupancy	250km^2	200km^2	400km^2

The Study also confirmed that *S. zanklon* shows a preference low-gradient, slow-flowing tributaries and freshwater marshes, as opposed to larger rivers or smaller fast-flowing watercourses. Generally, *C. anacoluthon* and *N. hongkongense* were found to prefer fast flowing upland streams shaded by secondary woodland; however, both species were also recorded in lower elevations.

Discussion

This research led to the publishing of peer-reviewed papers on species distribution, conservation status and threats for three of Hong Kong's endemic freshwater crabs; *S. zanklon, C. anacoluthon* and *N. hongkongense*. We were able to confirm that, given its habitat preferences *S. zanklon* is most susceptible of the three species due to development pressures and direct impacts.

Watercourses in which this species occurs are of diverse ecological value and states of naturalness and are under threat of loss and modification from urban development. Given the life cycle of the species, adjacent terrestrial habitats within the riparian corridor or marsh-edges are as important as the aquatic water bodies; as such, channelization of watercourses can be detrimental to species recruitment (Stanton & Leven 2016).

Cryptopotamon anacoluthon and *N. hongkongense* are more susceptible to indirect impacts through fragmentation. The habitat mosaics in which these two species occur are often fragmented by developed areas (Stanton *et al.* 2017, 2018) and a result of urbanisation do not share downstream confluences or natural habitat linkages. Many watercourses have been piped or channelised in their lower sections and lack suitable connectivity, thus potentially inhibiting the movement of crabs. Hence, it is likely that within their respective areas of occupancy there are now a number of more or less isolated sub-populations.

Our studies were not intended to constitute a review of the IUCN listing of these species. Nevertheless, we had sufficient confidence in our findings to suggest that the IUCN Red List status of these species should be revisited in their light. Cumberlidge *et al.* (2009, 2010) stated that the existing IUCN Red List status can be updated by gathering current data on the distribution, natural history, population trends, threats, and endemism of China's highly diverse freshwater crabs. From our findings, it would seem likely that *S. zanklon* and *C. anacoluthon* occur in the neighbouring province of Guangdong, though freshwater crabs, particularly the Chinese *Somanniathelphusa*, are problematic in identification as many species look identical externally and were originally described based on minute differences of dissected body organs (Huang *et al*. 2018) and further genetic studies are required.

Conclusion

Corlett (2010) discussed how in much of the tropics, the grey literature (of which, Hong Kong's EIA reports fall) has a greater volume then the peer-reviewed scientific literature in ecology and conservation. While there are sometimes limitations with the quality of the data published e.g. observer error, we suggest that, as we have demonstrated by our use of Hong Kong EIA data, having such a wealth of online data readily available through the EIA process can significantly advance our understanding of the distributions, abundance and habitat requirements of little studied and threatened species and hence can assist in their conservation. However, there are issues with access to this information: individual species are unlikely to be searchable in much of the grey literature using a standard search engine; thus we suggest that the step taken by us to review comprehensively a representative set of grey literature data and then publish in the peer-reviewed literature is desirable.

We believe that our studies have helped local conservation, generating findings to support Hong Kong's Biodiversity and Species Action Plan Red List, and potentially globally, providing much needed data to help inform future IUCN Red List assessments; whilst the case study presented here serves to demonstrate how the impact assessment process can contribute to the safeguarding of biodiversity through the medium of the robust and readily accessible EIA system of Hong Kong.

