Quantification of extinction risk for crustacean species: an overview of the National Red Listing process in Brazil

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Abstract

Crustacean species from Brazil were evaluated to define their conservation status under the Categories and Criteria of the IUCN Red List of Threatened Species at the regional level. This study represents an effort of the Chico Mendes Institute for Biodiversity Conservation (ICMBio), the Brazilian agency for conservation of biodiversity, and the Brazilian Crustacean Society (SBC) to systematically collate specific data for these species and to determine their risks of extinction. The IUCN Red List Categories and Criteria were applied to 130 candidate species, following IUCN Red List Guidelines. Assessments to determine the risk of extinction were conducted during a three-day workshop held in Brasília in September 2010, which brought together about 30 experts to share information about species and threats. A total of 14 species (11.6%), 12 of them endemic to Brazil, qualified for one of the three Red List categories of threat (CR, EN, or VU). Twenty-five species (20.8%) were listed as Data Deficient, and because of this lack of data the extinction risk for crustaceans may be under-estimated. IUCN Criterion B was most often used during the assessments (85%), and the main threats identified are associated with removal of riparian forest causing siltation, and discharge of domestic, urban, industrial, and agricultural effluents, degrading water quality, as well as uncontrolled fishery activities. The South Atlantic hydrological basin contains the largest number of threatened species, which indicates that increased attention from agencies, institutions, and researchers is needed to develop appropriate strategies and regulations to aid in their conservation.

Key words: Red List, threatened species, conservation, assessment.

Nauplius

Introduction

The Crustacea Brünnich, 1772 includes roughly 68,200 valid species worldwide and about 2,500 in Brazil (Martin and Davis, 2001; Amaral and Jablonski, 2005). This taxonomic group includes a great variety of morphological forms that inhabit terrestrial, freshwater, estuarine, and marine ecosystems. Their economic and ecological importance has been well documented (Bond-Buckup *et al.,* 2009). Microcrustaceans have an essential role in aquatic ecosystem food chains as an important energy transfer link connecting phytoplankton to higher trophic levels (Kennish, 1986). Marine decapod crustaceans, including lobsters, crabs, and shrimps, support important fisheries from tropical to polar seas (Fogarty and Botsford, 2006). In Brazil, for instance, spiny lobsters comprise the most important fisheries resource on the northern and northeastern coast (IBAMA, 2006). In addition, freshwater crabs and prawns require pristine water conditions and can be used as indicators for tracking changes in environmental quality of their habitats (Cumberlidge *et al.,* 2009; Pérez-Losada *et al.* 2008; Yeo *et al.,* 2008).

Over the past 50 years, humans have changed ecosystems more rapidly and extensively than in any comparable period of time in human history, largely to meet rapidly growing demands for food, freshwater, timber, fiber, and fuel (Millennium Ecosystem Assessment, 2005). Losses and degradation of ecosystems are clearly associated with the process of species extinction. Understanding the impacts of the threat process is critical to assessing extinction probabilities, because they may change nonlinearly with increasing human population growth and development, and their future trajectories and impacts vary with time and place (Mace *et al.,* 2008). Crustacean species, which may have predictive characteristics that significantly influence their extinction risk, appear to have potential as important elements to detect and document the status of the biodiversity of fauna affected by these threats. For example, some crab species occupy small ranges, sometimes with high levels of endemism, and have very specific habitat requirements; as do many shrimp species that have had their populations reduced by overexploitation.

Despite the obvious necessity of assessing the conservation status of this group, very little is known about the effects of degradation and habitat loss on individual crustacean species. Few aquatic invertebrate species have been evaluated by the International Union for the Conservation of Nature (IUCN) at global levels, compared with other taxonomic groups; one of these groups is the freshwater crabs (Cumberlidge *et al.,* 2009). Approximately 4% of the total species assessed by the IUCN are crustaceans, and at least 28% of these species are classified at high risk of extinction, mainly due to pollution, harvesting, invasive species, agriculture and aquaculture activities (IUCN, 2010). For these reasons, the Chico Mendes Institute for Biodiversity Conservation (ICMBio), a federal agency under Brazil's Ministry of Environment, and the Brazilian Crustacean Society (SBC) initiated efforts to systematically collate species-specific data for 130 species and to determine their risks of extinction. Here, we provide a general overview of the results of the conservation status assessment for crustacean species under the Categories and Criteria of the IUCN Red List of Threatened Species, on the occasion of the Brazil Red Listing process.

