ZONING IN: South Australian Aquaculture Report

2023

Government of South Australia

Department of Primary Industries and Regions

ZONING IN: South Australian Aquaculture Report 2023

Information current as of September 2023

Disclaimer

Front cover photo courtesy of clenseas.com.au

All Enquiries

Department of Primary Industries and Regions
2 Hamra Avenue, West Beach SA 5024
GPO Box 1625, Adelaide SA 5001
T 08 8207 5333
E pirsa.aquaculture@sa.gov.au

Foreword

Aquaculture is the fastest growing livestock industry in Australia (9% growth per year), expected to increase to $2 billion by 2027 to meet increasing global seafood demand. South Australia is in a prime position to contribute to that growth. As a world leader in the ecologically sustainable development of aquaculture, South Australia has the most comprehensive legislative frameworks in Australia to protect and manage the State's aquatic resources whilst encouraging aquaculture investment, growth and social licence. The Department of Primary Industries and Regions (PIRSA) is the State Government agency responsible for the regulation and management of the State's aquaculture industry and through science-based policies, ecologically sustainable development risk assessment, environmental monitoring, aquatic animal health programs and strict zoning requirements ensures South Australian seafood retains a high standard of environmental credentials.

Aquaculture in South Australia is relatively young when compared to other primary industries, commencing in the late 1980s with Oyster farming in the Spencer Gulf. Despite its youth, the State's aquaculture sectors have diversified and become a well-established industry with a highly sought-after and valued product. Key commercial aquaculture species include Southern Bluefin Tuna, Yellowtail Kingfish, Barramundi, Oysters, Mussels and Abalone. In 2021-22, the South Australian aquaculture industry contributed 53% of the State's seafood economic output, worth $238 million. An emerging sector that has the potential to provide significant benefits for South Australia is marine algae (seaweed). Numerous secondary industries have also developed from the aquaculture industry, creating additional economic and employment benefits for the State, particularly in regional communities.

The Government of South Australia invests significantly in research and innovation in the State's aquaculture industry. The South Australian Research and Development Institute (SARDI) is a world-class leader in seafood and aquatic species research and works closely with industry to develop and commercialise new projects. The Fisheries Research and Development Corporation (FRDC) is a significant co-funder of strategic research projects designed to further develop aquaculture management practices through improved environmental and planning knowledge, processes and technologies.

The report entitled 'ZONING IN: South Australian Aquaculture Report 2023' profiles this important industry, including production and value, and details information on current practices, management requirements, sector activities and environmental monitoring per sector. This annual report demonstrates the Government's commitment to public accountability in reporting on aquaculture activity.

Hon Clare Scriven MLC

Minister for Primary Industries and Regional Development

Minister for Forest Industries

11 / 09 / 2023

Contents

Background

Purpose

This report provides a summary of aquaculture production and management in South Australia. The report broadly covers aquaculture regulation and management, aquatic animal health regulation and management, production trends, environmental monitoring, socio-economic impacts, key research activities that underpin management, broad sector trends (including species farmed) and challenges. The report presents information in such a way to address components of the Global Sustainable Seafood Initiative, grouped into two broad categories: environmental monitoring and aquatic animal health. The information presented in this report is for the general public, key stakeholders of the aquatic environment and the seafood industry.

General background

Global demand for seafood is increasing and with wild caught fisheries close to their production limits, aquaculture will play a crucial role in future seafood production (FAO 2018a). On an international scale, 49% of total seafood production was from aquaculture in 2020, a record high (FAO 2022). Worldwide expectations are that by 2030, aquaculture will produce 53% of global seafood production (FAO 2022). Australia's fishery and aquaculture industry is a minor global player, producing around 0.15% of global fishery and aquaculture supply by volume and less than 1% of world trade by value (FAO 2018b). However, the Australian industry exports a range of high unit value fishery and aquaculture products, and is a major contributor to regional communities.

In line with the global rise in aquaculture production since the early 2000s, Australia's aquaculture sector has been steadily increasing its real value and proportional share of fisheries and aquaculture production volume and Gross Value of Production (GVP: ABARES 2022a). In 2020-2021, GVP of Australia's aquaculture sector increased by 9% to $1.73 billion (B), accounting for 56% of total fisheries and aquaculture GVP ($3.09 B; ABARES 2022b). In 2022-23, aquaculture GVP is expected to be the dominant sector of the seafood industry, estimated to reach a peak production value of $2.29 B for the first time (ABARES 2022b).

South Australia is considered to be one of Australia's most valuable aquaculture producing states, worth $237.9 million (M) in 2021-22 (BDO EconSearch 2023). South Australian aquaculture has a reputation for producing safe, sustainable, high quality and high value seafood products within an internationally recognised, and advanced, regulatory framework. Further advantages for aquaculture in South Australia include the availability of relatively inexpensive land, pristine environment, and freedom from many known aquatic diseases that can impact aquaculture. These characteristics create significant opportunities for growth in aquaculture activity in South Australia, including through expanding export markets, growth in trade and attracting investment to the State.

Seafood sustainability standards help ensure consistency and confidence in seafood production. There are multiple environmental and sustainability standards in the seafood industry including the Aquaculture Stewardship Council, Friend of the Sea or the Global Aquaculture Alliance. In South Australia, some seafood producers, including aquaculture operators, have already applied for and received third party certification in accordance with one or more of these standards. The Global Sustainable Seafood Initiative (GSSI) has developed a benchmark for seafood standards so that a seafood supplier can (a) know which standards meet the benchmark and (b) select one that best fits their requirements, therefore avoiding the need for dual or multiple certifications. The GSSI has the backing of the Food and Agriculture Organisation (FAO) and many countries including Australia, through the Fisheries Research and Development Corporation (FRDC). For more information see www.ourgssi.org and www.frdc.com.au.

This South Australian Aquaculture report provides a summary of the seafood certification programs achieved by the South Australian aquaculture industry. The report also provides some of the regulatory information that industry and third party accreditors may require for assessment against the GSSI benchmark.

South Australian aquaculture comprises numerous species farmed in both landbased and marine environments. They predominately include Abalone, Barramundi, Marron, Yabbies, Silver Perch, Trout, Microalgae, Murray Cod, Mussels, Oysters, Southern Bluefin Tuna, Yellowtail Kingfish and more recently seaweed (no commercial production yet).

Scope

The South Australian Aquaculture Report 2023 (the report) provides an overview of marine and landbased aquaculture in South Australia within the 2021-22 financial year, using the most recent data available. The report provides information directly related to each aquaculture sector (Tuna, Finfish, Abalone, Mussels, Oysters, Landbased, Tourism, and recently, Marine algae).

Data sources used for this report include the following:

- 2021-22 BDO EconSearch Pty Ltd production and economic data (BDO EconSearch 2023)
- 2021-22 Environmental Monitoring Program (EMP) data
- 2021-22 PIRSA Fisheries and Aquaculture management activities, industry trends and external factors.

Regulatory framework

General aquaculture regulation

South Australia strives to be at the forefront of aquaculture development and planning, and the *Aquaculture Act 2001* is currently the only dedicated aquaculture legislation of its kind in Australia. The Department of Primary Industries and Regions (PIRSA) is the State Government agency responsible for the regulation and management of the State's aquaculture industry.

South Australia has taken a strategic approach to regulation and seeks to proactively plan for the future growth and expansion of the industry. While competition for, and access to, South Australia's natural resources is increasing, the government is supporting the efficient and effective use of these resources through sound policies and planning and a one-stop-shop approach to aquaculture administration which involves PIRSA coordinating referrals and consultation with other government departments, key stakeholders and the community. The objects of the *Aquaculture Act 2001* are:

- To promote ecologically sustainable development of marine and inland aquaculture
- To maximise the benefits to the community from the state's aquaculture resources
- To ensure the efficient and effective regulation of the aquaculture industry.

The *Aquaculture Act 2001* establishes the broad framework for the regulation of aquaculture in South Australia by:

- Defining aquaculture as the farming of aquatic organisms for the purposes of trade, business or research
- Authorising aquaculture by setting the parameters within which it can occur
- Enshrining the principle of ecologically sustainable development (ESD)
- Providing for planning for the future of the aquaculture industry through the development/review of aquaculture zone policies
- Maintaining requirements for aquaculture leases and licences.

The *Aquaculture Act 2001* provides that no one may conduct aquaculture in South Australia unless authorised to do so by an aquaculture licence. There are two types of aquaculture that occur in South Australia:

- Marine aquaculture (aquaculture occurring in State waters)
- Landbased aquaculture.

For marine aquaculture, an aquaculture lease is required to provide access to specific areas of State waters and a corresponding aquaculture licence authorises the nature of the activity conducted (e.g. species to be farmed, farming method, amount of stock permitted). For landbased aquaculture, only an aquaculture licence is required.

In South Australia, assessment of individual aquaculture licence applications follow strict guidelines. A semi-quantitative risk assessment, based on a national best practice Ecological Sustainable Development (ESD) risk assessment framework (Fletcher et al., 2004) is applied to determine the sustainability and outcome of each individual application. The integrity of the assessment process relies on understanding both the nature of the environment in which the intended aquaculture operation occurs and the manner in which it interacts with or changes the environment that surrounds it.

As part of the assessment process, up to 36 possible risk events that are directly relevant to potential aquaculture influences, are considered and applied to both site and regional levels. Risk events are assessed for the construction phase and ongoing

activities. Some of the risks that are assessed include impacts to sensitive habitats, erosion, sedimentation, access by public, escape, disease management, chemical use, water flow, water quality, nutrient discharge, and interaction with threatened and migratory species.

PIRSA also applies general guidelines to minimise environmental harm, for example aquaculture activities are not to be placed over sensitive habits (e.g. seagrass or reef) unless the appropriate mitigating strategies are in place to minimise potential environmental harm. Aquaculture activity is excluded in buffer zones around areas of conservation and heritage significance such as seal colonies, aquatic reserves, shipwrecks and national parks unless the appropriate approval from relevant authorities is secured.

All applications for aquaculture licences are reviewed for environmental issues and referred to the Environment Protection Authority (EPA) for assessment to ensure the proposal meets the objectives of the *Environment Protection Act 1993* and associated Environment Protection Policies (EPPs). Environmental issues of interest to the EPA include protection of water quality, management of noise and air quality, solid waste management and disposal, storage, use and disposal of hazardous substances and ecological impacts from pollution.

It is important to note that PIRSA's ESD risk assessment process currently does not consider the positive impacts of an aquaculture activity, including ecosystem services, which are more recently being documented in the literature (Zhu et al., 2020; Naylor et al., 2021; Alleway et al., 2022; Jones et al., 2022). These positive aspects of aquaculture are increasingly being considered by regulators and the community, which better support social licence.

Social licence for aquaculture has been a challenge elsewhere in Australia and overseas. Achieving and maintaining social licence in aquaculture is important and requires good science-based governance, as well as adequate consultation, communication and awareness (Alexander, 2022).

Environmental regulation

Under the *Aquaculture Regulations 2016*, all aquaculture licence holders are required to submit an annual Environmental Monitoring Program (EMP) report to PIRSA which provides information on how they have been using the site. This information is vital to the continued sustainable management of the aquaculture industry. Information collected varies for each sector but generally includes:

- Site development and productivity (all sectors)
- Species farmed (all sectors)
- Amount of stock held on site per month (all marine)
- Feed and chemical inputs (all sectors)
- Water usage and discharge (landbased)
- Interactions with site infrastructure and marine vertebrates (all marine)
- Escape of stock (all sectors)
- Disease incidents (all sectors)
- Debris incidents (all marine)
- Waste and refuse disposal (all sectors).

Environmentally responsible infrastructure construction, waste disposal and general storage

Under regulation 25 of the *Aquaculture Regulations 2016*, aquaculture farming structures and general infrastructure are required to be maintained in such a condition that will prevent pollution, either at the construction or ongoing operations. At the decommissioning of a site, operators of marine leases are required to remove all structures and stock and rehabilitate the site to a condition to the satisfaction of the Minister.

Requirements for waste disposal and appropriate storage of chemicals, feed materials and general farm waste are legislated under the *Environment Protection Act 1993*, and associated EPPs. The EPA has also developed specific codes of practice for the Oyster and Abalone industry that highlight the environmental issues in relation to these industries and provide recommendations to assist farmers to meet their legislative requirements under the *Environment Protection Act 1993*.

Impacts on habitat and biodiversity

Minimising the impacts to the seafloor from marine aquaculture activities is important for ecological sustainable development. To achieve this, aquaculture activities involving feed addition (e.g. Tuna, Finfish and Subtidal Abalone) are not to occur over sensitive habitats (e.g. seagrass or reef) unless appropriate mitigating strategies are in place to minimise risk and monitor the seafloor over time. In addition, regulation 25 of the *Aquaculture Regulations 2016* requires that floating structures are kept at least 3 metres (m) above the seafloor to prevent scouring, rubbing or shading of the seafloor unless the licence holder has authorisation to do otherwise (for example subtidal Oyster structures).

