# Biosecurity threats and vulnerabilities of the Southern Rock Lobster Fishery

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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

| | |
|---|---|
| AIIMS | Australasian Inter-Service Incident Management System |
| AqCCEAD | Aquatic Consultative Committee on Emergency Animal Diseases |
| AQUAVETPLAN | The Australian Aquatic Veterinary Emergency Plan |
| ASQAP | Australian Shellfish Quality Assurance Program |
| AST | Amnesic Shellfish Toxin |
| BICON | Biosecurity Import Conditions |
| BIMS | Biosecurity Incident Management System |
| CCIMPE | Consultative Committee on Introduced Marine Pest Emergencies |
| CVO | Chief Veterinary Officer |
| DST | Diarrhetic Shellfish Toxin |
| EADRA | Emergency Animal Disease Response Agreement |
| EMPPlan | The Emergency Marine Pest Plan |
| HAB | Harmful Algal Blooms |
| MICOR | Manual of Importing Country Requirements |
| NBMG | National Biosecurity Management Group |
| NEBRA | National Environmental Biosecurity Response Agreement |
| NST | Neurotoxic shellfish toxin |
| PIRSA | Primarily Industries and Regions South Australia |
| PST | Paralytic Shellfish Toxin |
| ShellMAP | Shellfish Market Access Program (Tasmania) |
| SRL | Southern Rock Lobster |
| TACC | Total Allowable Commercial Catch |
| TRL | Tropical Rock Lobster |
| WSSV | White Spot Syndrome Virus |

# Executive Summary

*Background*

The Southern Rock Lobster (SRL) industry is an economically valuable wild-catch fishery sector in Australia worth over AUD$200 million annually. In recent years, the industry has been impacted by various biosecurity and other emerging threats, such as COVID-19, trading partner non-tariff barriers and harmful algal blooms (HAB). Moreover, climate change is influencing the distribution of diseases, invasive marine pests and other negative impacts on lobster populations.

Market access is imperative, with the majority of SRL catch exported, primarily to Asian markets. There are increasing requirements to demonstrate the health status of SRL and meet stringent export requirements to maintain market access.

Ausvet undertook an assessment of biosecurity threats and vulnerabilities of the SRL Fishery on behalf of the Fisheries Research and Development Corporation (FRDC) for Southern Rocklobster Limited. This report identifies these threats and discusses mitigation strategies and other recommendations to support the fishery.

*Objectives*

The overarching objective of this project was to enable improved biosecurity planning within the Southern Rock Lobster industry. More specifically, this included:

- Identify emerging and possible biosecurity threats
- Identify barriers to address these biosecurity threats and recommended actions to address these barriers
- Identify the outbreak response processes and outline the biosecurity response framework
- Present this information in a useable format for later use in biosecurity planning.

*Methods*

The methods included four components:

1. **Literature review** of emerging and possible biosecurity threats in the SRL industry to assess peer-reviewed publications, current state and federal legislation and policy and other grey literature to understand key biosecurity threats to the SRL industry.
2. **Stakeholder consultation** with relevant scientists, government personnel and Southern Rocklobster Limited. Discussions focussed on biosecurity threats, disease and marine pests, market access and food safety, disease surveillance, legislation and policy and emergency response.
3. **Fore sighting analysis for the SRL industry** to identify and highlight key drivers of future change and threats covering five domains (social, technological, economic, environmental and political and regulatory). Five future biosecurity scenarios were then evaluated to determine appropriate management strategies, with identification of enablers and barriers.
4. **Identification of key biosecurity threats, barriers/impediments and solutions**-from the literature review, stakeholder consultation and fore sighting analysis.

*Results and implications*

Table 1 summarises the biosecurity threats identified for the SRL industry. It outlines key management solutions and barriers/impediments to address these threats.

*Table 1: Summary table presenting biosecurity threats, management solutions and barriers for the Southern Rock Lobster industry in South Australia, Victoria and Tasmania, Australia.*

| Biosecurity threat | Driver of threat | Management solutions | Barriers/impediments |
|---|---|---|---|
| Invasive marine species and infectious organisms e.g. wakame, White Spot Syndrome Virus and emerging diseases. | Climate change.<br><br>Risk pathways e.g. vessels movements, crustacean imports.<br><br>Lobster aggregation along the supply chain. Supply chain practices facilitate infection transmission and immune compromise. | Disease surveillance.<br><br>Risk assessment of incursion pathways and mitigations.<br><br>Understand impacts of climate change on industry for adaption.<br><br>Incremental improvements to supply chain to minimise immune compromise. | Costs of implementing biosecurity practices and poor ability to influence larger risk pathways (e.g. shipping).<br><br>Supply chain is structured in a practical manner and is not cost effective to change. |
| Harmful algal blooms (HABs), biotoxins and public health risk. | Paralytic Shellfish Toxin (PST) is the primary concern for the Southern Rock Lobster (SRL) industry.<br><br>HAB range expansion is occurring due to climatic and non-climatic factors e.g. warming ocean temperatures. | Effective surveillance programs in all SRL states and regions within states. Lobsters can benefit from early detection as bivalves can be used as sentinel species, aligning with the Australian Shellfish Quality Assurance Program (ASQAP).<br><br>Risk assessment of areas that are not protected by the ASQAP and additional biotoxins (e.g. diarrhetic toxin, amnesic toxin etc.). | Reliance on mussels and phytoplankton to inform PST risk in SRL for human consumption. Gaps in this surveillance approach as geographic areas are missed. Resources and costs of surveillance.<br><br>Scientific understanding of risks of HAB to lobsters. |
| Legislation and regulations not fit for purpose for marine biosecurity. | Traditionally developed for livestock, there are gaps for aquatic industries. | New Commonwealth and State biosecurity legislation is being rolled out. These will improve management of biosecurity and responses in marine environments.<br><br>New 'general biosecurity duty' places responsibility on fishers and processors. Education and training will be needed. | Resources needed to implement training on ideal biosecurity practices. |

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| Emergency response to infectious disease outbreaks and challenges in the marine environment. | Practical and operational difficulties for eradication and control of diseases/ pests in the ocean.<br><br>Lack of a cost sharing agreement. | Southern Rocklobster Limited to contribute to a response through:<br><br>• Industry liaison role<br>• Support decision making, where possible<br>• Funding applications<br>• Effective communication with stakeholders before and during a biosecurity. | Challenges with a cost sharing agreement across the broader aquatic industry. |
| Trade and market access affected by biosecurity and risk of market closures. | Geopolitics.<br><br>Requirements to demonstrate disease freedom to trading partners. | Design a fit for purpose disease surveillance system for the SRL industry. This could be small appropriate and incrementally collect data.<br><br>Traceability system.<br><br>Quality assurance program.<br><br>Market diversification. | Ongoing costs for surveillance system.<br><br>Limited markets (diversification difficult due to lucrative trade with current markets).<br><br>Supply chain is structured to aggregate lobsters. Traceability would require individual animal identifiers, which are expensive. |
| Supply chain impacted by disease outbreak or contaminated product resulting in product recall. | Supply chain practices encourage disease emergence e.g. lobster aggregation from different locations and varying health status. | Incremental work to improve supply chain, implement a universal traceability system and a quality assurance program. | The supply chain necessarily leads to aggregation of lobsters for economies of scale and efficiency. Enhancements would require investment. |
| Environmental quality reduction and shifting habitat ranges for SRL due to ocean activities, land use changes and climate change. | Increasing human population leading to poorer water quality. | Routine monitoring of lobster populations to detect issues. | The SRL industry is a small player in the national economy and cannot directly or indirectly influence environmental quality or features affecting water quality. |

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|---|---|---|---|
| Reduced access to fishing areas due to e.g. offshore windfarms and new marine reserves resulting in concentrated fishing activities increasing biosecurity risks. | Increasing importance of environmental sustainability and the use of renewable energy sources. | Ongoing management of available fishing areas to monitor catch quotas, biosecurity risks, impacts on market supply and resource management. | Increasing shift towards the use of renewable energies and preservation of the ocean environment. |

*Recommendations*

A number of key recommendations have been developed, based on the biosecurity threats identified and the barriers/impediments to address them. The following recommendations are suggested:

1. Develop a disease surveillance plan to understand the health status of Southern Rock Lobster to support population health and market access.
2. Develop a biosecurity plan that provides comprehensive strategy and protocols for both vessels and live holding facilities.
3. Improve biosecurity planning by individual fishers and a quality assurance scheme to support new biosecurity legislation. This will require stakeholder engagement and education (e.g. DAFF, 2020) to maintain high biosecurity standards and limit disease and marine pest risk.
4. Conduct risk assessments along the coastal waters of Victoria, South Australia and west coast of Tasmania to understand HAB and toxin (e.g. PST) risks. This is to support the need for regular mussel and lobster monitoring in other regions that are not current under surveillance.
5. Improve biosecurity response preparedness for the Southern Rock Lobster industry. Appendix 3 outlines the gaps and areas for improvement to support the Southern Rock Lobster industry in the event of an emergency response.

*Keywords*

Southern Rock Lobster; Biosecurity; Disease; Marine pest; Harmful Algal Bloom; Emergency response

# Introduction

The Southern Rock Lobster (SRL) industry is a valuable wild-catch fishery sector in Australia worth over AUD$200 million annually. In recent years, the industry has been impacted by various biosecurity and other emerging threats, such as COVID-19, trading partner non-tariff barriers and harmful algal blooms (HAB). Moreover, climate change is influencing the distribution of diseases, invasive marine pests and other negative impacts on lobster populations. Biosecurity threats include infectious diseases, invasive marine pests, reducing environmental quality, weaknesses along the supply chain and limitations with legislation. There are a number of challenges when implementing mitigation strategies to manage these threats in the marine environment with limited control over water quality, the impacts of climate change, habitat change or destruction, restricting animal movements and interaction between other species.

Market access is imperative, with the majority of SRL catch exported, primarily to Asian markets. This reliance on international trade leads to greater sanitary requirements (e.g. food safety and disease freedom). These can be enforced arbitrarily by individual countries, though support is provided by the World Trade Organization Sanitary and Phytosanitary Measures (WTO SPS) agreement and its implementation through international standards set by the World Organisation for Animal Health (e.g. Aquatic code) and the Codex Alimentarius, though these rely in part on well-constructed surveillance data.

This project aims to understand the biosecurity threats facing the SRL industry and other vulnerabilities relating to market access, exports and future risks. This will enable Southern Rocklobster Limited to focus future biosecurity planning.

# Objectives

The overarching objective of this project was to enable improved biosecurity planning within the Southern Rock Lobster industry. More specifically, this included:

- Identify emerging and possible biosecurity threats
- Identify barriers to address these biosecurity threats and recommended actions to address these barriers
- Identify the outbreak response processes and outline the biosecurity response framework
- Present this information in a useable format for later use in biosecurity planning.

# Method

## 1. Literature review of emerging and possible biosecurity threats in the SRL industry

A literature review was conducted to understand the key biosecurity issues and other industry threats. Search engines included PubMed, Web of Science and Google Scholar. Key search terms included combinations of the following, 'southern rock lobster', 'disease', 'pests', climate change', 'disease surveillance', 'biosecurity' and 'legislation'. Peer-reviewed publications, current state and federal legislation and policy and other relevant grey literature were also reviewed. The reference lists of key documents were examined to identify additional relevant literature for inclusion in the review.

## 2. Stakeholder consultation

Consultation with key stakeholders was conducted to understand biosecurity and vulnerabilities across the industry.

A semi-structured questionnaire was developed to enable identification and documentation of key information covering a number of thematic areas including:

- Biosecurity
- Disease threats
- Pests
- Climate change impacts
- Market access and food safety
- Disease surveillance and monitoring
- Key policy and legislation
- Emergency response.

Table 2 outlines the stakeholders interviewed for this project. They included a range of individuals from industry, government and research institutes. The list was developed in consultation with Southern Rocklobster Limited.

*Table 2: Stakeholder interview list.*

| Affiliation | Name | Role |
|---|---|---|
| **Southern Rocklobster Limited** | Iain Evan | Chairman |
| **Department of Agriculture, Fisheries and Forestry** | Shelly Alderman | Export and Veterinary Division, DAFF |
| | Yuko Hood | Principle Science Officer (Aquatic Pest and Health Policy Section \| Animal Health Policy Branch) |
| | Lisa McKenzie | Export and Veterinary Division, DAFF |
| **Department of Natural Resources and Environment, Tasmania** | Kevin de Witte | Chief Veterinary Officer |
| | Emma Watkins | Deputy Chief Veterinary Officer |
| | Sonja Hempel | Principle Fisheries Management Officer (crustaceans & scallop fisheries) |

| | | |
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| | Holly Rickards | Fisheries Management Officer |
| **Department of Primary Industries and Regions, South Australia** | Giverny Rodgers | Principle Biosecurity Officer, Weeds and Pests |
| | Matt Bansemer | Aquatic Animal Health Manager |
| **Agriculture Victoria** | Tracey Bradley | Principle Veterinary Officer |
| **IMAS and University of Tasmania** | Alison Turnbull | Senior Research Fellow at the Institute for Marine and Antarctic Studies |
| **Adelaide University** | Charles Caraguel | Associate Professor in Veterinary Epidemiology |

## 3. Fore sighting analysis for the SRL industry

This section used fore sighting analysis to identify and highlight biosecurity and other emerging issues that are likely to be encountered by the SRL industry over the next 5 to 10 years and beyond. This involved categorising drivers for future change in the industry covering five different domains: social, technological, economic, environmental and political and regulatory factors.

Five different future biosecurity scenarios were then evaluated to understand threats that are likely to impact the industry and management solutions for these threats. These scenarios were developed based on current literature and stakeholder discussions.

## 4. Identification of key biosecurity threats, barriers/impediments and solutions

Findings from the literature review, stakeholder consultation and fore sighting analysis were used to identify key biosecurity threats for the industry, and barriers/impediments and solutions to deal with those biosecurity threats. These are presented in this section in the body of the report.

# Results, Discussion and Conclusion

## *1. Literature review of emerging and possible biosecurity threats in the SRL industry - Summary*

The literature review provides a thorough summary of key biosecurity threats and associated issues. The main findings are presented here in bullet point form and the complete literature review is presented in Appendix 2.

### Overview

- Lobster fisheries hold economic, social and cultural importance in Australia (Plagányi et al., 2018). It is an economically valuable fishery that generates gross revenue typically over AUD$200 million annually (Leon et al., 2020).
- Wild SRL are commercially harvested along the southern coastal waters and are considered a single biological stock, having a continuous distribution across this geographic range (Figure 1). They are classified as a sustainable stock in Australia.
- Management of the fishery is primarily state based with the use of various approaches to manage the population, including catch quota management systems, closed seasons, pot and boat limits and lobster size limits (Leon et al., 2020; PIRSA, 2020).

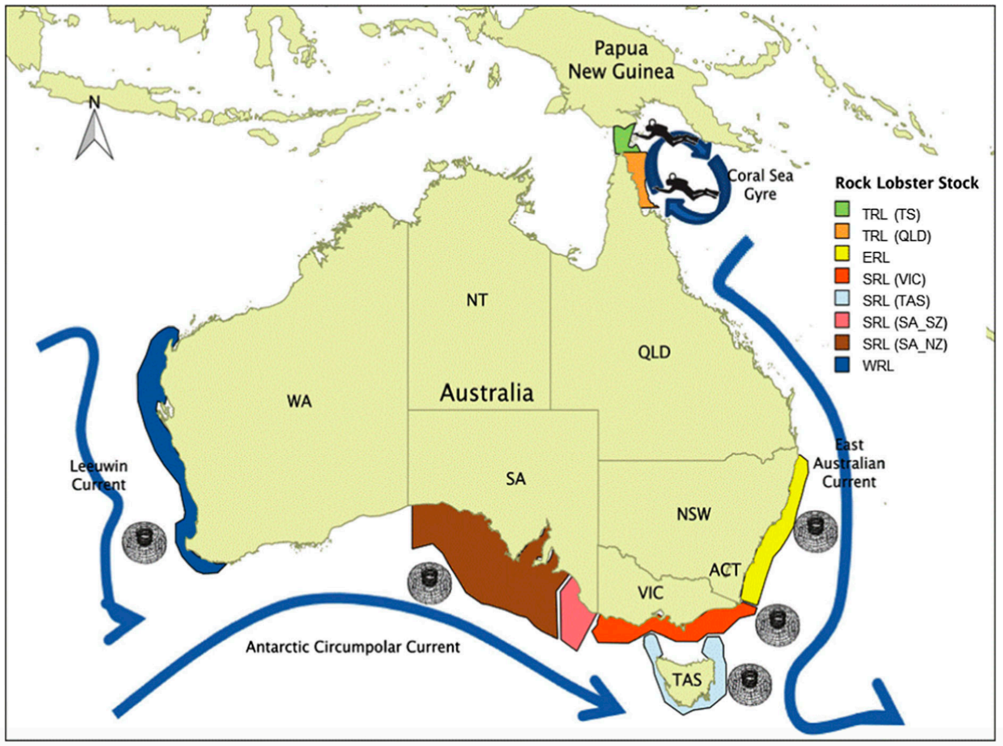
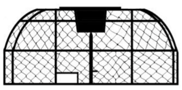



*Figure 1: Map of Australia illustrating geographic locations of the eight main Australian lobster fisheries, taken from Plaganyi et al. (2018); TRL: Tropical Rock Lobster; ERL: Eastern Rock Lobster; SRL: Southern Rock Lobster; WRL: Western Rock Lobster.*

## Supply chain and disease introduction pathways

- To identify biosecurity threats, it is important to understand the supply chain and the potential pathways for risks such as disease or marine pests. The relevant stages along the supply chain for this project are presented in Table 3, highlighting the key biosecurity and management risks.
- Lobster diseases can be transmitted via different routes including direct contact with other lobsters, through sea water and contaminated fishing equipment (Behringer et al., 2006).