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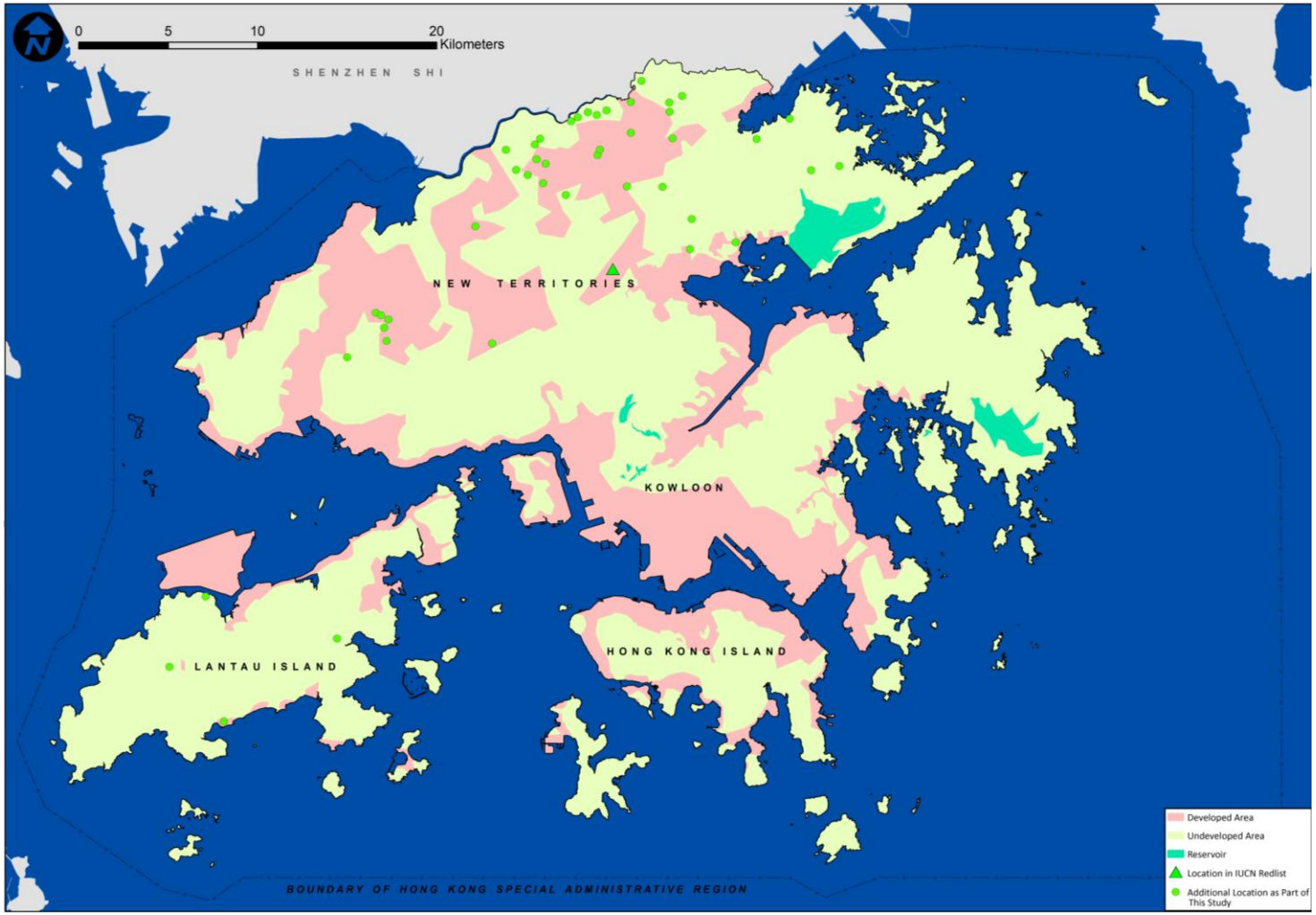

Figure 1. Distribution of *Somanniathelphusa zanklon* following a review of EIA studies