There are multiple areas in South Australia where aquaculture is restricted and require appropriate approvals e.g. around parks declared under the *National Parks and Wildlife Act 1972*, historic shipwrecks declared under the *Historic Shipwrecks Act 1981*, and within some zones of marine parks (*Marine Parks Act 2007*) which further protect sensitive areas. PIRSA also apply an aquaculture exclusion buffer around Australian Sea Lion (ASL) breeding and haul-out areas.

To ensure that aquaculture activities have minimal impact on Threatened, Endangered and Protected Species (TEPS), PIRSA undertake an ESD risk assessment prior to the approval of an aquaculture licence that includes an investigation of the impacts to TEPS (e.g. sharks, dolphins, seals, seabirds) that may occur in the area. All aquaculture licence holders are also required to submit an aquaculture strategy to the Minister on how they will avoid or minimise and respond to adverse impacts on, or adverse interactions with large marine vertebrates (e.g. TEPS, sharks) or seabirds (under regulation 18 of the *Aquaculture Regulations 2016*). The aquaculture strategy can be either sector based (for example see Mussels) or individual (licensee) and must be approved by the Minister (under regulation 19 or 20 of the *Aquaculture Regulations 2016*). The licence holder is bound by law to comply with the strategy. If an interaction does occur, licence holders are required (under regulation 27 of the *Aquaculture Regulations 2016*) to report the incident as soon as they become aware of the interaction, and work with PIRSA and relevant agencies (e.g. the Department for Environment and Water - DEW) to resolve the incident, and where required, undertake a review of mitigation strategies.

Interactions with sharks

A study conducted on the movement and residence of White Sharks (*Carcharodon carcharias*) and Bronze Whalers (*Carcharhinus brachyurus*) in southern Spencer Gulf (Rogers and Drew, 2018) identified that there is negligible overlap between sharks and Tuna/Finfish aquaculture activities in Spencer Gulf, suggesting that Tuna/Finfish aquaculture does not lead to aggregations of sharks to an area (for more information see Research). For the rare event when sharks become trapped inside a Tuna/Finfish pontoon, the study also developed industry guidelines for the safe removal and release of pelagic sharks from aquaculture pontoons. The guidelines provided an improvement on individual aquaculture strategies to mitigate shark interactions with Tuna/Finish aquaculture (pursuant to regulation 18 and 20 of the *Aquaculture Regulations 2016*).

More recently, a separate study monitoring White Shark and Bronze Whaler movements and residency adjacent to an aquaculture tourism lease containing Tuna/Finfish species in South Australia also did not find any evidence of the operation affecting the behaviour of these shark species (Huveneers et al., 2022).

It is noteworthy that husbandry practices of aquaculture operators have improved as the business of aquaculture has evolved and become more commercially focussed. Some of these husbandry practices include increased frequency of diver removal of dead fish from sea-cages, checking for holes in nets and introducing false bottoms to nets to increase the distance from the bottom of sea-cages to fish outside the cages—this decreases the opportunity for predators to reach dead fish in sea-cages.

Impacts on water resources

Nutrients (including faeces and un-utilised feed) released from aquaculture activities can have significant adverse impacts on water quality and benthic environments. To address this, aquaculture zone policies limit the biomass (and by association the amount of feed that is used) that can be farmed in an area. To further understand the impact of aquaculture on water quality, a regional monitoring program was implemented for Lower Spencer Gulf in 2015, in which water quality is a major component (see Tuna and Finfish sections). For landbased operators, water usage may be legislated by DEW.

Requirements for water quality are legislated under the *Environment Protection Act 1993* and the *Environment Protection (Water Quality) Policy 2015* administered by the South Australian EPA. All aquaculture licensees must comply with EPA legislation and not cause environmental harm.

Species selection and escapes

The escape of aquaculture stock can have serious implications for wild populations. Therefore, it is important to establish and maintain appropriate containment controls for stock to prevent an escape. There are however situations beyond the control of a licence holder where an escape can occur. To minimise the escape impact, PIRSA has multiple regulatory controls. The stock genetics are considered during the initial assessment of an application to farm and all licence holders must keep a stock register that outlines stock movements to and from the aquaculture site (regulation 15 of the *Aquaculture Regulations 2016*). In addition, all aquaculture licence holders are required to submit a strategy to the Minister on how they will minimise stock escapes, including infrastructure maintenance and staff training. The strategy must be approved by the Minister and the licence holder is bound by law to comply with the strategy. If an escape does occur, licence holders are required (under regulation 26 of the *Aquaculture Regulations 2016*) to report the incident within 24 hours and to rectify the cause of escape to prevent further escapes.

Compliance

Planning and compliance inspections are central to a well-established and contemporary industry. To ensure compliance with lease/licence conditions and relevant legislation, PIRSA authorised officers conduct routine field inspections and data audits for each aquaculture sector. Issues such as navigation, location of farming structures, species farmed, impacts to benthic habitats and discharge of water are among those variables that are investigated. Aquaculture site evaluations may also be conducted as part of the initial assessment of an application, in response to public concern, as an integral part of the risk assessment process for the licence application or as part of an audit program.

Aquatic animal health regulation

South Australia's freedom from many significant aquatic diseases provides competitive advantages in seafood production and market access. PIRSA maintains a dedicated aquatic animal health program, which aims to safeguard South Australia's fisheries and aquaculture resources from the impact of aquatic diseases. Aquatic Animal Health is regulated under the *Aquaculture Act 2001*, the *Aquaculture Regulations 2016*, the *Fisheries Management Act 2007*, the *Livestock Act* 1997 and Notices under the *Livestock Act 1997*.

Veterinary medicine use

Veterinary medicines are important disease management tools. When used correctly, veterinary medicines play a valuable role in ensuring animal welfare and maximising the quality and yield of primary produce. Aquaculture farmers must endeavor to use veterinary medicines that are registered under the *Agricultural and Veterinary Chemicals Code Act 1994* (Agvet Code) through the Australian Pesticides and Veterinary Medicines Authority (APVMA). However, for veterinary medicines that are not permitted or registered with the APVMA, the South Australian *Aquaculture Regulations 2016* (regulation 10) provides a mechanism for off-label use (unregistered with the APVMA) under prescription from a registered veterinarian. Reasons for off-label use include new emergent diseases in aquaculture (a comparably young primary industry), emergencies and experimental treatments to facilitate data collection for APVMA minor use permits or registration.

For off-label veterinary medicine use under the *Aquaculture Regulations 2016*, PIRSA requires a veterinary prescription and information on the product, disease diagnosis, species to be treated, efficacy, host safety and environmental risk (including environmental toxicity). Risk assessment, calculation of environmental trigger values and predicted residue calculations are included in the assessment process agreed to by the EPA. The EPA is consulted with for applications that include discharge to the environment. Requests for use of antibiotics are considered in line with the World Organisation for Animal Health (OIE) Aquatic Animal Health Code and in line with Australia's National Antimicrobial Resistance Strategy (AMR); that is, treatments for a diagnosed disease are considered (but not prophylactic treatment). For further information, see www.pir.sa.gov.au/aquaculture/aquatic_animal_health/veterinary_medicine_use_in_aquaculture

Livestock translocations

Aquatic livestock translocations are regulated under both the *Aquaculture Regulations 2016* and the *Livestock Act 1997* primarily for the purpose of reducing the risk of disease introduction and spread. Wild stock caught or collected for the purpose of aquaculture may require approval under both the *Fisheries Management Act 2007* (i.e. seedstock and broodstock). Legislative restrictions are in place to mitigate high risk movements of aquaculture livestock, including movements of livestock within South Australia, wild caught/collected stock brought onto a farm, and importing stock into South Australia.

Assessment of livestock translocation requests may include requirements for veterinary stock inspection, batch testing to rule out notifiable and infectious disease, health certification and requirements for hatchery biosecurity in line with national guidelines: www.agriculture.gov.au/animal/aquatic/guidelines-and-resources. For further information on aquatic diseases see: www.pir.sa.gov.au/biosecurity/aquatics/aquatic_diseases and for moving or importing aquatic animals see: www.pir.sa.gov.au/biosecurity/aquatics/moving_aquatic_animals

Disease management and surveillance

Disease management includes requirements to report disease (including notifiable diseases), report unusually high and unexplained mortality events, and requirements to maintain stock records (i.e. stock movement, mortality rate). These requirements are for aquaculture licence holders as prescribed under the *Aquaculture Regulations 2016*. In addition to batch testing for livestock translocations, these requirements provide for disease surveillance (passive), and early disease detection that can trigger investigations (e.g. aquaculture mortality or fish kill reports) to rule out disease (to support trade and market access, as well as provide for rapid disease response). Disease management also now includes zoning, for example Mollusc Disease Management Areas based on FRDC 2018-090 project (Roberts et al., 2020), which are now adopted in PIRSA's Emergency Response Plans. Emergency disease response protocols are in line with the OIE Aquatic Animal Health Code and Australia's Aquavetplan series of emergency disease response guidelines: www.agriculture.gov.au/animal/aquatic/aquavetplan

Active surveillance is also undertaken by PIRSA as required to confirm disease status or freedom from disease for the purpose of emergency response, to support policy (e.g. livestock translocation) or to support trade and market access requirements. Previous active surveillance in South Australia has occurred, including for Abalone Viral Ganglioneuritis (AVG), Withering Syndrome and *Perkinsus* (for Abalone), *Bonamia* (for Native Oysters), various notifiable prawn diseases (including White Spot Syndrome Virus, WSSV) and for Pacific Oyster Mortality Syndrome (POMS).

Disease management in aquaculture can also include farm biosecurity which may be a requirement for State livestock translocation approvals or a requirement of importing jurisdictions / countries. National guidelines now exist for aquaculture farm biosecurity including:

- Generic farm biosecurity guidelines (www.agriculture.gov.au/fisheries/aquaculture/farm-biosecurity-plan), or
- Sector specific farm biosecurity guidelines (www.agriculture.gov.au/animal/aquatic/guidelines-and-resources).

PIRSA respond to wild fish kills and suspected disease in aquaculture (see Fish kill and fish health investigations) to primarily rule out infectious and notifiable disease (PIRSA is the hazard leader for animal disease responses). If disease is detected, mitigation may include eradication, containment or control measures. If disease is ruled out and a chemical spill, oil spill or pollutant are determined to be a possible cause, then the appropriate government department are notified to investigate (e.g. the EPA or Department for Infrastructure and Transport (DIT)).

Fish kills are a global phenomenon and can be attributed to natural oceanographic cycles, disease outbreaks, harmful algal blooms (HABs), coastal pollution, marine heatwaves or climate change (Roberts et al., 2019; Smith et al., 2023). In South Australia, many small scale fish kills investigated have been attributed to shallow, unprotected waters that are greatly influenced by extreme weather conditions including temperature (i.e. peak summer and peak winter), dodge or minimal tides, anoxia (low dissolved oxygen), HABs, 'blackwater' events in freshwater systems (flooding and associated anoxic water from high organic loads) and acid sulphate soil disturbance. Susceptible species are generally those in shallow water environments (including juveniles of economically important species), particularly benthic and intertidal species. Common species associated with natural fish kill events include Bony Bream, Carp, Mullet, Garfish, Crabs and various Molluscs (including Abalone). Furthermore, causes of individual fish kill events can often remain unknown due mostly to the mortality not being observed and reported until fish wash ashore, which impedes appropriate sample collection and analyses. Investigations sometimes rely on anecdotal evidence and climatic weather observations as the basis for attributing "likely causes", with the situation closely monitored.

South Australian Shellfish Quality Assurance Program

The South Australia Shellfish Quality Assurance Program (SASQAP) is part of PIRSA's Biosecurity Division within the Food Safety Program. Biosecurity is the principal government agency charged with monitoring and maintaining shellfish food safety in South Australia (www.pir.sa.gov.au/biosecurity/food_safety/shellfish_sasqap).

SASQAP is a regulatory testing body that provides consumer protection and ensures development of domestic and international markets through the monitoring and testing of shellfish and water in shellfish growing areas in South Australia. Bivalve molluscs such as Oysters, Mussels, Cockles and Pipis are filter feeders that have the ability to concentrate bacteria, parasites, viruses, toxins and heavy metals.

If adverse conditions are likely to arise in a shellfish harvesting area, for example as a result of heavy rainfall events causing runoff from the land into the marine environment, SASQAP acts to close these areas as a precautionary measure to prevent contamination of the shellfish in the area. This serves to ensure only safe product reaches the market.

There are currently 28 classified shellfish harvesting areas in South Australia (Maps and GPS boundaries of harvesting areas - PIRSA), the majority of which are located on the west coast of the Eyre Peninsula. There are also some other areas within Spencer Gulf, Gulf St Vincent and on the coast of Kangaroo Island.