*Table 3: Relevant stages of supply chain and key biosecurity risks for Southern Rock Lobster in Australia.*

| Stage | Location | Key biosecurity and management risks |
|---|---|---|
| **Pre-capture** | **Ocean activities**<br> | • Commercial fishing vessels<br>• Shipping<br>• Vessel biosecurity practices including ballast water and biofouling<br>• Recreational fishers<br>• Navigation buoys, marine floats<br>• Sea planes |
| | **Environment**<br> | • Habitat disturbances<br>• Marine pests<br>• Water quality<br>• Movement of other marine species<br>• Ocean currents |
| **Capture** | **Rock lobster pots**<br> | • Direct contact between lobsters and stress/immunocompromise<br>• Lobster aggregation from different locations<br>• Bait type<br>• Bait source<br>• Fishing methods and equipment |
| | **Live holding on ships**<br> | • Lobster aggregation from different locations<br>• Stocking density<br>• Handling stress<br>• Water systems i.e. re-circulation or flow-through and water discharge practices<br>• Vessel biosecurity practices<br>• Discarded lobsters |
| **Holding** | **Transport and grading**<br> | • Lobster aggregation<br>• Truck biosecurity practices<br>• Handling stress<br>• Management practices i.e. emersion, exposure to the elements i.e. sun, rain and changes in temperature<br>• Physical injury |
| | **Live holding facilities prior to market (domestic/export)**<br> | • Lobster aggregation from different locations and vessels<br>• Stocking density<br>• Tank conditions and water quality<br>• Handling and stress<br>• Water system i.e. re-circulation or flow-through<br>• Facility biosecurity practices |

## Relevant legislation and regulations

- There are both federal and state legislation and regulations that support and control the wild catch SRL industry. They focus on fishery management, biosecurity, trade and market access and emergency response.
- Biosecurity legislation has been deficient for fisheries and wild catch species, but this is changing with new biosecurity acts, starting at the Commonwealth level and then cascading down through states and territories.
- For example, South Australia is in the process of developing a new Biosecurity Act. It introduces a new framework and concepts to manage biosecurity, including a 'General Biosecurity Duty'. This involves a greater shared responsibility for managing biosecurity risks, and the need for proactive responsibility of fishers to contribute to biosecurity. Other states (e.g. QLD, NSW) have already implemented similar legislation, or are planning to do so.

## Trade, market access and food safety

- The SRL industry relies heavily on overseas export markets with a small domestic market (Figure 2). Recent trade obstacles and import restrictions in 2020 with China impacted Australia's largest export market. This highlighted the vulnerability of the industry to changes in export market requirements and reliance on a single market.
- There are a number of countries that are emerging as new spiny lobster producers, including Vietnam, Indonesia, Malaysia, Cambodia and Cuba (Phu et al., 2022; Tirtadanu et al., 2021). This will introduce new trade competition.
- Food safety concerns for SRL include Paralytic Shellfish Toxins (PST), heavy metal contamination (such as cadmium, mercury, copper and zinc) and vibriosis. Preventing illness is the most important approach to minimise public health risks (SafeFish: http://safefish.com.au) (Austin, 2010; McLeod et al., 2018). Improvements to cold chain management and traceability would support outbreak response (SafeFish, 2024).

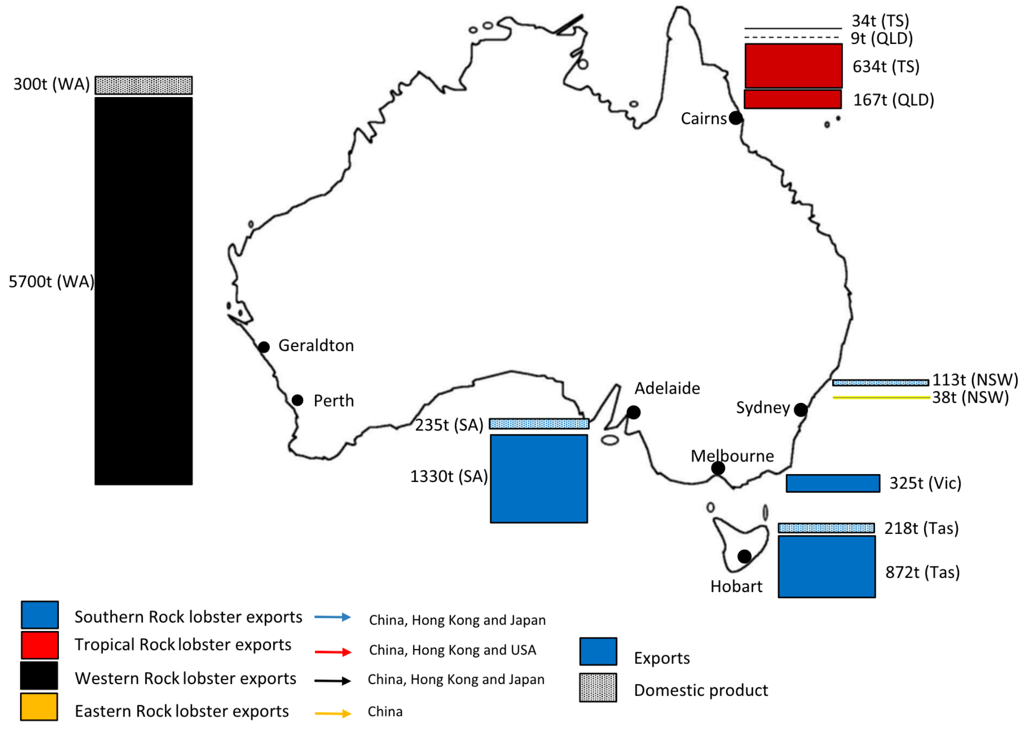



*Figure 2: Lobster exports and domestic production by state and lobster species, taken from Plaganyi et al. (2018).*

## Key diseases of concern for the industry

- Disease in the marine environment is often multifactorial, being influenced by environmental (e.g. salinity, temperature, season), host (e.g. susceptibility, size, sex), pathogen (e.g. virulence, transmission routes, infection dynamics) and anthropogenic factors (e.g. fishing effects, trap stress/injury) (Shields, 2012). Warming ocean temperatures and changing water quality are impacting lobster immune function, their resilience to different diseases and the ability of the organism to survive and transmit.
- Baseline disease information in SRL across Australia is relatively scarce, with limited passive and active disease surveillance. The causative agents of disease outbreaks in crustaceans are often unknown or unreported until it reaches onset of epizootic (Shields, 2012). This is a risk for the SRL fishery and market access as there are increasing demands from export destinations to demonstrate the disease status across a range of food and livestock products in Australia.
- White Spot Syndrome Virus (WSSV)
    - This virus has a wide host range and infects all decapod crustacean species including prawn, lobster, crab and crayfish (Oidtmann et al., 2018). It has not been documented in wild lobster populations (Shields, 2011). However, wild crustaceans typically exhibit subclinical infection, with no signs of disease, though it could have trade implications.
    - It has been detected in Australian prawns, both cultured and wild populations, in south-east Queensland (Nye et al., 2022). Additional outbreaks have occurred further south in New South Wales in 2022/23 but are not believed to be closely related to the Queensland strain (Hooper, 2023).
    - Surveillance in wild prawn populations has been conducted extensively across Australia to understand the distribution of WSSV and the risk it presents to SRL and other crustaceans (DAWE, 2020a). Wild prawn populations are distributed around Victoria and South Australia (ACPF, 2024).
- Harmful algal blooms (HABs) and biotoxins

    - HABs can produce a number of different biotoxins which can have human health impacts through seafood consumption. The primary concern for SRL is Paralytic Shellfish Toxin (PST).
    - The Australian Shellfish Quality Assurance Program (ASQAP) is a national program to support food safety of shellfish. This guides state and territory based biotoxin management plans.
    - Tasmania uses a monitoring program that focuses equally on mussel and phytoplankton sampling from targeted risk areas. Sentinel mussels have been shown to correlate well with PST uptake in SRL. South Australia and Victoria focus on detection of toxic phytoplankton during routine monitoring in shellfish harvesting areas to trigger testing of shellfish for biotoxins.
    - There are limitations to these management plans. In Tasmania, only the east coast undergoes monitoring. In South Australia and Victoria, surveillance is only conducted on commercial shellfish where they are harvested or grown. This limits the geographic distribution of monitoring, with some lobster fisheries not captured in surveillance e.g. there are some areas where lobsters are caught but mussels are not harvested, resulting in minimal effective monitoring in these areas. For example, south-eastern South Australia, parts of Victoria (PIRSA, 2016).
- Vibriosis
    - Vibriosis is a disease caused by a type of bacteria from the genus Vibrio. There are a number of different vibrio species that can infect lobster, with several being zoonotic (e.g. cause food poisoning like disease). They are ubiquitous in the marine environment, typically causing disease when lobster have a compromised immune system. Warming sea surface temperatures are resulting in increased prevalence of *Vibrio* spp. (Harrison et al., 2022).
- Other exotic and emerging diseases
    - There are a number of exotic and emerging diseases threatening lobsters globally (Shields, 2011). For many of them, understanding around susceptibility of *Jasus edwardsii* to infection is unknown. Further research is needed to understand distribution, prevalence and ability for SRL to become infected.
    - These include *Panulirus argus* virus 1 (PaV1), Milky Haemolymph Disease (MHD), various shell diseases such as Epizootic Shell Disease and Tail Fan Necrosis (Jones et al., 2024; Zha et al., 2019, 2018) and parasites such as Microsporidia (Shields, 2011; Stentiford et al., 2016).

## Invasive marine pests impacting the industry

- Marine pests can devastate the aquatic environment through habitat destruction, competition, localised extinction of native species, introduction of diseases and parasites, reduce biodiversity and have negative consequences on fishing and tourism (Williams et al., 2023).
- Risk pathways for introduction can include (but not limited to) (MPSC, 2020a):
    - Vessels i.e. commercial, shipping, recreational, cruises etc.
    - Fishery practices i.e. contaminated fishing equipment, bait, discarded product etc.
    - Recreational equipment
    - Marine debris
    - Navigation buoys and marine floats.
- Key marine pests and species that have undergone range extension that are recognised as significant in Australia include the Longspined Sea Urchin (*Centrostephanus rodgersii*), Wakame *(Undaria pinnatifida)*, carpet sea squirt (*Didemnum vexillum*) and the Eastern Rock Lobster (*Sagmariasus verreauxi*).
- The Longspined Sea Urchin is considered a native of mainland Australia. However, due to climate change and warming waters along the east coast, it has undergone a range extension down to the east coast of Tasmania, where it is considered a pest (IMAS, 2023).

- Wakame is already established in Australia, and is present in South Australia, Victoria and Tasmania. It has a high tolerance to changes in water temperature and the ability to thrive in disturbed environments (South et al., 2017).
- The carpet sea squirt has been reported in NSW and was detected for the first time in Western Australia early 2023 (DPIRD, 2023). It is essential that ongoing surveillance is conducted to implement immediate strategies to prevent further spread or establishment in southern Australian states.
- The Eastern Rock Lobster is considered a sustainable species in NSW. However, it has continued to move southward and along the south coast of Australia due to warming sea temperatures. It is now a recognised pest in Victoria (Seafood Industry Victoria, 2022) and has been detected as far west as the northern zone rock lobster fishery of South Australia (Linnane et al., 2023). This presents competition for resources with SRL and has potential implications if hybridisation were to occur (Syafaat et al., 2023).

## Climate change

- Climate change is greatly impacting the future of fisheries catches, profitability, industry sustainability and food security (van Putten et al., 2016). Climate variability, increasing sea temperatures, changing ocean currents and acidification of marine environments are just a few of the changes being experienced in the marine environment.
- South-eastern Australia is considered one of the fastest warming coastal areas in the southern hemisphere. It is warming three to four times faster than the global average, primarily due to changing ocean currents (Hinojosa et al., 2015; Hobday and Pecl, 2014).
- Temperature greatly impacts lobster physiological and immunological responses to microbial pathogens and parasites. Factors such as moulting, maturation, respiration and immune function can all be negatively impacted (Shields, 2019).
- Many marine species are moving poleward to cooler waters and finding new settlement areas (Tepker et al., 2023). Range shifts have the potential to push species outside of their typically fished areas, impacting yearly catches. A greater understanding is needed to predict potential new habitat areas. Tepker et al. (2023) suggests that with the southern movement of *J. edwardsii*, there will likely be a decrease in suitable habitat locations within the jurisdictions of South Australia, with Victoria and Tasmania predicted to contain high concentrations of suitable habitat locations.

## Emergency Response in the wild catch industry

- A marine aquatic biosecurity incident will mostly likely be triggered by an emergency aquatic disease or the detection of an invasive marine species. Responsibility for managing a response lies at the State and Territory level, with Commonwealth assistance if needed (for example through management committees and cost sharing, though cost sharing is limited for marine fisheries).
- There are two key resources to support these different incidents:
    - The Australian Aquatic Veterinary Emergency Plan (AQUAVETPLAN) provides a foundation document for an emergency response for an aquatic animal disease incursion
    - The Emergency Marine Pest Plan (EMPPlan) for invasive marine pests.
- More details for emergency responses are provided in Appendix 3.

# 2. Stakeholder consultation

A summary of the key findings from stakeholder interviews are presented below in Tables 4 – 10. They outline the key topic areas that were discussed and highlight major findings.

*Table 4: Drivers of biosecurity threats for the Southern Rock Lobster industry identified during stakeholder interviews.*

| Topic | Comments |
|---|---|
| **Climate change** | • Already impacting the SRL industry.<br>• Species and disease redistribution and movement (e.g. WSSV and Eastern Rock Lobster).<br>• Concern around species redistribution and the potential for hybridization between species, such as the SRL and the tropical rock lobster. |
| **Risk introduction pathways** | • Vessel movements and biosecurity practices.<br>• Commercial shipping (international and domestic), recreational fishers<br>• Ballast water.<br>• Biofouling, hull fouling – e.g. contaminated equipment or anchor line<br>• Holding tanks on vessels and water discharge.<br>• Onshore processors mixing lobsters from different areas and fishers. Risk of disease outbreak as some animals may be naïve to endemic diseases and stressed.<br>• Bait used by commercial or recreational fishers.<br>• Variability between boats. Smaller boats hold smaller numbers of lobster and typically remain in their local area. Large boats can receive more stock and cover greater fishing areas.<br>• Interstate imports – Under the LMRMA 1995 and the Fisheries (Rock Lobster) Rules 2022 in Tasmania, rock lobster of the genus *Jasus* and *Sagmariasus* may be imported, as long as they meet import requirements. The genus *Panulirus* is exempt from the Tasmanian rock lobster fishery rules.<br>• Changing currents in eastern Australia and Leeuwin current.<br>• Lobster imports. |
| **Biosecurity actions and compliance** | • There are limitations on being able to check compliance with vessels around cleaning and other biosecurity practices.<br>• Ideal biosecurity practices include good vessel and equipment hygiene, implement a biofouling management plan, during closed seasons take vessels out for drying, community education around marine pests to support surveillance.<br>• Minimise vessel movements. |
| **Harmful algal blooms and PST** | • HABs occurs across southern Australia. However, Tasmania has experienced the most notable human health impacts from PST.<br>• In South Australia, in western parts of the state, environmental conditions are more conducive to HABs as there are more sheltered bays. In southeast of the state, it more difficult for HABs to form, as they are broken up by the rough ocean conditions.<br>• HABs and PST surveillance programs have been implemented according to national quality assurance standards. In Tasmania, monitoring is focussed on shellfish and phytoplankton, with sampling sites located along the east coast. There are large areas, such as the west coast, that are not monitored and the distribution of HABs are unknown. |

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|---|---|
| | • South Australia and Victoria focus their surveillance on identifying toxic species in water samples, rather than monitoring bivalves. Tasmania uses bivalves as sentinel species to trigger sampling in SRL.<br>• Public education around food preparation and consumption is important (e.g. discard hepatopancreas).<br>• Monitoring is performed for PST and does not include other types of biotoxins e.g. diarrhetic and amnesic.<br>• Mussel production areas across Victoria, South Australia and Tasmania do not always align with SRL fishing areas. This has implications for disease surveillance and testing (i.e. gaps).<br>• A risk assessment is needed on the impacts of harmful algal blooms on SRL and gaps in current surveillance system and how best to risk mitigate these.<br>• Testing of lobster and mussels can be difficult due to the remote monitoring sites. It is also an expensive process and there are limited laboratories that can perform testing e.g. Symbio Laboratories in NSW and Analytical Services Tasmania. |
| **SRL capture methods** | • In some cases, when small lobsters are captured in pots, they will be left in the ocean to continue to grow until large enough for harvesting. This results in varying stocking density, and stressful conditions that could result in injury or disease.<br>• Lobsters are also required to be held at processing facilities onshore as part of the supply chain (i.e. aggregation). This has similar effects, but also results in a loss of traceability. |
| **Translocation programs** | • Some states, including Tasmania, have implemented a translocation program for SRL. Lobster in the southwest are taken to the east coast, to improve the population. This presents a potential biosecurity risk with lobster of unknown health status and vessels moving between different areas. |

*Table 5: Diseases of concern to the Southern Rock Lobster industry identified during stakeholder interviews.*

| **Topic** | **Comments** |
|---|---|
| **Diseases of concern** | • White Spot Syndrome Virus.<br>• Shell diseases in general. |
| **Emerging diseases** | • Vibriosis.<br>• Milky Muscle Disease.<br>• Microsporidiosis. |
| **Surveillance** | • Passive surveillance is the primary method for disease surveillance in the SRL industry. It may not be very sensitive and could be improved.<br>• For example, there are very few samples submitted for laboratory testing from the SRL industry and there is limited baseline information.<br>• Water quality monitoring is performed for HAB.<br>• Active surveillance isn't really done. |
| **Proof of freedom** | • As a result, Australia is limited in their ability to prove disease freedom from a number of lobster diseases. Trading partners will likely begin to ask for this information in the coming years. Industry could consider improving this in order to get ahead of these requests and collect baseline health data. |

*Table 6: Invasive marine pests of concern to the Southern Rock Lobster industry identified during stakeholder interviews.*

| Topic | Comments |
|---|---|
| **Marine pests of concern** | • Longspined Sea Urchin.<br>• Wakame.<br>• Carpet Sea Squirt. |
| **Pest management** | • Community education around reporting exotic species (e.g. use of RedMAP).<br>• Improving processes and legislation around water cleaning. Implementing a more risk-based assessment for permit applications.<br>• There is a *Centrostephanus* management plan in Tasmania. |
| **Surveillance** | • Passive surveillance is the most common method.<br>• Promote the use of RedMAP – Range Extension Database and Mapping project – Australia wide system to report marine species that are 'uncommon' in their local area. |

