

2026 Addendum:

Conservation Strategy for the

Singapore Freshwater Crab

Johora singaporensis



Prepared by the Freshwater Crab Conservation Working Group (FCCWG):



Note: The conservation strategy is based solely on the opinions of the authors and does not constitute a statement of policy, decision, or position on behalf of the participating organisations.

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Cover photographs: *Johora singaporensis* ex-situ © Tan Zhi Wan [front],
Johora singaporensis with claws up in defense © Tan Zhi Wan [back]

EXECUTIVE SUMMARY

The Singapore Freshwater Crab Conservation Strategy published in 2015 was developed through a workshop (the Freshwater Crab Conservation Round Table) in 2014 organised by the National Parks Board, Singapore, National University of Singapore, and Mandai Nature (formerly Wildlife Reserves Singapore Conservation Fund) and involving multiple stakeholders. The document outlined a hierarchy of statements from Vision to Actions for further research and conservation management of the Singapore freshwater crab, *Johora singaporensis*, to ensure the persistence of the species within its natural habitat, and its status as an icon for freshwater conservation in Singapore. In the present addendum, the Freshwater Crab Conservation Working Group (FCCWG), formed as a result of the workshop and strategy, presents a review of the conservation efforts since the formulation of the Conservation Strategy. Here, we scored the progress for each Action within the Conservation Strategy; detailed the relevant work conducted to address each action; whether the Action remained open/closed; and recommendations/conclusions.



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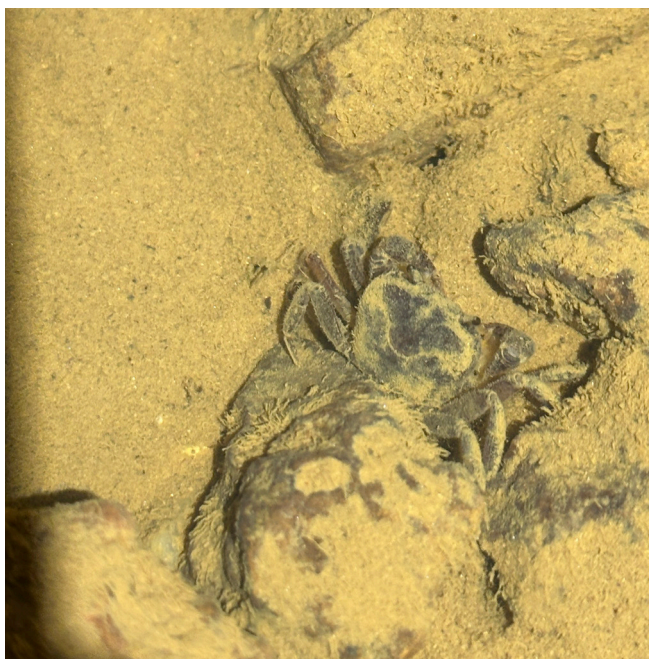
1. INTRODUCTION

1.1 Overview

The Critically Endangered and endemic Singapore freshwater crab *Johora singaporensis* Ng, 1986 (Crustacea: Potamidae) is the only crustacean species listed among the world's 100 most threatened species in Baillie and Butcher (2012), a collaborative effort with over 8,000 researchers from the International Union for Conservation of Nature Species Survival Commission (IUCN SSC) and the Zoological Society of London. The crab is an unlikely candidate for conservation given that conservation of invertebrates is often challenging, more so if the species is uncharismatic or not of economic or cultural significance (Collier et al. 2016). Ironically, despite possessing these characteristics, *J. singaporensis* was placed on the list (Baillie and Butcher, 2012)—eventually propelling a succession of conservation actions to ensure the species' survival in Singapore.

Crabs of the genus *Johora* ranging from southern Thailand, through the central highlands of Peninsular Malaysia, including islands off its east coast, down to Singapore. *Johora singaporensis* is the southernmost and only species of the genus to be found in Singapore (Ng 1988; Yeo et al. 2007). The species is endemic to Singapore, with its nearest relative found on mainland Peninsular Malaysia in southwestern Johor (Ng 1986, 1988). The species' highly restricted distribution in hill streams, a rare habitat-type in Singapore, its small population size, and especially the extirpation of the population from its type locality at Jungle Fall Valley in Bukit Timah Nature Reserve (one of only three known localities in 2008 led to the assessment of its conservation status in the IUCN Red List as Critically Endangered (Esser et al. 2008; Ng et al. 2015a). Despite the species' national natural heritage significance, there was no formal conservation plan until the Conservation Strategy for the species was launched in 2015 (Ng et al. 2015b; Yeo et al. 2016).