National Aquaculture Strategy

In October 2017, the Federal Department of Agriculture and Water Resources (DAWR) released a National Aquaculture Strategy, which was developed with, and supported by state and territory jurisdictions and industry (www.agriculture.gov.au/sites/default/files/sitecollectiondocuments/fisheries/aquaculture/national-aquaculture-strategy.pdf). The strategy is a national document designed to complement policy priorities and activities underway in jurisdictions aimed at supporting sustainable aquaculture growth. The strategy aimed to increase the value of Australia's aquaculture industry to $2 B per year by 2027. However, the value of Australia's aquaculture industry is now expected to reach a peak production value of $2.29 B for the first time in 2022-23 (ABARES 2022b).

The strategy aims to streamline regulatory frameworks and enhance research, development and extension for aquaculture in Australia. Further, this strategy supports aquaculture by promoting opportunities for Aboriginal communities and integrated multi-trophic aquaculture (IMTA). South Australia has been meeting goals of the strategy by creating two new zones at Point Pearce that allow for aquaculture activity that is in the interest of the local Aboriginal community, which will also provide opportunities for IMTA in the *Aquaculture (Zones-Eastern Spencer Gulf) Policy 2005*. Furthermore, with multiple aquaculture licences across the State now approved to farm seaweed (see Marine algae (seaweed)), there are greater opportunities for IMTA.

Seafood Growth Strategy for South Australia 2021-2031

In 2020, the state government established the Seafood Advisory Forum to bring together the different elements of the seafood industry: recreational fishers, commercial fishers, seafood processors, aquaculture, charter fishers, the restaurant sector and Aboriginal traditional fishers. The Forum has developed a 10-year strategic plan that aims to drive growth and opportunities for a sustainable, productive and profitable seafood sector in South Australia. The seafood growth strategy is underpinned by several key pillars that will support the State Government's Growth State plan, which aims to achieve a primary industries revenue of $23 B by 2030. More information on the Seafood Growth Strategy for South Australia can be found here: www.pir.sa.gov.au/__data/assets/pdf_file/0017/401480/seafood-growth-strategy-sa.pdf

Aquaculture activity in South Australia

Socio-economic data

Based on the most recent published BDO EconSearch report, the State's total value of seafood production (landed) in 2021-22 was $444.9 M, of which aquaculture contributed over half ($237.9 M) and wild-catch fisheries contributing the balance ($207 M) (Table 1, BDO EconSearch 2023). The State's total aquaculture production in 2021-22 was 20,737 tonnes (t), up 13% compared to 2020-21 (18,353 t). For comparison, the State's total wild-catch fisheries production in 2021-22 was 54,724 t, up 18% compared to 2020-21 (46,334 t, Figure 1). Despite wild-catch fisheries production being greater than aquaculture production, the total value of aquaculture was significantly greater. This demonstrates the high value of seafood derived from aquaculture. The contribution of each sector to the total production and value of aquaculture in South Australia during 2021-22 is shown in Figure 2.

The aquaculture industry in South Australia has developed significantly since the Oyster sector first began commercial production in the 1980s. South Australia is now home to the most diverse range of aquaculture sectors in Australia. The largest single sector in the State's aquaculture industry is Tuna (Figure 2), which accounted for approximately 46% or $110.4 M of South Australia's gross value of aquaculture production in 2021-22 (Table 1, BDO EconSearch 2023). The next three highest value sectors are Oysters (20% or $47.78 M), Marine Finfish (17% or $41.45 M), and Abalone (7% or $15.37 M). (Figure 2, Table 1).

The State's total value of aquaculture production in 2021-22 increased by 19% compared to 2020-21 ($200.09 M, Table 1). A large proportion of the South Australian aquaculture production, particularly Tuna, is considered a premium high value product, and is exported overseas to high-end markets. Accordingly, the value of the Australian dollar can have a significant impact on the economic performance of the industry. Significant changes in the value of the Australian dollar also have the potential to influence the demand for Australian aquaculture exports. The Australian dollar depreciated overall between 2020-21 (US$0.75) and 2021-22 (US$0.73), a decrease of 3 per cent (BDO EconSearch 2023), however total value of aquaculture production remained strong.

Table 1: South Australia aquaculture production and value for the years 2020-21 and 2021-22 (BDO EconSearch 2023)

	Weight ('000kg)			Value ($m)		
	2020/21	2021/22	Change	2020/21	2021/22	Change
Southern Bluefin Tuna	7,600	8,322	10%	91.00	110.40	21%
Marine Finfish	2,825	2,919	3%	33.56	41.45	24%
Oysters						
adult [a]	4,687	4,929	5%	43.75	47.78	9%
on-grown [b]	691	796	15%	2.42	2.61	8%
spat [c]	-	-	-	6.41	6.40	0%
Mussels	1,845	2,113	15%	3.69	4.65	26%
Abalone [d]	440	402	-9%	18.47	15.37	-17%
Freshwater Finfish	307	295	-4%	4.69	4.90	5%
Marron and Yabbies	2	4	89%	0.08	0.20	145%
Other [e]	647	1,753	171%	4.85	13.15	171%
Tourism (visitors)	0	0	0%	0.00	0.00	0%
Total [f]	**18,353**	**20,737**	**13%**	**200.09**	**237.90**	**19%**

[a] The weight for adult Oysters is an approximation on the basis that a dozen Oysters weighs one kilogram.

[b] The volume of production for on-grown Oysters is shown in '000s of dozens. The volume and value of juvenile Oysters sold for on-growing are excluded from the total volume and value of aquaculture as it is considered an input to production for the final sales of adult Oysters.

[c] The value of spat is also excluded from the total. All spat grown in SA is now sold in SA (i.e. no spat grown in SA is exported to other states) and is considered an input to production for the final sales of adult Oysters.

[d] Abalone produced from marine and land-based aquaculture sites, i.e. the data represent species not class of licence.

[e] Other aquaculture production in 2020-21 and 2021022 was mostly comprised of land-based Algae production.

[f] Totals may contain rounding errors.

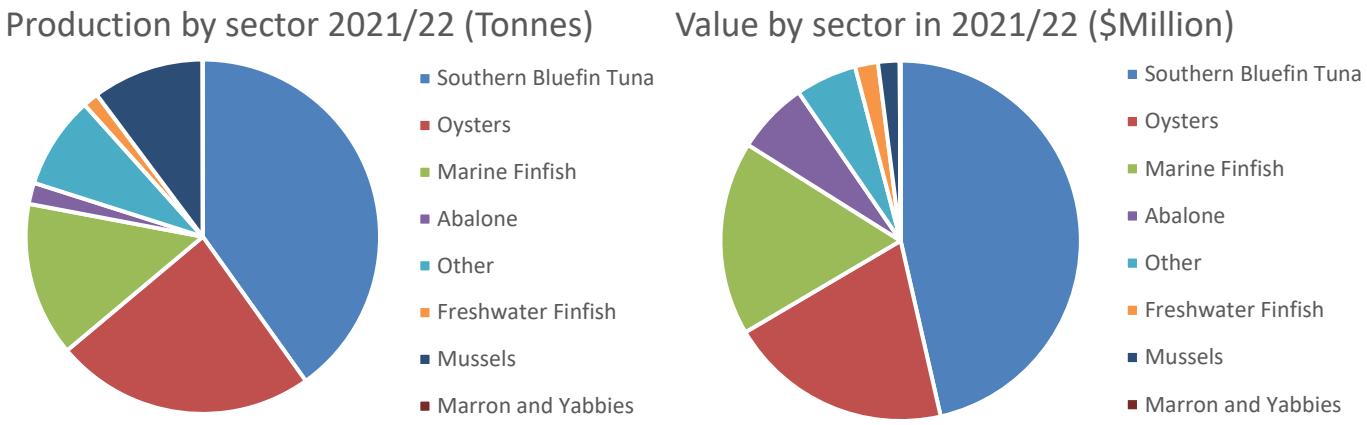


Figure 1. SA fisheries and aquaculture production (t) and value ($M) in 2021-22.

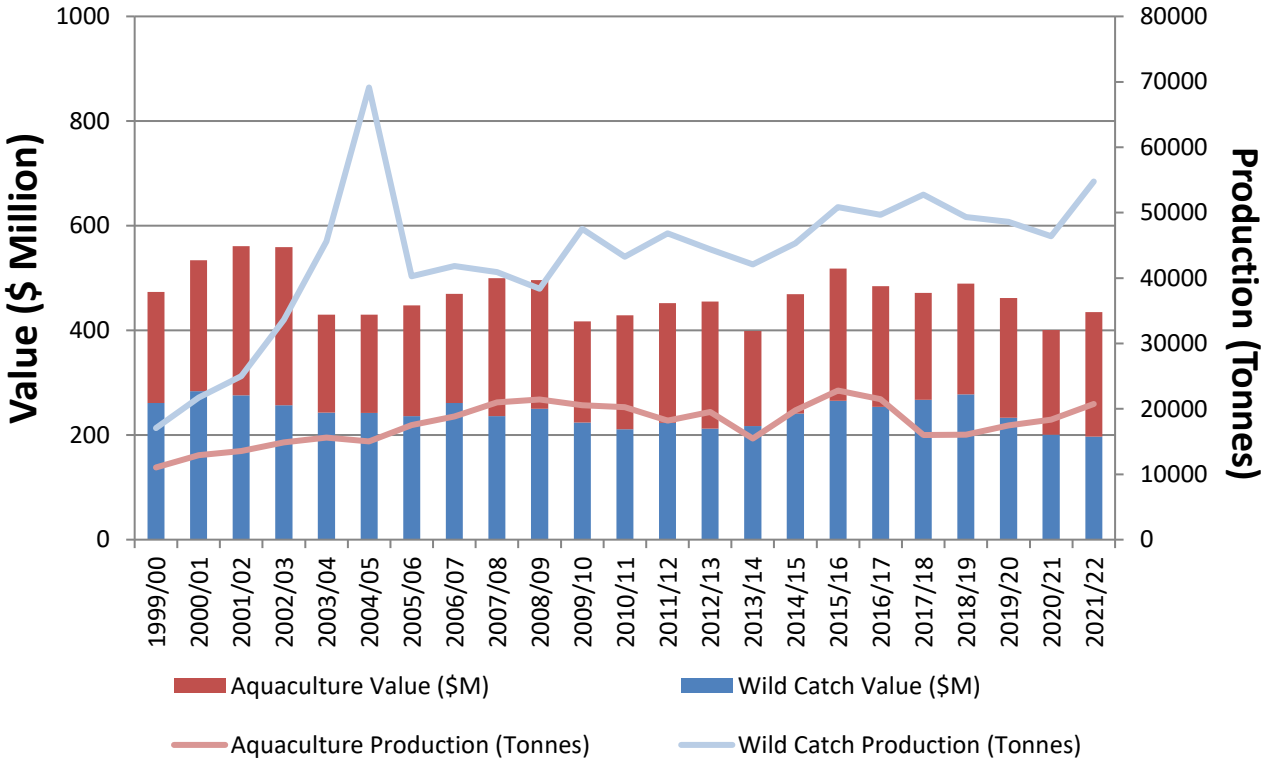


Figure 2. Contribution of each sector to the total production (t) and value ($M) of aquaculture in South Australia during 2021-22.

The overall increase in total value of aquaculture production was driven by Tuna ($110.40 M or 21% change), Oysters ($47.78 M or 9% change), Marine Finfish ($41.45 M or 24% change), Other ($13.15 M or 171% change), and Mussel ($4.65 M or 26% change) aquaculture sectors (Table 1, BDO EconSearch 2023). For detailed information on the change in total value of aquaculture production between 2020/21 and 2021/22 see [The economic contribution of aquaculture in the South Australian state and regional economies, 2021–22 (pir.sa.gov.au)](pir.sa.gov.au).

In 2021-22, aquaculture's total contribution to gross state product (GSP) of $367.9 M represented 0.29% of the total GSP for South Australia ($128.6 B). Around 68% of the contribution to GSP was generated in regional South Australia. Direct employment was estimated to be 1,296 Full Time Equivalent (FTE) jobs (815 on-farm and 480 in downstream activities) through direct employment and 1,547 flow-on jobs, giving total employment of 2,843 FTE (BDO EconSearch, 2023). Approximately 62%

of these jobs were generated in regional South Australia, particularly the Eyre Peninsula region, reflecting the dominance of Tuna, Marine Finfish and Mussel farming, the majority of production of Other aquaculture (predominantly microalgae) and Oyster farming (Figure 3). The production of remaining aquaculture species (i.e. Abalone, Freshwater Finfish and Marron/Yabbies) is more widely distributed across South Australia (BDO EconSearch, 2023).

