Investigation and improvement of live Blue Swimmer Crab handling in NSW

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In submitting this report, the researcher has agreed to FRDC publishing this material in its edited form.

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Abbreviations

CSC Controlled seawater conditions

- Temperature: 20.0 ± 0.5 °C
- Salinity: 35.0 ± 0.5 ppt
- pH: 8.00 ± 0.05
- Oxygen levels: saturated
- Ammonia: <0.01 mg/L
- Nitrite: <0.01 mg/L
- 12-hour day/night lighting cycle

DPI Department of Primary Industries (Queensland)

NSW New South Wales

SFM Syndey Fish Market

Executive Summary

What the report is about

This report presents pivotal findings from an in-depth investigation into optimising live handling practices for the commercial Blue Swimmer Crab (*Portunus armatus*) industry in New South Wales (NSW), with the overarching goal of unlocking high-value live trade opportunities. Initiated in 2019, the research was conducted by an experienced team of scientists at the Queensland Department of Primary Industries (DPI) in Coopers Plains, Brisbane. The primary objective was to develop effective handling protocols to improve the survival rates of Blue Swimmer Crabs from capture to market, thereby increasing the volume and quality of crabs available for sale. The study combined extensive literature review, laboratory trials and stakeholder engagement to provide a practical framework for fishers wishing to pursue the live Blue Swimmer Crab market, focusing on methods to reduce stress, minimise mortalities and maximise marketable yields.

Background

The NSW Blue Swimmer Crab fishery, a component of the Estuary General Fishery, is currently at a critical crossroads, grappling with the challenges of tightening quota restrictions, declining catches, recurrent flooding events and lingering impacts of the COVID-19 pandemic. These challenges have placed considerable pressure on fishers and their co-operatives, creating a need to explore alternative revenue models to ensure long-term viability. One promising solution is the expansion of the live Blue Swimmer Crab trade, which commands higher prices than raw or cooked products. Transitioning to this live trade would allow NSW fishers to capture premium markets, where post-pandemic demand for live seafood has strongly rebounded. However, Blue Swimmer Crabs are highly susceptible to stress and show limited survival out of water. Targeted research and investment are thus critical to develop best-practice protocols for catching, handling and transporting live crabs to mitigate mortalities and ensure they reach the market in optimal condition. These efforts will enable fishers to unlock greater returns and boost the sector's long-term resilience.

Objectives

The primary objective of this research was to establish clear handling guidelines and provide industry training to reduce the mortality rates of Blue Swimmer Crabs through the supply chain, thereby increasing the volume of live crabs reaching the market and enhancing financial returns for fishers. With the cessation of customised wet truck operations during the COVID-19 pandemic, a key focus was also to explore and optimise conditions for dry transport as a potential alternative.

Methodologies

The research employed a multi-faceted approach, beginning with a comprehensive literature review to examine crab stress factors and gather best practices for live crab handling from global sources. This was followed by a series of controlled laboratory experiments to assess the effects of various handling and storage conditions on live Blue Swimmer Crab survival. These experiments were specifically designed to address key questions posed by NSW crabbers, including on the maximum survival time of crabs out of water, methods for stress reduction, and the utility of chilled water dips to pacify crabs prior to transport. A total of 24 trials were conducted, incorporating different air exposure, de-stress and chilled-water dipping treatments, with monitoring and mortality recorded at 2-hour and 24-hour intervals after returning the crabs to recovery tanks. The results were statistically analysed, and visual observations were collated. Finally, industry workshops were held in key NSW fishing communities (Coffs Harbour, Newcastle, Yamba and Wallis Lake) in December 2024 to disseminate findings and provide hands-on training in best practices for live crab handling. These workshops engaged a diverse group of industry stakeholders, including crabbers, co-operative managers and floor staff, account managers, FRDC extension officers, and boating and fisheries regulators. Participants took part in practical demonstrations of the project outcomes and received printed copies of the handling guide developed as part of the study.

Key findings

The findings from the literature review underscored the significant stress factors that impact live crabs throughout the supply chain, including physical handling, air exposure, aggression and temperature changes. Key insights emphasise that minimising cumulative stress and employing tailored handling protocols are crucial to improving crab survival rates and preserving product quality. These findings informed experimental trials and supplemented the live handling guidelines provided in this report.

The laboratory trials demonstrated that Blue Swimmer Crabs can survive for at least 6 hours out of water when appropriately de-stressed and kept under quiet, damp, dark and cool (22 °C) conditions. Nevertheless, these crabs showed slower recovery than those kept out of water for shorter durations, suggesting that 6 hours is likely close to their tolerance limit. Notably, crabs held out of water for 12 hours experienced 100% mortality.

Blue Swimmer Crabs exposed to capture stress and then allowed to de-stress in aerated seawater exhibited significantly lower mortality rates following dry holding compared to those not receiving a de-stress treatment. Without the de-stress step, mortality rates reached as high as 77% after a 6-hour hold out of water. A de-stress period of at least 3 hours was deemed to be adequate prior to transport, with an overnight de-stress likely offering the most effective and logistically compatible option.

In chilling trials, cold dips in 10 °C seawater slurries for 10 or 120 minutes appeared stressful for Blue Swimmer Crabs and led to more than 16% mortality. The surviving crabs exhibited signs of distress, including flaccidity, lethargy and delayed recovery. Short dips at 15 °C caused no mortality, while 120-minute immersion resulted in 3.3% mortality, implying that prolonged exposure to even this moderate temperature may induce stress. Overall, the study revealed no apparent advantages of chilling Blue Swimmer Crabs prior to transport, at least at the temperature and time combinations tested.

Given that the primary goal for live transport is to keep crabs alive and in peak condition, pre-transport chilling is not advised for crabs destined for the live trade. Instead, applying a de-stress treatment (at least 3 hours, or overnight) before transport will likely be considerably more beneficial. Collectively, these findings suggest that dry transport of live Blue Swimmer Crabs is a viable option, provided transit times are relatively short and optimal conditions are maintained before and during the process.

Implications

These report findings and handling guidelines will support NSW Blue Swimmer Crab fishers in accessing or re-entering the high-value live crab trade, which was severely disrupted by the COVID-19 pandemic. Previously, custom wet trucks were used to transport live crabs to market. However, during the pandemic, these trucks ceased operation, and the live Blue Swimmer Crab trade largely disappeared. Implementing the recommended handling guidelines and dry transport protocols could allow crabbers to utilise regular road freight to transport live crabs to market. This approach would allow fishers to command premium prices for live crabs, improving profitability while reducing spoilage and waste, and maximising the value of each catch. Moreover, with fewer mortalities and higher returns for live products, the industry might require fewer crabs to achieve their economic targets, potentially easing fishing pressure and supporting environmental sustainability goals.

Re-establishing the live trade will also help to enhance the industry's reputation as a supplier of premium seafood. The upcoming opening of the brand-new Sydney Fish Market will provide an ideal platform to showcase live Blue Swimmer Crabs and boost demand for these products. With actionable guidelines for improving survival rates during transport, the current research findings provide a clear roadmap for fishers, logistics providers and market operators to capitalise on this opportunity and drive long-term growth for the NSW live Blue Swimmer Crab industry.

Recommendations

Further commercial trials are recommended to confirm these literature and laboratory findings under real-world conditions. If cold water dips are pursued as a method to pacify crabs before transport, shorter immersion times should be tested to assess their impacts on survival and recovery, as suggested by existing literature. Nevertheless, the potential benefits of pacifying crabs should be weighed against the probable risks of stress and mortality associated with these treatments.

Extension and adoption

A *Live Blue Swimmer Crab Handling Guide* was developed from the research findings, serving as a concise and practical reference for crabbers and other industry stakeholders. The FRDC will host this guide on their website to ensure ongoing accessibility. Printed copies were provided to NSW workshop participants to foster adoption of best practices and broader engagement in the live trade.

Keywords

Blue Swimmer Crab, capture, dry transport, handling, live trade, mortality, New South Wales, *Portunus armatus*, recovery, stress, storage, survival.

Introduction

The Blue Swimmer Crab, *Portunus armatus* (formerly *Portunus pelagicus*; Lai et al., 2010), has long held economic and social importance to New South Wales (NSW) fisheries, particularly in the Wallis Lake region (Johnson, 2024; Schilling et al., 2023). These crabs are harvested from estuarine and coastal waters along the length of the NSW coastline, primarily using traps and nets (Bellchambers & de Lestang, 2005). Renowned for their sweet flavour and high-quality meat, Blue Swimmer Crabs are in high demand both within commercial supply chains and among recreational fishers.

Despite its historical importance, the commercial Blue Swimmer Crab fishery in NSW is facing numerous environmental and economic challenges that threaten its sustainability and profitability. Since the transition to quota management in 2017 and implementation of stricter size limits, commercial catches have declined precipitously (Johnson, 2024; Johnston et al., 2023). Major flooding events in NSW estuaries in 2018 and 2022 have likely contributed to these declines by impacting crab stocks and limiting fishing activities (Johnston et al., 2023; NSW TAFC, 2024). Moreover, the COVID-19 pandemic further exacerbated the situation by disrupting supply chains and diminishing demand for live, fresh and dine-in seafood, particularly at the Sydney Fish Market (SFM; Ogier et al., 2021). These cumulative challenges have placed strain on many crabbers and their co-operatives, underscoring the need to explore alternative revenue models and maximise value from existing harvests. The expansion of the live Blue Swimmer Crab trade offers one prospective strategy to help alleviate financial pressures and enhance industry viability.

The existing market for Blue Swimmer Crabs is dominated by raw and cooked product sales, with prices on the SFM auction floor varying from $6.00 to $30.00 per kilogram over the last decade. This price volatility, driven by seasonal factors and extreme weather events, has created uncertainty for fishers. In contrast, live crabs command substantially higher prices, offering a lucrative opportunity to boost revenue and mitigate the impacts of declining catch volumes. Transitioning to the live trade would allow NSW fishers to capture premium markets, where post-pandemic demand for live seafood has rebounded. The opening of the brand new SFM in the near future, featuring expanded live tank facilities, presents an ideal platform to showcase live Blue Swimmer Crabs as a premium commodity.

The live Blue Swimmer Crab industry in Australia is still in its infancy and will require targeted investments in infrastructure, research and training to streamline operations and meet its full potential. Blue Swimmer Crabs are particularly susceptible to stress, and high mortality rates from inadequate handling or transport could significantly undermine profitability and product reputation. Developing effective processes and procedures for catching, holding and transporting live products will therefore be essential to ensure they reach the market in optimal condition. Moreover, the creation of clear, easy-to-follow best-practice handling guidelines, coupled with experimental trials to optimise live supply chains, will be critical in advancing the industry's understanding and capabilities. These efforts will empower fishers to adapt effectively and capitalise on this lucrative market segment, unlocking greater financial returns while strengthening the sector’s overall economic resilience.

Objectives

1. To produce handling guidelines and conduct industry training to reduce the mortality rates of live Blue Swimmer Crabs and thereby increase the volume of live product to market.

2. To improve the financial returns for fishers who adopt the guidelines and undertake the training provided.

Method

This study employed a multi-faceted experimental approach, including a literature review, controlled laboratory trials and industry workshops across multiple NSW fishing communities.

Literature review

To assess the current state of knowledge on Blue Swimmer Crabs and best-practice handling protocols, a comprehensive literature review was conducted at the outset of the project. Search terms and Boolean operators were used to explore peer-reviewed and/or published aquaculture and seafood science papers in bibliographic databases, such as Scopus, Web of Science and Google Scholar. Search strings included, but were not limited to, 'crab', 'Blue Swimmer Crab', '*Portunus*', 'live trade', 'transport', 'stress', 'mortality' and 'survival'. The grey literature was additionally investigated using similar search terms in Google, as well as broad online searches for relevant webpages, social media, (e.g. companies or organisations on Facebook, Twitter, YouTube) and digital documents (e.g. reports, brochures). The retrieved content was organised into an Excel database, including files and weblinks.

Titles, keywords and abstracts of the captured literature were initially screened for relevance. More meticulous review allowed refinement of key documentation covering stress factors and handling practices related to various crab species traded globally in the live format. This review informed experimental procedures and highlighted critical risk factors influencing crab survival throughout the supply chain, the findings of which are incorporated throughout this report.