Methods

The IUCN Red List Categories and Criteria were applied to 130 candidate species reported from Brazil, following the IUCN Red List Guidelines (IUCN, 2008). These species were selected based on their inclusion in previous Brazilian Red Lists (national or local levels) and those that have been evaluated by the IUCN and occur in Brazil. The list of candidate species received additions through suggestions from specialist researchers. Contributions to the candidate list could be communicated through the electronic address of the ICMBio or by contacting the Brazilian Crustacean Society, which nominated a crustacean specialist to prepare and liaise with other researchers in collecting information on taxonomy, distribution, population trends, ecology, habitat, threats, life history, and conservation actions for each candidate species.

Assessments to determine the risk of extinction were conducted during a three-day workshop held in Brasília in September 2010, which brought together about 30 experts to share information about species and threats and to apply together the IUCN Red List Categories and Criteria. The experts were divided into two main groups (for freshwater and marine/estuarine species), with the

help of two facilitators per group to appropriately apply the criteria and define categories. During the workshop, species were evaluated based on available information, through external consultation and with data contributed after workshop. After this phase, each species assessment will be confirmed through the peer-review process with at least two Red List Authorities. Subsequently, the final list with categories will be available on the ICMBio website (http://www.icmbio.gov.br).

The species were classified into different categories according to the level of risk (Figure 1): Extinct (EX), Extinct in the Wild (EW), Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT), Least Concern (LC), and Data Deficient (DD). CR, EN, and VU represent the three categories with a threat level. To qualify for listing in any of the threat categories, a species must meet any of five criteria A through E at that level (Mace *et al.,* 2008). These criteria are based on the biological indicators of populations that are threatened with extinction, such as rapid population decline or very small population size (IUCN, 2008). The different criteria measure extinction risk based on population reduction (A); geographic range size, and fragmentation, decline or fluctuations (B); small population size and decline (C); very small or restricted population (D); and quantitative analysis of extinction risk such

as population viability analysis (E). The category NT is assigned when a species has been evaluated against the criteria but does not fully meet all the thresholds or conditions required for a threatened category at present, but is close to qualifying for or is likely to qualify for a threatened category in the near future. A species was defined as DD when there is inadequate information to make a direct or indirect assessment of its risk of extinction based on its distribution and/or population status (IUCN, 2008).

Results and Discussion

Of the 130 candidate species, 10 were not evaluated (NE) because they are poorly known. A total of 14 species (11.6%) qualified for one of the three Red List categories of threat (CR, EN, or VU), 12 of them endemic to Brazil. Although Brachyura dominated with the largest number of species evaluated, Anomura had the highest number of species (12) that qualified in threatened categories – 92.3% of the evaluated taxa of this group (Table 1). Comparing the number of threatened species in the previous Red List (10 species), the overall number of threatened species increased somewhat, but the proportions of species in the different categories of threat differed markedly. In
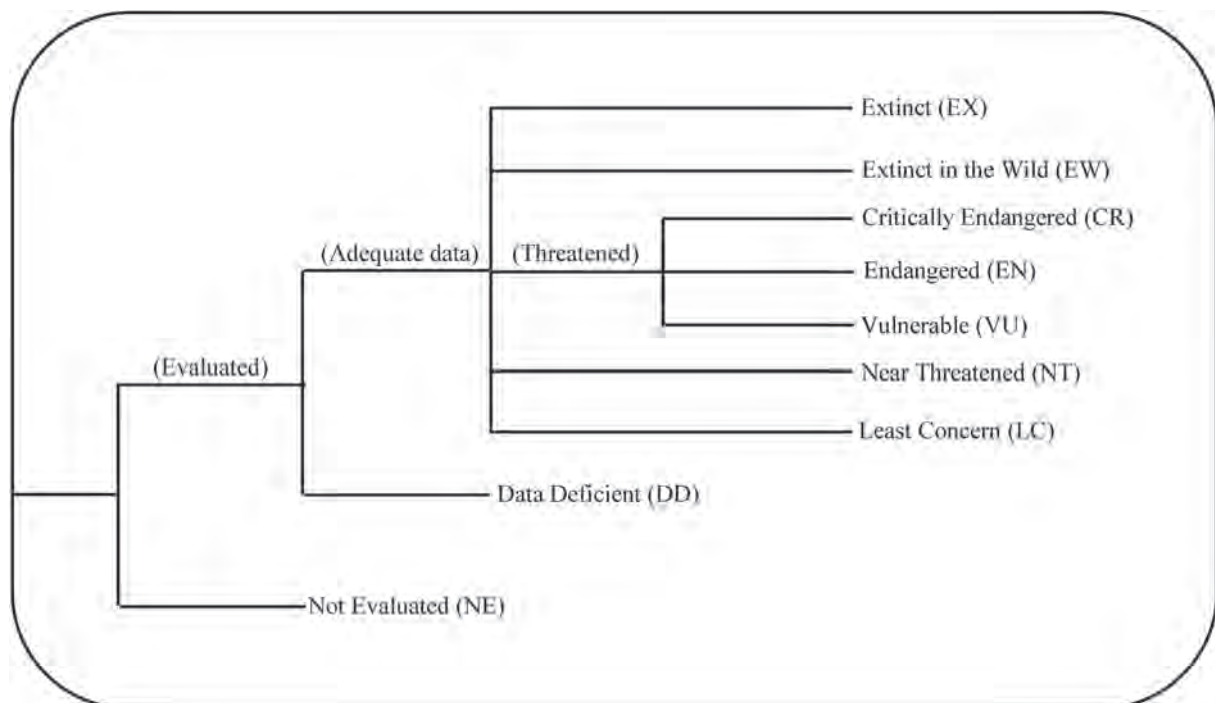