*Table 7: Comments on legislation and regulations relating to Southern Rock Lobster reported during stakeholder interviews.*

| Topic | Comments |
|---|---|
| **Response powers** | • Powers exist under state legislation to support a response. Both fisheries and biosecurity legislation will need to be enacted during a response. |
| **Marine pests** | • Fall under the fisheries management act which deals with preventing release and possession of noxious and exotic species. |
| **Compliance with legislation** | • Newly developed legislation for biosecurity puts responsibility on the fishers to manage their biosecurity risk. Some concern about how this can be managed and how compliance will be monitored. |
| **New legislation** | • In general, all jurisdictions are introducing or have already introduced new Biosecurity acts to modernise legislation and match Commonwealth Biosecurity Act 2015.<br>• In general, the new Biosecurity Acts introduce a 'General biosecurity duty'. For example, the South Australia, the new Biosecurity Bill states:<br><br>'A person has a duty (the general biosecurity duty) to take, so far as is reasonably practicable, measures to prevent, eliminate, minimise, control or manage a biosecurity risk when dealing with biosecurity matter, or a carrier, if the person knows or reasonably ought to know that the biosecurity matter, carrier or dealing poses a biosecurity risk' (PIRSA, 2023a). |
| **HABs and biotoxins** | • Involves three different departments including fisheries, marine resources and primary industry and human health.<br>• Falls under the Marine Resources Act in Tasmania.<br>• A review is needed to incorporate PST into food security legislation. |

*Table 8: Emergency response strategy and structure reported during stakeholder interviews.*

| Topic | Comments |
|---|---|
| **Response structure** | • Most likely a state-based response, with commonwealth assistance if requested (e.g. through the Aquatic Consultative Committee on Emergency Animal Diseases (AqCCEAD) and higher committees).<br>• Australasian Inter-Service Incident Management System (AIIMS) or Biosecurity Incident Management System (BIMS) framework with an Incident Management Team.<br>• Plans would be developed under a state structure, including emergency response plan.<br>• AQUAVETPLAN would guide a disease response. There is only one relevant disease specific plan for lobsters, which is WSSV. It has good principles that can be adapted to the wild catch industry and other diseases. There are several other plans of relevance for general operations. States are not obligated to use AQUAVETPLAN documents.<br>• Industry are not signatories of a cost sharing agreement e.g. the Emergency Animal Disease Response Agreement (EADRA). This limits industry involvement during a response. There will likely be no formal compensation pathway and control funding may be state based. Ad hoc funding deals may occur with the Commonwealth. |
| **Primary steps for a SRL response** | • The focus will initially be containment and delineation of the outbreak, followed by an assessment for eradication feasibility.<br>• Close affected and at-risk fishing areas.<br>• Movement restrictions for vessels, equipment and product.<br>• Ensure effective communication to both commercial fishers, recreational fishers and the public.<br>• For HAB, identify natural and physical barriers that will help to contain the outbreak such as large sandy beaches, coastlines with limited movement. |
| **Marine pests** | • Government and stakeholders would be consulted, followed by development of a response plan with the Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) informed.<br>• For marine pests, there is the National Environmental Biosecurity Response Agreement (NEBRA) which may be accessed for a major new pest.<br>• State would work with the industry and use contractors to support the response i.e. fishers, divers, consultancies (e.g. inspections and cleaning). They would require industry expertise and consultation. |
| **Vessel monitoring system** | • Vessel movements are important to monitor. In the event of an outbreak, traceability will be essential. In Tasmania for example, a vessel monitoring system is in place for compliance purposes under the Fisheries Rules 2019. Data can support back tracing activities.<br>• Lobster are primarily identified based on the area that they were harvested, not at the individual level. Once with onshore processors, lobsters are mixed during the grading process. This combines animals from different fishers into tanks, making it challenging to trace individual lobster from pot to plate. |
| **Industry involvement** | • The government would need to coordinate with the industry for their expertise and skills. Surveillance and sampling activities will require the support of the fishers. |

*Table 9: Trade and market access threats reported during stakeholder interviews.*

| Topic | Comments |
|---|---|
| **International export trade** | • Some markets are more sensitive to changes and have more import requirements.<br>• A better understanding of lobster diseases is needed in Australia. Understanding the distribution of endemic diseases and the ability to demonstrate proof of freedom is essential. This may be requested by trading partners at any time. |
| **Market diversification** | • Reliance on few markets, diversification is needed. |
| **Food safety** | • More frequent biotoxin outbreaks pose a threat to export markets (both domestic and international).<br>• Heavy metals and other residues such as cadmium. |
| **Live export** | • Heavy reliance on live export market.<br>• Some parts of the supply chain lack infrastructure for frozen product exports. |
| **Data** | • Need a database with baseline disease and biosecurity information for lobsters in Australia. This would support proof of freedom and provide information on endemic diseases. This may be requested by our export market. |

*Table 10: Other industry and biosecurity threats to the Southern Rock Lobster industry identified during stakeholder interviews.*

| Topic | Comments |
|---|---|
| **Lobster welfare** | • Live exports and euthanasia methods. |
| **Adaptations to climate change** | • Requirements to reduce carbon emissions and change to renewable energies.<br>• Infrastructure costs for renewable energies.<br>• Retro-fitting vessels is expensive. |
| **Reduced access to ocean** | There continues to be substantial pressure on the marine environment. This is reducing spatial access for fisheries. Increased use of ocean for:<br>- Recreational actives<br>- Infrastructure such as offshore windfarms (which would include an exclusion zone around the farm)<br>- New areas declared as marine reserves. |
| **Data** | • Baseline data needs to be collected on biosecurity and surveillance.<br>• Industry discussions are needed around data sharing so support the fishery. |

# 3. Fore sighting analysis for the SRL industry

Drivers for future change and threats were identified, covering five different domains: social, technological, economic, environmental and political and regulatory factors. These are outlined in Table 11.

Fore sighting has been used to evaluate five different future biosecurity scenarios that are relevant for the SRL industry. Scenarios have been developed based on literature and stakeholder interviews to identify emerging threats. They aim to cover threats that are likely to impact the industry currently, within the next 5 years and 10 years and beyond. Refer to Table 12.

*Table 11: Driver mapping for the Southern Rock Lobster industry in Australia.*

| Category | Trend | Shock | Importance for domain |
|---|---|---|---|
| **Social** | Changing consumer demand. | Reduced consumer demand. | Changing consumer preference. |
| | Increased food safety awareness. | Product recall from contaminated SRL. | Public health and consumer trust in SRL products. |
| | Continued live export of SRL. | Market closure due to lack of public support for live exports. | Public support and social license. |
| | Recovery from COVID-19. | Another pandemic restricting fishing practices and trade markets. | Impact of pandemic on SRL fishery. |
| | Increasing support for climate change adaptations and industry sustainability. | Reduced product demand due to limited adaptations by the SRL industry. | Public support and social license. |
| | Improving animal welfare i.e. transport and euthanasia methods. | Market closure due to lack of public support for euthanasia methods. | Lobster welfare and supply chain management. |
| | Indigenous lobster catch for traditional and commercial purposes. | Negative impacts on indigenous fishers. | Supporting indigenous fishing practices and compliance with fishing regulations. |
| **Technological** | Climate change mitigation and adaptations to fishing practices e.g. vessels moving to renewable energies. | Industry restrictions on fishery without adaptations. | Supply chain adaptations. |
| | Domestic advancements in lobster aquaculture. | Aquaculture surpasses wild catch fishery and increases competition. | SRL industry sustainability. |
| **Economic** | Limited export markets. | Market closures. | Market diversification. |
| | Increasing costs of production. | Unsustainable fishery costs. | SRL industry sustainability. |
| | Advancements in lobster aquaculture overseas. | Reduced demand for Australian SRL. | Changing consumer preference. |

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| | Increasing trade restriction and export requirements.<br><br>Not signatories of a cost sharing agreement (e.g. EADRA). | Market closures.<br><br>Funding disputes during a disease outbreak, less optimal control and eradication programs. | Data to support market access e.g. disease surveillance.<br><br>Emergency response preparedness. |
| **Environment** | Climate change<br><br>Increasing risk of marine pests.<br><br>Increasing exotic and emerging disease risks.<br><br>Reduced access to fishing areas from e.g. offshore windfarms (which include an exclusion zone) and new areas declared as marine reserves.<br><br>Risk of product contamination e.g. heavy metals or biotoxins. | Extreme weather events.<br><br>Environmental damage from marine pests impacting SRL.<br><br>Increasing disease outbreaks restricting trade and impacting lobster health.<br><br>Restricted fishing areas impacting SRL catch and concentrated fishing activities in other areas resulting in increased biosecurity risks, such as disease introduction.<br><br>Product recall from contamination. | Climate-sensitive diseases and shifting lobster habitat ranges.<br><br>Impacts of marine pests on SRL.<br><br>Biosecurity, disease surveillance and emergency response infrastructure.<br><br>Operational challenges to fishing practices.<br><br>Public health and consumer trust in SRL products. |
| **Political and regulatory factors** | Geopolitical issues with trading partners<br><br>Maintaining a sustainable SRL population for exports. | Market closure.<br><br>Reduced SRL population closing fishing and exports. | Relationships and expanding market opportunities.<br><br>Meet regulatory requirements for export. |

## Scenario analysis

Five scenarios have been considered in Table 12. They have been developed to capture emerging threats to the SRL industry. They need consideration to ensure preparedness work is implemented to enable rapid and efficient response if these events are encountered. They have considered scenarios that are a current risk and those they may impact the industry over the next 5-10 years.

*Table 12: Future scenarios evaluated for the Southern Rock Lobster industry in Australia.*

| Scenario | Description | Management strategies required (including enablers and barriers) |
|---|---|---|
| **1** | Marine heat wave occurs in an area with no mussel production and no monitoring in South Australia. This results in a large HAB that contaminates lobsters, with human cases of PST reported. A large amount of product needs to be recalled due to limited traceability. | Immediate deployment of resources to assess the extent of the HAB and the industries at risk. The lack of HAB monitoring in some coastal areas of South Australia means there has been a delay in detection, leading to a more extensive spread and potential contamination of large amounts of product.<br><br>Implement emergency response protocols and closure of at-risk fishing areas and product movement.<br><br>Sampling and testing of SRL in at-risk areas and surrounding locations. There are established surveillance and testing methods for PST in SRL and bivalves. The industry has experienced fishers that can support sampling activities.<br><br>Traceability and product recall protocols enacted. There is no universal traceability system used across the industry which may reduce efficiency in product recall. More product than required may need to be recalled due to uncertainty around the original source. This will have greater economic implications.<br><br>Communication plan for public health advisory and with the industry. Liaise with export markets and DAFF regarding contamination risk. |
| **2** | Trading partner requests evidence of sanitary status of SRL. This includes data demonstrating the efficacy of passive and active surveillance systems to support disease freedom. | Need to implement a surveillance plan for SRL to collect data that can demonstrate disease freedom or to understand distribution and prevalence of endemic diseases. There is a severe lack of disease surveillance data for SRL in Australia.<br><br>Limited to no passive or active surveillance being conducted in SRL. |

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| | | Data sharing between states to support industry SRL disease status. There are currently no practices in place to share data between states or a centralised data reporting system.<br><br>Surveillance requires education of fishers and processors to submit dead or sick lobsters so diagnosis can occur. This also requires funding to pay for diagnostic testing and reporting from the laboratory. These are both barriers. |
| **3.** | WSSV is detected in exported SRL by a trading partner which leads to suspension of trade to this market. This country has endemic WSSV, so the ban may be questionable under the World Trade Organisation SPS Agreement principles unless the importing country also has a control program. However, discussions and negotiations at the national government level are required to resolve the issue. | The SRL industry will need to provide evidence demonstrating SRL WSSV status. This is not available as there has been little testing of dead or moribund lobsters along the supply chain.<br><br>A communication plan with DAFF to support discussions with the trading partner. This should highlight WTO SPS Agreement principles. Or if infection is absent in SRL fisheries, urgent collection of data that demonstrates the SRL fishery is free of WSSV.<br><br>DAFF will require surveillance data from the SRL industry.<br><br>Discuss the establishment of bilateral agreements or protocols to address WSSV and testing. |
| **4** | Warming sea temperatures cause a range shift in lobster habitat, and new areas for fishing need to be investigated and re-assessment of fishing permits. | Routinely perform population and habitat assessments to understand the distribution, suitability for lobster, access for fishing and what biosecurity threats are present.<br><br>Engagement with fishers and industry stakeholders to gather observations on lobster distribution and discuss decision-making approaches around potential new fishing areas and permit reassessment.<br><br>Collaborate with researchers to assess the SRL population to obtain accurate local level predictions to support fishers and inform catchability.<br><br>Understand new biosecurity risks in different areas.<br><br>Review and update of fishing regulations. This may require the establishment of new zones or spatial management to ensure the long-term sustainability of the industry. |

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| | | Promotion and transition to sustainable fishing practices. This may include incentives and support for the adoption of these practices. |
| **5** | A large area of coastline in the Apollo Bay region (Western Zone) in the Victoria Rock Lobster Fishery management zone is reclassified as marine reserve and fishing activities are no longer permitted in this region. This has resulted in more concentrated fishing activities in other parts of the Western Zone and other fishers are concerned about the increased biosecurity risk and the potential for disease introduction. | Review of available fishing grounds and conduct a risk assessment to understand key biosecurity threats and mitigation measures required.<br><br>Ensure all fishers and relevant stakeholders are implementing appropriate biosecurity measures. This will require training and education to ensure all personnel are up-to-date with the most recent biosecurity requirements and regulations, reporting processes for suspected disease cases and the steps required during an outbreak response.<br><br>Revise auditing and monitoring schedule of fishing vessels and diseases surveillance activities.<br><br>Collaborate with researchers to assess the SRL population to obtain accurate local level predictions to support fishers and inform catchability at alternative fishing grounds. A review of quota management may be required to regulate fishing areas and prevent overfishing in certain areas. It will also be important to assess the impact this will have on market supply and lobster prices.<br><br>Review and update of fishing regulations. This may require the establishment of new zones or spatial management to ensure the long-term sustainability of the industry. |

# *4. Identification of key biosecurity threats, barriers/impediments and solutions*

Table 13 summarises the preceding work and presents the major biosecurity threats to the SRL industry in future years. Impediments and solutions to the threats are also identified. We conclude this discussion with a section recommending some future strategic steps that could be recommended to improve biosecurity.

*Table 13: Key biosecurity and emerging threats for the Southern Rock Lobster industry.*

| **Emerging and possible biosecurity threat** | **Biosecurity threat** | **Drivers of threat** | **Management solutions** | **Barriers/impediments** |
|---|---|---|---|---|
| **Invasive species and infectious organisms** | Emerging diseases (e.g. Vibriosis, Milky Muscle Disease, Microsporidiosis or a new disease not considered).<br><br>Transboundary diseases (e.g. WSSV).<br><br>Invasive species (e.g. Wakame, Carpet Sea Squirt).<br><br>Species redistribution and competition or hybridisation (e.g. Eastern Rock Lobster, Longspined Sea Urchins).<br><br>Invasive and infectious organisms can have adverse impacts on lobster fisheries through: | Climate change (e.g. warming oceans) can support pathogen and marine pest survival and distribution.<br><br>Risk pathways<br><br>• Vessel movements (biofouling, ballast, water from holding tanks)<br>• Bait movement and purchase<br>• Moving and mixing lobsters<br>• Crustacean and lobster imports (within and into Australia).<br><br>Modest surveillance capability and implementation. | Greenhouse gas mitigations, realising that SRL industry can only assist indirectly through collective action. In-depth understanding of how climate change will impact industry.<br><br>Risk assessment of incursion pathways under SRL industry control (fishing vessel biosecurity and biosecurity at processors) and design risk mitigations. For example, traceability of lobsters, vessel hygiene, ensure legitimate bait supply.<br><br>Increase resilience of lobsters at fishery and processor level. At fishery level this includes sustainability practices associated | Globalisation is essential for Australians quality of life and shipping will continue with ongoing non-zero risk of introductions of invasive species/diseases. Future outbreaks are assured.<br><br>Cost of implementing biosecurity practices (e.g. vessel hygiene).<br><br>Supply chain practices where it is essential to aggregate and hold lobsters leading to infection transmission and immune compromise.<br><br>Small industry with limited resources for implementation |

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| | • Mass deaths and illness in populations from infection<br>• Competition for food or shelter from invasive species.<br>• Predation or habitat change from invasive species. | Impediments to emergency response (cost and responsibilities). | with appropriate harvesting and stocking. Enhance health of held lobsters through appropriate supply chains (e.g. storage, emersion etc).<br><br>Implement (for disease) or use (marine pests e.g. RedMAP) simple surveillance systems for early warning and to collect data to support trade. This will include education, and funding for diagnostic steps at laboratories). | of programs such as surveillance and cost sharing agreements. |
| **Harmful algal blooms and biotoxins** | Several toxins are produced by algal blooms that may have human health impacts through lobster consumptions:<br><br>• Paralytic Shellfish Toxin<br>• Diarrhetic Shellfish Toxin (DST)<br>• Amnesic Shellfish Toxin (AST)<br>• Neurotoxic Shellfish Toxin (NST).<br><br>PST is a concern for the lobster industry.<br><br>Organisms causing DST and AST are present in Australia and some have caused disease in mussels (e.g. pipis and DST). NST organisms have not been identified in | HAB range expansion driven by climatic and non-climatic factors including ocean warming, marine heatwaves, pollution and nutrient run-off. | There is a national quality assurance program for mussels implemented by individual states which manages risks of harmful algal blooms. Lobsters can benefit from early detection as bivalves that are monitored can function as a sentinel species/early warning system.<br><br>This is an effective program for mussels. Some heterogeneity in state implementation, for example Tasmania focuses on identification of toxic species of harmful algae and equally heavily on measuring toxins in bivalves. Other states are more focused on just toxic species identification with a lesser focus on toxins in bivalves. | The reliance on monitoring systems for mussels to inform human consumption does leave some gaps of relevance for lobster surveillance. For example there are geographical areas where lobsters are harvested but mussels are not, meaning there is little effective monitoring for lobsters in some areas. For example, western Tasmania, south-eastern South Australia, parts of Victoria.<br><br>Resources and costs of surveillance. Extending the quality of surveillance (e.g. more tissue toxin assessment) or extending geographic monitoring to non-mussel areas would incur a cost that government would likely seek |