Laboratory trials

To determine the effects of various handling methods on Blue Swimmer Crab survival, laboratory trials were carried out at the Queensland Department of Primary Industries (DPI's) sophisticated facilities in Coopers Plains, Brisbane. The trials encompassed 24 different laboratory-based experiments conducted in recirculation tanks under controlled seawater conditions (CSC). Importantly, these experiments aimed to address several key handling-related inquiries posed by industry stakeholders (Box 1), which informed the study objectives and best practice guidelines.

Box 1: Key industry stakeholder queries raised regarding live handling of Blue Swimmer Crabs

1. How long can Blue Swimmer Crabs survive out of water?
2. Is it feasible to dip crabs in cold water to pacify them prior to transport?
3. Is a 10 °C dip too cold for Blue Swimmer Crabs?
4. Is a cold dip necessary?

The initial 12 trials aimed to establish preliminary baseline data on Blue Swimmer Crab behaviour and responses to capture, handling and transfers in and out of water. Specifically, these trials aimed to gauge the maximum survival time of crabs out of water, as well as the impacts of pre-handling stress and de-stress treatments on survival. Each subsequent trial built on the insights gained via this initial experimentation.

Sourcing, transport and holding crabs for laboratory trials

Live Blue Swimmer Crabs for the various trials were sourced directly from local fishers in the Moreton Bay region, Queensland. Minimal transport delays were achieved by collecting the crabs directly from the boat ramp. To prevent injury to both the crabs and researchers, the crabs' claws were secured with cable ties. The crabs were then transported to the Coopers Plains facility in an insulated wet tank, with seawater chilled to 20 °C to reduce stress during transit. Oxygenation was supplied via a portable 12-volt air compressor connected to an air stone. Upon arrival at Coopers Plains, the crabs were transferred to recirculation tanks to acclimatise in a controlled environment.

To ensure optimal conditions for the crabs and facilitate reproducible results, the following parameters were maintained in recirculation tanks under CSC:

- Temperature: 20.0 ± 0.5 °C
- Salinity: 35.0 ± 0.5 ppt
- pH: 8.00 ± 0.05
- Oxygen levels: saturated
- Ammonia: <0.01 mg/L
- Nitrite: <0.01 mg/L
- 12-hour day/night lighting cycle

Trials 1–4: Preliminary evaluation of crab survival out of water

Trials 1 to 4 intended to gauge the maximum survival time of Blue Swimmer Crabs out of water, thus simulating dry transport conditions.

To assess survival rates, 10 crabs were removed from the recirculation tank and placed in a plastic tub covered with damp hessian to create a dark, humid environment at room temperature (22 °C). After 2 hours out of water, the crabs were gently returned to the recirculation tank. To ensure safe immersion, air bubbles were purged from the gills by positioning the crabs bottom-down in shallow water just covering their mouthparts, facilitating respiration through open mouthparts until water flowed across their gills. Each crab's recovery was observed immediately after immersion and monitored at 2 hours and 24 hours after the crabs were returned to the recirculation tank for recovery. Mortality rates were recorded as the percentage of crabs that did not survive.

This process was repeated in subsequent trials, with durations out of water extended to 4, 6 and 12 hours to determine the maximum crab survival period out of water.

Trials 5–6: Preliminary evaluation of pre-handling stress and de-stress treatments

As visual observations indicated that some crabs displayed skittishness and stress during individual handling, trials 5 and 6 were designed as a paired experiment to investigate the impacts of pre-handling stress on mortality. Both trials followed a similar procedure; however, trial 6 included the evaluation of a de-stress treatment.

For trial 5, 10 crabs were held overnight in CSC at 20 °C before being individually captured with a fish net. This capture method triggered a fight-or-flight response, causing the crabs to swim frantically in attempts to escape. The crabs were then placed in a plastic tub and held out of water for 6 hours at 22 °C, covered with damp hessian (Image 1).

Image 1 Blue Swimmer Crab held out of water in a plastic tub covered by damp hessian

For trial 6, 10 crabs were removed from the water the day before trial 5 commenced, using the same capture method as stated above. They were placed in a plastic mesh tray with a lid and then immediately returned to the water overnight, allowing them to de-stress by exchanging water across their gills (Image 2). The following day, the crabs in the lidded tray were removed as a single unit, concurrently with the crabs from trial 5. As in trial 5, the crabs from trial 6 were transferred to a plastic tub and held out of water for 6 hours at 22 °C, covered with damp hessian to keep them moist. All crabs in both trials were monitored as previously described.

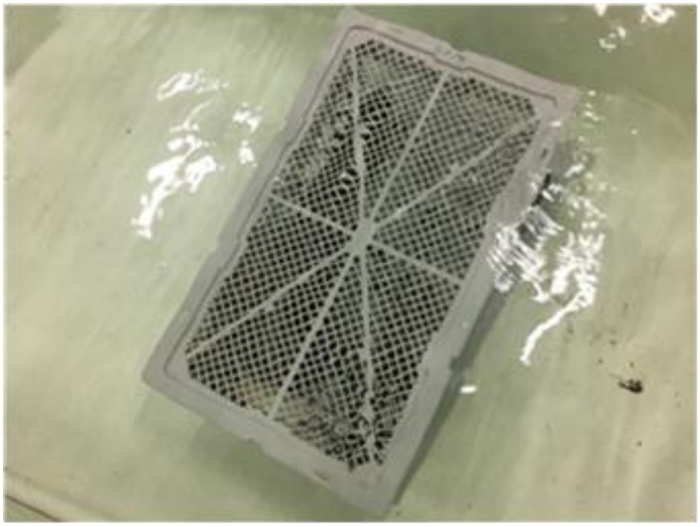

Image 2 Crab de-stress treatment during trial 6

Trials 7–18: Trials to determine minimum effective de-stress time

Trials 7 to 18 aimed to determine whether shorter de-stress treatments could sufficiently alleviate stress in crabs prior to dry transport, in comparison to the overnight de-stress used in trial 6. Three distinct treatments were tested to assess the impacts of varying de-stress durations on crab mortality rates following a 6-hour hold out of water. The treatments, along with the number of replicates, are detailed in Table 1. The methodology employed was consistent with trials 5 and 6, except for the varying de-stress times. Monitoring and mortality recordings were carried out at 2 hours and 24 hours post-recovery.

Table 1 De-stress treatment trial design.

Transfer type	**Time out of water (hours)**	**Replicates (n)**	**Crabs per replicate (n)**
Stressed transfer (no de-stress step)	6	4	10
Stressed transfer (followed by 30-minute de-stress)	6	5	10
Stressed transfer (followed by 3-hour de-stress)	6	3	10

Trials 19–24: Trials to assess the need for pre-transport chilling and appropriate temperatures

In response to industry inquiries on optimal chilling conditions for crabs prior to transport, trials 19 to 24 were designed to evaluate the effects of different water temperatures on crab mortality rates. Crabs were first de-stressed for 3 hours before being exposed to controlled temperatures of either 10 °C and 15 °C for different time periods.

For the 10 °C chill trials, 20 crabs were divided into two lidded plastic mesh crates and allowed to recover for 3 hours in CSC at 20 °C. Following recovery, both mesh crates were removed from the recirculation tank and gently placed in a 200 L tub containing aerated seawater at 10 °C, maintained by an air stone. To achieve the target temperature, the seawater was pre-cooled using 5-L blocks of frozen seawater (Image 3), which reduced the water temperature from 20 °C to 10 °C within ca. 15 minutes without altering salinity. Salinity was confirmed at ~35 ppt using a salinity meter (TPS model WP-81, with TPS conductivity probe EC1003). The ice blocks were removed once the desired temperature was reached, and salinity was re-verified. One crate was retrieved from the 10 °C seawater after 10 minutes and the second crate after 2 hours, with both immediately returned to the 20 °C recirculation tank for recovery.

The same procedure was followed for the 15 °C trials using identical methods. Each temperature trial was conducted in triplicate, with monitoring and mortality recordings carried out at 2 hours and 24 hours post-recovery.

Image 3 Frozen seawater blocks used to chill seawater to the desired temperature

Statistical analysis

The results from both the de-stress trials (7–18) and chilling trials (19–24) were analysed by a senior DPI biometrician using appropriate statistical models.

For the de-stress trials, a generalised linear mixed model (GLMM) was applied to assess how varying de-stress treatments (0, 0.5 and 3 hours) and recovery times (2 and 24 hours) impacted crab mortality rates. The model assumed that the data followed a binomial distribution, which is common for binary outcomes such as survival (alive or dead). The trial date was fitted as a random effect and the treatment as a fixed effect. Multiple link functions (logit, probit and complementary-log-log) were tested, yielding consistent conclusions for all models. The GLMM for 2-hour post-recovery mortality showed that the random effects had no impact, effectively reducing the model to a generalised linear model (GLM) without random terms.

For the chilling trials, a binomial statistical model with a logit link function was used to examine the effects of temperature treatments (10 °C and 15 °C) and recovery times (2 and 24 hours) on crab mortality. Due to lower-than-expected variability in the data, dispersion was fixed at one to better fit the model. The model only considered treatment effects, excluding differences between replicates. When replicates were included, the model's degrees of freedom were reduced from 4 to 2.

Industry workshops

To extend practical knowledge and best practices to the industry, DPI researchers conducted workshops in December 2024 for interested crabbers across key NSW fishing communities, including Coffs Harbour, Newcastle, Yamba and Wallis Lake. These workshops offered hands-on training and guidance on optimal handling techniques to enhance crab survival and quality for the live trade. Participants also received a copy of the *Live Blue Swimmer Crab Handling Guide* as a reference tool to support their continued adoption of best practices.

Literature review

Blue Swimmer Crab taxonomy, morphology and distribution

Blue Swimmer Crabs are brachyurans of the Portunidae family with a wide distribution across the Indo-Pacific region. Previously thought to comprise a single species (*Portunus pelagicus*), the temperate Australian morphotype is now classified as *Portunus armatus* (Lai et al., 2010), while *P. pelagicus* also occurs around the northwest and central north parts of Australia.

With two large clawed front legs, six walking legs and two smaller back legs shaped like paddles, Blue Swimmer Crabs are powerful swimmers (Image 4). These crabs are readily identified by their distinctive elongated hexagonal carapace shape, with nine spines either side of their eyes and long front pincers. Their common name derives from their striking blue colour, especially evident in males, while females exhibit a more mottled brown appearance. Their coloration can vary slightly with location and habitat.

Image 4 Blue Swimmer Crab, *Portunus armatus*
(Source: DPIRD, NSW)

In Australian waters, Blue Swimmer Crabs are distributed from Geographe Bay on the south coast of Western Australia, north to the Northern Territory, throughout Queensland, and down the east coast to the NSW-Victoria border. They are also found in the warmer waters of the South Australia gulfs. The crabs occur in estuarine and coastal waters to a depth of ca. 60 m (Kailola et al., 1993), favouring sandy or muddy seabed bottoms but also occurring in seagrass and seaweed beds. They typically live 3–4 years and reach a maximum carapace width of ca. 200 mm. The main commercial harvesting areas have traditionally been in Western Australia, Queensland and NSW (Johnston et al., 2023).

NSW Blue Swimmer Crab fishery

In NSW waters, Blue Swimmer Crabs are primarily targeted within the 'Estuary General' fishery, with smaller numbers also taken as bycatch in the 'Estuary Prawn Trawl' and 'Ocean Trawl' fisheries. Four NSW estuary areas contribute to ca. 85% of the reported commercial catch (Hanamseth et al., 2024; Johnson, 2020). Among these, the Wallis Lake estuary has long stood out as the most productive and heavily exploited area, generally accounting for around 60% of commercial landings (Johnson, 2020; 2024; Johnston et al., 2023; Schilling et al., 2023).

Although previously assessed as 'sustainable' (Johnson et al., 2018; 2020), NSW Blue Swimmer Crab stocks were recently reclassified as 'depleting' in a 2023/24 stock assessment (Johnson, 2024; Johnston et al., 2023). Between 2000 and 2016, commercial catches in NSW fluctuated around 140 tonnes annually. However, following the implementation of quota management (December 2017) and increase in legal minimum size (65 mm carapace length), reported commercial landings declined sharply, falling to ca. 80, 50 and 20 tonnes in 2021, 2022 and 2023, respectively (Johnson, 2024; Johnston et al., 2023). These declines were likely exacerbated by large-scale flooding events in NSW estuaries in 2018 and 2022, which are believed to have impacted crab catches and catch rates (NSW TAFC, 2024).