Figure 1. Representation of the IUCN Red List scheme (Source: Mace *et al.,* 2008)

Table 1. Summary of the Red List Category classification for Crustacea taxonomic groups. (CR = Critically Endangered, EN = Endangered, VU = Vulnerable, NT = Near Threatened, DD = Data Deficient, LC = Least Concern).

Taxonomic group	Number of species evaluated	Threatened species			NT	DD	LC
		CR	EN	VU			
Amphipoda	1	—	—	—	—	—	1
Cladocera	4	—	—	—	—	1	3
Copepoda	17	—	—	—	—	10	7
Decapoda							
Achelata	6	—	—	—	—	1	5
Anomura	13	7	3	2	—	1	—
Astacidea	5	—	—	—	—	1	4
Brachyura	55	1	1	—	3	4	46
Caridea	13	—	—	—	1	3	9
Dendrobranchiata	5	—	—	—	—	4	1
Thalassinidea	1	—	—	—	1	—	—
Total	120	8	4	2	5	25	76

the previous Red List, no species was listed as CR and only two species as EN. Currently, more than 57% of the threatened species are facing the highest risk of extinction (CR). Five species (4.2%) were listed as Near Threatened because they partially met the quantitative thresholds in some criteria to qualify for a threatened category.

Twenty-five species (20.8%) were listed as Data Deficient, primarily due to gaps in knowledge of population trends in their entire range of occurrence, or because of doubts about fishery statistics. Two groups had especially high numbers of species listed as DD: copepods and Dendrobranchiata shrimps. The extinction risk for crustaceans may
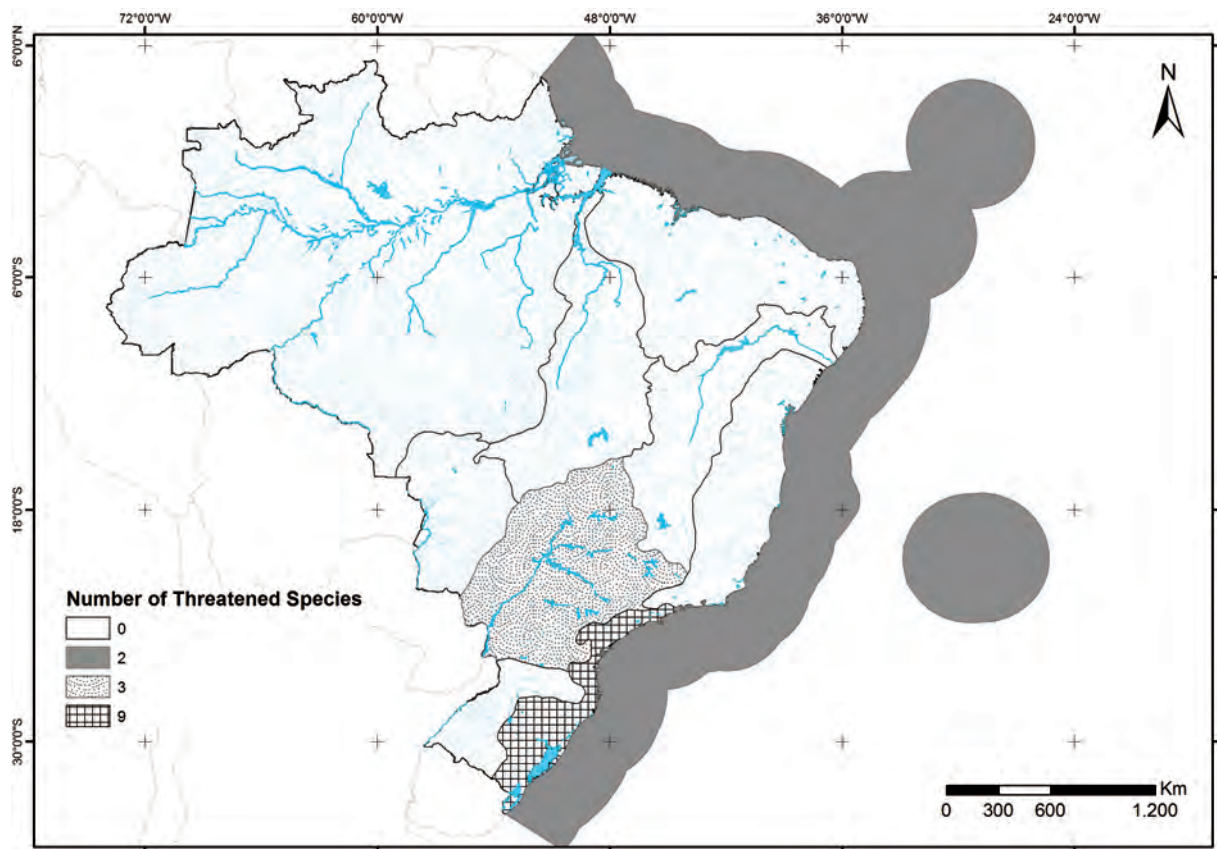