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| | Australia (though similar organisms have been found).<br><br>See Hallegraeff et al. (2021) for more information.<br><br>Risk of an undetected event of PST or another toxin emerging and leading to food safety event (illness, product recalls, loss of markets). | | An assessment should be conducted to identify possible risks associated with these gaps (see right column). If these gaps are significant, then risk mitigations should be established (e.g. expanded monitoring systems focused on lobster). | to recover from the SRL industry.<br><br>Understanding and research on harmful algae in Australia – there is uncertainty of species of importance and distribution, role and potential impacts etc.<br><br>Ballast water from international shipping can introduce new and harmful species. |
| **Legislation and regulations** | Some current legislation is complex, diverse and not fit for purpose for marine biosecurity (aged legislation). Leads to adverse biosecurity implementation.<br><br>New legislation has a new requirement for a 'general biosecurity duty' which is an opportunity and a threat. An opportunity to improve practice, but a threat for individual fishers due to increased biosecurity compliance costs and penalties. | Traditionally the legislation for animal diseases has been designed for livestock. As a result, it has not focused holistically on relevant biosecurity and fisheries. This has meant gaps in legislation and regulations for SRL fisheries.<br><br>This has led to responses and responsibilities for biosecurity having sub-optimal implementation in the past, leading to increased biosecurity risks. | The Commonwealth and then gradually all states and territories have or are developing new biosecurity legislation that is fit for purpose. For example, the Commonwealth developed a new act in 2015, Tasmania developed a new act in 2019 and South Australia is writing a bill currently.<br><br>These acts will improve management of biosecurity and responses in marine environments. They all impose new general biosecurity duties, including on lobster fishers and processors.<br><br>Education (e.g. DAFF, 2020) and training for fishers and processors will ensure that these groups understand their responsibilities | Resources – e.g. time to undertake training and implement practical biosecurity practices (e.g. hygiene of vessels etc.). These will be a burden on industry, though the benefits will be reduced risk of biosecurity events. |

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| | | | and how to practically meet requirements. | |
| **Emergency response** | Responses to outbreaks are complicated by the practical and operational difficulties of eradication and control in the ocean environment. This can lead to poor ability to control biosecurity threats.<br><br>Lack of a cost sharing agreement between aquaculture/marine fisheries industries and governments. This may lead to underfunded outbreaks with poor consultation and suboptimal implementation. | This is in part due to the physical ocean environment in marine fisheries and is common to most marine ecosystems. It is hard to implement surveillance and control activities in an ocean environment, which limits effectiveness of eradication programs.<br><br>The absence of a cost sharing agreement for an aquatic disease outbreak. These systems are in place for livestock e.g. EADRA and marine pests e.g. NEBRA. This means that some governments e.g. Commonwealth will refuse to liaise with industry in the event of an outbreak and no compensation will be available for fishers with little money to support a response. | Southern Rocklobster Limited to contribute to a response through:<br><br>• Industry liaison roles at state disease coordinating and local control centres in the event of an outbreak<br>• Attempt to influence decision making nationally through lobbying members of appropriate committees (e.g. Chief Veterinary Officers).<br>• Apply for ad hoc funding (e.g. compensation) as and when possible<br>• Effective communication with industry and other relevant stakeholders<br>• Consider other options for cost sharing agreements in advance of an outbreak (i.e. outside of sector wide agreement). | The marine and aquatic fisheries and aquaculture industries are diverse and complex and very localised. This means that they all have different risks, sizes and capacity and capability to contribute to the costs of an emergency response. However, all will be responsible in the event of an emergency in one sector under a cost sharing agreement. This has meant the broader industry has not been able to come together and commit to a single unifying cost sharing deed with governments.<br><br>Lack of technology for underwater surveillance and disease control. |
| **Trade and market access** | Market access affected by biosecurity considerations. The risk is that there are sudden closures of markets for real our contrived biosecurity issues. | Geopolitics.<br><br>Requirement for evidence of disease freedom required by trading partners rather than accepting Australia’s word or quality of veterinary services.<br><br>Globalisation dispersing infectious and invasive organisms. | Design a fit for purpose disease surveillance system for the SRL industry.<br><br>• The aim would be to receive dozens of laboratory accessions each year in an ongoing fashion. These should be for dead or moribund lobsters from the supply chain. | Surveillance system would be an ongoing expense for industry.<br><br>Limited markets that can match China’s buying power makes it difficult to support other markets when the China market is going well. However, there |

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| | | Many near neighbours have a poor disease status relative to Australia. | • These lobsters should be screened for transboundary diseases of significance and should have appropriate pathology tests conducted to diagnose cause of illness (if relevant).<br>• Recording this in a central information system would enable the development of a data set documenting the health status of SRL which would support trade in the future.<br>• Would require both education of fishers, cooperation of government (laboratories) and resources (cash).<br><br>Traceability systems.<br><br>Quality assurance program.<br><br>Market diversification. | are issues when the China market closes.<br><br>Supply chain is structured for lobster aggregation, and traceability would require an individual animal identifier similar to livestock. This is expensive.<br><br>Quality assurance program would be an extra layer of administration beyond health certificates/Manual of Importing Country Requirements (MICOR). It would add to the administrative burden. |
| **Supply chain** | Disease outbreaks or product contamination e.g. PST, heavy metals in supply chain resulting in product recall and/or product loss. | Supply chain practices encourage disease emergence and outbreaks if there are infectious organisms of concern present. For example, aggregation of lobsters from diverse areas with different infection history, stressors leading to immune suppression and close high-density conditions for periods of time. | Incremental work to improve supply chain. For example, to understand risk factors, to identify improvements to supply chain and shorten time from harvest to sale in market.<br><br>Traceability systems.<br><br>Quality assurance program. | The supply chain necessarily leads to aggregation of lobsters for economies of scale and efficiency.<br><br>Enhancements require investment/cash in a small industry. |

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| | | These are classic conditions leading to disease emergence across a wide range of species (e.g. cattle in feedlots, salmon in cages, prawns in ponds etc.). | Investment in equipment that is fit for purpose and enhances lobster health and fitness. | |
| **Lobster aquaculture** | There are improvements to lobster aquaculture globally. If a viable aquaculture industry develops at scale this could threaten the SRL fishery. This could change the risk profile for Australian lobster fishers. | Intensive lobster aquaculture could lead to ample availability of cultured lobster that could. compete with Australian wild catch lobsters.<br><br>This could lead to the development of cultured lobsters in Australia and biosecurity risks due to intensive aquaculture near wild populations (for example abalone in Victoria and AVG).<br><br>This could lead to importation of lobster to Australia and incursion of infectious organisms into Australia (e.g. see shrimp imports and impacts on prawn farmers/fishers due to WSSV). | Southern Rocklobster Limited to keep a watching brief on these developments.<br><br>Provide technical support to regulatory authorities on biosecurity risks and mitigations. | Small industry with limited lobbying power and limited resources for work such as this.<br><br>Cheap and plentiful food is an objective of governments – meaning that imports may well be allowed in a future scenario. |
| **Environmental quality and habitat suitability** | Increasing impacts on ocean from a variety of activities can lower habitat quality and reduce lobster population health.<br><br>Lobster species are shifting habitat ranges due to climate | For example, increased human population leading to poorer water quality (e.g. land-based agriculture, sewerage, greenhouse gas emissions leading to changes to east coast water temperatures etc.). | Routine monitoring of lobster populations to detect issues.<br><br>Development of controls on land. | The SRL industry is a small player in the national economy and cannot directly or indirectly influence environmental quality or features affecting water quality. |

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| | change. New areas may pose different biosecurity threats. | | | |
| **Reduced access to fishing areas** | Reduced access to fishing areas due to e.g. offshore windfarms (which include an exclusion zone) and new areas declared as marine reserves resulting in concentrated fishing activities increasing biosecurity risks. | Increasing importance of environmental sustainability and the use of renewable energy sources. | Ongoing management of available fishing areas to monitor catch quotas, biosecurity risks, impacts on market supply and resource management, | Increasing shift towards the use of renewable energies and preservation of the ocean environment. |
| **Social license** | Whilst animal welfare is not a biosecurity issue, we thought it was worth listing.<br><br>Poor animal welfare, whether real or perceived will reduce social license to trade in overseas markets with live lobster. For example, whilst modern live exports of sheep and cattle have relatively good animal welfare, this trade has been identified for closure in coming years by the Commonwealth Government. | Social awareness of the Australian community. | Assessment of welfare of supply chain.<br><br>Science based and stepwise improvements to welfare practice in pragmatic and cost-efficient ways. Given the length of the supply chain, this is also likely to improve product quality. | Sometimes lobsters fall outside welfare Acts and regulations, or at least are not perceived to be an important species.<br><br>Uncertainty of welfare science in crustaceans.<br><br>Industry reluctance to open a ‘Pandoras box’. |

# Recommendations

Key recommendations and future work needed to better prepare the SRL industry for biosecurity threats and other emerging issues that require action are outlined below.

## Develop a disease surveillance plan to understand the health status of Southern Rock Lobster to support population health and market access.

We recommend the development of a disease surveillance plan for the SRL industry. There is limited disease surveillance being performed across the SRL supply chain and little baseline information is available on current SRL disease status in Australia. Disease surveillance in an important aspect of preparedness and early detection, to minimise the impacts of disease outbreaks. Moreover, by understanding disease risk, proactive biosecurity measures and other strategies can be implemented to support lobster health. Furthermore, this sort of information will be essential to support export markets in the future.

A surveillance plan would need to consider both active and passive disease surveillance approaches. Active surveillance activities generally consist of cross-sectional surveys, where samples are tested for the presence of different diseases. These surveys are repeated periodically to monitor changes in disease prevalence, understand what is driving disease and to understand impacts on the population.

Passive disease surveillance involves fishers on the frontline reporting observations or submitting samples for testing. This is a very important approach for the surveillance of diseases causing clinical signs. This is a lower cost surveillance method that provides a sustainable system to enhance active surveillance activities. This would include lobsters on fishing vessels and those at live holding facilities. Passive surveillance is very important in the detection of exotic and emerging diseases and understanding changes in disease distribution.

Both methods will be important as diseases vary in their presentation. For example with WSSV, SRL and other wild crustaceans typically experience subclinical infection. This results in fishers being unable to identify sick lobster. Education to support those involved in passive disease reporting will also be important (e.g. who to ring and send samples to, recording data etc.).

A risk assessment will also support identification of other marine species that need to be considered in the surveillance plan to inform the health status of SRL. For example, wild prawns in the geographic area of SRL fishing areas would be important to target in surveillance, to understand the risk of infection for WSSV.

## Develop a biosecurity plan that provides comprehensive strategy and protocols for both vessels and live holding facilities.

We recommend the development of a biosecurity plan for the SRL industry. It will be informed in part by recommendation one and this report. A comprehensive strategy and protocols factoring in key components of the supply chain, including vessels and live holding facilities are essential for ongoing health of SRL and sustainability of the industry.

## Improve biosecurity planning by individual fishers and a quality assurance scheme to support new biosecurity legislation. This will require stakeholder engagement and education to maintain high biosecurity standards and limit disease and marine pest risk.

New biosecurity legislation is placing the onus of responsibility for biosecurity on fishers. There are increasing demands from trading partners for evidence of good biosecurity practices and food safety.

It is recommended that all fishers implement an individual biosecurity plan (for example including an annual biosecurity vessel audit). This is to document compliance against biosecurity requirements, other legislative requirements, environmental compliance and identify any at-risk management practices that may pose a biosecurity threat. This could be similar in principle to the livestock production assurance scheme administered by the Integrity Systems Company to which all red meat producers adhere where there are farm biosecurity plans and documentation.

This activity will require stakeholder engagement and education, to support the industry in maintaining high biosecurity standards to limit disease and marine pest risks. But could comprise the core of a quality assurance scheme. The schemes do not have to be onerous.

## Conduct risk assessments along the coastal waters of Victoria, South Australia and west coast of Tasmania to understand HAB and toxin (e.g. PST) risks. This is to support the need for regular mussel and lobster monitoring in other regions that are not currently under surveillance.

Tasmania has a well-established Biotoxin Management plan following toxic blooms from *Alexandrium tamarense* over the past decade. It involves surveillance of sentinel mussels and phytoplankton to support surveillance decisions in SRL. Mussel sentinel lines have been shown as effective in indicating risk of elevated PST in lobsters.

To support the need for regular mussel and lobster monitoring in other regions, we recommend that risk assessments are conducted along the coastal waters of South Australia, Victoria and western Tasmania. Monitoring and testing of lobster can be costly, thus it is important to understand the needs across these different regions. Warming ocean temperatures are making the emergence of HAB more unpredictable, with high-risk seasons not as consistent. Moreover, as water temperatures change, different areas become more suitable for the emergence of HAB. There are also several other possible biotoxins from HAB. Such an assessment could include other toxins of relevance.

It is important to note that the use of sentinel bivalves won’t be appropriate for all areas as mussel production regions don’t always align with SRL fishing areas.

## Improve biosecurity response preparedness for the Southern Rock Lobster industry by understanding the response structures, key roles and responsibilities, operational and management needs and resource requirements.

Please refer to Appendix 3. This section outlines gaps and areas for improvement to support the SRL industry in the event of an emergency response.

# Extension and Adoption

The extension and adoption of project findings are crucial for disseminating knowledge, supporting decision-making and identifying practical applications to support industry. This work has been presented to Southern Rocklobster Limited and will also be presented at the upcoming Biosecurity Symposium in August 2024 and the Seafood Directions Conference in September 2024.

To support further extension, the findings will be presented to the next Southern Rocklobster Limited Industry Partnership Agreement meeting. This presentation will be accompanied by a one-page summary document highlighting the key findings of the report (Appendix 4).

# Appendices

# Appendix 1 – References


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# Appendix 2 – Complete literature review

## Overview

The Southern Rock Lobster (SRL) industry in Australia operates primarily in South Australia, Victoria and Tasmania (Figure 1). Lobster fisheries hold economic, social and cultural importance in Australia (Plagányi et al., 2018). It is an economically valuable fishery that generates gross revenue typically over AUD$200 million annually (Leon et al., 2020). Wild SRL are commercially harvested along the southern coastal waters and are considered a single biological stock, having a continuous distribution across this geographic range. They are classified as a sustainable stock in Australia. SRL are generally found in water depths of approximately 1 to 200m and depend on reef habitat for shelter and food availability (Linnane et al., 2019).

Management of the fishery is primarily state based with the use of various approaches to manage the population, including catch quota management systems, closed seasons, pot and boat limits and lobster size limits (Leon et al., 2020; PIRSA, 2020). Commercial fishing areas have been divided into different production zones, which can be seen below (Figures 3, 4 and 5). These are primarily based on SRL stock and habitat availability (PIRSA, 2020). This also allows different management approaches to be applied to the different zones to support population sustainability and to manage other factors such as disease and marine pests.

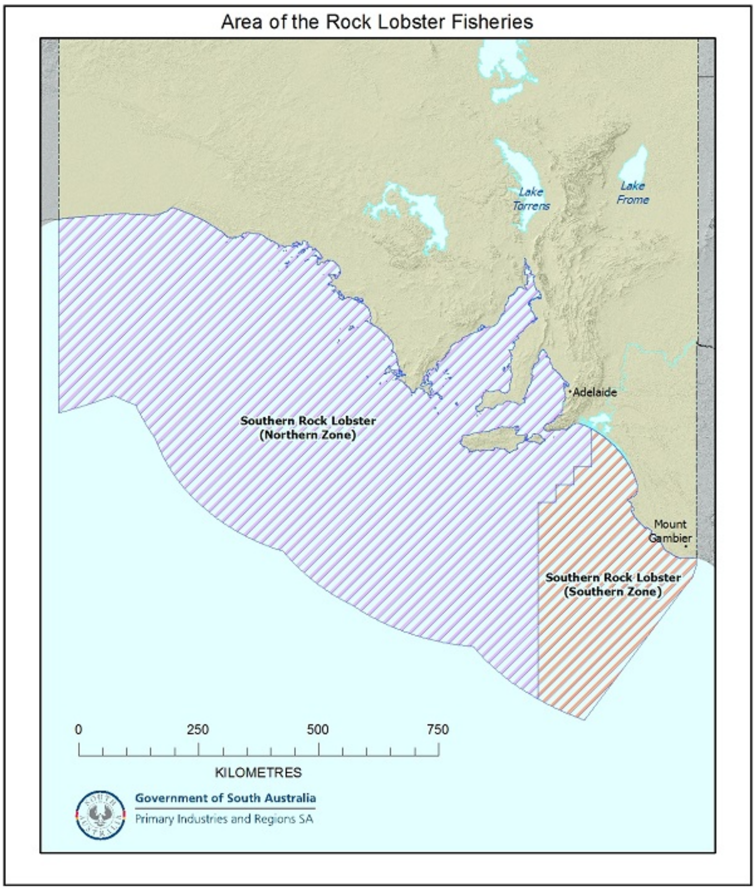


*Figure 3: South Australia Southern Rock Lobster fishing zones (PIRSA, 2023b).*


*Figure 4: Extent and spatial structure of the Victorian Rock Lobster Fishery (VFA, 2017a).*


*Figure 5: Southern Rock Lobster fishing, zones in Tasmania (Tasmanian Government, 2021).*

## Supply chain and disease introduction pathways

The SRL supply chain from Australia is typically focussed on live seafood markets in Asia (Turnbull et al., 2021b). To understand biosecurity threats, it is important to understand the supply chain and the potential pathways for risks such as disease or marine pests. The relevant stages along the supply chain for this project are presented in Table 3, highlighting the key biosecurity and management risks. Lobster diseases can be transmitted via different routes including direct contact with other lobsters, through sea water and contaminated fishing equipment (Behringer et al., 2006).

As an example, important biosecurity risks occur at aggregation points of lobsters along the commercial supply chain. These occur in baited pots for capture, temporary storage at sea in pots, wet storage on vessels and at onshore live holding facilities. SRL from different locations mix together presenting a risk for outbreaks of endemic or exotic diseases as there will be varying immunity to diseases in mixed lobster that come from different areas. There are a number of documented cases where stressful conditions have led to immune compromise and expression of disease such as mortality from a number of organisms (Fitzgibbon et al., 2019; Radhakrishnan and Kizhakudan, 2019). In general, there are limited disease outbreak reports in lobster, possibly because they are relatively resilient animals (Shields 2011), but also possibly because there is minimal active surveillance.