The COVID-19 pandemic also brought substantial challenges to the NSW Blue Swimmer Crab industry, particularly by disrupting tourism activities at the Sydney Fish Market (SFM). Trade at SFM has traditionally been heavily driven by Chinese tourism, with tour buses bringing thousands of visitors to this iconic market each week. However, pandemic-related border closures, along with trade disputes between Australia and China, resulted in a prolonged ban by the Chinese government on group tours to Australia (McGregor, 2022). The pandemic's ripple effects not only negatively impacted the live and fresh Blue Swimmer Crab trade, but also the dine-in food service markets that these products feed into (Ogier et al., 2021). Fortunately, China's travel ban has since been lifted, allowing tour packages to resume and creating a renewed demand for the live seafood trade.

Demand for live crabs

To meet the growing demand for premium-quality products, the supply of live crabs to global markets is increasing, a trend expected to continue expanding (Research and Markets, 2019). This forecast is supported by numerous accounts of rising demand for live crab products (GII Research, 2024; Grand View Research, 2023). In Singapore and Malaysia, consumer interest in live crabs from Indonesia has surged, while demand from Chinese buyers remains unmet (Tempo, May 2019). The high demand for live crabs has also been highlighted in world trade analysis reports by Globefish (FAO, 2016).

Globally, eight crab species are primarily traded as live product (Table 2), most of which have a long history of live trade in both local and export markets.

Table 2 Crab species commonly traded as live product.

Crab species	Common name	Major source	Reference
Cancer pagurus	Brown crab	UK	Chartois et al., 1994
Cancer magister	Dungeness crab	USA	Cascorbi, 2004
Carcinus maenas	Green shore crab	UK	Robson et al., 2007
Callinectes sapidus	Blue crab	USA	Ewart, 2000
Maja squinado	Spider crab	Europe	Chartois et al., 1994
Necora puba	Velvet crab	UK	Robson et al., 2007
Scylla spp.	Mud crab	Australia, SE Asia, India	Lee, 1992; Peralta & Cheung, 2017
Ranina ranina	Spanner crab	Australia	Dichmont & Brown, 2010

Live products typically command a premium price over chilled or frozen ones. For instance, live Blue Swimmer Crabs have been reported to deliver three times the return of chilled green crabs on the same day of sale (pers. comm., Wallis Lake Co-operative, 2018). Nevertheless, a challenge for this live trade is that Blue Swimmer Crabs have a reputation for their limited survival time out of water, often dying quickly after being removed from fishing gear.

Previous attempts to supply markets with live Blue Swimmer Crabs have shown variable success. However, given the price incentive associated with live products and the limited availability of Blue Swimmer Crab resources, there is a revived interest in supplying these crabs in the live form. In NSW, one fisher is already targeting this market, and others are eager to join the live trade. The geographical location of these fishers offers a distinct advantage, enabling a short transit to market. Even so, live crabs require meticulous handling throughout the supply chain to maximise their survival and quality.

Stressors and stress responses in live crabs

Given their high value and demand, live crab products have been the focus of extensive research to understand the specific stress factors for various species and to determine the appropriate handling protocols that minimise stress levels.

Crabs, as aquatic animals, are biologically acclimatised to living in water. When removed from their natural environment, crabs are exposed to numerous environmental and physiological stressors. These stressors, while not necessarily lethal individually, can collectively contribute to high total stress levels. The accumulation of stress during harvesting and subsequent handling through live product distribution chains is recognised as a primary cause of mortality in crustaceans (Chung & Lin, 2006; Morris & Airriess, 1998; Taylor & Butler, 1978; Uglow, 1973).

Crabs experience a stress response when their physiological systems are pushed beyond their limits, triggering various compensatory reactions to maintain survival. A single stress stimulus can result in many interconnected effects, such as increased stress hormone levels, depletion of energy reserves, elevated oxygen consumption and increased excretion of respiratory waste products. Prolonged stress exposure can have severe consequences, including ovary re-absorption and consequent tainting of the flesh, weakened immunity and increased susceptibility to disease. An individual crab’s response to stress depends on its physiological condition, which is influenced by health status, physical damage, moulting cycle phase and growth or breeding stage. Crabs in a weakened or compromised state have a reduced capacity to withstand stress and are likely to succumb more quickly.

Out of water, crabs face multiple stressors beyond restricted respiration, such as dehydration, temperature fluctuations, noise, breeze, handling impacts and other disturbances. Additionally, many crab species display rapid aggressive behaviour to the proximity of other crabs and perceived threats, instinctively attempting to defend themselves by attack. These environmental and physiological factors combine to impose cumulative stress on crabs, often reaching lethal levels.

The following sections elaborate on the critical stress factors that should be considered during the capture, handling and transport of live Blue Swimmer Crabs, namely physical handling, air exposure, aggression, temperature changes and salinity.

Physical handling

In Australia, Blue Swimmer Crabs are typically caught using small-scale gear such as baited traps, hoop nets or mesh entanglement nets (Bellchambers & de Lestang, 2005; Uhlmann et al., 2009). Both trap and mesh net capture methods involve close interaction between the crab and fishing gear, frequently resulting in the crabs being firmly attached to the gear when hauled onto the vessel. As fishers rapidly disentangle them from the gear, the crabs are exposed to substantial stress and often incur physical damage, including the loss of claws (chelipeds) and walking legs (pereiopods). Notably, damage to the fifth pereiopods, known as pleopods or swimming legs, often leads to mortality (Uhlmann et al., 2009).

Like most crustaceans, portunid crabs can readily shed limbs in response to injury, aggression or predation, via a process known as autotomy (Juanes & Smith, 1995; Wood & Wood, 1932). This shedding is a protective reflex mechanism that occurs with or without external force, breaking the limb at a specific fracture plane near the base. When a clean detachment occurs, this usually results in minimal bleeding as the wound seals rapidly. However, if limb breakage occurs distal to the fracture plane, wound sealing may be slow or incomplete, leading to severe blood loss and likely mortality. Leland et al. (2013) found that 57% of injuries in Blue Swimmer Crabs harvested in traps were due to autotomy. Moreover, Uhlmann et al. (2009) reported that unsealed wounds and associated blood loss were the main predictors of Blue Swimmer Crab mortality within 24 hours of capture.

In addition to capture trauma, physical handling further along the supply chain can impose incremental stress and injury on live crabs. This includes during stages such as mortality inspections, loading and unloading, exposure to transport vibrations and impacts, and emersed holding on arrival at markets. Therefore, it is essential that crabs are gently removed from fishing gear and handled with care throughout the supply chain to avoid physical damage and limb loss. At the same time, these processes need to be completed as quickly as possible to minimise the crab's air exposure, balancing careful handling with efficient processing to reduce stress and potential mortality.

Air exposure

In their natural environment, crabs respire through aerobic metabolic pathways, utilising oxygen as their primary energy source. These aerobic pathways produce carbon dioxide as a waste product, which is exchanged through the gills back into the surrounding water (Henry & Wheatly, 1992; McMahon, 2001). When removed from water (emersed), their gills lose functionality, preventing gas exchange and imposing severe stress on the animals (Durand & Regnault, 1998; Simonik & Henry, 2014; Varley & Greenaway, 1992; Whitely & Taylor, 2015).

To cope with low oxygen (hypoxic) conditions, the gills of crabs are adapted to engage anaerobic metabolic pathways for temporary periods (Barrento et al., 2012; Lorenzon et al., 2008; McMahon, 2001; Taylor & Butler, 1978; Woll et al., 2010). In this state, the crabs respire at a substantially reduced rate, entering a semi-comatose condition. The shift to anaerobic pathways leads to increased lactate levels in the crab haemolymph (blood), which provides an immediate energy source for essential functions. Nevertheless, the subsequent breakdown of lactate yields toxic metabolic by-products, notably ammonia (Shi et al., 2021). Unlike most terrestrial animals, crabs have limited mechanisms for effectively clearing ammonia from their systems, especially when out of water with impaired gill function. Given their high sensitivity to even low ammonia levels, accumulation rapidly results in systemic toxicity, ultimately proving fatal for crabs (Romano & Zeng, 2010; Zimmer & Wood, 2017).

Mounting evidence suggests that different crab species exhibit different anaerobic metabolic responses to air exposure and hypoxia, influencing their survival probabilities out of water (Burke, 1979; Shi et al., 2021). Crabs inhabiting intertidal zones generally demonstrate a greater capacity to initiate and sustain anaerobic respiration. This is likely an adaptation to the variable environmental conditions they encounter, including fluctuations in water exposure, oxygen levels and temperature. For instance, Mud Crabs (*Scylla serrata*) can survive out of water for 15 days under optimal conditions (Poole et al., 2008). Conversely, the gazami crab (*Portunus trituberculatus*)—a close relative of the Blue Swimmer Crab—cannot tolerate emersion for more than 24 hours, even under optimal conditions (Dong et al., 2019). A study on Blue Swimmer Crabs taken as bycatch in otter trawls showed that 86% survived a 30-minute air exposure (Wassenberg & Hill, 1989).

Activity aggression

Blue Swimmer Crabs are active swimmers and foragers, displaying predatory tendencies alongside aggressive and sometimes cannibalistic behaviour. Aggression often leads to limb loss or carapace damage, with the latter almost invariably resulting in mortality (Thorpe et al., 1995). Carapace damage is particularly likely when crabs are crowded or held at high densities (Marshall et al., 2005), such as when they are removed from fishing gear and stored in bins on board the vessel. Ariyati et al. (2018) found that Blue Swimmer Crabs had significantly higher survival rates when kept at low densities, emphasising the importance of minimising crowding to reduce aggressive interactions.

Temperature changes

Fluctuations in temperature are known to impose substantial physiological stress on portunid crabs. The Blue Swimmer Crab fishery is predominantly coastal, encompassing waters up to 60 m deep, where crabs are rapidly raised through the seawater thermocline during gear hauling. Once on board, the crabs are exposed to ambient temperatures, as well as direct sunlight. This sudden shift causes stress accumulation in the crabs and increases their metabolic rates (Lu et al., 2015).

In a study on gazami crab (*P. trituberculatus*), Dong et al. (2019) found that survival rates for emersed crabs were highest at 10 °C. Other researchers have suggested that 12 °C is the lowest tolerance limit for *P. trituberculatus* to retain vigour (Lu et al., 2016). These findings may be relevant to Blue Swimmer Crabs in NSW, although there could be an extent of acclimatisation to local estuarine environments.

Commercial fishers of Blue Swimmer Crabs in NSW and Western Australia have used ice-water slurries in attempts to pacify crabs during on-board handling (Bellchambers et al., 2005; Broadhurst & Millar, 2018). In temperature-time investigations of this handling process, it was found that both slurry temperature and exposure time significantly affected Blue Swimmer Crab recovery times. Specifically, recovery was slower with lower slurry temperatures and longer exposure times (Bellchambers et al., 2005). The researchers recommended exposure to 6 °C for 30 seconds only, as this both pacified the crabs and minimised recovery time. Similarly, Broadhurst & Millar (2018) suggested that limiting ice slurry exposure to below 2 minutes would likely have minimal impact on Blue Swimmer Crab vigour.

Salinity

Blue Swimmer Crabs are euryhaline animals with the ability to survive in a range of salinities, at least in the short term (Xu & Liu, 2011). Nevertheless, they prefer full-strength seawater with salinities between 32–35 parts per thousand (ppt; or 3.2–3.5% dissolved salts). Some portunid crab species are weak osmoregulators and experience stress under low salinity conditions (Engel, 1977). Research on Blue Swimmer Crabs has shown significantly elevated ammonia levels in their haemolymph under low salinities, indicating poor tolerance for such environments (Romano & Zheng, 2011). Thus, it is important to keep Blue Swimmer Crabs in full-strength seawater both on the vessel and during holding.

Live crab handling practices

From the body of research on factors contributing to stress in crabs, three areas are critical in supplying live crabs to market: physical disturbance, exposure to air and light, and temperature. Handling guidelines that aim to mitigate these stressors have been developed for various commercially important crab species. The description that follows is relevant to all live crab species and is summarised from several existing best-practice guidelines for handling live crabs, including Seafish (1986; 2007), Codex Alimentarius (2003), BIM Ireland (O'Dwyer et al., 2021) and NT Code of Practice for Mud crabs (c-aid.com.au).

The overriding rule for survival of crabs out of water:

Keep them quiet Keep them damp Keep them dark Keep them cool!