Figure 2. Numbers of threatened crustacean species across Brazilian hydrological basins and the southwestern Atlantic Ocean (represented by the Brazilian Exclusive Economic Zone – EEZ).

be under-estimated, because of this high proportion of species listed as DD. The global assessment for 1280 species of freshwater crabs also reported a high proportion of species listed as DD – almost half of the group (Cumberlidge *et al.,* 2009). The proportion of species considered not threatened also differed markedly, with 82% of brachyuran crabs, 69% of caridean shrimps, and 41% of copepods being listed as LC. The global assessment of freshwater crabs (Cumberlidge *et al.,* 2009) listed four species from Brazil in threatened categories (three as VU, one as EN) and seven as DD. These species were re-evaluated during this regional assessment, and the categories were changed as follows: five species changed from DD to LC, three species from VU to LC, one species from NT to LC, and one species from EN to NE. Two species remained in the DD status, and evaluations of two recently described species were added.

Crustacean species included here were mostly assessed under Criterion B, and they are restricted-range species (12 of 14 species that qualified for some threat category met Criterion B). This criterion measures the possibility of extinction based on a small geographic range combined with continued decline and habitat fragmentation (Mace *et al.,* 2008). Besides having a very small geographic range, these species have highly specialized patterns of resource use, which makes them more susceptible to habitat loss. However, data on population trends and abundance are generally unavailable for crustaceans.