Post-harvest mortality results in significant economic loss. Studies have shown that lobster have difficulty recovering from stressful post-harvest practices. These result in metabolic stress and leave the animal vulnerable to infection or other opportunistic pathogens. There are a number of stressors along the supply chain including injury, limb loss, emersion, changing water quality, handling and periods of fasting during transport and holding (Day et al., 2019).

Traceability in the SRL supply chain is useful to ensure food safety and imperative for an efficient and timely response to be enacted during a disease outbreak, both for lobster and zoonotic diseases. Various methods have been investigated, both at the batch and individual level, but no universal approach has been adopted across the industry (Bonney et al., 2019; Vo, 2021). None have been completely successful as once lobsters arrive at holding facilities, new animals are typically mixed with existing stock from different origins. This is to maximise holding capacity and ease of management. However, this limits the ability to back trace animals along the supply chain (Patel et al., 2020). A framework for the industry and a number of digital tools and techniques have been developed to support traceability at different levels along the supply chain (Bonney et al., 2019).

## Relevant legislation and regulations

There are both federal and state legislation and regulations that support the wild catch SRL industry. Table 13 outlines the key legal instruments on a national level and for each state. They focus on fishery management, biosecurity, trade and market access and emergency response.

The management of SRL populations are essential as the Commonwealth Department requires all commercial fisheries that export product to be assessed against the Environment Protection and Biodiversity Conservation Act 1999. The commodity needs to be deemed as being managed in an ecologically sustainable way to gain export approval. For example, South Australia was assessed in 2015 and was granted export approval for a period of 10 years to 2025 (Government of South Australia, 2021). This is an evaluation and assessment that is ongoing. Literature supports the need for conservative Total Allowable Commercial Catch (TACCs) to protect existing biomass and sustain resources for rock lobsters (Linnane et al., 2010).

In 2021, Australia released new agricultural export legislation. The Export Control Act 2020 and the Export Control (Fish and Fish Products) Rules 2021 are of relevance to the SRL industry. The Export Control (Fish and Fish Products) Rules outline requirements for registered establishments, which include fishing vessels and live lobster holding facilities. They must have suitable construction, equipment, work practices and food safety systems (DAFF, 2023a). This aligns with the Manual of Importing Country Requirements (MICOR), where a number of countries will only receive exports from export-listed registered establishments (more information on MICOR is provided below). Under the Export Control Act 2020, an establishment is equivalent to a premises and fish and fish products are considered prescribed goods.

Biosecurity legislation has traditionally lacked consideration of fisheries and wild catch species, but this is changing with new biosecurity acts, starting at the Commonwealth level and then cascading down through states and territories. For example, currently in South Australia, there is no biosecurity act and the management of biosecurity events in fisheries requires application of several legislative instruments, none of which are perfectly suited (e.g. Fisheries Management Act 2007, Aquaculture Act 2001 and Livestock Act 1997). South Australia is in the process of developing a new Biosecurity Act which will replace the biosecurity functions in existing Acts. This process commenced in late 2022 and has involved extensive stakeholder consultation conducted by the Primarily Industries and Regions South Australia (PIRSA). The draft Biosecurity Bill integrates components from several Acts. It also introduces a new framework and concepts to manage biosecurity, including a 'General Biosecurity Duty'. This duty applies to everyone and involves a greater shared responsibility for managing biosecurity risks. This creates a proactive responsibility for fishers to contribute to biosecurity. For example, a practical example of this would be that fishers can no longer move biofouled boats between fishing areas, and instead would have a responsibility to clean the boat hull before moving.

Despite this, state fishery legislation currently covers requirements for a number of relevant areas, including management of noxious aquatic species or exotic aquatic disease, use of baits and the management of water disposal in which aquatic organisms have been kept. State fishery legislation has the ability to close fishing areas and restrict vessel and equipment movement, which is necessary during an emergency response. For example in Tasmania, the Living Marine Resources Management Act 1995 has the power to shut fisheries and stop fishing activities while the new Biosecurity Act 2019 can restrict vessel and product movement or enact an emergency response.

In terms of animal welfare, Victoria considers decapod crustaceans, including lobsters, in their welfare legislation (Prevention of Cruelty to Animals Act 1986). Tasmania does not include commercial fishing in relation to their animal cruelty legislation (Animal Welfare Act 1993), nor does SA (Animal Welfare Act 1985). This is relevant in terms of live export of lobsters and the euthanasia methods being used. Additionally, NSW, ACT, NT and QLD all consider lobsters in their welfare legislation to varying degrees.

Legislation aims to protect the livelihoods of traditional indigenous fishers and traditional owners are recognised as a stakeholder group entitled to special rights and access. Fishing requirements vary between state. In Victoria, indigenous fishers are exempt from holding a fishing license. In Tasmania, indigenous fishers much comply with recreational regulations, but are not required to hold a license. In South Australia, they are allocated a defined share of the TACC (Plagányi et al., 2018). Indigenous practices will need consideration during an emergency response.

It is important to note that once SRL have been harvested and being handled by food processors, they fall under the relevant Biosecurity and Livestock Act. Additionally, there are a number of federal and state regulations associated with food safety and public health that need to be abided by.

*Table 13: Relevant federal and state legislation and management plans for the Southern Rock Lobster industry, Australia.*

| **Type** | **South Australia** | **Victoria** | **Tasmania** |
|---|---|---|---|
| **Federal legislation** | *Fisheries Management Act 1991*<br><br>*Fisheries (Management) Regulations 2019* | | |

| | | | |
|---|---|---|---|
| **and regulations** | *Fisheries Administration Act 1991*<br><br>*Biosecurity Act 2015*<br><br>*Export Control Act 2020*<br><br>Export Control (Fish and Fish Products) Rules 2021<br><br>*Food Standards Australia New Zealand Act 1991*<br><br>*Environment Protection and Biodiversity Conservation Act 1999* | | |
| **State legislation** | *Fisheries Management Act 2007*<br><br>*Aquaculture Act 2001*<br><br>*Livestock Act 1997*<br><br>Biosecurity Bill (proposed) | *Fisheries Act 1995*<br><br>*Livestock Management Act 2010*<br><br>*Aquaculture Act 2001*<br><br>*Prevention of Cruelty to Animals Act 1986* | *Tasmania Living Marine Resources Management Act 1995*<br><br>*Biosecurity Act 2019* |
| **State regulations** | Fisheries Management (General) Regulations 2017<br><br>Fisheries Management (Rock Lobster Fisheries) Regulations 2017 | Fisheries Regulations 2019 | Fisheries (General and Fees) Regulations 2016<br><br>Fisheries (Rock Lobster) Rules 2022<br><br>Fisheries (Processing and Handling) Rules 2021 |
| **Strategy and management plans** | Management Plan for the South Australian Commercial Northern Zone Rock Lobster Fishery<br><br>Northern zone Rock Lobster fishery harvest strategy<br><br>Management Plan for the South Australian Commercial Southern Zone Rock Lobster Fishery<br><br>Southern zone Rock Lobster fishery harvest strategy | Victoria Rock Lobster Fishery Management Plan<br><br>Code of Practice Southern Rock Lobster<br><br>Victorian Marine Biotoxin Management Plan | Rock Lobster Fishery Management Plan<br><br>Rock Lobster Biotoxin Management Plan |

# Trade, market access and food safety

## SRL trade and market access

The SRL industry relies heavily on overseas export markets with a small domestic market (Figure 2). During 2018-2019, China accounted for approximately 91% of Australian rock lobster exports. In 2020, exports shifted away from China due to a number of trade obstacles and import restrictions and went to alternative markets, including Hong Kong and other Association of Southeast Asian Nations (ASEAN) member countries. This also included a limited increase in exports to the United States (US) and the Middle East. This highlighted Australia's reliance on a single market, leaving the industry vulnerable to sudden changes. New market opportunities are vital for industry sustainability. Moreover, market trends need to be monitored to ensure product is meeting global market demand. For example, there has been a shift from frozen to chilled produce due to changing consumer preference and improvements in cold chain technologies (Southern Rocklobster Limited, 2017).

Importation of live rock lobster presents a disease entry pathway. Currently, Australia has some limited lobster imports. Live Tropical Rock Lobster (*Panulirus ornatus*) caught exclusively in the Torres Strait Protected Zone and imported from Papua New Guinea may be imported into Australia following strict import conditions, outlined within the Australian Biosecurity Import Conditions (BICON). Australia also imports frozen lobster from Brazil, India and Indonesia, which meet the stringent requirements documented in BICON and the Imported Food Control Act 1992.

There are a number of countries that are emerging as new spiny lobster producers, including Vietnam, Indonesia, Malaysia, Cambodia and Cuba (Phu et al., 2022; Tirtadanu et al., 2021). This introduces new trade competition. China continues to be a significant importer from a number of these countries. Moreover, trade bans placed on Australia have allowed new players to enter the market. New regulations, however, have been impacting imports. For example, at the end of 2023, China declared the wild Tropical Rock Lobster (TRL) as endangered and exporters are now required to demonstrate that their lobsters are farm-raised and not wild caught (Dao, 2023). This highlights risks to market access and the need to be prepared for changes in export market requirements.

The MICOR outlines essential information for exporters to meet importing country obligations for SRL and other commodities. Requirements are grouped with other crustacean species, with no SRL-specific requirements. Given the high value of this commodity, the development of SRL-specific MICOR would be valuable in supporting exporters to manage compliance. This has been reported in a study reviewing the SRL cold chain (KPMG, 2020). Some countries have stricter import requirements for crustaceans, such as listed establishments and maximum cadmium levels, and this has the potential to change over time.

## Food Safety

In regard to food safety, rock lobster is generally considered a low-risk product as it is live and typically cooked prior to consumption. Food safety concerns for SRL include Paralytic Shellfish Toxins (PST), heavy metal contamination (such as cadmium, mercury, copper and zinc) and vibriosis. Preventing illness is the most important approach to minimise public health risks (Austin, 2010; McLeod et al., 2018). Improvements to cold chain management and traceability would support outbreak response (SafeFish, 2024).

SRL is classified as moderate risk for PST for consumption of whole lobster (Hallegraeff et al., 2018). Toxins primarily accumulate in the hepatopancreas and tail meat is considered low risk due to negligible PST accumulation (Turnbull et al., 2018). Cooking studies have demonstrated that toxicity levels in the hepatopancreas remain unchanged, even after steaming and boiling, which is a food safety concern (Turnbull et al., 2018). The consumption of hepatopancreas is common amongst recreational fishers in Tasmania and South Australia (Madigan et al., 2018). Education around food preparation and hygiene is important. More details on harmful algal blooms (HABs) and paralytic shellfish toxin (PST) are in the section below.

*Vibrio* food poisoning events are typically associated with bivalves, such as oysters and mussels. However, in NZ over summer 2021-2022, human illness was associated with lobster, abalone, sea urchin and finfish species. There are currently no national standards to *Vibrio spp*. in seafood and management is based on response following an outbreak. There are many knowledge gaps for environmental risk and human health that need investigation and are part of ongoing research (SafeFish, 2024). With the changing marine environment, such as increasing ocean temperatures, the risk and impacts of *Vibrio* are likely to increase.

## Key diseases of concern for the industry

Disease in the marine environment is often multifactorial, being influenced by environmental, host, pathogen and anthropogenic factors (Figure 6). Warming ocean temperatures and changing water quality are impacting lobster immune function and their resilience to different diseases. Literature reports that lobsters are not faced with as many pathogens and parasites, in comparison to other decapod crustaceans (e.g. prawns and crabs) (Behringer et al., 2012). However, caution is required in making this conclusion as clinical signs in wild catch species, such as SRL, may be missed as animals are not frequently observed in the wild, although they may be closely scrutinised during live holding as a form of passive surveillance. Additionally, there is limited active disease surveillance performed in Australian SRL fisheries and harvested lobster. It should also be noted that for some diseases, wild crustaceans typically experience subclinical infection with no obvious signs of disease.

Live holding facilities provide an opportunity for lobster to be monitored more readily. They also provide an environment that can be more conducive to expression of disease, resulting from close contact, high stocking rates, handling stress and water quality variation. The process of capture and storage has also been shown to negatively impact SRL immune function, putting them at risk of disease (Day et al., 2019). This suggests holding facilities to be a key point for conducting disease surveillance.

Baseline disease information in SRL across Australia is relatively scarce, with limited active disease surveillance. The causative agents of disease outbreaks in crustaceans are often unknown or unreported until it reaches onset of epizootics (Shields, 2012). This is a risk for the SRL fishery and market access as there are increasing demands from export destinations to demonstrate the disease status across a range of food and livestock products in Australia. For example, this occurred for Australian live cattle exports to Indonesia in 2023. Market access was temporarily lost and there were limited surveillance data for Lumpy Skin Disease in northern Australia to support disease freedom. This type of issue could be replicated for lobster in the future.

Australia lists 13 reportable diseases for crustaceans (Table 14). White Spot Syndrome Virus (WSSV) is the primary pathogen on the list that can infect lobsters. The reportable diseases list for crustaceans aligns with the National Priority List of Exotic Environmental Pests, Weeds and Diseases (EEPL) for aquatic animals, including White Spot Syndrome Virus, Yellow Head disease and Crayfish plague (DAFF, 2023b). The occurrence of these diseases may or may not have population level impacts on SRL depending on the disease and epidemiology. However, they could have impacts on market access regardless of whether they cause disease or simply infect lobster with no clinical signs.

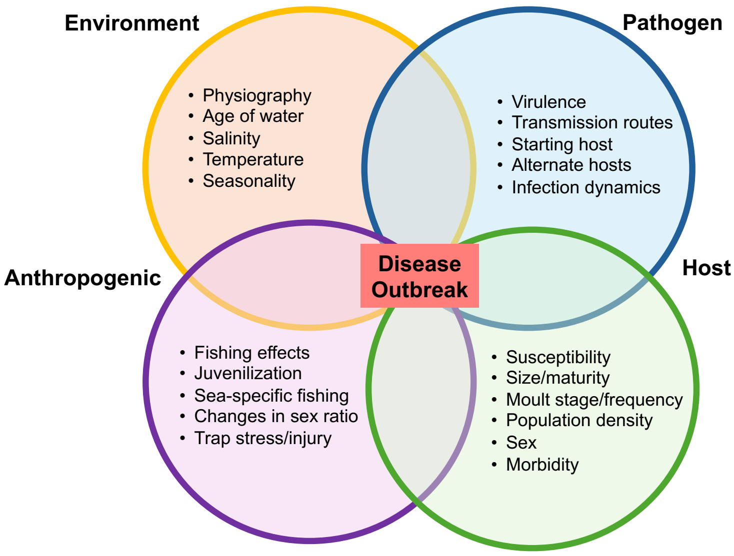


*Figure 6: Conceptual model of factors contributing to outbreaks in crustacean fisheries, adapted from (Shields, 2012).*

*Table 14: Australia's National List of Reportable Diseases of Aquatic Animals - Crustaceans.*

| **Disease** | **OIE Listed** | **Present in Australia** | **Primary host species** | **Lobster susceptibility**[1] |
|---|---|---|---|---|
| **White Spot Syndrome Virus** | Yes | Yes[2] | All decapods | Yes[3] |
| ***Aphanomyces astaci* (crayfish plague)** | Yes | No | Crayfish | No[4] |
| **Taura Syndrome Virus** | Yes | No | Prawn | No |
| **Yellow head virus genotype 1** | Yes | No | Prawn | No |
| **Gill-associated virus** | No | Yes[5] | Prawn | No |
| **Infectious hypodermal and haematopoietic necrosis virus** | Yes | Yes[6] | Prawn | No |
| ***Macrobrachium rosenbergii* nodavirus (white tail disease)** | Yes | Yes[7] | Prawn | No |
| **Infectious myonecrosis virus** | Yes | No | Prawn | No |
| ***Monodon* slow growth syndrome** | No [8] | No | Prawn | No |
| ***Hepatobacter panaei* (necrotising hepatopancreatitis)** | Yes | No | Prawn | Yes[9] |
| **Acute hepatopancreatic necrosis disease** | Yes | No | Prawn | No |
| **Enterocytozoon hepatopenaei** | No | No | Prawn | No |
| **Decapod iridescent virus 1** | Yes | No | Prawn, crabs, crayfish | ? |

[1]Based on current knowledge and published literature in 2024
[2]Most recent detection in prawns was in February 2023 in NSW (Australian Government, 2023)

[3]WSSV has not been detected in wild populations of spiny lobsters. However, it has been experimentally transmitted to six lobster species from the genus *Panulirus* (Ross et al., 2019) and infects all decapod crustaceans.
[4]Freshwater crayfish are susceptible. Other crustaceans including the Chinese mitten crab (*Eriocheir sinensis*), river crab (*Potamon potamios*) and Asian freshwater shrimp (*Macrobrachium dayanum*) (DAWE, 2019).
[5]Reported in NSW, QLD, Northern Territory and Western Australia (DAFF, 2020)
[6]Reported in Northern Territory and Queensland (DAWE, 2020b)
[7]Reported in Queensland (DAWE, 2020c)
[8]Listed regionally by ENACA
[9]American lobster (*Homarus americanus*) has been experimentally infected by NHP (Avila-Villa et al., 2012).

## White Spot Syndrome Virus (WSSV)

WSSV has a wide host range and infects all decapod crustacean species including prawn, lobster, crab and crayfish (Oidtmann et al., 2018). It is reportable under the World Organisation for Animal Health (WOAH) Aquatic Animal Health Code and is listed as a disease of concern in all States. This pathogen is exotic to Australia, but incursions have been detected in the Northern Territory (believed eradicated) and in Queensland and New South Wales in recent times. It can be transmitted vertically (e.g. mother to offspring), horizontally by consumption of infected tissue and by waterborne routes. Spiny lobsters are not naturally infected with WSSV and it has not been documented in wild lobster populations (Shields, 2011). However, wild crustaceans typically exhibit subclinical infection, with no signs of disease. Experimental infection has been demonstrated with six lobster species from the genus *Panulirus* (Ross et al., 2019) and European lobster (*Homarus gammarus*) (Bateman et al., 2012). Clinical disease has resulted in lobster from intramuscular injection and consumption of shrimp products infected with high dose WSSV (Ross et al., 2019). Experimental infection has not yet been demonstrated in SRL.