Capture

Crabs need to be handled gently. Although they appear robust due to their hard shells, they readily cast claws and legs. Consequently, it is important to take care when removing crabs from fishing gear, as their inherent response to physical handling will be to show resistance and cling to the trap mesh or entanglement net. Rough handling, such as tossing, dropping and other handing-related impacts, can damage the hepatopancreas located in the crab's head area. This fragile organ contains highly active protease enzymes (Pavasovic, 2004), which can rapidly digest the crab's tissue if damaged. Even minor injuries to claws or tips of walking legs may result in heavy blood loss, as clotting often does not occur at the wound site (Paterson et al., 2007; Uhlmann et al., 2009).

For many crab species, claws should be tied or banded to minimise natural aggression and cannibalistic behaviour when crabs are in close contact. This action should be performed as soon as possible after crabs are removed from the water. Restricting claw movement also meets workplace health and safety (WH&S) requirements for fishers and handlers.

On vessel

Landing operations should be conducted gently yet swiftly, as crabs experience stress from any disturbance during handling. Crabs should be carefully placed into a storage crate, similar to a Sydney

Fish Market lobster tub, preferably with solid sides to prevent claws and legs from getting caught in crate mesh or holes. The storage crate should be robust yet lightweight, and capable of absorbing minor shocks during handling. Crabs should be packed relatively closely to limit their movement, thus reducing oxygen demand and minimising aggressive interactions between crabs that could lead to injury. A porous cover, such as hessian sacking, should be used to protect the crabs from direct sunlight and breeze. This cover should always be kept wet or damp. Crates should be stored in a cool, shaded and dark area, with movement restricted. Stacking crates to a maximum of five levels is recommended to keep crabs stable. This also helps to reduce light penetration and retain moisture within the crates. Nevertheless, care should be taken to ensure sufficient ventilation can still occur.

Whenever possible, crabs should be stored in seawater tanks with constant flow through from a deck hose. Ideally, a fine-bubble air stone should also be included to improve oxygenation. For stress-sensitive crab species, the water temperature should be a few degrees Celsius lower than that from which they were taken. This will help to reduce the crabs' metabolic rates and limit stress.

Holding storage

The highest crab mortality rates are likely to occur within the first 48 hours after they are taken from the water. Regular monitoring of the crabs is therefore essential; however, this should be conducted with care to limit disturbances and additional stress for the crabs.

For short-term storage of less than 24 hours, most crab species can tolerate being stored under conditions similar to dry storage on board the vessel. It is crucial to check the crabs regularly, keeping them cool, damp, out of direct light and in a quiet, undisturbed breeze-free environment.

For longer-term storage, fully equipped seawater tanks provide the most effective holding conditions. This setup requires adequate space and supply of fresh, clean, full-strength seawater. Tanks should be equipped with a bio-filtration system and water quality closely monitored. The crabs are likely to empty their guts within 48 hours after capture, creating a high load of waste material in the tank and rapidly reducing water quality. As before, water temperature should be maintained a few degrees Celsius lower than that of the crabs' typical harvest environment. This will help to keep the crabs in a semi-sedated state, with reduced respiration and metabolic rates, thereby minimising stress on the animals. Effective aeration of the water is essential, and the system should be capable of releasing very fine air bubbles to ensure optimal oxygen distribution through the water volume. This process can be enhanced through the use of a recirculating system.

For many crab species, it is vital that re-immersion into water is carried out slowly. The best method is to re-immerse crabs individually, positioning them bottom-down and face-up with their mouthparts just below the water surface. The crab will then take in water, re-activating function, and will expel water, often along with air bubbles. Crabs should be held in this way until no further air bubbles are observed. At this point, they will generally start to struggle to free themselves, indicating that they can be safely released. The duration of this process varies depending on how long the crabs have been held dry, but usually takes only a few moments (Poole et al., 2008).

Pack out for dry shipment

Immediately prior to pack out, crabs are often cooled to the lowest possible temperature that they can tolerate without inducing excessive stress. This cooling sedates the crabs, making them less aware of handling-related stress. The optimal temperature and duration depend on the crab species and should be established through experimental trials. After sedation, pack-out conditions should mirror those of dry holding storage. Tying or banding the claws helps reduce aggression and should be maintained throughout the supply chain. Crabs should be closely packed to limit movement, with their preferred positioning varying by species. For example, spanner crabs are calmest when packed face-down, mud crabs when positioned bottom-down, and Blue Swimmer Crabs when placed on their backs.

Once packed, crabs should be kept cool with sufficient ice or gel packs to maintain low temperatures throughout the transport process. The coolant packs should not be in direct contact with the crabs; rather, they should be placed on a wet cloth or similar material to prevent 'cold burn' of the crabs. Damp paper is insufficient insulation for this purpose and can also be shredded by the crabs, potentially resulting in minute paper fragments adhering to and damaging their gills.

Transport

The duration and conditions of transport vary widely depending on the crab species, harvest area and market location. When transported by air, crabs are packed out dry in compliance with air freight regulations. A common transport method is road freight, which can occur in the following truck types:

Non-refrigerated truck

Temperature and moisture control are the main critical factors in non-refrigerated trucks, as internal temperatures can become extremely high in warm climates. This may lead to increased crab activity, elevated energy expenditure, physical damage and rapid dehydration. Thus, effective measures to keep the crabs cool are generally required during this type of transport.

Refrigerated truck

Refrigerated trucks offer the advantage of moderating external climate conditions. However, since these trucks often carry mixed cargo, the internal temperatures are frequently set too low for live crabs, causing severe stress and high mortality rates. Some refrigerated trucks are designed with adjustable compartments to allow frozen, chilled and live products to be carried simultaneously. The compartments are created using firmly fitting insulation boards to segregate the sections, which can be effective if the boards are fitted correctly. A recognised issue with these refrigerated trucks is the influence of the previous load on the compartment temperature. It is therefore imperative that the internal temperature within the truck is adjusted to levels suitable for live crabs.

Vivier truck

In Europe and North America, specialised 'wet' or vivier trucks are used that contain a series of seawater tanks for transporting live seafood products. As with land-based tank holding, these truck tanks require well-aerated seawater maintained at a consistently low temperature. Advanced monitoring systems are employed to continuously track all internal tank parameters, including air pressure, dissolved oxygen levels and water temperature.

An alternative approach for carrying live seafood is the cascade system, consisting of stacked trays with recirculating seawater running through them. This system is designed as a free-standing unit that can be loaded on and off the truck with minimal disturbance to the live products. When operated effectively, the cascade system appears to work well and has the advantage of substantially reducing the weight of water being transported.

Unload

Upon arrival at the final destination, the unload step should also be conducted with care to avoid incremental stress for the crabs following transport. Crabs should be checked for condition and liveliness as soon as possible after unloading. They should then be promptly transferred to seawater tanks for holding prior to being placed on the market floor.

Summary of handling factors for various crab species

Table 3 summarises key handling factors that should be considered for various crab species, beyond general best practices. At the time of writing, few handling guidelines existed in the literature specifically for live Blue Swimmer Crabs, underscoring the importance of this study. Detailed handling guidelines tailored to Blue Swimmer Crabs are presented later in this report.

Table 3 Specific handling considerations for various crab species.

Crab species	Harvest waters	Handling considerations
Mud crab	Tropical / sub-tropical	• Tolerate extended periods out of water. • Recovery by immersion in water for 96 hours significantly reduces mortalities. • Limit of temperature tolerance for tropical crabs is 18 °C.
Spanner crab	Tropical / sub-tropical	• Spray crabs with seawater when removed from the ocean to reduce mortalities. • Holding in air at low temperature on vessel improves survival through subsequent water holding storage.
Blue crab	Sub-tropical	• Favoured in softshell form. • Soft shells are transported at 4 °C in moist marsh grass or damp paper.
Brown crab	Temperate	• Tolerate 24 hours out of water. • Require water immersion for long transport. • Claw tendons nicked straight after capture.
Shore crab (or 'green crab')	Temperate	• Tolerate 48 hours out of water.
Velvet crab	Temperate	• Lose water and accumulate waste metabolic products rapidly. Gills dry out, becoming permanently damaged. • Die within 4 hours out of water. • Should always be transported in water.
Spider crab	Temperate	• Die rapidly after removal from water. • Should always be transported in water.
Dungeness crab	Temperate	• Tolerate 24–48 hours out of water at low temperature and high humidity. Prefer immersed transportation.

Sources: Seafish (1986; 2007), Codex Alimentarius (2003), BIM Ireland (O'Dwyer et al., 2021), NT Code of Practice for Mud crabs (c-aid.com.au).

Results

Preliminary handling trials

Trials 1 to 4 were implemented to gauge how long it is possible to hold live Blue Swimmer Crabs out of water to simulate dry transport. This included visual observations of perceived stress factors, along with mortality metrics during handling and transfer. Table 4 shows the recorded mortality results from this trial group.

Table 4 Mortality rates (%) of Blue Swimmer Crabs held out of water for various time periods.

Trial	n	Time out of water (hours)	Mortality at recovery (%)	Mortality at 2 hours post-recovery (%)	Mortality at 24 hours post-recovery (%)
Trial 1	10	2	0	0	0
Trial 2	10	4	0	0	20
Trial 3	10	6	0	0	0
Trial 4	10	12	100	---	---

In trial 1, crabs were observed to be relatively calm in response to capture and transfer into the dry plastic tub. Following a 2-hour hold out of water, all crabs survived, with 0% mortality upon return to the recovery tank and at 24 hours following this return. These results prompted attempts to increase the time periods out of water in subsequent trials.

In trial 2, crabs endured a 4-hour dry hold, again showing 0% mortality upon initial return to the recovery tank. However, mortality rates increased to 20% at the 24-hour post-recovery mark, suggesting that some form of stress had occurred. Visual observations indicated that some crabs in trial 2 had exhibited a fight-or-flight response during capture. This could imply variability in stress responses among individual crabs, possibly leading to mixed results for trial 2.

Trial 3 further extended the time out of water to 6 hours, with 0% mortality recorded across all monitoring time intervals. Visual observations noted a relatively calm response to capture in this trial group. Nevertheless, these crabs took considerably longer to recover compared to those from trials 1 and 2. The trial 3 crabs showed minimal responsiveness when first returned to water, taking up to two hours to recover. While the absence of mortalities was a promising result, the slow recovery time suggested that 6 hours out of water was close to the limit for live Blue Swimmer Crabs.

In trial 4, crabs were held out of water for 12 hours, despite indications that 6 hours might be the upper limit. Visual observations indicated a relatively calm response to capture in this trial group. The decision to proceed with these trials was based on anecdotal reports from crabbers suggesting potential survival for 12 hours out of water. However, results showed 100% mortality in trial 4, with all crabs unresponsive upon return to the recovery tanks. Thus, 12 hours out of water appears to exceed the survival threshold of Blue Swimmer Crabs.

Trials 5 to 6 were conducted to provide insights on the effects of a de-stress treatment on crab survival after a 6-hour dry hold, comparing no de-stress treatment (trial 5) with a de-stress treatment (trial 6). Table 5 shows the recorded mortality results from this trial group.

Table 5 Mortality rates (%) of crabs with no de-stress and overnight de-stress treatments.

Trial	n	Transfer type	Time out of water (hours)	Mortality at recovery (%)	Mortality at 2 hours post-recovery (%)	Mortality at 24 hours post-recovery (%)
Trial 5	10	Stressed (no de-stress step)	6	50	50	50
Trial 6	10	Stressed (followed by overnight de-stress)	6	0	0	0

The results from these trials supported the hypothesis that crabs exhibiting a fight-or-flight response during capture are stressed. These crabs are more likely to experience higher mortality rates if immediately removed from the water and held out without a prior de-stress period. Specifically, 50% of crabs from trial 5 died when not receiving a de-stress treatment, whereas a 0% mortality rate was achieved when a de-stress step was included in trial 6 (table 5). These results are also supported via visual observations of slow and weak recovery in crabs that were not de-stressed after capture.

In trials 1–4, as well as trials 5–6, crabs were observed to show signs of stress at 6 hours out of water. While it was possible to keep them alive when a de-stress step was included, pushing beyond the 6-hour mark was not considered preferable for further replicate trials. A maximum 6-hour duration was deemed sufficient to yield meaningful results for continued trials simulating dry transport conditions.