With a clear direction and plan of action set, and collaboration amongst key stakeholders, the conservation strategy paved the way for successful conservation actions for the species, as well as presenting a significant milestone for conservation of invertebrates globally. Here, we summarise the Conservation Strategy, discuss the progress and milestones achieved since its implementation, and outline further steps forward.



J. singaporensis in stream. | Photograph © Soh Bryan

1. INTRODUCTION

1.2 Conservation Strategy for the Singapore freshwater crab, *Johora singaporensis*

The Conservation Strategy was conceptualised and developed through a three-day roundtable discussion involving various organisations and stakeholders in 2014, and launched in 2015. The strategy was a collaborative effort driven by Mandai Nature (originally Wildlife Reserves Singapore Conservation Fund), National Parks Board, Singapore, and National University of Singapore. The strategy formulated an overarching vision, which was supported by broad practical goals, and realised through specific objectives and actions.

1.2.1 Vision

The Singapore freshwater crab will become a living ambassador for freshwater conservation into perpetuity. Wild populations in their natural range will be resilient to the threats they face, and the species will no longer be Critically Endangered. The innovative conservation efforts implemented will serve as an inspiring national and global model.



J. singaporensis ex-situ. | Photograph © Daniel Ng JJ

1. INTRODUCTION

1.2.2 Goals

Goal A: The Singapore freshwater crab will continue to be found in the hill stream ecosystems of Singapore well into the future.

Goal B: The Singapore freshwater crab will become a symbol of national pride for all Singaporeans and will be an ambassador for the management of the country's freshwater habitats.

1.2.3 Objectives & Actions

Goal A

Objective 1: To provide the scientific knowledge necessary to both inform management of the Singapore freshwater crab and to monitor changes in its population and habitat as a result of management. (Consists of Actions 1.1a–c, 1.1a–d)

Objective 2: To promote management that will stabilise population levels and then lead to an increase in crab numbers and distribution. (Consists of Actions 2.1, 2.2)

Goal B

Objective 1: All key groups of Singaporeans will become aware and proud of the species and of the importance of its ecosystem. (Consists of Actions 1.1, 1.2)

Objective 2: Provide co-ordination and focus to all conservation efforts. (Consists of Actions 2.1, 2.2)

1.3 Purpose of addendum

This addendum addresses Goal B, Objective 2, Action 2.1, which requires the Working Group to evaluate the implementation of the Conservation Strategy since its adoption. Specifically, this document tracks the progress towards the strategy's goals, objectives, and actions, and provides an update of activities undertaken, outcomes achieved, and ongoing/future priorities. This will serve as a mechanism to assess effectiveness, identify gaps and priorities, and inform future conservation decision-making for the endemic and Critically Endangered Singapore freshwater crab.

2. REVIEW OF CONSERVATION STRATEGY

The Conservation Strategy was reviewed by the Freshwater Crab Conservation Working Group over two sessions in 2026. The first session was conducted remotely, through the online review of a report card, where Working Group representatives of the three member organisations (i.e., Mandai Nature, National Parks Board of Singapore, and National University of Singapore) scored the progress of each of the 13 Actions or Sub-Actions. The report card was created referencing past reviews of conservation strategies/plans (Ministry of Agriculture and Forestry, 2023; Washington et al., 2014). The progress scores ranged from 1–4, with the definition of each score as follows: (1) Completed, (2) Progressing as planned, (3) Started but not progressing as planned, and (4) Not yet started. All scores were accompanied by justification, for example, references to the completed actions in the form of data/published works or reasons detailing delays/unfeasibility of the action. A section on future directions was included in the report card to facilitate discussions for the next steps in the Conservation Strategy as well.