Australia experienced its first outbreak of WSSV in 2000 in the Northern Territory when crab brood stock were fed infected imported green prawns (DPI, 2001). The outbreak was believed eradicated. The second WSSV outbreak occurred in 2016 on a prawn farm in Logan River (Gibson and Bathgate, 2023). By March 2017, seven farms had been confirmed positive in the outbreak and wild-caught prawns were detected in north-west Moreton Bay. Restricted areas and movement controls were implemented throughout this time. A recent analysis suggests it is likely that WSSV is currently established and should be considered enzootic in the Moreton Bay region in Queensland (Nye et al., 2022). Further outbreaks have occurred further south in New South Wales in 2022/23. However, they are not believed to be closely related to the Queensland strain and it has not been determined how the outbreak arose (Hooper, 2023).

A national surveillance program was initiated in 2017 and conducted extensive testing of wild crustaceans across Australia to understand the distribution of WSSV and the risk it presents to SRL and other crustaceans. Virus continues to be detected at low levels in south-east Queensland (DAWE, 2020a). Wild prawn populations are distributed around Victoria and South Australia (ACPF, 2024). Close monitoring is also needed for invasive marine pests that can contribute to WSSV transmission, such as the Chinese mitten crab (exotic to Australia) (Desrina et al., 2022).

## Harmful Algal Blooms and biotoxins

HABs can produce a number of different biotoxins which can have human health impacts through seafood consumption. These include paralytic shellfish toxin (PST), diarrhetic shellfish toxin (DST), amnesic shellfish toxin (AST), neurotoxic shellfish toxin (NST). The primarily concern for the Australian lobster industry is PST. Both DST and AST are also present in Australia and have been associated with cases of human food poisoning, to a lesser extent. More recently, DST has been a food safety issue for the NSW pipi industry. NST organisms have not been identified in Australia, though similar organisms have been found (Hallegraeff et al., 2021).

Paralytic Shellfish Toxins are produced by marine and estuarine dinoflagellate algal species including *Alexandrium, Gymnodinium* and *Pyrodinium* (McLeod et al., 2018). Bivalve shellfish, such as oysters and mussels, consume and accumulate biotoxins. Lobsters then consume bivalves and can accumulate toxins in their body, primarily in the hepatopancreas. When high concentrations are reached, they can result in cases of human illness following consumption of lobster. There are no food standards applied for PST in the rock lobster industry. Several export markets, including Hong Kong and China, have a bivalve regulatory limit of 0.8mg saxitoxin (STX) equivalents/kg (Tasmanian Government, 2023; Turnbull et al., 2021b). Of note for supply chain risk, exposure to toxic algal cells in water alone is not sufficient to accumulate PST (Turnbull et al., 2021b). This supports that lobsters are not at risk in wet storage.

Since 2012, novel PST-producing *Alexandrium catenella* blooms never reported in Australia have now become an annual event along the east coast of Tasmania. The most toxic year recorded to date was 2017, with mussels recording 150mg (STX) equivalents/kg (Condie et al., 2019). These blooms have likely been climate driven. From experiences in Tasmania, blooms can stretch over 200km of coastline, impacting a number of industries (Condie et al., 2019). Research has identified the highest risk months as July to January (Turnbull et al., 2021a). However, this is becoming more variable with climate change, and blooms may occur outside these risk periods.

The Australian Shellfish Quality Assurance Program (ASQAP) has been developed to support food safety of shellfish and compliance against relevant codes. It aligns with pre- and post-harvest operational standards and includes biotoxin risk management requirements (ASQAAC, 2023). Recently, SafeFish applied to Food Standards Australia New Zealand (FSANZ) to harmonise marine biotoxin standards for bivalve molluscs for DST and PST (FSANZ, 2023).

In line with the ASQAP, Tasmania, South Australia and Victoria each implement their own biotoxin management plans. Tasmania has the most comprehensive monitoring program in place, due to their history of HAB and PST. They implement the Rock Lobster Biotoxin Management Plan and the Tasmanian Shellfish Market Access Program (ShellMAP). Monitoring focuses equally on both regular shellfish meat and phytoplankton sampling from targeted risk areas. This supports decision making around SRL sampling, with bivalves used as effective sentinel species for surveillance (Tasmanian Government, 2023, 2020). PST uptake by SRL correlates well with mussels during bloom events. This approach has been validated and it considered a cost-effective surveillance strategy to manage PST risk in Tasmanian (Turnbull et al., 2021a). Surveillance is limited to the east coast.

In South Australia and Victoria, biotoxin management focuses on detection of toxic phytoplankton during routine monitoring in shellfish harvesting areas (PIRSA, 2016; VFA, 2017b). Only when elevated levels of toxic phytoplankton are detected are shellfish tested for biotoxins. Surveillance is only conducted on commercial shellfish. This limits the geographic distribution of monitoring. Moreover, there are some areas where lobsters are captured but mussels are not harvested, resulting in minimal effective monitoring in some areas. For example, south-eastern South Australia, parts of Victoria (PIRSA, 2016).

## Vibriosis

Vibriosis is a disease caused by various types of bacteria from the genus *Vibrio*. They are a ubiquitous bacteria found in the marine environment with a number of different species that are pathogenic to lobster and several being zoonotic, presenting a public health risk (Shields, 2011). Diseases resulting from *Vibrio* spp. are typically seen more in farmed aquatic species than wild and are often multifactorial, i.e. resulting from changes in environment and host. Risk factors such as poor water quality, stress and high stocking density play a role (de Souza Valente and Wan, 2021). Warming sea surface temperatures, however, are resulting in increased prevalence of *Vibrio* spp. in marine environments (Harrison et al., 2022). Studies have suggested the link between increased global incidence of vibrio and climate change, with altered patterns of bacterial survival.

Preventive management is the primary method to avoid the onset of vibriosis, which is more difficult to manage (and likely rarer) in wild catch species than those in aquaculture facilities. Given the interaction between host, environment and pathogen for disease to emerge, a better understanding of vibrio in the Australia SRL environment is needed. More details regarding its zoonotic potential are presented in the Food Safety section above.

## Other exotic and emerging diseases

There are a number of other exotic and emerging diseases threatening lobsters globally. Outlined below are key pathogens reported in the literature. For a number of them, understanding around susceptibility of *Jasus edwardsii* to infection is unknown. Further research is needed to understand distribution, prevalence and ability for SRL to become infected.

- *Panulirus argus* virus 1 (PaV1): It is the first virus known to be pathogenic to wild lobster (Li et al., 2006). It infects *Panulirus argus* lobster (the Caribbean spiny lobster), with a predilection for juveniles (Shields, 2011).
- Milky Haemolymph Disease (MHD): It is a rickettsial-like organism that infects TRL (*Panulirus* spp.). It was first reported from cultured lobsters in Vietnam in 2008. Although it is considered exotic, there are other rickettsial-like organisms that can infect crustaceans in Australia (Diggles, 2021).
- Shell diseases compromise lobster health and impact market value. There are a number of different types that typically involve multiple microbial species and are often multifactorial, resulting due to an interaction between the environment, host and agent (Rowley and Coates, 2023). As a result, biosecurity and preventive management is only one aspect of disease control. Examples include Epizootic Shell Disease (ESD) and tail fan necrosis (TFN). TFN is a bacterial infection that is typically found among spiny lobsters in aquaculture and commercial fisheries, but has been detected in wild spiny lobsters in New Zealand and Australian waters (Zha et al., 2019, 2018). A lot about the disease process is still unknown and there are still uncertainties around whether a primary pathogen is involved (Jones et al., 2024).
- Microsporidia are obligate intracellular parasites, related to fungi, that are found globally (Tourtip et al., 2009). The *Ameson* spp. have been detected in Australian lobsters (*Panuliris cygnus* and *Panulirus ornatus*), but prevalence is considered low (Dennis and Munday, 1994) and occurrence in lobsters in rare (Shields, 2011). Microsporidia result in infection of the muscles, causing the muscle fibres to turn creamy white, making the product unmarketable. The parasite is generally very stable in the environment, and can infect a number of other aquatic species, including prawns and crab. Disease is often linked with suboptimal environmental conditions and immune suppression. It has zoonotic potential and has been flagged as an emerging pathogen (Stentiford et al., 2016).

## Invasive marine pests impacting the industry

Marine pests can devastate the aquatic environment through habitat destruction, localised extinction of native species, introduction of diseases and parasites, reduce biodiversity and have negative consequences on fishing and tourism (Williams et al., 2023).

Risk pathways for introduction can include (but not limited to) (MPSC, 2020a):

- Vessels i.e. commercial, shipping, recreational, cruises etc.
- Fishery practices i.e. contaminated fishing equipment, bait, discarded product etc.
- Recreational equipment
- Marine debris
- Navigation buoys and marine floats.

A key contributor to marine pest introduction and spread is vessel movement. A study was conducted to understand domestic vessel movements and the spread of marine pests in Australia (Kinlock et al., 2003). A risk assessment identified commercial fishing vessels as highest risk for domestic translocation of marine pests. This was influenced by the number of voyages being undertaken, the amount of time spent in and around ports and frequent interaction with the seabed. Figure 7 taken from Kinlock et al. (2003), illustrates how an initial introduction of a marine pest can then result in secondary sites becoming invaded. Sites of invasion are often located at centres of boating activity such as ports and marinas, allowing contamination and spread of pests by different vectors, such as vessels. Analysis of vessel movement and potential introduction pathways can support targeted management and biosecurity strategies (Costello et al., 2022).

The Australian Priority Marine Pest list is presented in Table 15, with accompanying state-based information. Three of those species are considered established in Australia. The European shore crab (*Carcinus maenas*) and wakame (*Undaria pinnatifida*) are present across all three primarily states of SRL fishery. The northern Pacific seastar is present in Victoria and Tasmania, but has yet to reach South Australia. The National Priority List of Exotic Environmental Pests, Weeds and Diseases also identifies the carpet sea squirt (*Didemnum vexillum*). This is an emerging marine pest of concern that has recently been detected in Western Australia.

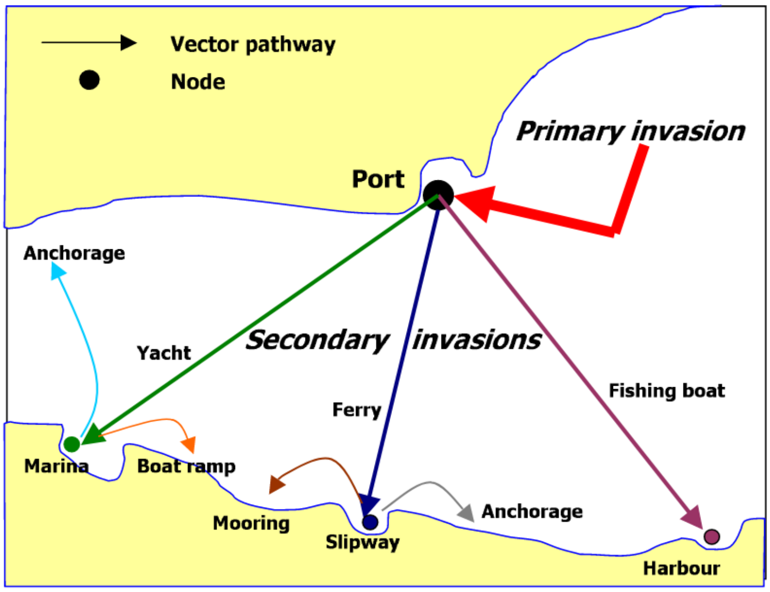


*Figure 7: Schematic diagram representing the secondary invasion process of marine pests taken from Kinlock et al. (2003).*

*Table 15: The Australian Priority Marine Pest List and status of different states.*

| Marine pests | National status | South Australia status[1] | Victoria status[2] | Tasmania status[3] |
|---|---|---|---|---|
| **European shore crab (*Carcinus maenas*)** | Established | Present | Present | Present |
| **Wakame (*Undaria pinnatifida*)** | Established | Present | Present | Present |
| **Northern Pacific seastar (*Asterias amurensis*)** | Established | Absent | Present | Present |
| **Asian green mussel (*Perna viridis*)** | Exotic | - | - | - |
| **Black-striped false mussel (*Mytilopsis sallei*)** | Exotic | - | - | - |
| **Brown mussel (*Perna perna*)** | Exotic | - | - | - |
| **Charru mussel (*Mytella strigata*)** | Exotic | - | - | - |
| **Chinese mitten crab (*Eriocheir sinensis*)** | Exotic | - | - | - |
| **Harris' mud crab (*Rhithropanopeus harrisii*)** | Exotic | - | - | - |
| **Green Mussel (*Perna canaliculus*)** | Exotic | - | - | - |

[1] Additional marine pests established in South Australia include: Asian date or bag mussel, European fan worm, Aquarium Caulerpa (NIMPIS, 2023).
[2] Additional marine pests established in Victoria include: Asian shore crab, Asian date or bag mussel, European fan worm (NIMPIS, 2023).
[3] Additional marine pests established in Tasmania include: New Zealand screw shell (NIMPIS, 2023).

A summary of four key marine pests is presented below. These are causing concern across the SRL fishery states. This includes the Longspined Sea Urchin (*Centrostephanus rodgersii*), Wakame *(Undaria pinnatifida)*, Carpet Sea Squirt (*Didemnum vexillum*) and the Eastern Rock Lobster (*Sagmariasus verreauxi*).

## Longspined Sea Urchin

The Longspined Sea Urchin (*Centrostephanus rodgersii*) is native to Australia. However, it is considered a pest in Tasmania after migrating from NSW to the east coast of Tasmania (Ling, 2009). This is the result of warming waters along the east coast of Australia and demonstrates an example of range extension from mainland Australia through the impacts of climate change (IMAS, 2023). The grazing patterns of sea urchins are detrimental to native algal beds, consuming kelp forests and other marine plants and reducing them to 'urchin barrens' on the sea floor (Ling and Keane, 2018). The SRL depends on the reef and kelp bed habitat for production and protection.

The SRL is an opportunistic and generalist predator consuming bottom-dwelling invertebrates such as molluscs, crustaceans and echinoderms. This includes the Short Spined Sea Urchin (*Heliocidaris erythrogramma*) and the longspined urchins (*C. rodgersii*). A recent study found that *C. rodgersii* is the least preferred choice of prey for SRL, in comparison to other native prey such as abalone and snails (Smith et al., 2022). Moreover, there is a size dependence on this predatory interaction, with only lobsters well above the harvested size-limit physically capable or predating *C. rodgersii* (Ling, 2009; Smith et al., 2023). Due to fishing in Tasmanian waters, lobsters of this size are very limited in number.

Studies have suggested that due to the low predation rates of longspined urchins and limited biomass of SRL, the SRL is not a viable biological control method and is unlikely to control the expansion of this species alone (Plagányi et al., 2018; Smith et al., 2022). Additional control measures are needed to protect the ecology of the reef and important commercial stocks such as the SRL (Smith et al., 2022). A plan was developed to identify strategies for the management of *C. rodgersii*. In the short-term, options such as targeted culling and commercial harvesting can be used. However, investment into long-term options are needed (Westcott et al., 2022).

## Wakame

*Wakame (Undaria pinnatifida)* is a kelp species that is native to Northern Asian waters. It is considered one of the most successful invasive marine species due to its high tolerance to changes in temperature, ability to thrive in disturbed environments and continued spread between regions via vessel movements and other marine activities (South et al., 2017). It is now established in Tasmania and Victoria and was first detected in South Australia in winter of 2023.

The range and distribution of wakame is determined primarily by sea surface temperature. With changing ocean temperatures, modelling has identified its potential to establish in NSW, SA, Qld and southern WA. It can colonise in different environments, ranging from sheltered port areas through to wave-exposed shorelines. It is detrimental to the environment through displacement of native seaweeds, loss of biodiversity, habitat modification and can cause economic loss to commercial harvests (MPSC, 2020b). Containment of spread needs to focus on management of aquaculture, small vessel movement, biofouling, ballast water and management of current infected areas (MPSC, 2018).

## Carpet Sea Squirt

The carpet sea squirt (*Didemnum vexillum*) is considered an invasive marine pest in Australia (NIMPIS, 2023). This species has spread globally through various introduction pathways including vessel hull fouling, ballast water discharge, attached to marine vessels and fishing equipment (Cook et al., 2016). It has the ability to rapidly colonise and establish, posing a threat to marine habitats through competition of resources with native species. This can lead to habitat degradation and loss of biodiversity, which can impact lobster habitat.

The carpet sea squirt has been reported in NSW and was detected for the first time in Western Australia early 2023. A biosecurity incident was declared on the 25th January 2023 and a Quarantine Area notice issued. Strategies including vessel movement restrictions, strengthening biofouling inspections and treatment of vessels that regularly operate in the Quarantine Area have been implemented, among other activities (DPIRD, 2023). Delimiting surveys are underway to understand the extent of the incursion.

This marine pest has not been detected in key SRL states. However, it is essential that ongoing monitoring is conducted to implement immediate strategies to prevent further spread or establishment in southern Australia.

## Eastern Rock Lobster

The Eastern Rock Lobster (ERL; *Sagmariasus verreauxi*) is another species of lobster found along the east coast of Australia. It is considered a sustainable stock in NSW with the greatest abundance along the NSW coast, where it is caught for commercial and recreational fishing purposes (Liggins, 2020). As waters are warming, it has continued to move southward and along the south coast of Australia. It is now a recognised pest in Victoria (Seafood Industry Victoria, 2022) and has been detected as far west as the northern zone rock lobster fishery of South Australia (Linnane et al., 2023).

The shift of ERL into shared habitat with SRL will likely increase competition for food and shelter. Physiological thermal tolerance windows will vary between species and will impact their ability to compete for resources (Twiname et al., 2022). There is also the theoretical risk of hybridisation. Lobster species within the same genus or closely related taxa are more likely to hybridise. SRL and ERL belong to different genera, but this doesn’t rule out the potential for interbreeding (Syafaat et al., 2023). The impacts of hybridisation and/or range extension on these species are unknown at this stage.

## Climate change

Climate change is greatly impacting the future of fisheries catches, profitability, industry sustainability and food security (van Putten et al., 2016). Climate variability, increasing sea temperatures, changing ocean currents and acidification of marine environments are just a few of the changes being experienced in the marine environment.

### Increasing water temperatures

There are a number of environmental parameters that have been associated with the daily commercial catch rate of SRL (Feenstra et al., 2014). Seasonal changes in water temperature are believed to contribute to the catchability of males (Ziegler et al., 2004). Increasing water temperatures may impact the variations typically experienced across the seasons, reducing catchability. Prolonged exposure to warmer waters can impact lobster mobility, resulting in increased energy expenditure and reduced activity, affecting ability to forage for food, avoid predators and increased stress levels.