De-stress trials

Trials 7 to 18 investigated whether shorter de-stress treatments could sufficiently de-stress crabs and reduce mortalities during simulated dry transport conditions. Crabs that had experienced capture stress were subjected to either no de-stress, half-hour de-stress or 3-hour de-stress treatments, with mortality measured at 2 hours and 24 hours after their return to the recirculation tanks for recovery.

At 2 hours post-recovery, the statistical analysis showed a significant effect of treatment ($p < 0.001$; Table 6). Pairwise comparisons (95% least significant difference, LSD) indicated that crabs not undergoing a de-stress treatment had significantly higher mean mortality than those receiving either of the two de-stress treatments. However, no significant difference in mortality was found between the 30-minute and 3-hour de-stress treatments, although mortality was observably higher for the 30-minute treatment (Figure 1).

Table 6 Statistical comparison of crab mortality rates associated with varying de-stress treatments, measured at 2 hours post-recovery.

Treatment	**Predicted mean (logit scale)**	**Standard error, SE (logit scale)**	**Mortality (%)**
Stressed transfer (no de-stress)	1.229 **a**	0.349	77.36
Stressed transfer (followed by 30-minute de-stress)	-1.904 **b**	0.430	12.96
Stressed transfer (followed by 3-hour de-stress)	-3.367 **b**	1.081	3.33
p-value	< 0.001		
Average 95% LSD	15.34		

Note: Statistically significant differences are indicated by non-identical subscript letters (**a** and **b**).

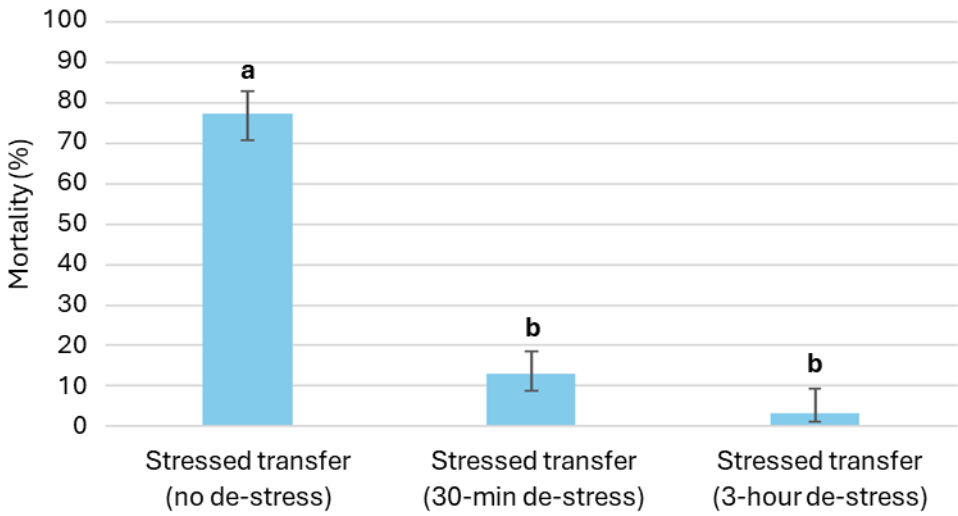

Figure 1 Mortality rates (%) associated with various de-stress treatments at 2 hours post-recovery. Statistically significant differences are indicated by non-identical subscript letters (**a** and **b**).

Mortality rates were analysed at 24 hours post-recovery to assess whether the crabs were able to survive in the longer term, akin to checking the liveliness of crabs the day after transport. At this time point, the statistical analysis similarly showed a significant difference between treatments ($p = 0.002$; Table 7). Again, pairwise comparisons (95% LSD) revealed that crabs without a de-stress treatment exhibited significantly higher mortality rates than those undergoing the two de-stress treatments, but no significant differences were found between the de-stress treatments themselves (Figure 2).

Table 7 Statistical comparison of crab mortality rates associated with various de-stress treatments, measured at 24 hours post-recovery.

Treatment	Predicted mean (logit scale)	Standard error, SE (logit scale)	Mortality (%)
Stressed transfer (no de-stress)	1.226 **a**	0.337	77.31
Stressed transfer (followed by 30-minute de-stress)	-1.492 **b**	0.358	18.36
Stressed transfer (followed by 3-hour de-stress)	-3.303 **b**	0.996	3.55
p-value	0.002		
Average 95% LSD	2.071		

Note: Statistically significant differences are indicated by non-identical subscript letters (**a** and **b**).

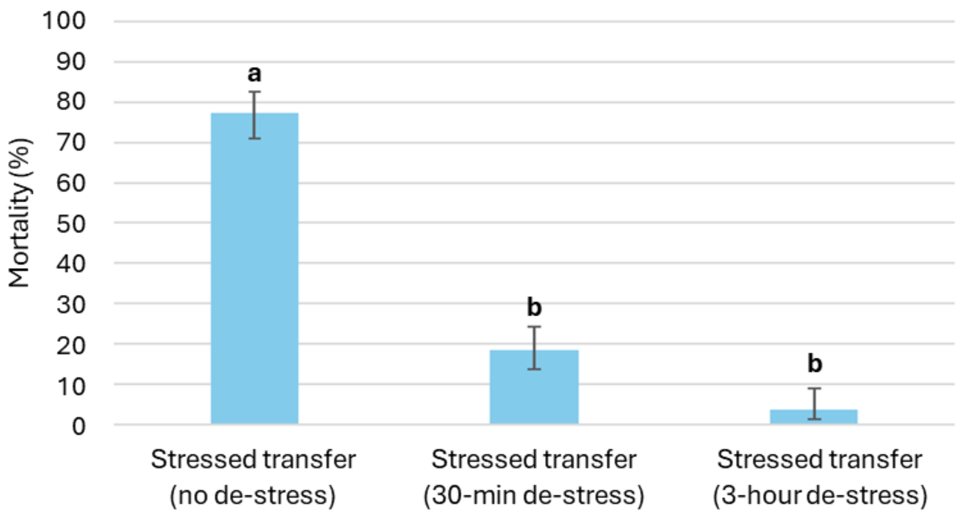

Figure 2 Mortality rates (%) associated with various de-stress treatments at 24 hours post-recovery. Statistically significant differences are indicated by non-identical subscript letters (**a** and **b**).

Although no significant differences in mortality rates were statistically demonstrated between the two de-stress treatments, crab survival was observably higher for the 3-hour treatments. It is thus recommended that a minimum de-stress period of 3 hours is applied prior to transport, with an overnight de-stress potentially more suitable in terms of logistics.

Chilling trials

Trials 9 to 24 explored the feasibility of chilling crabs to subdue them prior to transport, assessing the effects of various temperature (10 °C and 15 °C) and time (10 or 120 minutes) combinations on crab mortality rates, 2- and 24-hours post-recovery.

Statistically, no significant differences were found in mortality rates based on the chilling time, regardless of temperature or recovery time (Table 8; Fig. 3). This lack of significant difference could be attributed to only a few replicates and only two treatments being compared.

Table 8 Replicate and average mortality rates (%) for crabs exposed to various time-temperature chilling treatments, measured at 2- and 24-hours post-recovery.

Temperature (°C)	Exposure time (minutes)	Mortality at 2 hours post-recovery (%)					Mortality at 24 hours post-recovery (%)				
		Rep 1	Rep 2	Rep 3	Average	SD	Rep 1	Rep 2	Rep 3	Average	SD
10	10	0	10	0	**3.3**	5.77	10	10	30	**16.7**	11.55
10	120	10	10	0	**6.7**	5.77	10	10	30	**16.7**	11.55
15	10	0	0	0	**0.0**	0.00	0	0	0	**0.0**	0.00
15	120	10	0	0	**3.3**	5.77	10	0	0	**3.3**	5.77

Note: Rep = replicate; SD = standard deviation

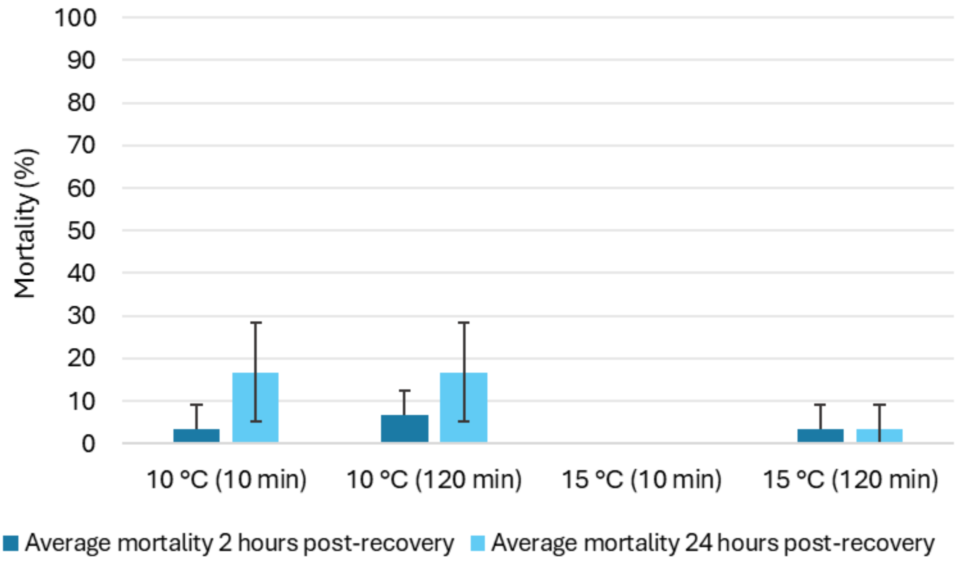

Figure 3 Mortality rates (%) associated with various chilling trials at 2- and 24-hours post-recovery.

Despite these statistical outcomes, visual observations and results suggested that chilling treatments were likely stressful for the crabs. Holding crabs at 20 °C and then exposing them to chilled seawater at 10 °C for either 10 or 120 minutes resulted in over 16% mortality. Dipping crabs in 15 °C water yielded better results, with a 10-minute dip not causing any mortality and a 120-minute dip resulting in around 3% mortality at this temperature.

Discussion

Handling Blue Swimmer Crabs to reduce stress and maximise survival is a delicate balancing act. Crabbers who take extra care during fishing operation can reduce mortality rates and extend the lifespan of their catch. Blue Swimmer Crabs experience substantial stress and mortality when removed from water due to impaired respiration. Without water, their gills cannot function effectively, leading to a rapid build-up of toxic metabolic waste in the crabs' system (Henry & Wheatly, 1992; Romano & Zeng, 2010). Unlike intertidal species such as mud crabs, which can rapidly shift to and sustain anaerobic metabolism (Gu et al., 2017; Poole et al., 2008), Blue Swimmer Crabs appear less well adapted to do so.

Stress triggers in crabs elevate hormone levels, deplete energy reserves and increase waste excretion. Prolonged stress can have severe consequences, including ovary re-absorption and heightened disease susceptibility (Chung & Lin, 2006; Whitely & Taylor, 2015). Various stressors—such as capture, sudden temperature changes, breezes, noise and other disturbances can initiate a stress response, typically resulting in ammonia build-up in the crabs' body (Morris & Airriess, 1998; Simonik & Henry, 2014). If not effectively reduced, this toxic build-up can be fatal. The only way that crabs can dilute this waste is by flushing seawater across their gills, a process that is not possible when they are out of water.

The findings of this study highlight the importance of de-stressing live Blue Swimmer Crabs in clean, aerated seawater to allow them to expel toxic waste and recover before further handling. Significant differences in mortality rates were found between crabs that received a de-stress treatment and those that did not. Mortality reached as high as 77% when no de-stress step was included, while crabs undergoing de-stress treatments experienced significantly lower mortality rates. A minimum de-stress period of 3 hours is recommended prior to transport, although an overnight purge would likely be most effective and compatible with logistical arrangements. During the de-stress, crabs should not be checked, graded or disturbed in any way to avoid re-stressing them.

Crabs require access to full-strength seawater to effectively flush accumulated ammonia from their systems. Excessive stress and toxic waste accumulation may manifest visually, with crabs expelling brown or grey bubbles or foam from their mouths. Image 5 shows a live Blue Swimmer Crab being placed in a recirculation tank after 6 hours out of water, with the circle indicating the yellow-brown liquid being expelled from the crab's mouth once its gill function resumes.