In addition to the Economic Contribution of Aquaculture in the South Australian State and Regional Economies 2021-22 report, BDO EconSearch has developed South Australia Aquaculture Economic Indicators Dashboards for 2021-22, which summarise the key economic indicators (production, value, household income, employment, contribution to Gross State Product) and associated trends for each aquaculture sector; see Tuna, Marine Finfish, Mussels, Oysters, Abalone, Freshwater Finfish, Marron and Yabbies, and Other. For an overview of SA Aquaculture; see Summary economic indicators dashboard 2021-222.

Figure 3: Distribution of aquaculture sectors in South Australia, predominantly located in the regions.

South Australian aquaculture production and value of production between 1999-2000 and 2021-2022 is shown in Figure 4. Factors that have historically influenced aquaculture production and value in South Australia include:

- Fluctuating dollar against the Japanese yen which impacts on the price received for Tuna when exported to Japan. The impact of the falling yen is demonstrated in the decrease in aquaculture value of production in 2013-14.
- Increased Southern Bluefin Tuna quota allocation.

- Reduction in Oyster spat availability due to the occurrence of POMS in Tasmania which is demonstrated in the decrease in aquaculture value of production in 2016-17 and 2017-18. To assist with the recovery of the Oyster sector, fees were waivered for the period 1 January 2018 to 30 June 2020.

- Innovation and expansion of other aquaculture sectors such as the fluctuating production of Microalgae in recent years.

- Significant bushfires from November 2019 to January 2020 in four regions of South Australia, including the South-east, Yorke Peninsula, Kangaroo Island (KI) and the Adelaide Hills. A large proportion (70%) of the bushfire damage (300,000 hectares) occurred on KI, resulting in 60% of the total primary production area being damaged (187,000 hectares). A total of 19 properties licensed to conduct aquaculture on KI were affected by the bushfires. This was either through loss of stock, damage to aquaculture infrastructure (e.g. netting, fences), or access to processing facilities/local purchasers. Fires within the other regions of the State did not come in contact with registered aquaculture licences.

- Coronavirus (COVID-19) was declared a global pandemic in March 2020 which resulted in the closure of restaurants and food outlets, and a reduction or loss in access to domestic and export markets for South Australian seafood industries. Despite this, the value of production in the aquaculture industry increased by 8% in 2019-20 from the previous year. The majority of aquaculture sectors however reported negative impacts to their businesses from the pandemic, in particular the Mussel industry which reported significant impacts to the value of their production as a result of COVID-19 restrictions decreasing access to export markets and dampening of domestic food service consumption. To assist the recovery of the South Australia aquaculture industry from the impacts of COVID-19, the collection of 2021-22 aquaculture sector fees were deferred for six months and any outstanding 2019-20 fees were also deferred. The next round of fees were not collected until January 2021.

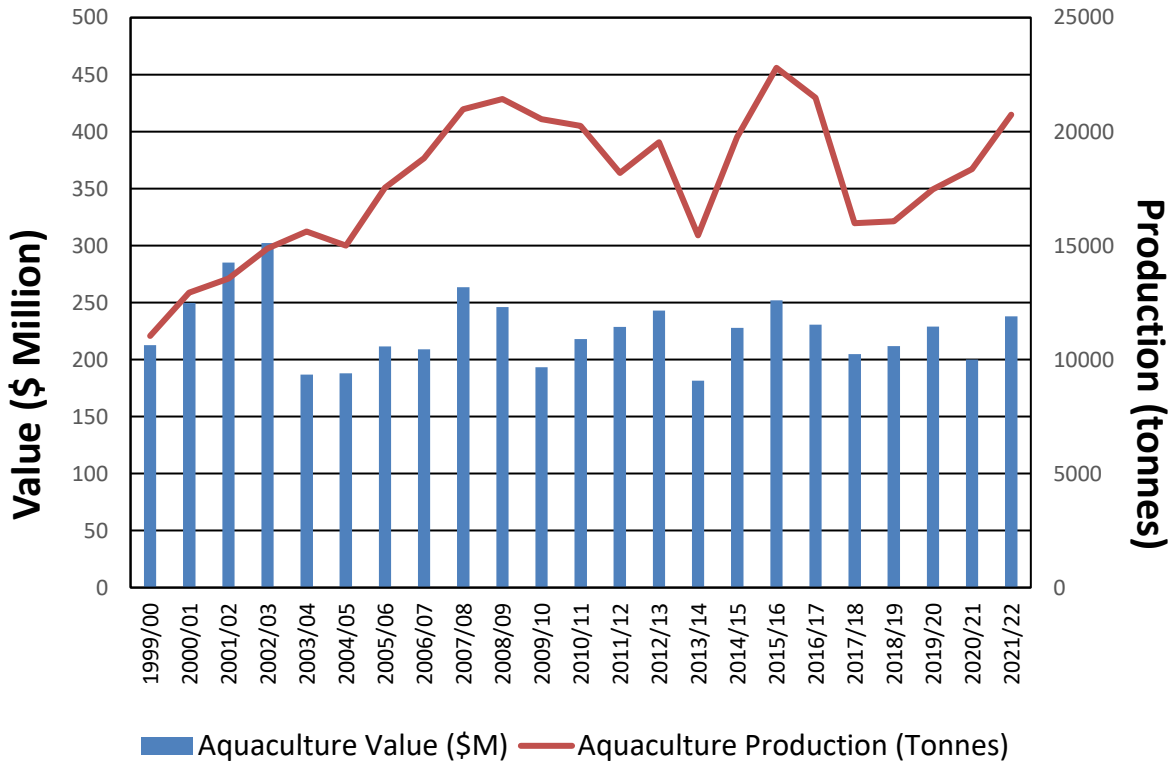


Figure 4. South Australia aquaculture production (t) and value ($M) from 1999-00 to 2021-22

Industry licence holders

The total number of active aquaculture licences in South Australia during 2021-22 was 490 (correct as of 30 June 2022), comprising 429 marine sites and 61 landbased sites (Figure 5). Included in these numbers are 6 marine maintenance sites licensed by the Tuna sector to hold and maintain sea-pontoons and one marine site licensed for tourism activities (not operating in 2021-22). A full list of the aquaculture licences for which this report relates is provided in Appendix 1.

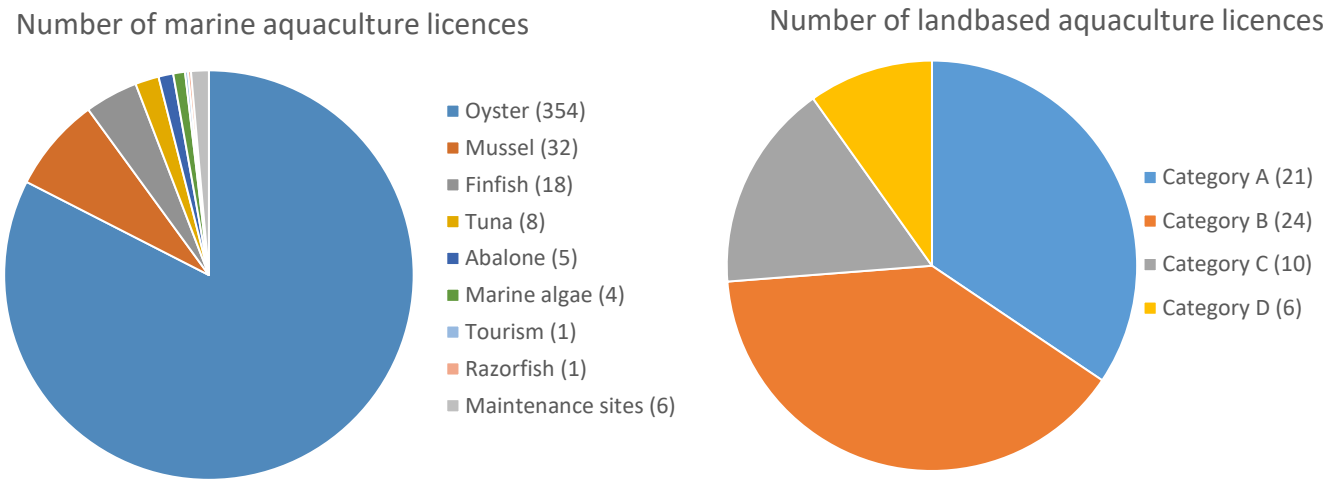


Figure 5. A summary of South Australian marine and landbased aquaculture licences 2021-22

Aquaculture applications processed by PIRSA

PIRSA processes a range of applications each year, which are requested from the aquaculture industry to improve/change the activities of their business. Lease and licence changes managed by PIRSA can include, for example, assessments for new licences, movements of leases, variations of leases/licences (e.g. species additions, divisions and amalgamations, infrastructure changes), transfers, renewals and surrenders. Table 2 represents the number (total 78) and type of application completed by PIRSA in 2021-22.

Table 2: Summary of aquaculture applications completed in 2021-22

Application type	Amount
New lease and licence	5
Lease and licence movement	1
Licence variation	10
Lease and/or licence division	3
Lease and/or licence amalgamation	2
Lease and/or licence transfer	24
Lease renewal	32
Lease/ licence surrender	1
Change of specified person/s	0

Aquaculture policy

Summary of aquaculture zone policies in South Australia

Aquaculture zone policies set out considerations for aquaculture that are specific to the environmental, sociological or geographical characteristics of the zone area. Aquaculture zones prescribe the maximum hectares (ha) that can be developed and the class of species permitted for the purposes of aquaculture. Dependent on the species considered, a maximum biomass (tonnage) can also be prescribed. The prescribed criteria are determined by the physical and biological characteristics of the zone and the biological requirements and typical farming infrastructure of the species being considered for the zone. An aquaculture zone identifies a general area in which aquaculture has been deemed suitable, noting that any specific application to undertake aquaculture within a zone is still assessed on its merits and for the specific location.

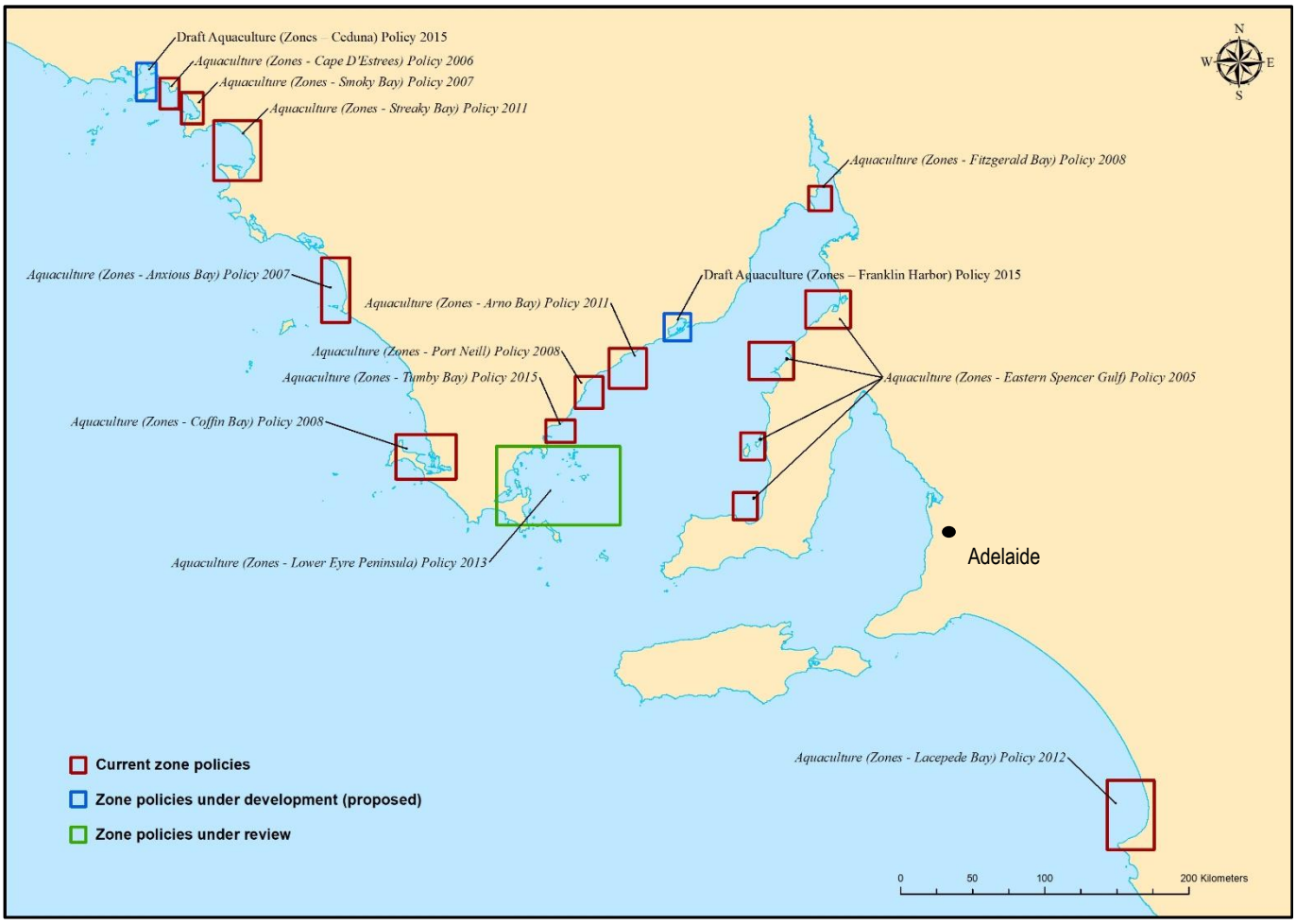


Figure 6. General indication (not actual size) of aquaculture zone policies in South Australia (current and proposed).