Figure 8 illustrates changes in sea surface temperature (SST) around Australia from the 1980's until 2018 (Gervais et al., 2021). Southeastern Australia is considered one of the fastest warming coastal areas in the southern hemisphere. It is warming three to four times faster than the global average, primarily due to ocean currents (Hinojosa et al., 2015; Hobday and Pecl, 2014).

Temperature greatly impacts lobster physiological and immunological responses to microbial pathogens and parasites. Factors such as moulting, maturation, respiration and immune function can all be negatively impacted (Shields, 2019). Effects that have already been seen include movement of lobster to deeper waters due to increasing sea temperature, changes to growth rate, reduced size at maturity and changing distribution patterns (Phillips et al., 2017). It is suggested that environmental stressors, such as those caused by warming waters, are making lobster more sensitive and this is impacting holding capacity and increasing mortality rates (Fitzgibbon et al., 2019).

Other notable impacts include changes to shell bacterial communities which can be altered by hotter and colder water temperatures. This leaves lobsters vulnerable and has been found to play a role in shell diseases such as Epizootic Shell Disease (ESD) in American lobster (Ishaq et al., 2023). Declining kelp habitats, that are an important food and refuge for SRL, are greatly affecting lobster productivity (Hinojosa et al., 2015).

A study was conducted by Tepker et al. (2023) to understand the most important environmental determinants of suitable habitat for spiny lobsters (genus *Jasus*) to predict future distribution. Many marine species are moving poleward to cooler waters and finding new settlement areas. Range shifts have the potential to push species outside of their typically fished areas, impacting yearly catches. A greater understanding is needed to predict potential new habitat areas. With these changes in location, consideration is needed for new fishing permits for different areas. The study found the most important environmental variable influencing *J. edwardsii* was benthic temperature. They found that with the southern movement of *J. edwardsii*, there will likely be a decrease in suitable habitat locations within the jurisdictions of South Australia, with Victoria and Tasmania predicted to contain high concentrations of suitable habitat locations (Tepker et al., 2023).

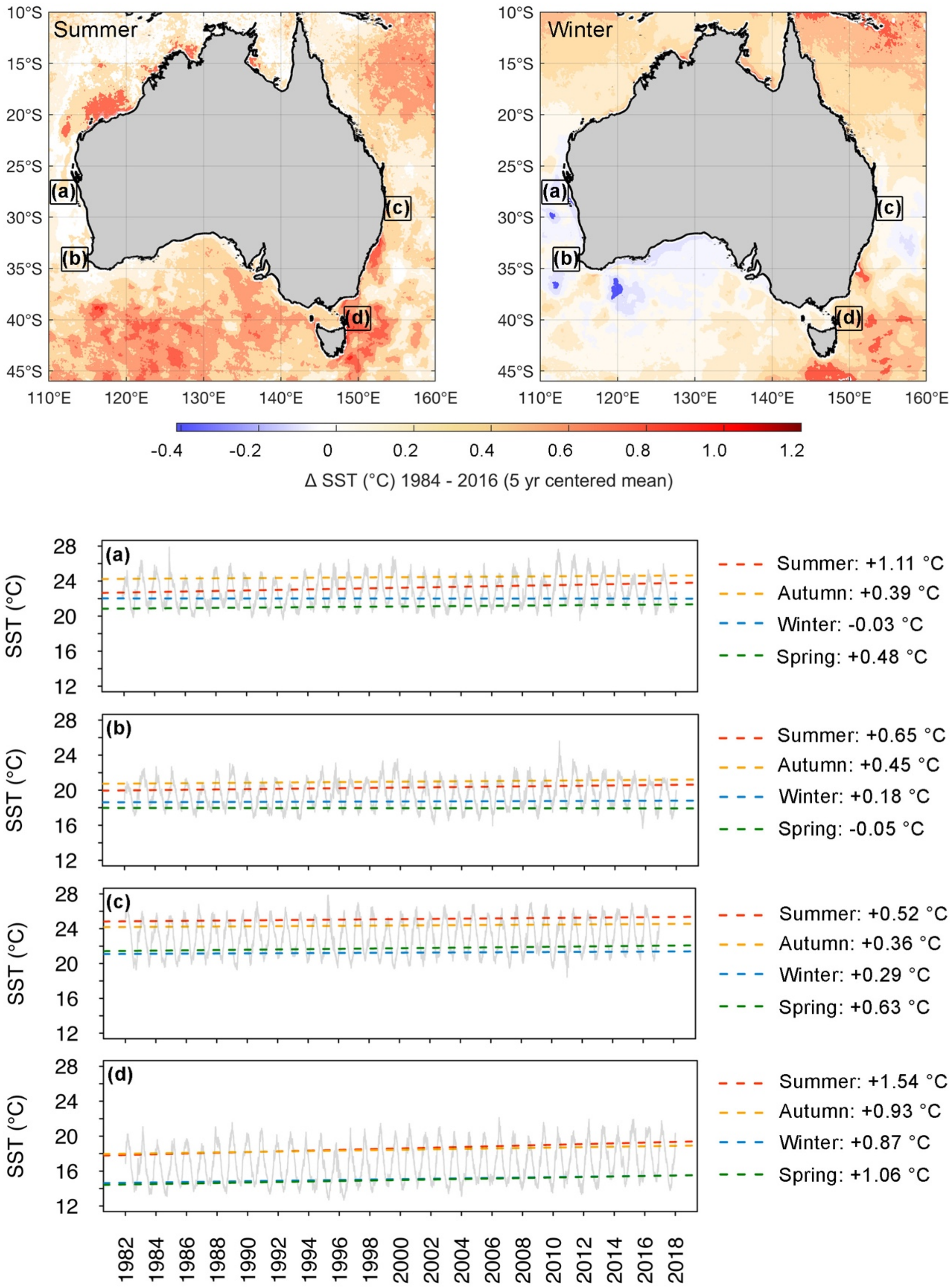


*Figure 8: Changes in mean summer and winter sea surface temperature surrounding Australia from 1982 to 2018. Figure taken from Gervais et al. (2021). Plots correspond with four geographically explicit regions (a-d).*

## Other biosecurity and industry threats

### Impacts of COVID-19 and future pandemics

The COVID-19 pandemic brought about significant disruptions to vessel movements and fishing activities. Fishing operations faced particular challenges in implementing physical distancing while performing day-to-day activities (Plagányi et al., 2021). Both commercial and recreational fishing vessels were affected by social distancing requirements and movement restrictions imposed during the pandemic (Huveneers et al., 2021).

Decreased catches were experienced in in February and March 2020 and have been attributed to the reduced demand in China during the pandemic. Moreover, this also corresponded with Chinese New Year, which is a high demand period (Huveneers et al., 2021).

Global events such as this post a threat to the industry, with different requirements and restrictions having the potential the limit fishing ability.

### Lobster bait types and shortages

SRL are captured using baited pots and there are regulations around what bait types are permitted (Rizzari and Gardner, 2019). The type and source of bait can constitute a biosecurity risk, presenting an introduction pathway for different diseases. The origin of WSSV is contested in the scientific literature. However, one hypothesis is that it entered Australia from imported uncooked (green) prawns used as bait or burley (Knibb et al., 2018; Oakey and Smith, 2018).

A recent survey identified a risk of bait supply in the Australian SRL Fishery. The majority of bait comes from Australia or New Zealand and is either purchased or approved by-catch species. The preferred types of bait in the SRL include Blue Mackerel, Jack Mackerel, Australian Salmon and Barracouta, which make up approximately 90% of bait used (Rizzari and Gardner, 2019).

This is an area to be monitored, to ensure adequate bait is available for the industry and other sources that pose a disease entry risk are not used.

## Emergency response in SRL

A marine aquatic biosecurity incident will mostly likely be triggered by an emergency aquatic disease or the detection of an invasive marine species. The size and importance of the outbreak will determine if the response is managed by the State or Commonwealth.

There are two key resources to support these different incident types:

1. The Australian Aquatic Veterinary Emergency Plan (AQUAVETPLAN) provides a foundation document for an emergency response for an aquatic animal disease incursion. There are two disease strategy manuals available for crustacean diseases, including Crayfish plague and White Spot Disease. There are additional supporting documents including operational procedure manuals, including decontamination, destruction and disposal and management manuals to guide establishment of control centres and different enterprises.
2. For invasive marine pests, the Emergency Marine Pest Plan (EMPPlan) is in place and aligns with the Biosecurity Incident Management System (BIMS) (MPSC, 2020a). These include a generic manual, and species-specific manuals for the Northern pacific seastar (*Asterias amurensis*), European green crab (*Carcinus maenas*), black-striped mussel (*Mytilopsis sallei*), Asian green mussel (*Perna viridis*) and Wakame (*Undaria pinnatifida*). A marine pest emergency may be declared when a marine pest species causes a biosecurity incident that meets national significance criteria that is outlined in the National Environmental Biosecurity Response Agreement (NEBRA). Moreover, the Consultative Committee on Introduced Marine Pest Emergencies (CCIMPE) may determine that a marine pest poses a significant threat to Australia's marine environment or industry.

There are a number of state-based response and management plans that have been developed due to jurisdictional impacts from different biosecurity threats, namely marine pests such as the Longspined Sea Urchin and HAB biotoxins. Moreover, states have developed their own priority disease and marine pest lists for reporting, that align with their biosecurity legislation. This is because responsibility for managing outbreaks does lie at the State and Territory level.

Disease outbreaks in wild catch marine species present several challenges that are more difficult to manage in comparison to aquaculture systems and traditional livestock. These include (but not limited to):

- Open ocean facilitates potential exposure to pathogens and limited capacity to manage water contamination
- Reliance on vessel owners complying with movement restrictions and biosecurity
- Differences in biosecurity practices between commercial and recreational fishers
- Inability to contain animal movement (i.e. free roaming marine species)
- Resource and skill requirements to support sampling and surveillance activities.

To understand SRL movements and the risk of disease spread, a recent tag-recapture study investigated the movement patterns of SRL in Victoria. Across a 20-year period, 83% of lobsters were recaptured within 1km of their tagging site and 93% within 5km (Skeer et al., 2020). Movement was primarily moving inshore and offshore, not to other areas. However, many crustacean diseases are multi-host. Thus, other susceptible species may move and come in contact with lobsters. Moreover, SRL go through a spawning and larval phase, where they can travel large distances by ocean currents, potentially contributing to disease spread. Interestingly, disease has been shown to alter the social behaviour of lobsters, with avoidance of diseased conspecifics changing disease transmission dynamics (Dolan III et al., 2014)

Valuable information can be drawn from other aquatic disease outbreaks that have occurred in Australia, including Pacific Oyster Mortality Syndrome (POMS) and Abalone Virus Ganglioneuritis (AVG). A supplementary extension report completed as part of this project (Appendix 3) provides details for a SRL emergency response.

# Appendix 3 – Additional report: Outbreak response process and preparedness activities

## Introduction

Ausvet undertook an assessment of biosecurity threats and vulnerabilities of the Southern Rock Lobster Fishery on behalf of FRDC for one of their stakeholders, Southern Rocklobster Limited. As part of this project, FRDC requested that Ausvet present some additional information to identify the outbreak response processes and outline the biosecurity response framework.

This short report presents that information. In particular, it focuses on:

- Outlining the national structure for an emergency aquatic animal disease response (including the Biosecurity Incident Management System). We have also discussed the national response structure for a pest incursion.
- Identifying most likely strategic response options
- Outlining Role of Industry (Southern Rocklobster Limited) in a response
- Making recommendations for Southern Rocklobster Limited to prepare or respond to an incursion.

## Methods

Ausvet utilised the methods presented at the beginning of this report, incorporating a literature review and stakeholder consultation. Expert opinion from Ausvet was also used to describe how and what a response would look like. Ausvet staff have written biosecurity emergency response plans nationally and globally, written AQUAVETPLANs and been involved in responding to many serious biosecurity events in the past.

# Structure of an Aquatic Emergency Animal Disease Response

## Factors affecting the broad structure of a response

The structure of an Aquatic Emergency response will depend on a number of factors associated with the biosecurity event. These are outlined in Table 16.

*Table 16: Factors influencing the structure and approach to an emergency aquatic animal disease response.*

| Outbreak characteristic | Details |
|---|---|
| **Pest verse disease** | A marine aquatic biosecurity event will most likely be an emergency aquatic disease incursion or an introduction of a damaging invasive marine pest. Either scenario would lead to slightly different responses.<br><br>The most important aquatic diseases and pests are found in The National Priority List of Exotic Environmental Pests, Weeds and Diseases (DAFF 2023). There is a longer list of Australia's National List of Reportable Diseases of Aquatic Animals, although it should be noted that the list includes other important endemic diseases that will not initiate a response (DAFF, 2020).<br><br>In general, this current additional report covers the structure of an aquatic disease response. We present the focus of a parallel marine pest response in a section below to illustrate similarities. |
| **Size and importance of the outbreak - national or state response?** | If the biosecurity event is for an important exotic disease or marine pest and/or the outbreak is found in more than one state or territory, it is likely the outbreak will be treated as a national response. If this occurs, the Aquatic Consultative Committee on Emergency Animal Diseases (AqCCEAD) may be initiated. This means that national coordination and management of the outbreak will likely occur. If the outbreak is for a lower priority disease or occurs in only one state, the response is likely to be managed solely by the government of the affected jurisdiction with notifications to the AqCCEAD. |
| **Variation between State level responses** | If the response is not on a national level, then the affected state government will manage the response.<br><br>The state government disease response structures vary by state jurisdiction, but have some consistency. There is usually a state response plan, which is not generally public. The response is usually led by the state Chief Veterinary Officer (CVO). The CVO receives technical advice from experts within the state Department of Agriculture and with operational and enforcement assistance from the statutory authority for fisheries. The legislation is relatively complex. For example, in South Australia the three Acts of concern are:<br><br>1. Livestock Act 1997 – Management of domestic animals and notifiable diseases (lobsters when they are harvested and held by processors, but not pre-harvest).<br>2. Aquaculture Act 2001 – Main relevance for an outbreak is deals with veterinary medicines off label and reporting disease outbreaks in aquaculture. |

| | |
|---|---|
| | 3. Fisheries Management Act 2007 – This act confers ability to close fisheries and restrict gear and movement and enforce biosecurity. It can only be used for 12 months and then orders must be renewed. All fish processors also have licenses under this Act.<br><br>It should be noted that there is a new Biosecurity Bill being prepared to replace the Livestock Act 1997 in South Australia. This will be expanded to more animals beyond just livestock (e.g. marine animals) and will likely be applied to outbreaks in lobsters in the future. This will put more of an onus on fishers for biosecurity in routine activities. Most states are currently or have recently revised their biosecurity legislation following a new Commonwealth Biosecurity Act in recent years (the Commonwealth Biosecurity Act 2015). |

## Broad cross government structure of a national response

There are several levels to a major response. For a disease response, this includes the following structure:

### 1. The state jurisdiction/s

The state or territory jurisdiction leads the development of the response plan and the operational response on the ground. They have leadership and responsibility for the outbreak in their jurisdiction. There may be several States or Territories involved.

However, for a small emergency that does not cross borders or require national coordination, there may only be a single state jurisdiction involved. In that case, the following structures may not be involved in a response. For larger responses, the following structures will be involved once a request is made to stand up the AqCCEAD.

### 2. National Aquatic Consultative Committee on Emergency Animal Diseases

The AqCCEAD will be initiated if there is a request for national coordination. This committee is composed of:

- CVO as chair
- State and territory CVOs
- Australian Centre for Disease Preparedness (ACDP)
- There is no industry representative as the SRL industry are not signatories of the Emergency Animal Disease Response Agreement (EADRA).

The AqCCEAD coordinates Australia's national technical response to emergency aquatic animal disease events. It is responsible for determining the nature, extent and significance of a suspected disease event in aquatic animals in Australia. For example, this organisation coordinates technical discussions and approves technical response plans from individual state and territory jurisdictions during a large multi-jurisdictional response. This may also include large responses of a significant disease that threaten national industry or environment.

Currently, the aquatic industry stakeholders (e.g. Southern Rocklobster Limited) have not signed up to a deed of cost sharing, such as the EADRA (AHA 2023). This means that there is no significant national funding available or representation of industry on the AqCCEAD. This is in contrast to livestock where all major industries have signed a cost sharing agreement (e.g. EADRA) and have a seat at the decision-making tables.

### 3. National management group

This is comprised of the heads of relevant departments in each jurisdiction (Commonwealth and states and territories) and senior industry leadership. They sign off on strategic plans and the funding for a response.

But as there is no cost sharing agreement (e.g. EADRA), it is unlikely this type of group will meet and approve plans and budgets for an aquatic animal disease event. Other pathways such as Agricultural Ministers Meeting, Agricultural Senior Officials Committee or the National Biosecurity Committee may be the appropriate place for such discussions. However, such discussions may be *ad hoc* and irregular in the absence of a cost sharing agreement.

## Biosecurity Incident Management System

Two fundamental systems are used in Australia to provide a conceptual framework and continuity for biosecurity emergency responses (Animal Health Australia, 2021; DAFF, 2012). The AIIMS is an all-emergency services framework that allows greater inter-operability with other sectors. It provides the concept for incident classification, considering its potential consequence and impact. The Biosecurity Incident Management System (BIMS) contextualises these concepts to biosecurity incidents and ensures the appropriate level of coordination, resources and support are provided during a response.

The BIMS framework for a large state-based disease outbreak is presented in Figure 9. In this example, a response would be state based, and would have a state coordination centre and one or more local disease control centres. Other levels are possible from 1- 5, with 1 being the smallest response and 5 being the largest (DAFF, 2012). The relevant role for Southern Rocklobster Limited may be in a liaison role in such a response. For example, the CEO of Southern Rocklobster Limited may be a liaison to the Incident management role at the state coordination centre and provide strategic advice. More junior employees or other representatives of the industry may be appropriate as a liaison at the local control centre level to achieve operational objectives (e.g. assist with the practicalities of surveillance).