The primary threats to crustacean species are associated with removal of riparian forest, causing siltation; and discharge of domestic, urban, industrial, and agricultural effluents, degrading water quality (both cited for 57% of the threatened species). These threats have serious and critical consequences for freshwater biodiversity, and have two associated issues: (1) since 1960, inputs of reactive (biologically available) nitrogen in terrestrial ecosystems have doubled, and inputs of phosphorus have tripled; and (2) the simplification of the landscape and destruction of riparian forests allow the unbuffered flow of nutrients between terrestrial and aquatic ecosystems (Millennium Ecosystem
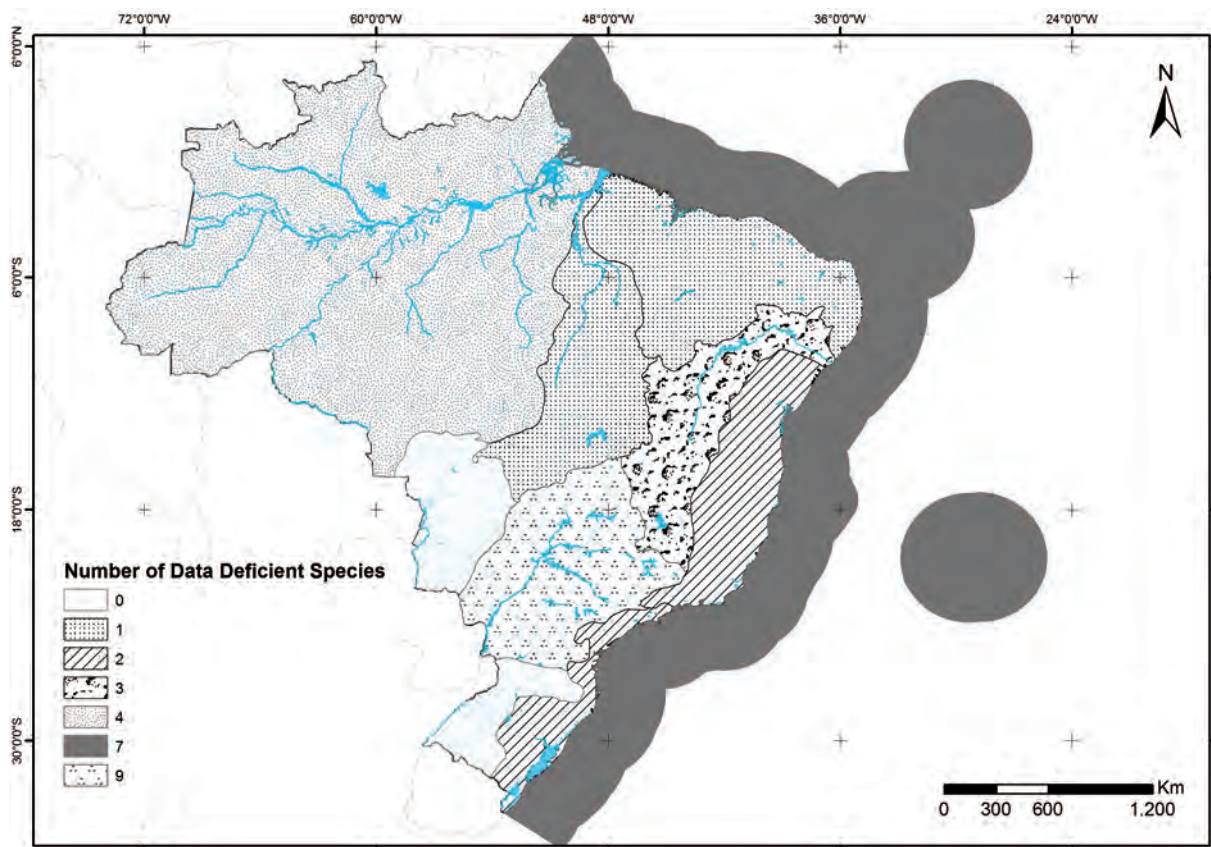

Figure 3. Numbers of crustacean species listed as DD (data deficient) across Brazilian hydrological basins and the southwestern Atlantic Ocean (Brazilian Exclusive Economic Zone – EEZ).

Assessment, 2005). Other threats cited during the assessments include invasive species, overexploitation, and human recreational activities.

The geographical analyses for the threatened species and for those listed as DD are depicted in Figures 2 and 3. The South Atlantic hydrological basin has the highest number of species under threat, and watersheds located in the northern and northeastern regions of Brazil have no threatened species. The concentration of threatened species in southern Brazil shows that the threats are not evenly distributed and this indicates that increased attention from agencies, institutions, and researchers is needed to develop appropriate strategies and regulations to aid in their conservation. The high priority for conservation investment of the ecoregions in these watersheds was also demonstrated by Pérez-Losada *et al.* (2008). In the southwestern Atlantic Ocean, only two crustacean species are deemed to be threatened. However, marine species have not yet been comprehensively assessed (of the 120 species evaluated, only 25 are marine), and therefore it is not possible to determine threats related to geographical patterns in the marine/estuarine ecosystems. Furthermore, assessments for marine decapod crustaceans are more complicated, because these species have well-defined spatial distributions that provide a metapopulation structure, and our current understanding, in general, is most often associated with the dynamics of single populations (Fogarty and Botsford, 2006; Botsford and Hastings, 2006). Efforts should be devoted in the future to study target species in their entire range of distribution, in order to minimize this lack. The largest number of species categorized as DD was identified in the Paraná and Amazon basins, as well as in the marine Brazilian Exclusive Economic Zone.

Recommendations

Although this is merely a first attempt, we are more than convinced that crustaceans are poorly represented on the Red List, with assessments restricted to the better-known and small groups. It is essential that these species be continuously assessed as to their conservation status. A more comprehensive national survey is necessary to increase the proportion of described species that have been evaluated. Future activities should focus on conservation efforts and adoption of strategies to promote the recovery of these identified threatened species as a way of maintaining biodiversity levels, for instance through the development of action plans. An action plan synthesizes the available information about particular species or zoogeographic units, and provides guidance for conservation actions with goals, activities, and defined responsibilities.

Acknowledgements

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