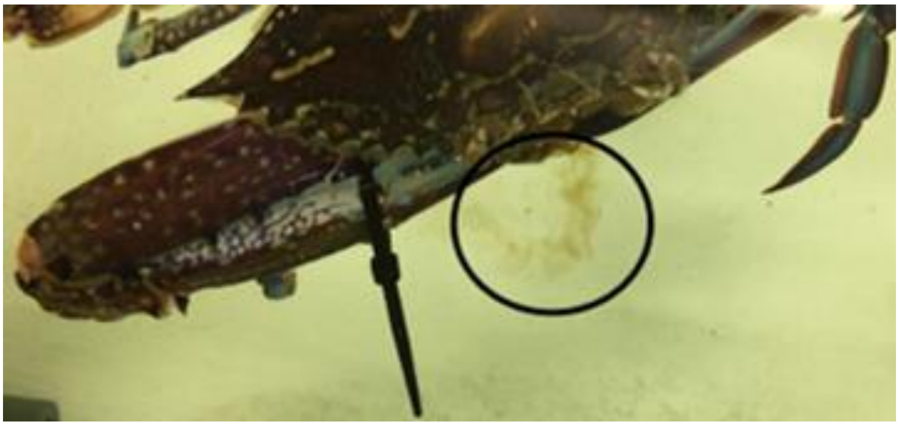

Image 5 Blue Swimmer Crab purging yellow-brown waste on return to water

Given the sensitivity of Blue Swimmer Crabs to handling stress, taking measures to minimise this stress will greatly enhance survival during live transport. Incorporating an additional de-stress step before transport is expected to significantly increase survival rates, aligning with similar recovery recommendations for handling live mud crabs (Poole et al., 2012).

The remainder of this discussion is dedicated to addressing the key handling-related inquiries posed by industry stakeholders for this study, as outlined in Box 1 of the Methods section.

How long can Blue Swimmer Crabs survive out of water?

Blue Swimmer Crabs are typically caught using baited round mesh traps (50 mm stretched mesh opening; Broadhurst & Millar, 2018). The sudden act of retrieving these traps stresses the crabs and triggers a fight-or-flight response as they are removed from the water, which may lead to exhaustion. The findings of this study indicate that, in this stressed state, crabs face more than a 77% chance of mortality if transported immediately after capture.

The laboratory trials demonstrated that Blue Swimmer Crabs can survive out of water for up to 6 hours, provided they are given a recovery de-stress treatment while on board and prior to dry transport. Crabs undergoing a 30-minute or 3-hour de-stress treatment had significantly reduced mortality rates compared to those not receiving a de-stress treatment. Although no significant mortality differences were found between the two de-stress durations, observably lower rates were achieved with the 3-hour treatment (3.55%) than with the 30-minute treatment (18.36%). For this reason, a minimum 3-hour de-stress is advised to maximise survival rates, with an overnight de-stress being optimum.

Crabs should be transferred to the final transport container (lidded basket) prior to the de-stress treatment and then returned to the recirculation tanks. This minimises individual handling when removing them from the holding tank, reducing the chances of triggering another stress reaction.

Is it feasible to dip crabs in cold water to pacify them prior to transport?

Commercial fishers of Blue Swimmer Crabs in NSW and Western Australia have used ice-water slurries in attempts to pacify crabs during on-board handling (Bellchambers et al., 2005; Broadhurst & Millar, 2018). Cold water immersion is known to reduce the heart rate and metabolic activity of crabs (Weineck et al., 2018), slowing their movement and potentially making handling easier. Studies have shown that short-term exposure to low temperatures reduces vigour, enhances meat quality and may decrease limb autotomy (Bellchambers et al., 2005; Carls & O'Clair, 1990; Hughes & Stevens, 1998).

However, the literature also indicates that rapid temperature changes in crabs can induce stress and increase metabolic rate (Lu et al., 2015), which may ultimately lead to fatalities (Bellchambers et al., 2005; Broadhurst & Millar, 2018; Carls & O'Clair, 1990; Lu et al., 2015). This is particularly true when crabs are exposed to extreme cold conditions. Evidence from laboratory studies in Western Australia highlights the risks associated with sudden temperature shifts. In trials, Blue Swimmer Crabs taken from 18 °C water and submerged in cold-water slurries at temperatures of 0, 5, and 10 °C for 15–30 minutes showed mortality rates as high as 40% (Bellchambers et al., 2005). Further, Broadhurst and Millar (2018) estimated a 50% probability of Blue Swimmer Crab mortality with a 9-minute exposure to ice slurry, underscoring the potentially lethal impact of rapid chilling.

The results of this study supported findings that sudden temperature changes and low temperature conditions can rapidly kill Blue Swimmer Crabs, with over 16% mortality recorded in the 10 °C chilling trials. Thus, while it might well be feasible to chill crabs prior to transport, whether this will be beneficial is questionable.

Is a 10 °C dip too cold for Blue Swimmer Crabs?

Research shows that both the temperature of the slurry and the duration of exposure significantly affect Blue Swimmer Crab mortality rates and recovery times (Bellchambers et al., 2005; Broadhurst & Millar, 2018). Specifically, lower slurry temperatures and longer exposure times are associated with higher mortality risk and slower recovery times.

Although no statistically significant differences in mortality were observed across the chilling treatments in this study, visual observations and results suggest that Blue Swimmer Crabs exhibit a stress response when exposed to chilled water, often becoming limp and unresponsive. In some cases, such exposures proved fatal.

Notably, it was found that transferring Blue Swimmer Crabs from 20 °C water to slurries at 10 °C for either 10 or 120 minutes resulted in over 16% mortality. Crabs that survived these treatments displayed signs of distress, including flaccidity, lethargy and slow recovery. These findings imply that 10 °C is indeed too cold for safely chilling Blue Swimmer Crabs, at least at the immersion times tested.

The current trials also investigated the effects of 15 °C treatments on crab survival. A 10-minute submersion in 15 °C water did not cause any mortalities and could be a more suitable alternative to the 10 °C treatments. Nevertheless, exposure to 15 °C water for 120 minutes resulted in 3.3% mortality, implying that prolonged immersion at this temperature may also induce stress.

Is a cold dip necessary?

Although immersion in ice slurries may temporarily pacify crabs, it will still subject them to a degree of stress, albeit minor. This study revealed that even temperatures of 10 °C or 15 °C can induce stress in Blue Swimmer Crabs and, if maintained for prolonged periods, increase mortality rates. These findings align with results reported by Morris and Airriess (1998) and Simonik and Henry (2014).

Overall, this study revealed no perceivable benefits of chilling Blue Swimmer Crabs prior to transport. In fact, chilling often rendered the crabs limp and unresponsive, which complicated assessments of their strength, liveliness and general suitability for live transport. This impairment can be particularly problematic for the live trade, where visual indicators of vitality are crucial for determining market quality. The lack of clear advantages, coupled with observable stress responses, suggests that pre-transport chilling may not be an optimal approach for live Blue Swimmer Crabs.

Further research may be warranted to assess whether shorter chilling durations could improve crab survival and recovery rates, as suggested by other authors (Bellchambers et al., 2005; Broadhurst & Millar, 2018; Leland et al., 2013). However, it is essential to carefully weigh the potential benefits of subduing the crabs against the probable risks of stress and mortality associated with these treatments.

Given that the primary goal for live transport is to keep crabs alive and in optimal condition, pre-transport chilling is not advised for crabs destined for the live trade. Instead, implementing a de-stress treatment for at least 3 hours, or ideally overnight, before transport is likely to be considerably more advantageous than adding incremental stress via chilling. The de-stress step allows the crabs to physiologically stabilise and reduce accumulated stress, lowering metabolic rates naturally rather than through abrupt temperature changes.

Conclusion

The findings from this study underscore the significant stress factors that impact live crabs throughout the supply chain, including physical handling, air exposure, activity aggression, temperature changes and other disturbances. Key insights emphasise the importance of employing tailored handling protocols to minimise cumulative stress and reduce mortality rates. Drawing on both the literature review and laboratory trials, Table 9 summarises these stressors and appropriate mitigation strategies, thus providing a comprehensive best-practice guideline for handling live Blue Swimmer Crabs to maximise their survival rates and preserve product quality.

Table 9 Stress factors and recommended handling practices for live Blue Swimmer Crabs throughout the supply chain.

Stage	Stress factor	Key considerations	Method to minimise
Capture	Physical damage	• Limb loss • Blood loss from unsealed wounds	• Clear fishing gear at least daily. • Retrieve fishing gear with a smooth, continuous motion, avoiding jerking. • Carefully disentangle crabs from fishing gear. Avoid forcefully bashing gear to dislodge tangled crabs. • Do not throw or drop crabs into baskets.
	Air exposure	• Increased metabolic rates and stress	• Remove crabs from gear swiftly but gently to minimise air exposure.
On vessel	Air exposure	• Increased metabolic rates and stress	• Transfer crabs promptly to a covered flow-through tank with recirculating seawater from a pickup or deck hose. If this is not available, use aerated water and replace manually. Keep water temperature a few degrees Celsius lower than that from which crabs were taken. Alternatively, hold crabs in crates lined and covered with damp hessian. • Keep crabs out of sunlight and breeze.
	Temperature	• Temperature change, direct sunlight	
	Dehydration	• Wind disturbance and drying of gills	
	Physical damage	• Limb and carapace damage during sorting, or through aggression if held at high density	• Sort crabs carefully. • Preferably tie or band claws to reduce aggressive interactions between crabs. • Maintain low crab densities in seawater tanks or storage bins.
Land holding	Damage during transfer from vessel	• Limb and blood loss	• Unload crabs gently but rapidly.
	Air exposure during transfer	• Increased metabolic rates and stress	• Hold crabs in a well-maintained recirculation tank at controlled seawater

	Temperature	• Temperature change, direct sunlight	conditions (CSC, see the methods section). • Re-immerse crabs into water gradually, purging waste products from their mouths and reactivating gill function.
	Dehydration	• Wind and transfer disturbance, drying of gills	
	Water quality	• Water temperature and oxygen levels • Efflux waste levels	• Monitor water quality regularly, ensuring adequate water exchange.
Pack out	Air exposure	• Increased metabolic rates and stress	• Ensure a gentle but rapid pack out in a quiet, draft-free environment.
	Disturbance	• Noise, light, drafts	
	Temperature	• Temperature change	• Hold pack-out room at 15–20 °C.
	Physical damage	• Limb and blood loss, aggression	• Pack crabs relatively closely in transport containers to limit their movement.
Pre-transport*	Air exposure	• Ammonia toxicity due to air exposure and accumulated stress from pack out and prior handling	• Allow crabs to de-stress by placing them in lidded baskets within recirculation tanks or tubs containing clean, aerated seawater for a minimum of 3 hours, or preferably overnight.
Transport	Temperature	• Too cold or variable temperatures	• Ensure transport containers have insulation capacity. • Do not place coolant packs in direct contact with crabs to avoid cold burn. • Maintain transport temperatures between 18–25 °C.
	Air exposure	• Increased metabolic rates and stress	• Aim for a transport method that minimises transit times. • Cascade systems within vehicles may be a viable future transport option.
	Disturbance / damage	• Transport vibrations or impacts	• Pack transport containers tightly to buffer vibrations and impacts.
Unload	Disturbance / damage	• Physical shock during unload	• Unload gently to avoid incremental stress on crabs following transport. • Check crabs for condition and liveliness as soon as possible after unloading.
	Air exposure	• Increased metabolic rates and stress	• Crabs should be promptly transferred to seawater tanks.

***Note: It is not advisable to dip Blue Swimmer Crabs in chilled water (10–15 °C) to pacify them prior to transport.** This study indicated that rapid temperature changes impose stress on the crabs and increase mortality risk.

Implications

These report findings and handling guidelines will help NSW Blue Swimmer Crab fishers to access or re-enter the high-value live crab trade, which was severely disrupted by the COVID-19 pandemic. Previously, custom wet trucks were used to transport live crabs to market. However, during the pandemic, these trucks ceased operation, and the live Blue Swimmer Crab trade largely disappeared.

Implementing the recommended handling guidelines and dry transport protocols could allow crabbers to utilise regular road freight and existing lobster tubs to transport live crabs to market. This approach would allow fishers to command premium prices for live crabs, improving profitability while reducing spoilage and waste, and maximising the value of each catch. With fewer mortalities and higher returns for live products, the industry might also require fewer crabs to achieve their economic targets, potentially easing fishing pressure and supporting environmental sustainability goals. Similarly, consumers stand to benefit from higher-quality crabs due to reduced handling stress.