## Marine pest incursion instead of disease

It is important to note that there is a parallel system for managing pest incursions. This is similar to and modelled on the response structure for diseases. A national response structure is guided by the National Environmental Biosecurity Response Agreement (NEBRA) (DAFF 2022), which establishes the national arrangements for responding to an incursion of exotic pests and diseases that impact on the environment (including costs). The NEBRA system comprises:

1. NEBRA
2. The Consultative Committee for Introduced Marine Pests (CCIMPE) is the technical committee that advises the National Biosecurity Management Group (NBMG) in relation to marine pest incursions being considered under the NEBRA.
3. National Biosecurity Management Consultative Committee (NBMCC) is the committee that provides technical and expert advice to the NBMG to support determinations on whether a national eradication response is recommended.
4. National Biosecurity Management Group (NBMG) is the peak, national biosecurity decision-making forum in the event of an incident of a pest or disease. The NBMG determines if an incident is considered nationally significant, technically feasible to eradicate and cost-effective. The NBMG will also consider the response plan for eradication and associated costs.

State jurisdictional responses and operational involvement underpins NEBRA. That is, similar to the disease situation, the states have decision making and operational responsibility in their jurisdictions. However, when an outbreak is large and considered of national significance, national funding mechanisms can be implemented and the NEBRA system allows this to occur and encourages national coordination. The state response will frequently rely on the relevant primary industries Department and the statutory authority for fisheries in the state.

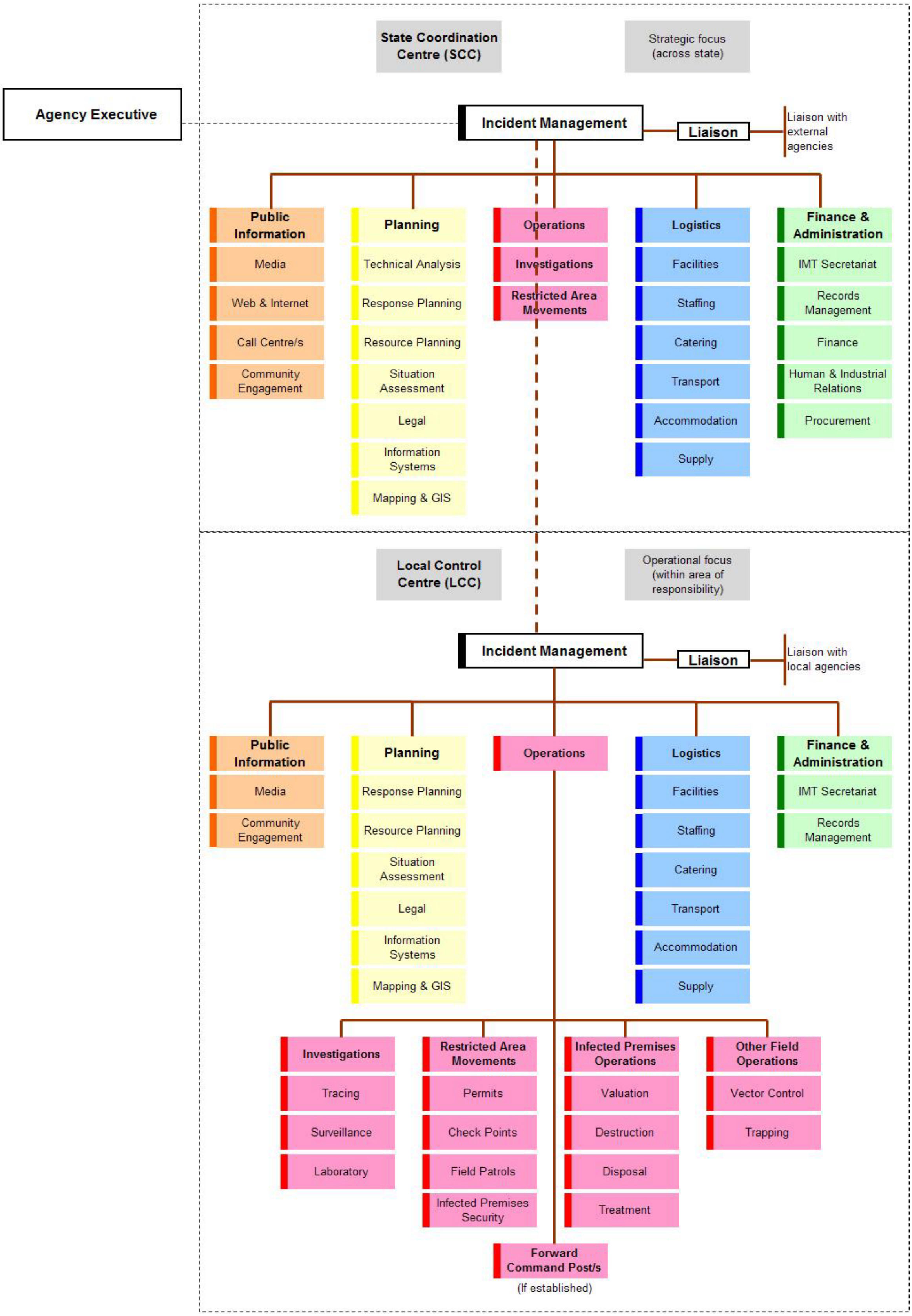


*Figure 9: Example incident organisation structure for a level 3 classification (the largest outbreak response in a single state) (DAFF, 2012)*

# Technical response options most likely

The broad strategic approaches available to respond to an outbreak of either a pest or disease in marine environments includes:

1. Eradication
2. Containment of disease transmission or pest species growth and spread. This is the most common action in aquatic biosecurity events due to difficulty/impossibility of managing events in marine environments.
3. Asset protection
4. No response.

In general, it will not be known which strategic approach to apply to managing an outbreak at its outset. As the extent of the outbreak becomes apparent and the technical feasibility and cost of eradication is known, decisions about strategy can be made. Therefore, as a holding pattern at the beginning of an outbreak, the response usually starts with movement restrictions and fisheries closures to prevent further spread of infection or marine pests. There will also be a focus on surveillance to determine the current extent of infection or the pest incursion (delimiting surveillance). Enhanced biosecurity will also be promoted to enable some industry functioning, but will reduce the risk of further transmission of infectious organisms or pests. Once the incursion is contained and the extent determined (for example with oceanographic modelling), a science and economic based decision can be made on whether the incursion can be eradicated, or instead other options such as ongoing containment, asset protection or no further response is indicated.

There is an important resource called AQUAVETPLAN available to guide the technical response to disease incursions. This has several types of documents including:

- Operational manuals (decontamination, destruction and disposal)
- Management manuals (control centres under BIMS, enterprise manuals describing sectors)
- Disease specific guides (e.g. for crustaceans this includes Crayfish plague and White Spot Disease).

AQUAVETPLAN can be used to guide the technical requirements of a response, especially early in an outbreak when time is short. However, it should be noted that these are non-binding technical guides. Each state and territory will formulate its own technical response and is not bound by AQUAVETPLAN.

The most relevant AQUAVETPLAN for the SRL industry is likely the White Spot Syndrome Virus AQUAVETPLAN. This will provide good guidance on the way a response will be operationally implemented for many similar diseases.

# Role of industry (Southern Rocklobster Limited) in a response

State Government will run a response on the ground and make decisions with possible assistance from other national bodies during a national response.

Industry has an important role in responding to an outbreak. The technical knowledge and capability of industry will be vital to support operational activities and management of a response. Liaising with industry will be essential to ensure a response is appropriate and minimises damage and impacts on the sector. The absence of a cost sharing deed in the fisheries and aquaculture industries, similar to the Emergency Animal Disease Response Agreement (EADRA) with livestock species, limits formal involvement of industry in national decision making during a response. Despite this, consulted stakeholders expressed the need for involvement of industry in a response for the good of the industry and to ensure a response was appropriate for this fishery sector.

Industry's main role would include three levels:

- **Decision making**

Most responses are planned and implemented at state and territory level, and industry could contribute at this level. This would generally be as industry liaison roles at the state coordination centre where decisions are made at the state level.

Whilst the national Aquatic Consultative Committee on Emergency Animal Diseases (AqCCEAD) may seek advice from industry in an informal manner, industry's role would be limited due to the absence of a cost sharing agreement.

- **Operational assistance**

Industry has key competencies and expertise on vessel operation, fishing and general operational skills. These abilities would be very useful at the local control centre level at each state and territory jurisdiction. For example, to provide practical support to surveillance and control activities and in making sure that operational decisions such as movement restrictions, fisheries closure and biosecurity measures are practical and useful.

- **Communication with industry stakeholders**

During a response, timely and effective communication is essential. Critical information will need to be disseminated to inform relevant stakeholders on response updates, provide information on disease control measures and response strategies. Clear and open lines of communication need to be made accessible to the industry.

As the response progresses, there will be the implementation of movement restrictions, surveillance requirements, changes to fishery activities, among a number of other activities. It will be important that industry stakeholders understand their role and feel supported. This will be important to foster trust and cooperation, facilitating sharing of crucial data and resources with those on the frontline.

# Recommendations for Southern Rocklobster Limited to prepare or respond to an incursion

During an emergency incident, response time will need to be rapid and work volume will be high. Preparedness and planning activities conducted by the Southern Rock Lobster industries in advance of a biosecurity incident will be very worthwhile.

| Stage | Step | Details |
| --- | --- | --- |
| **Prior to an outbreak** | Prepare up to date member lists and contact details to enable rapid communication in the event of an emergency. | An update to member mobile and email addresses is recommended. The email address will allow rapid communication of situation reports that are essential in an outbreak and the mobile number will allow direct communication where that is required. This is likely already available. |
| | Prepare a template for a situation report documenting briefly what is happening in the outbreak. | This will enable a lower burden of work under pressure in real time. There will likely be limited staff numbers at Southern Rocklobster Limited and this would support reporting and documentation, and no need for document planning in real time. |
| | Key members of industry leadership to read and familiarise with relevant AQUAVETPLANS (e.g. White spot disease and generic chapters such as operational and management manuals). | This will give a good general understanding of what a response will look like technically so that leadership can be familiar with the key steps and approaches that will occur. Whilst this may have a strong focus on aquaculture, many of the key principles will be similar. |
| | Industry leadership (e.g. CEO or board chair of Southern Rocklobster Limited) to establish working relationships with key decision makers in each state (e.g. Chief Veterinary Officers etc.). | This will ensure that lines of communication exist in advance of a biosecurity disease event. |
| | Southern Rocklobster Limited to identify staff and members that are strategically aware and capable of contributing to a response. | Contribution will be at a high level to work as liaison to incident management at the state disease coordination centre and if required at the national level (recognising this may be informal contact). Alternatively, identify one or two subcontractors that could be engaged at short notice to assist Southern Rocklobster Limited in technical considerations and liaison during an event. |
| **During an outbreak** | Implement industry communication. | Populate the situation report and regularly communicate this to members via email to ensure industry is familiar and knowledgeable about the outbreak. Lack of accurate and timely knowledge from their industry body will be substituted with speculative information from uniformed sources and lead to disunity. |

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| | Approach the State Disease Coordination Centre to have an industry liaison placed within the BIMS structure (or AIIMS). | Here they can advocate for industry and provide technical assistance on the practicalities of various disease management options. |
| | Approach the relevant state and national technical decision makers to assist in presenting industry's opinion and informally assist decision making at a higher level. | The aim will be to establish contact with the relevant technical decision maker such as the Chief Veterinary Officer or Chief Environmental Biosecurity Officer, depending on the type of outbreak and level of response.<br><br>Practically, a regular catch-up time should be arranged with higher level decision makers. Whilst there will already be some representation at the state disease coordination centre, this will potentially have a lower influence. It will be important to have communication with those higher levels to support decision makers and industry. These include the AqCCEAD as a chair (national CVO) or participating (state CVO) and could take informal advice from industry to a meeting which would assist the response.<br><br>However, as a caveat, there is no deed of cost sharing and therefore no formal involvement of industry in higher level decision making can be demanded. |
| | Identify SRL fishers in each affected area that could be available to provide operational assistance to local control centres. | Identify and assist these fishers establish contact with the local control centre. These fishers are likely to be under movement and fishing restrictions and not able to make an income and not automatically qualify for compensation (no cost sharing deed). They may be able to be contracted to provide valuable operational assistance to government during surveillance or control operations, thereby assisting cash flow and response activities. This may be well received by state regulatory authorities as they may have no operational experience and may not be able to manage occupational health and safety requirements for the particular surveillance or control required. |

# Appendix 4 – Biosecurity threats and vulnerabilities of the Southern Rock Lobster Fishery: Summary document

# Bio-security threats and vulnerabilities of the Southern Rock Lobster Fishery

*By Edwina Leslie and Brendan Cowled*

## Background

The Southern Rock Lobster (SRL) industry is an economically valuable wild-catch fishery sector in Australia worth over AUD$200 million annually. In recent years, the industry has been impacted by various biosecurity and other emerging threats, such as COVID-19, trading partner non-tariff barriers and harmful algal blooms (HAB). Moreover, climate change is influencing the distribution of diseases, invasive marine pests and other negative impacts on lobster populations.

An assessment of biosecurity threats and vulnerabilities of the SRL Fishery was conducted on behalf of the Fisheries Research and Development Corporation (FRDC) for Southern Rocklobster Limited. This article provides a summary of findings.

## Method

The methods included four components:

1. Literature review
2. Stakeholder consultation
3. Fore sighting analysis for the SRL industry
4. Identification of key biosecurity threats, barriers and solutions.

## Summary of biosecurity threats, management solutions and barriers

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| 1 | **Invasive marine species and infectious organisms e.g. wakame, White Spot Syndrome Virus and emerging diseases**<br>*Driver of threat*: Climate change, risk pathways for transmission e.g. vessel movements, crustacean imports and lobster aggregation along the supply chain.<br>*Management solutions*: Disease surveillance, risk assessment of incursion pathways and understanding the impacts of climate change on the industry for adaptation.<br>*Barriers*: Costs of implementing biosecurity practices and limited influence on larger risk pathways (e.g. shipping). |
| 2 | **Harmful algal blooms (HABs), biotoxins and public health risk**<br>*Driver of threat*: HAB range expansion is occurring due to climatic and non-climatic factors e.g. warming ocean temperatures. Paralytic Shellfish Toxin (PST) is the primary concern for the SRL industry.<br>*Management solutions*: Effective surveillance programs in all SRL states and regions are needed. Early detection can be supported through the use of bivalves as sentinel species, aligning with the Australian Shellfish Quality Assurance Program (ASQAP). Risk assessments of areas that are not protected by the ASQAP and additional biotoxins.<br>*Barriers*: Reliance on mussels and phytoplankton to inform PST risk in SRL for human consumption. There are gaps in this surveillance approach as geographic areas are missed. Consideration of the resources and costs of surveillance are also needed. |
| 3 | **Legislation and regulations not fit for purpose for marine biosecurity**<br>*Driver of threat*: Traditionally developed for livestock, there are gaps for aquatic industries.<br>*Management solutions*: New Commonwealth and State biosecurity legislation is being rolled out. These will improve management of biosecurity and responses in marine environments. There are also new 'general biosecurity duties' placing responsibility on fishers and processors. Education and training will be needed.<br>*Barriers*: Resources needed to implement training on ideal biosecurity practices. |
| 4 | **Emergency response to infectious disease outbreaks and challenges in the marine environment**<br>*Driver of threat*: Practical and operational difficulties for eradication and control of diseases/pests in the ocean. The lack of a cost sharing agreement also needs consideration.<br>*Management solutions*: Southern Rocklobster Limited to contribute to a response through:<br>• Industry liaison role<br>• Support decision making, where possible<br>• Funding applications<br>• Effective communication with stakeholders before and during a biosecurity.<br>*Barriers*: Challenges with a cost sharing agreement across the broader aquatic industry. |

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| 5 | **Trade and market access affected by biosecurity and risk of market closures**<br>*Driver of threat:* Geopolitics and requirements to demonstrate disease freedom to trading partners.<br>*Management solutions:* Design a fit for purpose disease surveillance system for the SRL industry, establish a universal traceability system and quality assurance program. Investigate avenues for market diversification.<br>*Barriers:* Resources needed to implement training on ideal biosecurity practices. |
| 6 | **Supply chain impacted by disease outbreak or contaminated product resulting in product recall**<br>*Driver of threat*: Supply chain practices encourage disease emergence e.g. lobster aggregation from different locations and varying health status.<br>*Management solutions:* Incremental work to improve the supply chain, implement a universal traceability system and a quality assurance program.<br>*Barriers:* An efficient supply chain leads to aggregation of lobsters for economies of scale. Enhancements would require investment. |
| 7 | **Environmental quality reduction and shifting habitat ranges for SRL due to ocean activities, land use changes & climate change**<br>*Driver of threat:* Increasing human population is leading to poorer water quality.<br>*Management solutions:* Routine monitoring of lobster populations to detect issues.<br>*Barriers:* The SRL industry is a small player in the national economy and cannot directly or indirectly influence environmental quality or features affecting water quality. |
| 8 | **Reduce access to fishing areas resulting in concentrated fishing activities and increasing biosecurity risks**<br>*Driver of threat*: Increasing importance of environmental sustainability and the use of renewable energy sources.<br>*Management solutions:* Ongoing management of available fishing areas to monitor catch quotas, biosecurity risks, impacts on market supply and resource management.<br>*Barriers:* Increasing shift towards the use of renewable energies and preservation of the ocean environment. |

## Project recommendations

A number of key recommendations have been developed based on project findings. They include:

1. Develop a disease surveillance plan to understand the health status of Southern Rock Lobster to support population health and market access.
2. Develop a biosecurity plan that provides comprehensive strategy and protocols for both vessels and live holding facilities.
3. Improvement of biosecurity planning by individual fishers and a quality assurance scheme to support new biosecurity legislation. This will require stakeholder engagement and education to maintain high biosecurity standards and limit disease and marine pest risk.
4. Conduct risk assessments along the coastal waters of Victoria, South Australia and west coast of Tasmania to understand HAB and toxin (e.g. PST) risks. This is to support the need for regular mussel and lobster monitoring in other regions that are not currently under surveillance.
5. Improve biosecurity response preparedness for the Southern Rock Lobster industry by understanding the response structures, key roles and responsibilities, operational and management needs and resource requirements.

Photos: Southern Rock Lobster, © Status of Australian Fish Stocks, Fisheries Research and Development Corporation

**FRDC funded project '*2023-026: Biosecurity threats and vulnerabilities of the Southern Rock Lobster Fishery*'.**
**The full report can be found: https://www.frdc.com.au/project/2023-026.**