There are twelve aquaculture zone policies prescribed in South Australia (Figure 6), which represent management areas where aquaculture is either excluded or permitted. These zone policies occupy approximately 425 024 ha or 7% of our State waters (Appendix 2). Ten of the zone policies are located off the coast of the Eyre Peninsula, one off the western side of the Yorke Peninsula and one in the State's southeast. More than half (52%) of the area allocated to aquaculture zone policies in South Australia is comprised of aquaculture exclusion zones where no aquaculture activity is permitted. Exclusion zones generally include sensitive habitats or areas that have been identified as important for other users of the marine environment (e.g. commercial and recreational fishers). The remaining 48% is set aside to allow aquaculture production to occur and are known as aquaculture zones. In general, between 5-10% of the area within an aquaculture zone is allocated for aquaculture at any one time. This equates to approximately 0.2% of State waters currently available for aquaculture, of which 0.06% was held as aquaculture leases in 2021-22.

The *Aquaculture (Zones – Lower Eyre Peninsula) Policy 2013* is the largest in terms of total area within the State, most valuable in terms of production and value, and has the most diverse range of species produced. The most recent zone policy is

located off the coast of Tumby Bay on the Eyre Peninsula (Figure 6). Details on each policy are provided in Appendix 2 or at www.pir.sa.gov.au/aquaculture/policy_and_legislation_for_aquaculture/zone_policies.

The prescribed classes of aquaculture considered for an aquaculture zone can include:

- The farming of aquatic animals (other than specified animals) in a manner that involves regular feeding (i.e. prescribed wild-caught Tuna, Marine Finfish, Abalone or any other species requiring supplementary feed);
- The farming of molluscs (i.e. Abalone and filter feeding organisms such as Oysters, Mussels, scallops);
- The farming of bivalve/filter feeding molluscs (i.e. filter feeding organisms such as Oysters, Mussels, Scallops); and
- The farming of Algae.

Aquaculture zone policy development and review

Aquaculture zone policy ~ Development

There were no new zone policies finalised in 2021-22, however, two new zone policies continue to be developed within the Franklin Harbor and Ceduna growing regions to consolidate existing aquaculture activity occurring within these two regions.

Aquaculture zone policy ~ Review

The review of aquaculture zone policies is undertaken to support the ecologically sustainable growth of existing (e.g. Tuna, Finfish, Oysters, Mussels, Abalone) and emerging (Marine algae, Echinoderms, Tourism) aquaculture sectors. Reviews also ensure policies stay relevant and appropriate in relation to the latest science and industry developments. In 2019, a review of the *Aquaculture (Zones – Lower Eyre Peninsula) Policy 2013* (Figure 6) commenced. The review ensures the Zone Policy continues to maximise the use of marine resources for the purpose of aquaculture and provide sustainable industry growth. An Advisory Committee was established, including members from the Tuna, Finfish and Mussel aquaculture sectors, EPA, former Department of Planning, Transport and Infrastructure (DPTI) and PIRSA (including the South Australian Research and Development Institute (SARDI)) to inform the review. Other Agencies were consulted during the review, including DEW. A Draft *Aquaculture (Zones – Lower Eyre Peninsula) Policy 2023* and supporting Report was developed and underwent public consultation between late 2022 and early 2023, with finalisation to occur thereafter as per the requirements of the *Aquaculture Act 2001*. The proposed amendments include greater capacity for bivalve and seaweed aquaculture, and increases in Tuna and Finfish biomass in areas further from shore, which was based on published carrying capacity modelling. Conservative measures were used to determine the limits, which importantly result in average nutrient concentrations reaching background levels in receiving environments outside the aquaculture areas.

The *Aquaculture (Zones – Eastern Spencer Gulf) Policy 2005* was reviewed in 2020-21 to permit the farming of algae in the three Hardwicke Bay aquaculture zones following an expression of interest by the Narungga Nation Aboriginal Corporation. A Draft *Aquaculture (Zones – Eastern Spencer Gulf) Amendment Policy 2020* and supporting Report was developed and underwent public consultation in late 2020. The Policy was approved on 11 May 2021 by the former Minister for Primary Industries and Regional Development. In addition, the Policy was amended via a notice in the Government Gazette to revoke the designation of the Point Peace (east) and Point Pearce (west) intertidal aquaculture zones as a public call area. This amendment was made to stimulate aquaculture development to support the local Aboriginal community, consistent with the prescribed criteria of these aquaculture zones.

Public call for aquaculture zone policy tenure

Once an aquaculture zone policy is legislated after the aquaculture zoning process, an aquaculture lease and corresponding licence are required to undertake farming activities within the zone. It is important to distinguish between aquaculture zoning and individual site allocation and management. Aquaculture zone policies provide a broad overview of the ecological environment and establish areas in which aquaculture is deemed appropriate to occur, while controls relating to the performance of farm operations are applied through conditions of marine aquaculture leases and corresponding licences and the *Aquaculture Regulations 2016*.

Applications for lease tenure within an aquaculture zone are referred to the Aquaculture Tenure Allocation Board (ATAB). If a zone is prescribed as a public call area within an aquaculture zone policy, a public call is made inviting applicants to submit their proposal on the required application form. There are three aquaculture zones which do not require a public call to be made: Lincoln (inner) sector of the Lincoln aquaculture zone (as this zone is specifically for Tuna farming and holders of

Commonwealth Tuna quota); Point Pearce (east) intertidal aquaculture zone; and Point Pearce (west) intertidal aquaculture zone (as these two zones are intended to allow for aquaculture activity that is in the interest of the local Aboriginal community). Table 3 outlines lease tenure allocation for public and non-public call areas between 2018 and 2022. There was no public call in 2021-22, however, PIRSA continued with the assessment of licence applications received from a large public call and non-public call (10 aquaculture zones) in 2019-20.

Lease applications are assessed by the ATAB who then makes a recommendation to the Minister responsible for the administration of the *Aquaculture Act 2001* on which applications should proceed. The successful applicant will be invited to submit an aquaculture licence application, which will be subject to a comprehensive ESD risk assessment conducted by PIRSA and provision to mandatory referral agencies for comment. Applications for pilot leases outside an aquaculture zone are not subject to a competitive allocation process. The competitive allocation process ensures a fair and efficient means of allocating the State's marine aquaculture resources. The allocation process is used to determine which applicant will use the public resource at an optimum level in terms of the quality and quantity of output relative to the capacity of the environment.

Table 3: Lease tenure allocation for public and non-public calls within aquaculture zones between 2018 and 2022

Year	Zone Policy	Aquaculture Zone	Hectares released	Hectares allocated
2018	*Aquaculture (Zones – Fitzgerald Bay) Policy 2008*	Fitzgerald Bay	123	123
2018	*Aquaculture (Zones – Streaky Bay) Policy 2011*	Haslam (north bank)	8.481	6
2018	*Aquaculture (Zones – Streaky Bay) Policy 2011*	Point Gibson	10	10
2018	*Aquaculture (Zones – Lower Eyre Peninsula) Policy 2013*	Lincoln (inner sector)	NA*	125
2020	*Aquaculture (Zones – Lower Eyre Peninsula) Policy 2013*	Louth Bay	51	51
2020	*Aquaculture (Zones – Lower Eyre Peninsula) Policy 2013*	Boston Bay (Boston Bay and Boston Island east sectors)	19	19
2020	*Aquaculture (Zones – Lower Eyre Peninsula) Policy 2013*	Lincoln (outer sector)	5000	0
2020	*Aquaculture (Zones - Anxious Bay) Policy 2007*	Anxious Bay	120	120
2020	*Aquaculture (Zones – Tumby Bay) Policy 2015*	Tumby Bay	1295	800 pending
2020	*Aquaculture (Zones – Coffin Bay) Policy 2008*	Kellidie Bay	3	3
2020	*Aquaculture (Zones – Streaky Bay) Policy 2011*	Streaky Bay	40	0
2020	*Aquaculture (Zones – Streaky Bay) Policy 2011*	Blanche Port	37.5	0
2020	*Aquaculture (Zones – Eastern Spencer Gulf) Policy 2005*	Point Peace (east) intertidal	NA*	20
2020	*Aquaculture (Zones – Eastern Spencer Gulf) Policy 2005*	Point Pearce (west) intertidal	NA*	30

* Hectares released not applicable as aquaculture zone not designated as a public call area.

Pending – pending outcome of applications in progress

Aquaculture zone policy tenure allocation overview

PIRSA monitors the tenure (leasable ha) and biomass limits prescribed within each zone policy to ensure that tenure allocated is within the defined limits. The following figures (7-15) provide an indication of the tenure that is available within each of the zone policies listed in Appendix 2.

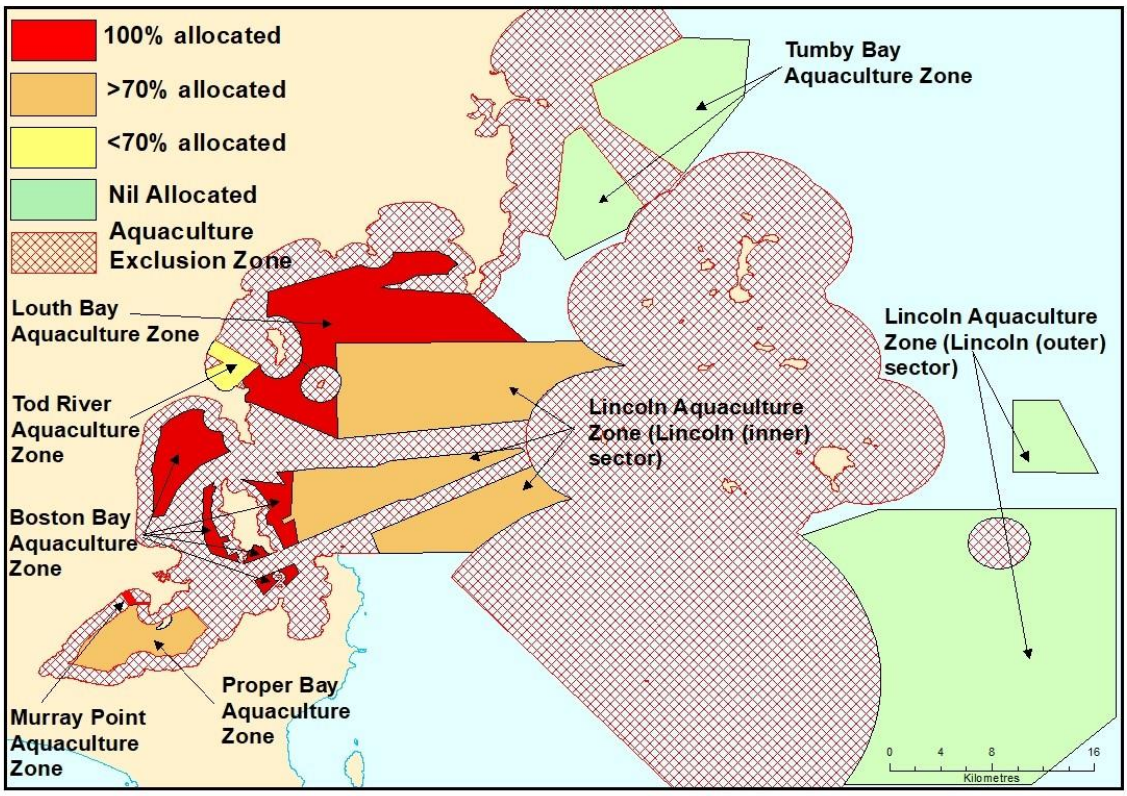


Figure 7. Tenure indication within the *Aquaculture (Zones – Lower Eyre Peninsula) Policy 2013* and *Aquaculture (Zones – Tumby Bay) Policy 2015.*