The second review, a face-to-face meeting, consolidated discussions on scoring of the report card by the various organisations. The Working Group included an additional scoring system for each Action to determine if it should remain open or closed. Actions that remain open would be considered as ongoing and to be continued regardless of the progress score, whereas closed Actions were considered completed or incomplete/unachievable, and the Action achieved or no longer to be pursued, respectively.

The Action was also categorised into three score categories, Accepted scores (all organisations aligned in scoring), minor clarifications (one organisation scored differently), major discussions (all organisations differed in scoring). All final scores were determined during the second review after careful deliberation among all organisations within the Working Group.



Johora singaporensis on rock. |
Photograph © Tan Zhi Wan

2. REVIEW OF CONSERVATION STRATEGY

Table 1. Final Score, open/close category and evidence for scoring of all Actions in the Singapore freshwater crab conservation strategy.

	Components	Final Score	Open/ Closed	Evidence
Goal A				
Objective 1: To provide the scientific knowledge necessary to both inform management of the Singapore freshwater crab and to monitor changes in its population and habitat as a result of management.				
Action 1.1: Understanding the habitat and range of <i>Johora singaporensis</i> .	a. Determination of the optimal abiotic habitat requirements (e.g., temperature, oxygen levels, pH levels, etc.) and the optimal biotic habitat parameters (e.g., description of the ecological communities in the streams and the interactions between crabs and key species). This will be achieved by environmental niche modelling and by ground surveys. The optimal levels and limits of these key parameters will then be determined through manipulation.	3	Open	Optimal abiotic habitat requirements were completed (Chua et al., 2015), while biotic habitat parameters were partially completed by Chua (2014). Environmental niche modelling has not been conducted as fine-scale data and methods were previously not available. Optimal habitat limits for the species cannot be tested without sacrificing animals and thus, not feasible. Left open to relook environmental niche modelling using newer methods.
	b. Determination of the Extent of Occurrence and the Area of Occupancy (current + potential) of this species through surveys of streams that record the presence/absence of crabs.	1	Closed	The extent of occurrence and area of occupancy of this species have been determined through surveys (unpublished data).
	c. Identification of potentially suitable streams beyond the current Extent of Occurrence that might be rendered suitable for the support of additional populations of <i>J. singaporensis</i> , and the measures required to do so.	1	Closed	Suitable streams have been identified and translocation efforts were successfully conducted (Lin, 2017).

2. REVIEW OF CONSERVATION STRATEGY

Table 1. Final Score, open/close category and evidence for scoring of all Actions in the Singapore freshwater crab conservation strategy.

	Components	Final Score	Open/ Closed	Evidence
Goal A				
Objective 1: To provide the scientific knowledge necessary to both inform management of the Singapore freshwater crab and to monitor changes in its population and habitat as a result of management.				
Action 1.2: Understanding the demographics and genetics of <i>Johora singaporensis</i> .	a. Monitoring of trends in population size and structure including seasonality and recruitment. Protocols will be developed and implemented within 12 months.	1	Open	Monitoring protocol developed and implemented for accessible sites (unpublished data). Left open as annual monitoring will continue.
	b. Determination of the minimum viable population (MVP) to inform management, and the possible supplementation of existing and/or new populations. The MVP model will be developed, data on key threats will be collected, and the MVP model will be refined within 12 months.	1	Open	MVP was calculated (unpublished data). Left open as there are plans to re-run the model with newer data.
	c. Understanding and maintaining, or if possible increasing, the genetic diversity of populations. A population genetic study of <i>J. singaporensis</i> will be conducted within 12 months.	1	Open	An initial population genetics study was conducted with results suggesting fragmented populations and recommends genetic mixing (Tay et al., 2018). Left open as there is research in progress on evaluating the success of genetic mixing through translocation.

2. REVIEW OF CONSERVATION STRATEGY

Table 1. Final Score, open/close category and evidence for scoring of all Actions in the Singapore freshwater crab conservation strategy.