Re-establishing the live trade will also help to enhance the industry's reputation as a supplier of premium seafood. The upcoming opening of the brand-new Sydney Fish Market will provide an ideal platform to showcase live Blue Swimmer Crabs and boost demand for these products. With actionable guidelines for improving survival rates during transport, the current research findings provide a clear roadmap for fishers, logistics providers and market operators to capitalise on this opportunity and drive long-term growth for the NSW live Blue Swimmer Crab industry.

Recommendations

In the initial project proposal, the NSW industry requested an easy-to-read best practice guideline for improving the live handling of Blue Swimmer Crabs, supported by laboratory experiments and commercial transport trials. Unfortunately, commercial-scale trials were unable to proceed during the life of the project owing to disruptions caused by consecutive flooding events in NSW estuaries and low Blue Swimmer Crab catches. Moreover, the COVID-19 pandemic reduced global travel, decreasing the demand for live crabs at Sydney Fish Market. These concurrent challenges prompted fisher's co-operatives and private businesses on the mid-NSW coast to shut down their live holding facilities, leaving no stakeholders with recirculation tanks to host the commercial trials. With tourism-driven seafood demand rebounding post-pandemic and interest in the live Blue Swimmer Crab trade accordingly rising, it is highly recommended that commercial trials be conducted to validate the findings from the literature and laboratory phases of this study in real-world conditions.

If cold-water dips are pursued as a method to pacify crabs prior to transport, shorter immersion times should be tested to determine their impacts on crab survival and recovery, as suggested by existing literature. Nevertheless, the potential benefits of pacifying crabs should be carefully balanced against the potential risks of increased stress and mortality associated with such treatments.

Extension and Adoption

A ***Live Blue Swimmer Crab Handling Guide*** has been developed based on the research findings, serving as a concise and practical reference tool for crabbers currently engaged in or planning to enter the live Blue Swimmer Crab trade. To ensure ongoing accessibility, the FRDC will host a PDF version of this guide on their website, providing an ongoing resource to support the industry as it matures. This guide is also particularly timely given the interest from Western Australian crabbers in expanding their live Blue Swimmer Crab trade, offering a strong foundation for industry-wide adoption of best practices.

Industry workshops were initially sub-contracted to the NSW Professional Fishers Association (PFA) to train NSW crabbers on the research findings. However, following dissolution of the PFA during the project, Queensland DPI researchers stepped in to carry out these training sessions. Held in December 2024 across key NSW fishing communities – Coffs Harbour, Newcastle, Yamba and Wallis Lake – the workshops attracted a diverse group of industry stakeholders, including crabbers, co-operative managers and floor staff, account managers, FRDC extension officers, and boating and fisheries regulators. Participants engaged in hands-on demonstrations of optimal live crab handling practices, addressing practical supply chain challenges and fostering industry readiness for the live trade. To support adoption of best practices, attendees received printed copies of the *Live Blue Swimmer Crab Handling Guide* developed as part of the project, encouraging broader engagement in the live Blue Swimmer Crab market.

Project materials developed

In addition to this report, a *Live Blue Swimmer Crab Handling Guide* was developed to summarise best practice guidelines for handling Blue Swimmer Crabs for the live trade. This guide will be hosted on the FRDC website to ensure ongoing accessibility. The content of the guide is included below.

Live blue swimmer crab handling guide

NSW crab fishery

2024

Queensland Government

Live blue swimmer crab handling practices

This handling guide is designed for participants in the NSW blue swimmer crab fishery to optimise quality, sustainability and profitability. Drawing on learnings from our research trials, it outlines the best practices for handling, transporting and storing live blue swimmer crabs to maintain a premium product. For crabbers involved in the live trade, following these recommendations will help increase crab survival rates and ensure that only full, strong and healthy crabs reach the market, thereby maximising their value. Even if live trade is not the goal, the guidelines will still help to retain the quality of the catch at a premium.

The NSW fishery, which operates in estuarine and coastal waters such as the Hawkesbury River, Port Stephens and Wallis Lake district, is governed by strict regulations to protect the environment and ensure sustainability. Effective handling practices throughout the supply chain are crucial in supporting these regulations and preserving the ecological and economic sustainability of the fishery. Ultimately, keeping crabs in peak condition from capture to sale benefits all stakeholders, from fishers to consumers, helping to secure the best market value for the catch and promoting the long-term viability of the fishery.

FRDC project 2018-024 – Investigation and Improvement of Live Blue Swimmer Crab Handling in NSW

FRDC
FISHERIES RESEARCH & DEVELOPMENT CORPORATION

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Lift traps gently

Retrieve traps with a smooth, continuous motion to minimise harm to live crabs. Sudden jerking of traps from the sea bottom can stress and physically damage the crabs, potentially downgrading them from premium live product. Remove crabs gently from the pots and avoid forcefully bashing the trap to dislodge tangled crabs, as this can cause additional damage, bleeding and limb loss, further downgrading their quality.

Image 1 A live blue swimmer crab foaming from the mouth can indicate stress. Such crabs are best downgraded.

Sort crabs immediately

Carefully separate soft, injured or weak crabs, particularly those with any missing legs and claws. Newly moulted crabs are soft and easily stressed, making them more vulnerable to transport and temperature changes. Soft crabs will also have a low meat yield, resulting in a poor eating experience for consumers, and are best returned to the water. Injured, bleeding or foaming crabs will be compromised and are likely to die during live transport. While downgraded crabs can still be sold as green, it is recommended not to include them as part of your live shipment.

Tie crabs for live trade

Crabs intended for live trade should be tied promptly using rubber bands or cable ties, then returned to recovery tanks as soon as possible. While tying blue swimmer crabs is not usually required, our research found that tying the claws limits their movement and consequently the number of aggressive interactions between crabs. This reduces potential damage caused through fighting.

Image 2 A live blue swimmer crab with its claws tied with rubber bands to prevent fighting with other crabs. Cable ties are also an effective option for restricting claw movement.

Clear pots every 24 hours

It is advisable to clear crab traps at least every 24 hours. Crabs left tangled in traps for extended periods are more likely to experience excessive stress, reducing their chances of survival.

Hold crabs onboard in a flow-through tank

Carefully handled crabs have a much higher chance of survival. Never throw or drop live crabs into holding baskets or tanks. Place them gently and allow them time to recover in a flow-through tank.

Image 3 Handle crabs with care. Never drop or throw crabs into baskets.

Protect crabs from sun and breeze

It is best to hold crabs onboard in a covered tank with recirculating water from a pickup or deck hose. Alternatively, crabs can be held in crates lined with hessian and covered to minimise disturbance. Exposure to sun and even slight breeze can dehydrate and stress live crabs, potentially leading to death. Return live crabs to recovery tanks as quickly as possible to reduce stress and protect them from the effects of sunlight and breeze.

Always handle crabs with care to avoid unnecessary stress and injury. Stress triggers a rapid build-up of toxic metabolic waste in the crabs' systems, which can lead to significant mortalities.

Purge crabs prior to transport

Our research indicated that blue swimmer crabs are highly sensitive to handling stress, mainly due to the accumulation of stress-induced toxic waste in their bodies. Their only way to cope with such stress is by pumping clean water across their gills to dilute the toxic waste products. This is not possible when they are dry. We found a significant advantage in de-stressing live crabs by purging them in clean aerated seawater, allowing them to expel the waste and recover before further handling.

De-stress dips make a significant difference

Our results revealed a significant difference in mortality rates between crabs receiving a de-stress dip and those that did not. Up to 76% mortality was seen when there was no de-stress step in the process, whereas crabs receiving the de-stress treatments experienced significantly lower mortality.

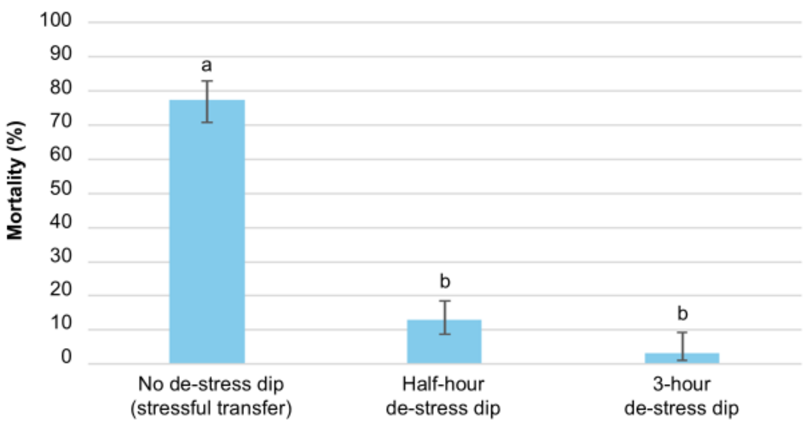

Figure 1 Blue swimmer crab mortality rates with and without a de-stress dip. Up to 76% mortality was observed when there was no de-stress step in the process. Statistically significant ($P < 0.01$) differences are indicated by non-identical subscript letters.

We recommend an overnight purge as the most effective method, with a minimum of a three-hour purge. During this time, the crabs should not be checked, graded or disturbed in any way.

Warning!

Allow live blue swimmer crabs to de-stress in a recirculation tank prior to any live transport.

Once crabs have been graded, place them in a lidded basket and allow it to float in a recirculation tank or tub containing clean aerated seawater to allow the crabs to de-stress (preferably overnight or minimum three hours).

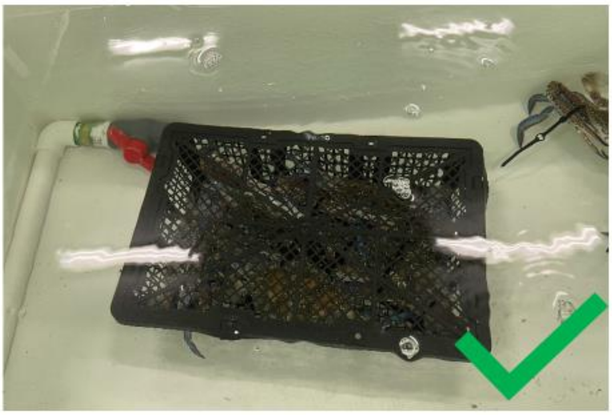

Image 4 De-stress crabs before transfer or transport by floating lidded baskets in a recirculation tank containing clean aerated seawater, preferably overnight or for minimum three hours.

Image 5 Small volumes of crabs can be purged in a tub containing clean aerated seawater, preferably overnight or for minimum three hours.

Warning!

Allow live blue swimmer crabs to destress in a recirculation tank prior to any live transport.

The image below shows a stressed crab being returned to the water in a recirculation tank. The circle indicates the yellow-brown toxic liquid being expelled from the crab's mouth as it attempts to dilute the toxins.

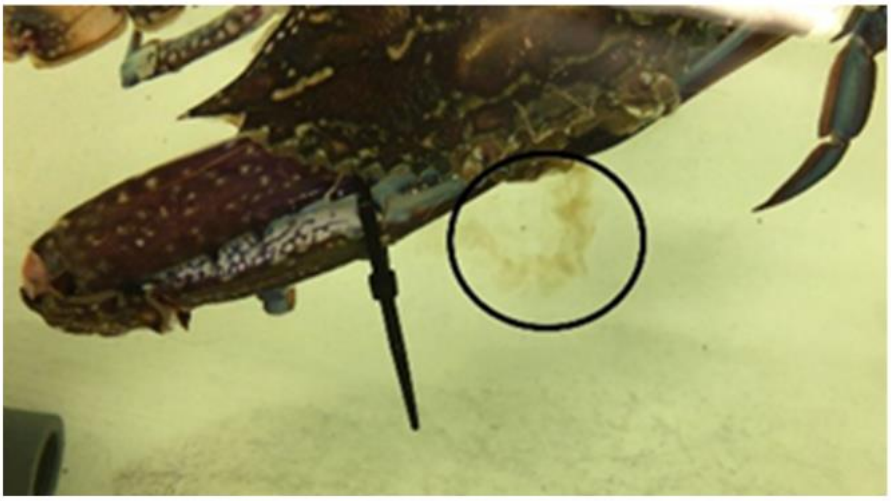

Image 6 Blue swimmer crab expelling yellow-brown toxins during the de-stress dip.

If the crab is unable to sufficiently dilute the toxins, the build-up in its system may become fatal.

Maintain optimal water quality

To preserve the health and value of live crabs, it is essential to maintain the quality of water in recirculation tanks within specific parameters.