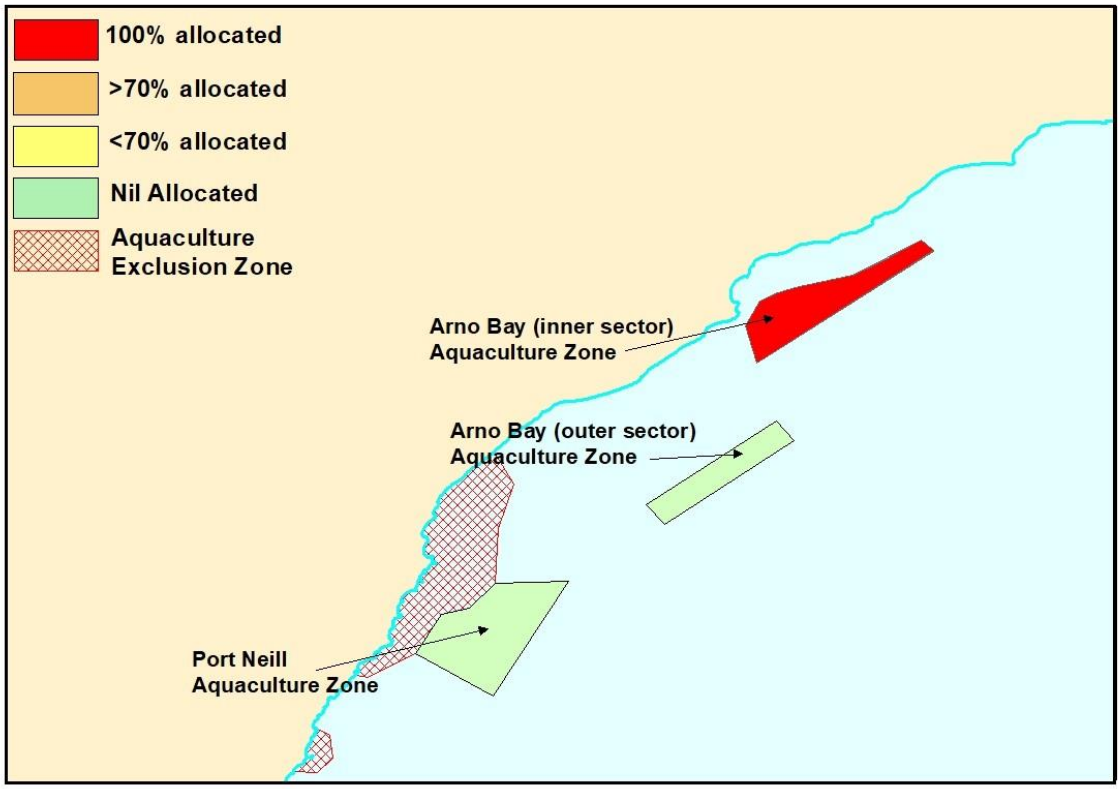


Figure 8. Tenure indication within the *Aquaculture (Zones – Port Neill) Policy 2008* and *Aquaculture (Zones – Arno Bay) Policy 2011.*

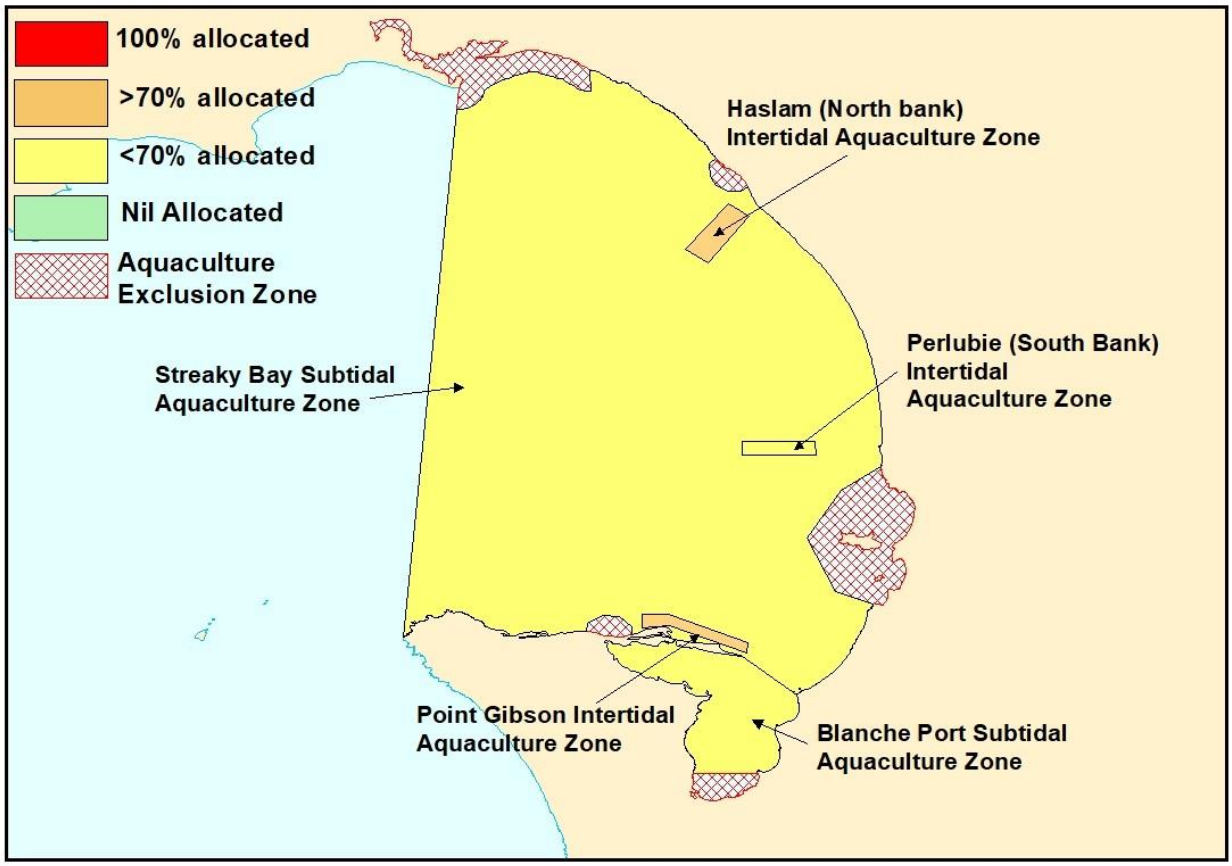


Figure 9. Tenure indication within the *Aquaculture (Zones – Streaky Bay) Policy 2011*.

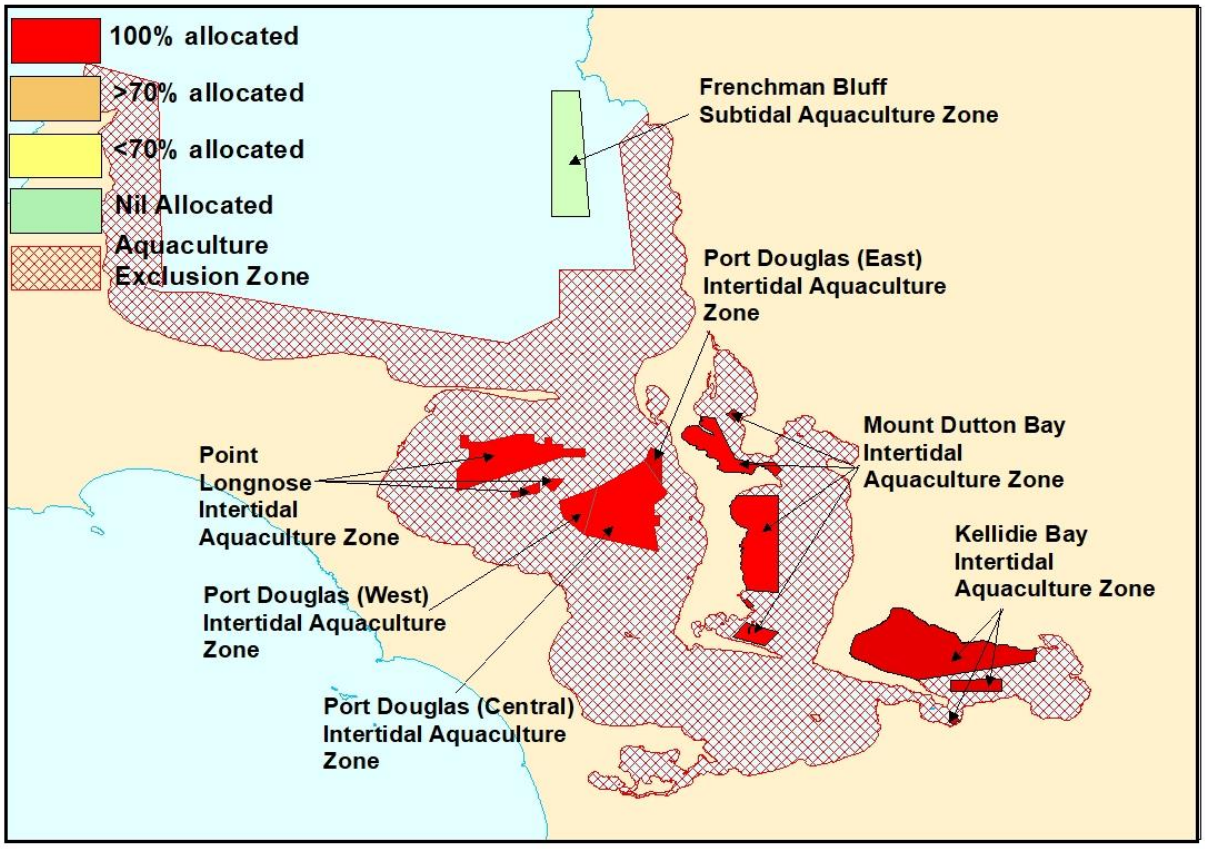


Figure 10. Tenure indication within the *Aquaculture (Zones – Coffin Bay) Policy 2008*.

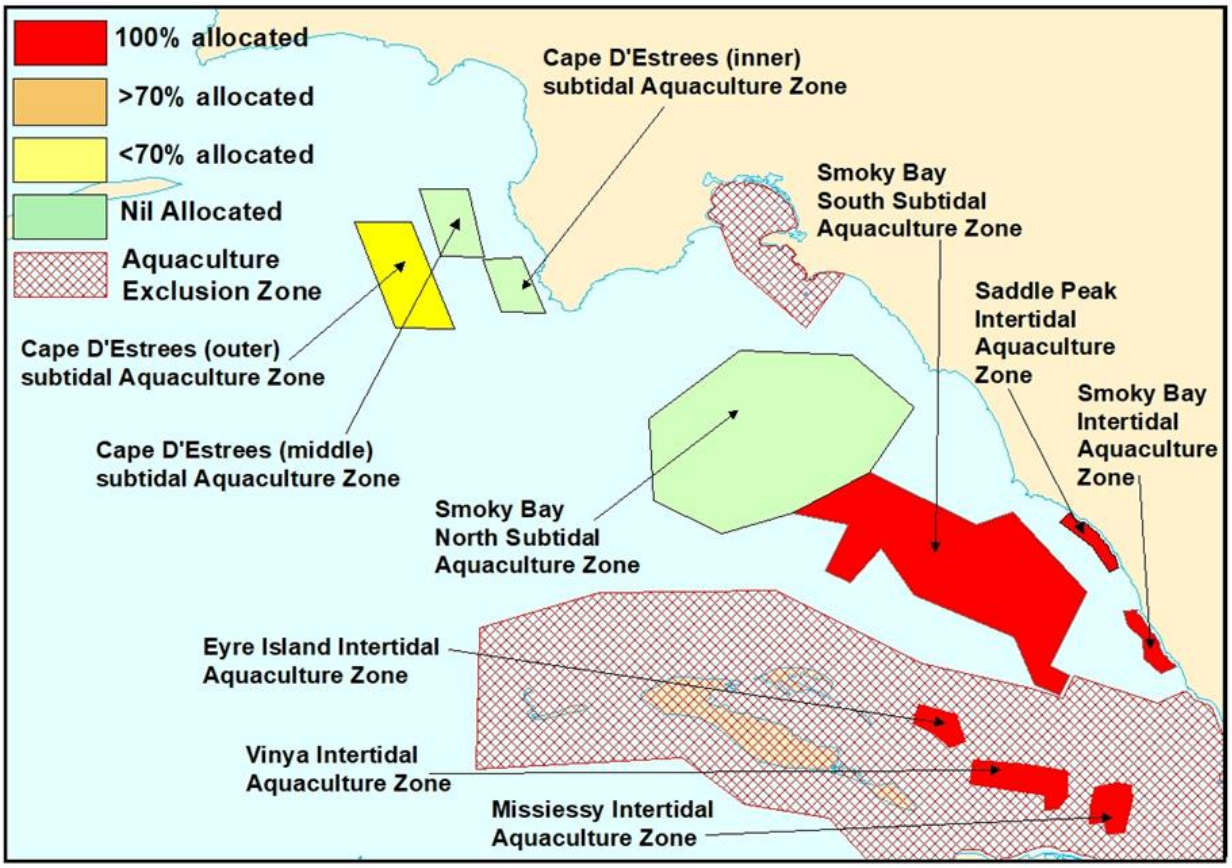


Figure 11. Tenure indication within the *Aquaculture (Zones – Cape D'Estrees) Policy 2006* and *Aquaculture (Zones – Smoky Bay) Policy 2007*.