	Components	Final Score	Open/ Closed	Evidence
Goal A				
Objective 1: To provide the scientific knowledge necessary to both inform management of the Singapore freshwater crab and to monitor changes in its population and habitat as a result of management.				
Action 1.2: Understanding the demographics and genetics of <i>Johora singaporensis</i> .	d. Understanding the life history of <i>J. singaporensis</i> . A study of the life history patterns and population dynamics will be conducted within two years.	1	Closed	Life history patterns and population dynamics have been detailed based on ex-situ husbandry and in-situ surveys (unpublished data).
Objective 2: To promote management that will stabilise population levels and then lead to an increase in crab numbers and distribution.				
Action 2.1: Develop site-specific management plans for each location where the species currently occurs and for each potential reintroduction site.	Each site where the species is found has different characteristics (setting, threats, and ownership) and will require site-specific management. Management prescriptions will need to be tailored to each site and then implemented with appropriate local stakeholders. The management prescriptions should draw on knowledge generated from Objective 1.	1	Open	The Working Group has constant engagement with local stakeholders and site-specific management prescriptions. Left open as engagement will continue through various activities organised by the Working Group.

2. REVIEW OF CONSERVATION STRATEGY

Table 1. Final Score, open/close category and evidence for scoring of all Actions in the Singapore freshwater crab conservation strategy.

	Components	Final Score	Open/ Closed	Evidence
Goal A				
Objective 2: To promote management that will stabilise population levels and then lead to an increase in crab numbers and distribution.				
Action 2.2: Establish a healthy breeding population in captivity to act as a source for the introduction/ re-introduction of healthy individuals into suitable habitats to complement the in-situ strategies.	A captive population can also contribute to Action 1.2 under Goal B. A workplan for the establishment of a captive breeding programme will be developed. The plan will include: (1) the source of founder stock based on numbers in the wild and their population characteristics; (2) the establishment of multiple breeding facilities; (3) the development of husbandry protocols and securing of sufficient resources; and (4) the identification of appropriate success indicators for captive management—such as survival rate to breeding size. The workplan will be completed and then initiated by the middle of 2016. The husbandry protocol will continue to be refined through knowledge gained during successful keeping and breeding of the species.	1	Open	A healthy breeding captive population was established through the successful development of husbandry protocols (unpublished data). Multiple breeding facilities were trialled but one facility is sufficient. Left open as the captive population will still be maintained as an ex-situ assurance population.

2. REVIEW OF CONSERVATION STRATEGY

Table 1. Final Score, open/close category and evidence for scoring of all Actions in the Singapore freshwater crab conservation strategy.

	Components	Final Score	Open/ Closed	Evidence
Goal B				
Objective 1: All key groups of Singaporeans will become aware and proud of the species and of the importance of its ecosystem.				
Action 1.1: Develop multi-stakeholder specific conservation communications and messaging that highlights the unique characteristics of this freshwater crab, evokes national pride and awareness of the ecosystem and its ecosystem services, and stimulates conservation action.	The first step will be to identify all stakeholders and understand ways to engage them in freshwater crab and ecosystem conservation. Once the messages to be conveyed are determined, there will be a need to customise delivery (episodic & extended) to each stakeholder group. Specific activities may include the development of a number of freshwater ecosystem kiosks across the island.	1	Open	All organisations have successfully engaged stakeholders using various conservation messagings (e.g. Friends of Biodiversity, Talks, Conferences). Public engagement will continue, following the vision's messaging. Left open as engagement will continue through various activities organised by the Working Group.
Action 1.2: Establish a healthy breeding population and develop a captive display that captures the public's attention and connects, inspires, and educates the public about freshwater crabs.	The specific activities for the establishment of a captive population are given under Goal A, Objective 2, Action 2.2 above.	3	Closed	A healthy breeding population was established. Taking into account the crab's cryptic behaviour and welfare considerations, the working group has decided to adopt alternative outreach methods to educate the public about freshwater crabs. Videos and communication materials will be employed to educate the public about freshwater crabs.

2. REVIEW OF CONSERVATION STRATEGY

Table 1. Final Score, open/close category and evidence for scoring of all Actions in the Singapore freshwater crab conservation strategy.