Image 7 Monitor water quality on a daily basis to prevent build-up of toxins.

It is best to monitor these basic parameters daily until you understand what volume of crab can be held without exceeding these water quality parameters:

- Seawater temperature: 18 °C to 25 °C
- Oxygen: saturated
- pH: 7.9 to 8.1 (use sodium bicarbonate to increase pH, if necessary)
- Salinity: 30–35 ppt (bubble off chlorine with an air stone overnight before adding town water to the tank when diluting salinity)
- Ammonia: <0.1 mg/L
- Nitrite: <0.3 mg/L
- Nitrate: <50 mg/L (regular water exchanges to dilute).

Important!

Crabs should not be allowed to free range prior to transfer or transport. The act of catching the crabs individually for transfer / transport will cause new stress for the crabs. You will need to start the de-stress cycle again.

Image 8 Do not allow crabs to free range prior to transfer or transport (top). Place them in lidded baskets for the de-stress process (bottom) and keep them in the same baskets for shipping.

Graded crab should be de-stressed in a lidded basket submerged in a recirculation tank or tub containing clean aerated seawater, preferably overnight or for a minimum of three hours prior to any transport. Mortality checks should be carried out the night before or at least three hours before transporting crabs. Crabs should be gently removed from the tank with the lid intact so as not to disturb them. This will keep them calm. Crabs should be shipped in the lidded baskets and not transferred to another container.

Warning!

Do not chill crabs prior to transport

Crabbers asked if it is feasible to dip crabs in cold water to subdue them prior to transport. However, our trials showed that rapid temperature changes can kill blue swimmer crabs.

We found that holding crabs at 20 °C and then dipping them in chilled seawater at 10 °C for either 10 or 120 minutes was stressful for the crabs, resulting in 16% mortality. Dipping crabs in 15 °C water gave better results, with a 10-minute dip not causing any mortality and a 120-minute dip resulting in 3% mortality at this temperature.

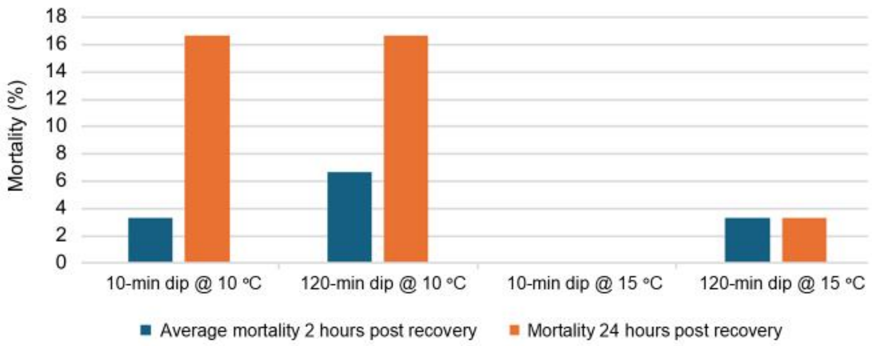

Figure 2 Mortality rate of live blue swimmer crabs exposed to cold water dips for different temperature and time combinations. Dipping crabs in 10 °C water resulted in 16% mortality.

We also noted that subjecting crabs to a cold dip made them go limp, making it difficult to gauge their strength and liveliness prior to transport. We found no benefit in using cold dips for crabs before transport.

Image 9 Dipping crabs in cold water can cause temperature shock and associated mortalities.

Blue swimmer crabs can survive short periods out of water

Our research indicated that live blue swimmer crabs can survive for up to 6 hours out of water, provided they have been purged overnight and have not experienced additional stress. The crabs must remain undisturbed in a lidded basket. This basket can then be gently placed into a Sydney Fish Market lobster tub with a lid for transport at room temperature (18 °C to 25 °C). This potentially gives the crabbers a short window to transport their crabs to a live market facility without the use of a specialised wet truck.

Image 10 After purging, live blue swimmer crabs can be placed in a lobster tub while still in a lidded basket.

Keep crabs at 18 ºC to 25 ºC during transport

A temperature range of 18 °C to 25 °C is optimal to ensure that live blue swimmer crabs have the best chance to reach consumers in premium market condition. A healthy crab packed in an appropriate box and kept at this temperature will provide the best financial return to all industry sectors.

Live blue swimmer crabs should be kept in holding tanks until the last possible minute. Crabs to be transported should remain covered in an air-conditioned vehicle to keep the temperature stable.

Return blue swimmer crabs to a recirculation tank as soon as possible after transport

For the best recovery results following transport, lower crabs gently back into water of a similar temperature and allow air bubbles to be purged from the mouth. If air bubbles get caught in the gills, the crab will most likely die.

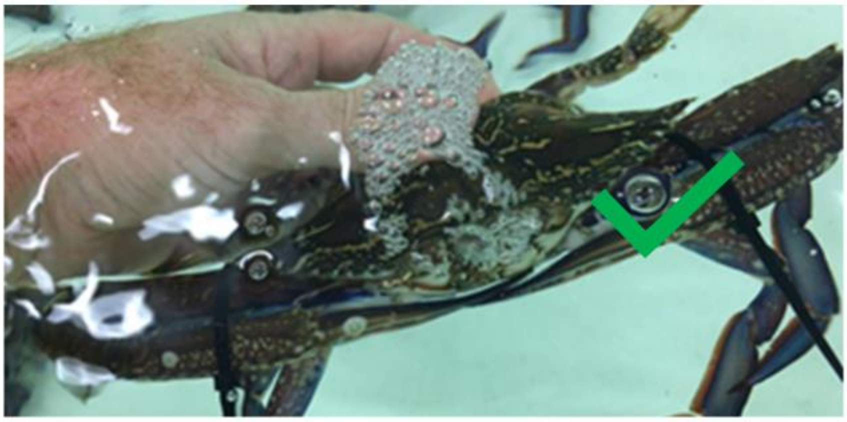

Image 11 Return crabs gently to water after transport and purge air bubbles from the mouth.

If it is not possible to return and care for crabs individually, the next best way is to hold them in the transport mesh basket and gently lower the basket into the recirculation tank, watching for the crabs to purge the air from their gills.

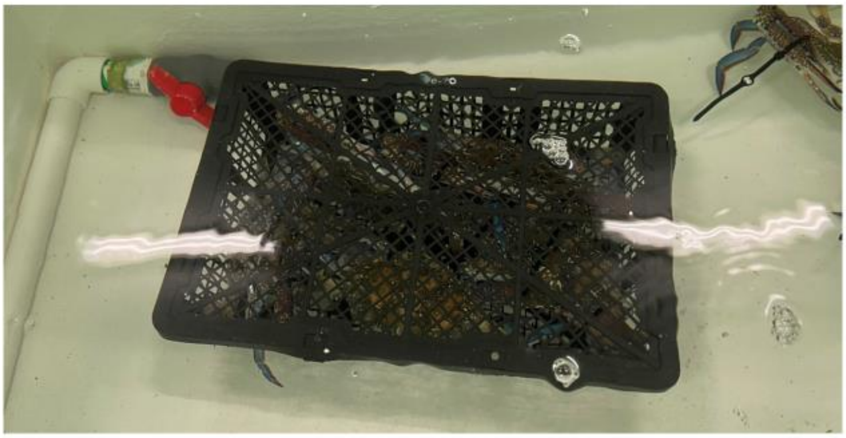

Image 12 Alternatively, return crabs gently to water in mesh transport basket for purging.

Water

Crabs are highly sensitive to contaminated water and can die if exposed. To maintain their quality, always use clean, aerated seawater. Avoid seawater from potentially polluted sources like shallow creeks, waterways, areas near fuelling stations or industries that might contaminate the water. Do not keep crabs in tanks located below deck where they might be exposed to bilge water, which may contain traces of oil and fuel.

Ongoing hygiene

Ongoing hygiene is crucial. Keep the deck, mats, traps, holding containers, and any other surfaces that come into contact with crabs clean to avoid contaminating the live product. The boat should be thoroughly cleaned before each fishing trip and maintained in a clean condition throughout. Use only 'food safe' cleaning and sanitising products, and always follow the manufacturer's instructions when using them.

Legislation

This live handling guide is intended to help you manage your crabs effectively for live trade. However, it does not replace the need to understand and comply with NSW fishing regulations.

Summary

- Handle crabs with care. Lift traps gently and do not drop or throw crabs into baskets.
- Clear pots every 24 hours to reduce stress.
- Sort crabs and tie claws immediately.
- Hold crabs in flow-through tanks onboard using deck hose or water pickup. Alternatively, use aerated water and replace manually.
- Keep crabs out of sunlight and breeze.
- Hold crabs in well-maintained recirculation tanks. Monitor water quality.
- De-stress graded crabs in lidded baskets submerged in recirculation tanks or tubs with clean aerated seawater, preferably overnight or for a minimum of three hours.
- Transport in lidded baskets at 18 °C to 25 °C. Avoid sudden temperature changes.
- Return to water ASAP and purge air from gills.

More information

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Queensland Government

Appendices

Appendix 1 Summary of stress factors and best handling practices for live Blue Swimmer Crabs.

Stress factors

- Accumulation of stress during harvesting and handling.
- Environmental stressors:
  - Air exposure leading to impaired respiration and increased metabolic demand.
  - Temperature changes causing metabolic rate fluctuations and stress.
  - Dehydration and drying of gills when out of water.
  - Noise and disturbances (e.g., breeze, physical handling) contributing to stress.
- Physiological stressors:
  - Increased stress hormone levels with heightened metabolic activity.
  - Accumulation of metabolic waste products like ammonia in the bloodstream, leading to rapid toxicity and potential mortality.
  - Damage from aggression and cannibalism among crabs.

Best handling practices

General handling

- Always handle crabs gently to prevent physical damage like limb loss or shell damage.
- Grade out crabs with missing or damaged limbs; these are unsuitable for the live trade.
- Use solid storage or fine mesh inserts in handling containers to prevent limbs from getting stuck or damaged.
- Keep crabs damp, dark, cool and quiet to minimise stress during storage and transport.
- Damp, clean hessian is suitable for covering crabs; however, this should be cleaned regularly and sun-dried to reduce bacterial contamination.
- Avoid sudden temperature changes. Maintain temperatures within 10 °C of the crabs' native water temperature.
- Perform regular condition checks. Mortality risks are highest in the first 48 hours post-capture.
- Minimise air exposure during all stages of handling and transport.

Capture

- Clear traps at least every 24 hours.
- Retrieve fishing gear with a smooth, continuous motion and avoiding jerking.
- Remove crabs from fishing gear rapidly and gently to minimise air exposure and prevent injury (limb loss, carapace damage). Avoid forcefully bashing gear to dislodge tangled crabs.
- Do not throw or drop crabs into baskets.
- Keep crabs out of sunlight and breeze.
- Sort crabs carefully, only selecting those with hard shells. Newly moulted crabs will have soft shells and are unsuitable for transport.
- Preferably tie or band claws to reduce aggressive interactions between crabs.
- Transfer crabs promptly to a covered flow-through tank with recirculating seawater from a pickup or deck hose; otherwise use aerated water and replace manually. Alternatively, hold crabs in crates lined and covered with damp hessian.
- Maintain low crab densities in seawater tanks or storage bins.

Storage

- Short-term storage: maintain damp, low-light, cool conditions.
- Long-term storage: use aerated seawater tanks with proper filtration to maintain water quality. Maintain controlled seawater conditions (CSC, see the methods section).
- Monitor water quality regularly and ensure adequate water exchange to prevent deterioration caused by waste buildup.

Re-immersion and recovery

- Re-immerse crabs gradually and preferably individually, purging waste products from their mouths and reactivating gill function.
- Monitor behaviour during re-immersion to ensure acclimatisation before full release.

Pack out for shipment

- Ensure a gentle but rapid pack out in a quiet, draft-free environment.
- Pack crabs relatively closely in transport containers to limit their movement.

Transport

- De-stress crabs prior to dry transport by placing them in lidded baskets within recirculation tanks or tubs containing clean, aerated seawater for at least 3 hours, or preferably overnight.
- Ensure transport containers have insulation capacity.
- Do not place ice packs or gel coolants in direct contact with crabs to avoid cold burn.
- Maintain transport temperatures between 18–25 °C.
- The use of seawater during transport is ideal to maintain hydration and respiration.
- Consider specialised refrigerated vehicles or vivier trucks to optimise transport conditions.

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