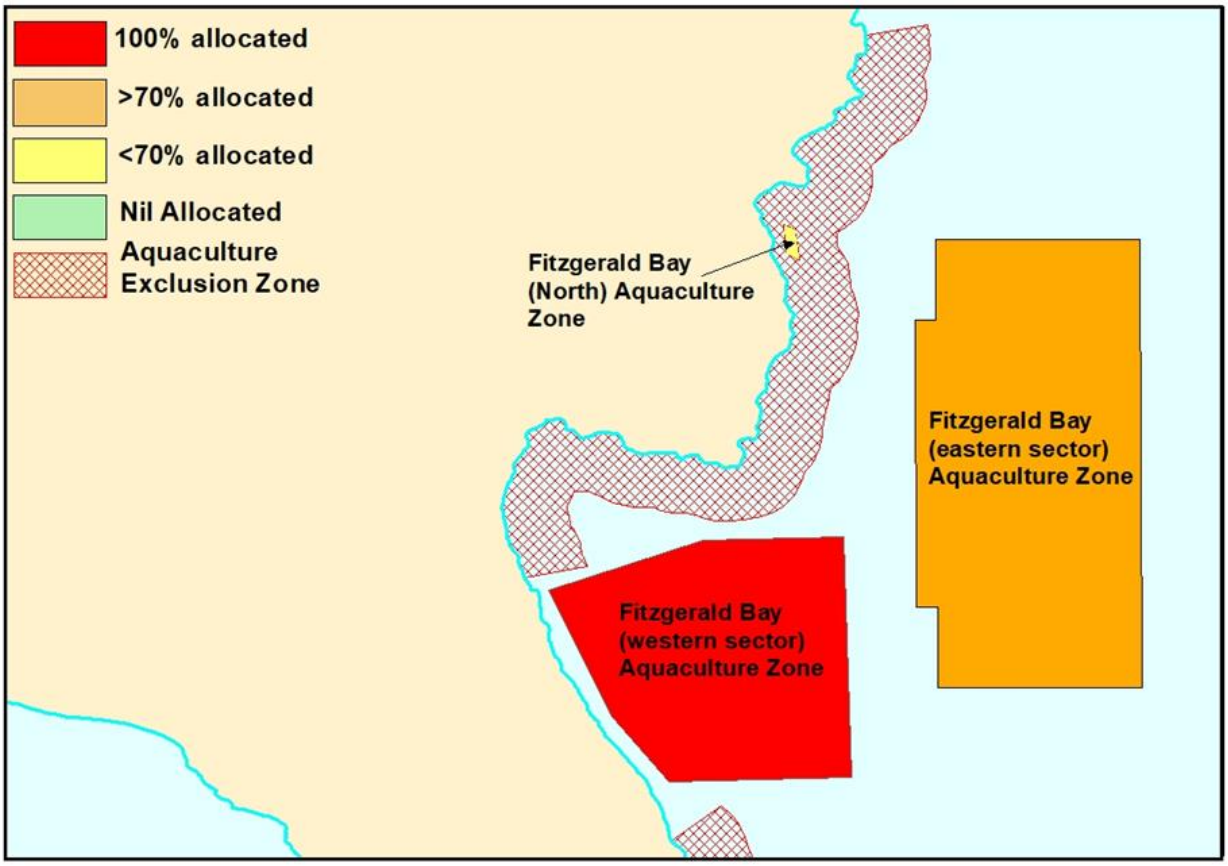


Figure 12. Tenure indication within the *Aquaculture (zones – Fitzgerald Bay) Policy 2008.*

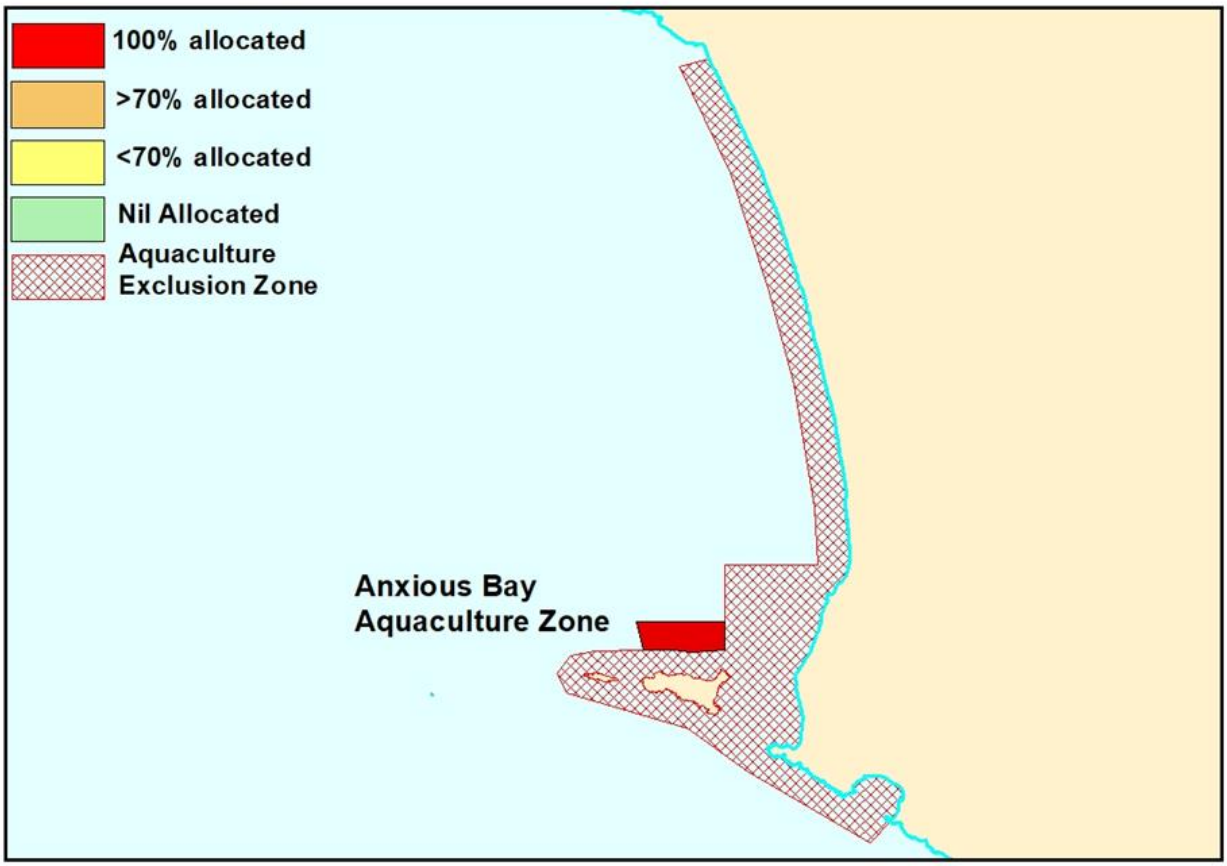


Figure 13. Tenure indication within the *Aquaculture (Zones – Anxious Bay) Policy 2007*.

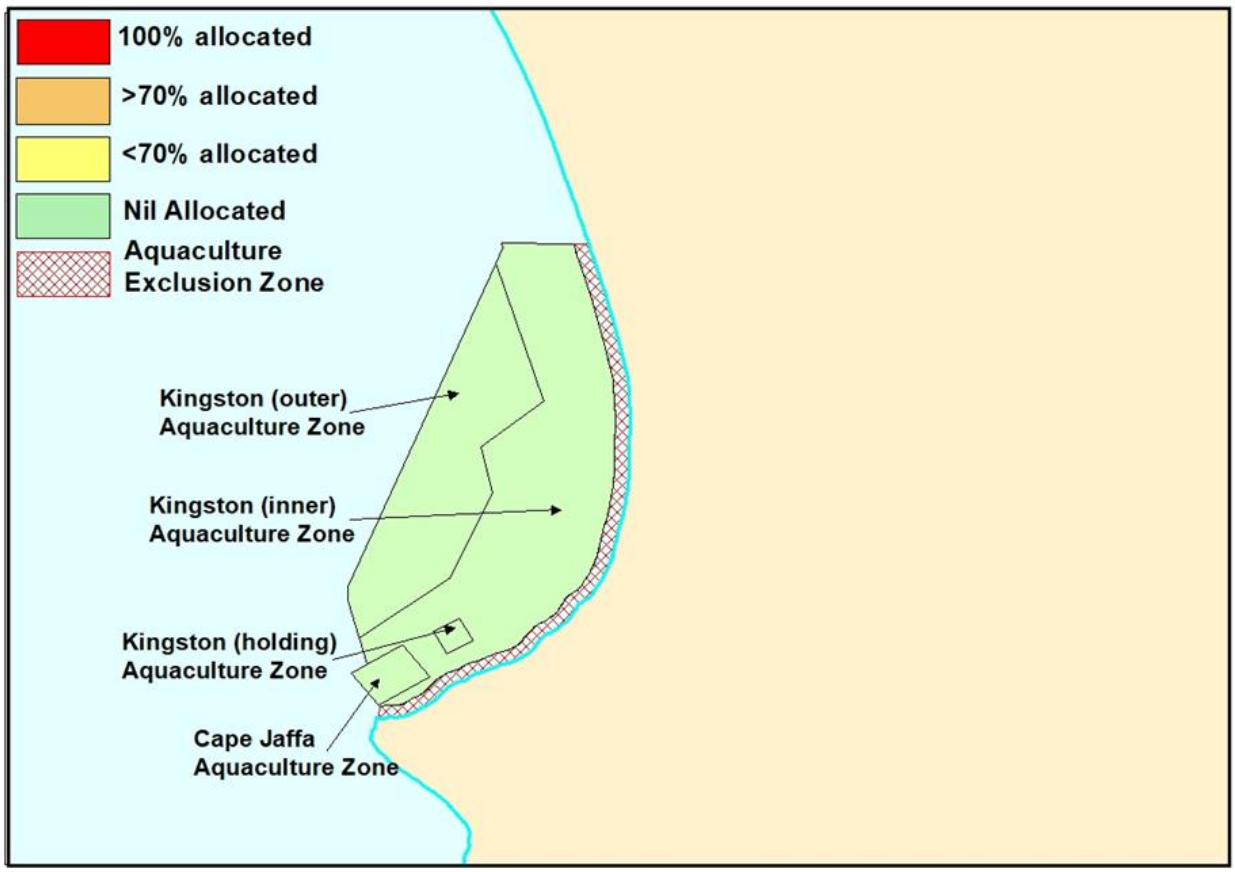


Figure 14. Tenure indication within the *Aquaculture (Zones – Lacepede Bay) Policy 2012.*