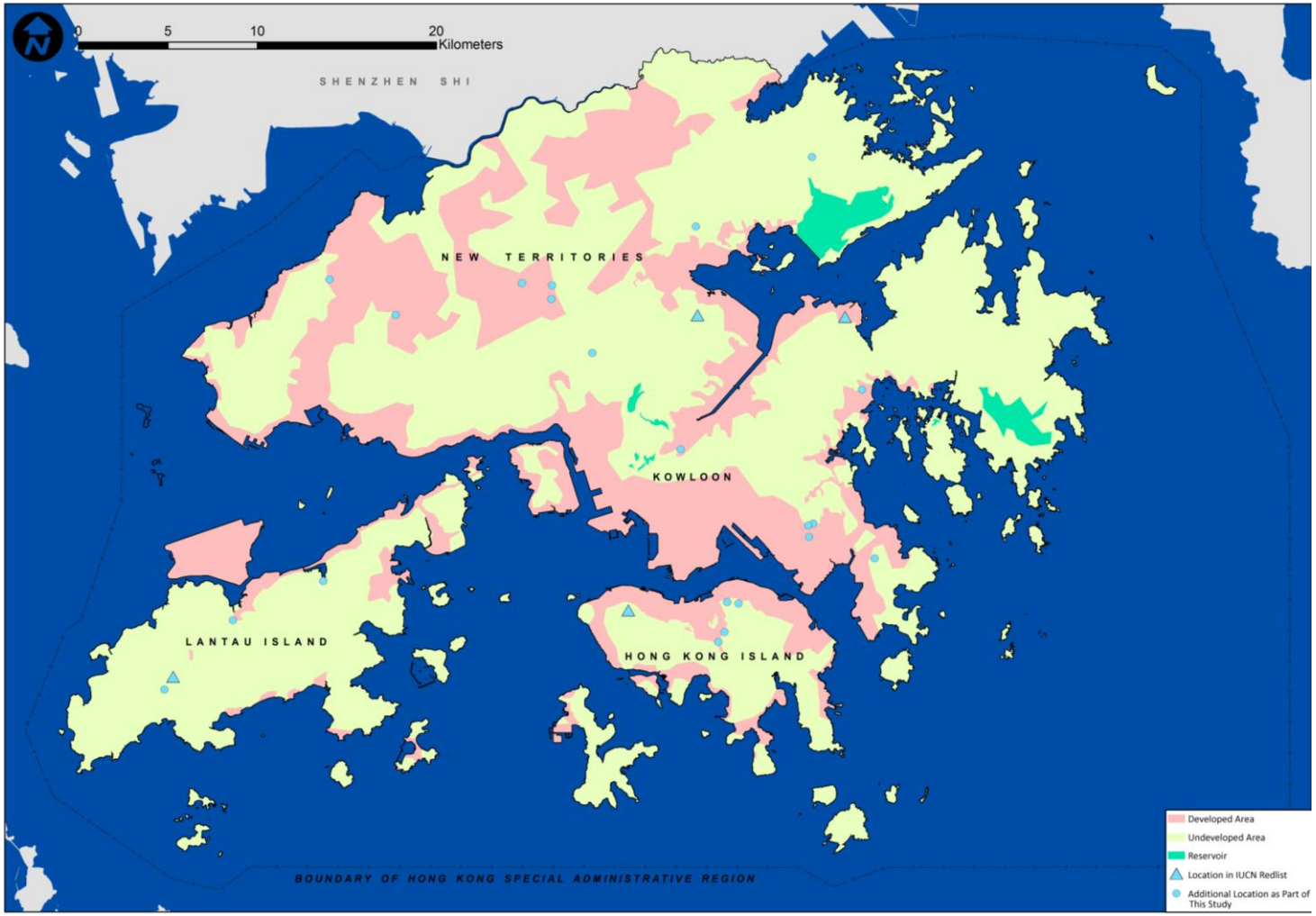

Figure 2. Distribution of *Cryptopotamon anacoluthon* following a review of EIA studies

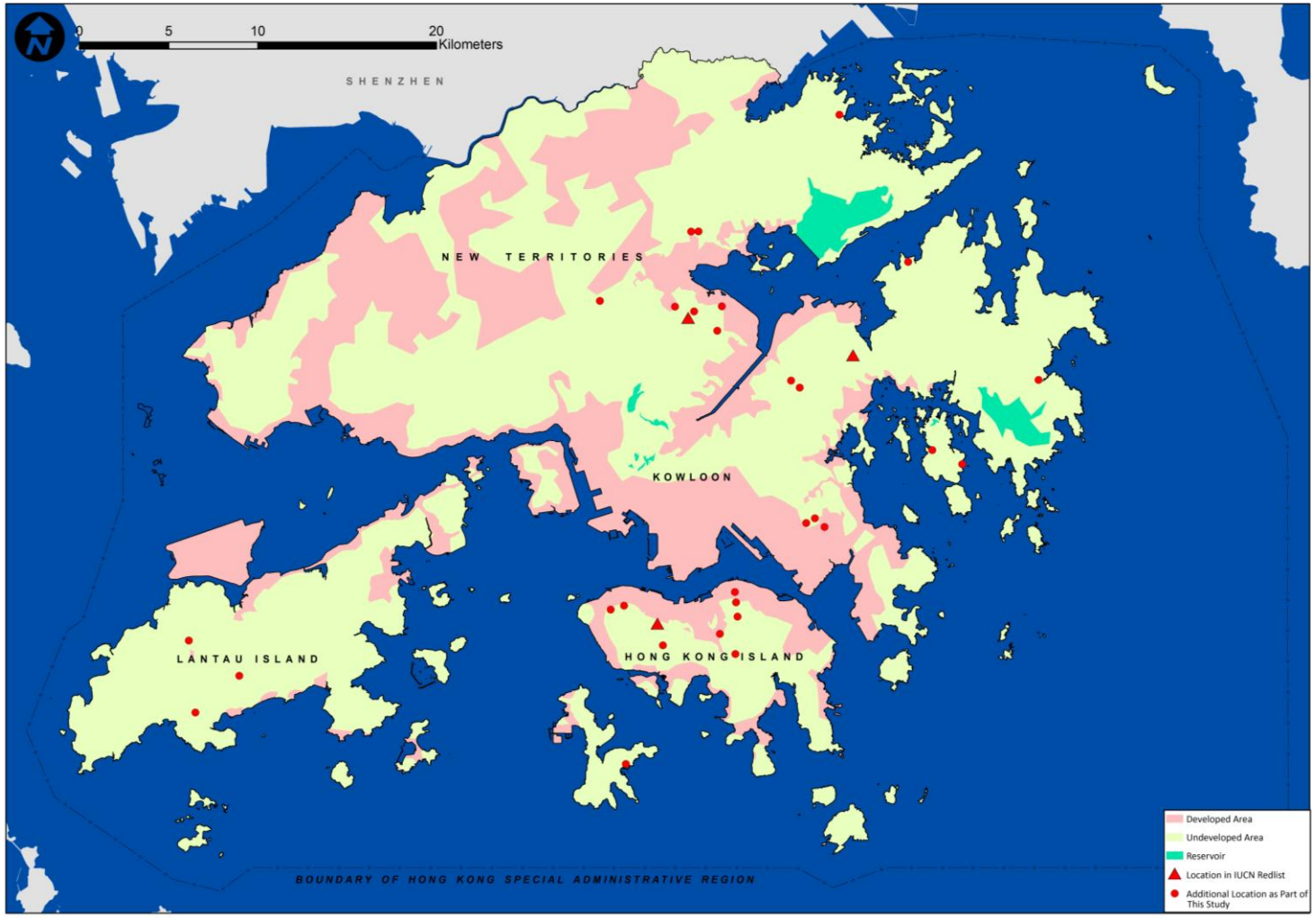

Figure 3. Distribution of *Nanhaipotamon hongkongense* following a review of EIA studies