	Components	Final Score	Open/ Closed	Evidence
Goal B				
Objective 2: Provide co-ordination and focus to all conservation efforts.				
Action 2.1: Establish a Working Group chaired by the National Parks Board of Singapore.	The Working Group will keep all relevant partners informed and encourage the sharing of relevant information on research and management of the crab. The Working Group will promote the implementation of the Conservation Strategy and monitor its implementation. It will evaluate progress after 3 to 5 years.	1	Open	Evaluation of the Conservation Strategy completed. Left open as the Working Group will continue to meet to share updates regarding the species and address Open Actions in the Conservation Strategy Addendum.
Action 2.2: Establish an electronic repository of communication material to support conservation activities.	It will be important to have easy access to knowledge that will allow rapid communication if needed or for the development of communication to support awareness-raising and education activities.	1	Open	An internal repository was set up and hosted. All resources were collated and consolidated in this repository. Left open as the repository will continue to host newer research materials whenever published.

3. UPDATES TO CONSERVATION STRATEGY

This addendum provides updates on the conservation work done on the Singapore freshwater crab a decade after the publication of the conservation strategy. Of the 13 Actions, 11 have been addressed, and the remaining two Actions (scored 3) were partially addressed. Nine Actions remain open, reflecting areas where continued effort is required, while four have been closed. The Working Group will continue to advance work on the open Actions.

Three completed and closed Actions (Goal A: Action 1.1B, Action 1.1C, and Action 1.2D) were part of existing research and collaboration between three institutes. In the past decade from 2015 to 2025, consistent monitoring of *Johora singaporensis* in hillstreams in Singapore provided better understanding of the species' distribution, specifically informing the Extent of Occurrence and Area of Occupancy (unpublished data). Studies of life history and population dynamics were also simultaneously conducted through ex-situ husbandry with the captive breeding population at the National Parks Board facility (Tan, 2018; unpublished data) and in-situ population monitoring studies (Lin, 2017).

Suitable streams beyond the current population distribution were also identified to accommodate translocation efforts of the species in 2017 (Lin, 2017). Importantly, the progress of these conservation efforts was shared with the general public as periodic updates to the Conservation Strategy (Ministry of National Development, 2017; Binny, 2024) as well as through education on conservation efforts (Khew, 2018; NParksSG, 2020).



Researchers heading to field site. |
Photograph © Soh Bryan

3. UPDATES TO CONSERVATION STRATEGY

Two Actions scored 3 (Started but not progressing as planned), where one was closed and one remained open (see Table 1 above). Goal B: Action 1.2 (establish a healthy breeding population and develop a captive display) began successfully, with ex-situ establishment of a captive breeding population (Tan, 2018); however, the Working Group concluded that a captive display was not feasible because the cryptic nature of the species makes it unsuitable for display, as well as animal welfare concerns. Nevertheless, education about *J. singaporensis* as part of Singapore's natural history remains crucial, and will continue to be featured in biodiversity festivals and exhibits wherever feasible (e.g. NParks Spotlight, NParks Festival of Biodiversity Booths). On the other hand, Goal A: Action 1.1A (determination of the optimal abiotic habitat requirements and the optimal biotic habitat parameters) will remain open. While studies on the species' abiotic and biotic habitat requirements proceeded with student research projects (Chua, 2014; Chua et al., 2015; unpublished data), determining optimal habitat parameters has proved to be unfeasible due to methodological limitations surrounding environmental niche modelling. Instead, a principal component axis analysis was conducted to determine optimal abiotic habitat conditions qualitatively. Additionally, it is not feasible to determine the species' optimal habitat limits experimentally as it may involve some mortality in the crabs. In recent years, however, newer environmental niche modelling methods have been developed with improved resolution (Rivadeneria et al., 2025), which can now be employed for the species.

Determining optimal habitat requirements can assist current efforts to determine more suitable translocation sites and to ensure existing habitats remain suitable for existing populations.

The remaining eight completed and open Actions will remain open due to the nature of the activities involved. These Actions were regarded as necessary for continued conservation of this species, and conservation education for the public. These include regular monitoring, determining a minimum viable population, genetic monitoring, engagement with local stakeholders, maintaining the captive population and the internal information/communication repository, and public engagement—all managed by the Freshwater Crab Conservation Working Group.



An example of a hill stream habitat. |
Photograph © Soh Bryan

APPENDIX I

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