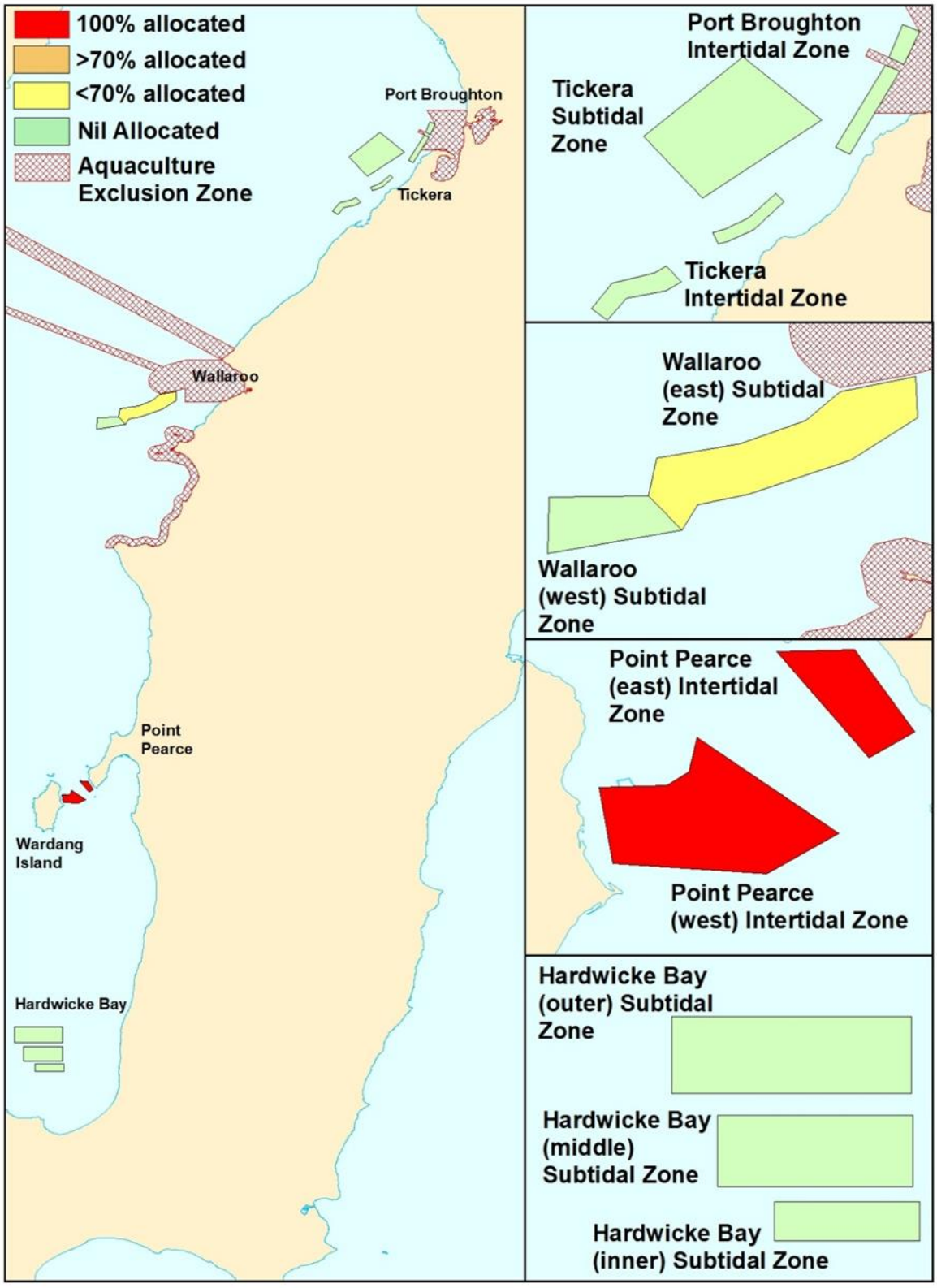


Figure 15. Tenure indication within the *Aquaculture (Zones – Eastern Spencer Gulf) Policy 2005*..

Aquaculture outside zone policies in South Australia

Aquaculture can take place inside or outside designated aquaculture zones. The advantage of applying for aquaculture activities within an aquaculture zone is that prior regulatory and general assessment processes have already been undertaken and therefore the application assessment and approval process is streamlined. For instance, several legislated referrals to other agencies and technical investigations to provide environmental information are conducted when a zone is being developed and are not required to be duplicated for applications inside a zone. In particular, the requirement for proponents of individual aquaculture proposals to seek development approval from the relevant planning authority. For aquaculture activities

located outside existing aquaculture zone policy areas in South Australia (e.g. Kangaroo Island, Yorke Peninsula, Victor Harbor, Ceduna, Smoky Bay and Cowell), the application assessment and approval process is not as streamlined due to the lack of prior technical investigations/consultation and the need for additional approvals (e.g. development approval).

Aquaculture (Standard Lease and Licence Conditions) Policy 2022

On 16 February 2022, the *Aquaculture (Standard Lease and Licence Conditions) Policy 2022* (the Policy) was approved, and came into operation on 18 August 2022. The Policy standardises aquaculture lease and licence conditions which will encourage aquaculture development and improve investor confidence by simplifying the regulatory environment, including reducing 'red-tape', for aquaculture operators. Conditions contained within the Policy constitute conditions of an aquaculture lease and licence and, are to be read as forming part of a lease and licence holder's obligations. Individual lease and licence certificates containing conditions still remain, however the Policy replaces the majority of these conditions, irrespective of when a lease/licence was issued. The Policy provides flexibility to allow certain conditions within the Policy to be overridden by specific conditions on an individual aquaculture lease and licence certificate where appropriate.

As of 18 August 2022, aquaculture lease and licence holders need to abide by conditions contained within the Policy and also individual lease and licence certificates. In 2022-23, all aquaculture lease and licence certificates were reissued to reflect standardised conditions within the Policy, with only conditions specific to the activity being undertaken on a lease or licence remaining. Most conditions contained within the Policy are existing conditions of aquaculture leases and licences with their intent maintained, so impacts to aquaculture obligations are minimal. An education and awareness campaign was and continues to be undertaken as part of implementation of the Policy, including compliance inspections by Fisheries Officers. Further information regarding the Policy, including the development and implementation process, and copies of supporting documentation (i.e. the supporting report and document responding to submissions received on the Policy) can be found on the PIRSA Fisheries and Aquaculture website.

Changes to the *Aquaculture Act 2001*

In 2018, the State Government made an election commitment to explore options to develop and increase investment in the State's aquaculture industry. To meet this commitment, in 2019 PIRSA made amendments to the *Aquaculture Act 2001* to increase the maximum term that may be given to an aquaculture production lease from 20 years to 30 years, and to enhance notification to registered third party interests on leases prior to a lease being cancelled. To provide existing aquaculture production lease holders an earlier opportunity to achieve longer lease terms, rather than wait until their next renewal date, amendments were also made to permit them to apply to the Minister for a one-off extension of their lease term up to 30 years. Application forms and further information surrounding the one-off extension opportunity were made available on the PIRSA website. These changes will increase certainty for financiers and may increase the access of capital to aquaculture operations. It will also provide the aquaculture industry with more certainty and security in their rights moving forward.

During 2021, PIRSA led the development of the Aquaculture (Tourism Development) Amendment Bill 2021 to amend the *Aquaculture Act 2001* and its passage through the Parliament of South Australia. In December 2021, the Parliament of South Australia passed the Bill, and thereafter the *Aquaculture (Tourism Development) Amendment Act 2021* received Royal assent from the Governor. The amendments, yet to come into effect, will streamline the assessment and approval process for proponents of marine-based tourism developments located within aquaculture zones, which complement, promote, or be of benefit to aquaculture undertaken within respective aquaculture zones. Once in effect, stakeholders will no longer be required to separately seek development consent and an authority to use the seabed from multiple government authorities under other legislation but can come directly to PIRSA to assess and approve their proposals under the *Aquaculture Act 2001*. The provisions of the *Aquaculture (Tourism Development) Amendment Act 2021* are proposed to come into effect by proclamation during the 2023/24 financial year following PIRSA undertaking a review of the *Aquaculture Regulations 2016*, as well as other administrative processes, to support the implementation of the amendments and ensure the assessment of aquaculture tourism development activities can be undertaken consistent with the objects of the *Aquaculture Act 2001*.

Tuna

Overview of the industry

The Tuna aquaculture sector is well established, with significant growth in production since its initiation in the 1990s. The species targeted by this sector is the Southern Bluefin Tuna (SBT) (*Thunnus maccoyii)*.

SBT farming (or ranching) represents a high performing sector of the South Australian aquaculture industry. In 2021-22, there were 14 Tuna farms licensed by PIRSA which occupied 1 869.77 ha of water. A majority of these (13) were located east of Boston Island, near Port Lincoln. The remaining site was located in Arno Bay (10 ha) which was used to hold broodstock and was later converted to a Finfish licence. Eight of the 14 licences in Port Lincoln actively farmed SBT (1 804.77 ha) and the remaining 6 licences (55 ha) were used as maintenance sites for storing of sea-cages between production periods. Tuna aquaculture licences are listed in Appendix 1.

The industry is based on the wild capture of juvenile SBT between December and March each season. The amount of Tuna caught is restricted by an annual quota determined by the international management body, the Commission for the Conservation of Southern Bluefin Tuna (CCSBT). Over 85% of Australia's SBT quota is used for farming in South Australia, with the remaining quota fished by longline and allocated for charter/recreational catch. The global and Australian quota has continued to increase from 2012 when the CCSBT adopted a Harvest Strategy that uses a scientific model to determine what is a sustainable global catch. Based on the global total allocation, each individual member country has an allocated quota that is a proportion of that global total. Since 2012, Australia's quota has increased gradually from 4 015 t in 2011 to 6 238 t per annum for 2021-2023. The quota for 2024-2026 has been set and is likely to result in a 17% increase in quota from December 2023 as a result of the strong recovery of SBT stocks globally (EconSearch 2023). According to the most recent FRDC status of Australian Fish Stocks report (2021), the sustainability rating for SBT has moved to sustainable, demonstrating that consistent, scientifically sound management can bring back stocks that had previously been overfished. For more information see www.fish.gov.au/report/391-Southern-Bluefin-Tuna-2020. Note that 95% of the Australian SBT quota is automatically allocated by legislation to the commercial sector (farming and wild-caught) and 5% for catch by the charter/recreational sector.

Juvenile SBT are moved from their natural wild migratory path through the Great Australian Bight into off-shore sea-pontoons (40-45 m diameter) located near Port Lincoln, where they are on-grown to a larger market size and condition. SBT are held in sea-pontoons for a grow-out period of approximately 6 months during which time they can double their whole weight. During grow-out Tuna are typically fed their natural diet which is wild caught fresh sardines. Sardines in SA are sustainably caught under strict catch quota limits, which are set annually/biannually by a scientific assessment of the sardine population. In 2018, the South Australian Sardine Fishery (SASF) was certified by the Marine Stewardship Council (MSC). The SASF received the highest ever score for a first time certified fishery in the world, from over 400 fisheries certified worldwide by the MSC. For a summary of production and value, and other key economic indicators and trends for the Tuna aquaculture sector, see Tuna farming Economic Indicators Dashboard 2021-22.

Farmed Tuna are South Australia's largest aquaculture export. Historically, exports have almost totally gone to Japan, however, in recent years exports to Korea and China have grown to be up to 10% of the total harvest. In addition, the Australian domestic market has grown quickly, including development of new value-added products.

The environmental impact of sea cage aquaculture has been well described and can include impacts associated with dissolved nutrients from fish metabolism, and solid waste from faeces and un-utilised feed (note: feed wastage is avoided as it is economically unviable). For Tuna, these are predominantly dispersed in the water column (~85%), with the remainder deposited on the underlying seafloor (Fernandes et al., 2007a and 2007b, Tanner and Volkman 2009). Recently, PIRSA approved the farming of seaweed (as biofouling) on a Tuna aquaculture licence which will assist with nutrient offsets for the industry.

To ensure the impacts are minimal and managed to an acceptable level, a carrying capacity model developed by SARDI is used to set precautionary biomass limits for both individual sites and across the entire Tuna farming zone. These biomass limits are based on published models to ensure minimal impacts to the environment, with water quality maintained at below Australian and New Zealand Environment and Conservation Council (ANZECC) guidelines. Zone policies are developed to protect the environment from significant ecological impacts that the Tuna sector may have within their growing regions, and to ensure husbandry standards are enforced. The environmental monitoring program (EMP) process provides ongoing environmental monitoring information required to identify and control the occurrence of any impacts the Tuna sector may present on both an individual site level and a whole of sector level. In addition, it is a legislative requirement for licence holders to fallow or move sea-pontoons each year to provide the seafloor time to recover. This is in addition to the Tuna farming cycle that allows the seafloor 6 months to fallow between the end of harvest (July/August) and restocking from January the following year.

The wider ecological benefit of Tuna farming is that in the wild the SBT age-groups captured for farming have a high annual natural mortality of 20-30% from predators and periods of starvation. They are also believed to have a relatively poor feed conversion ratio (FCR) in the wild because of the high energy used in escaping predators and in annual migrations from the Indian Ocean to the Great Australian Bight. In contrast, in farms the natural mortality is less than 1% in the grow-out period and much more of the energy from feed goes into growth rather than escaping predators and migration. In addition, Tuna farming maximises the seasonal grow-out (summer) and the quality (fat) content in autumn/winter before harvest.

Environment

Regional environmental monitoring program (AEMP)

In 2015, a new regional aquaculture environmental monitoring program (AEMP) was developed for the Finfish and Tuna aquaculture sectors in lower Eyre Peninsula. The program was designed over a four year cycle with a review in the fourth year to inform the design of the next four-year cycle. The program was designed to describe the overall health of the region with respect to cumulative aquaculture impacts rather than monitoring at the site or lease scale, in response to recognition that the majority of nutrient waste from Finfish and Tuna licensed sites is dissolved in the water column and is likely carried offsite. The monitoring program was developed in consultation with the Tuna and Finfish aquaculture industries, PIRSA (including SARDI) and the EPA.

The program was divided into a pelagic (oceanographic) component and a benthic (seafloor) component. Information collected and analysed for the first four-year regional program (2015-2019) included water quality, oceanography, nutrients, bacteria and benthic infauna assemblages, all of which contribute to understanding impacts of aquaculture at a regional and zone scale and to help validate the existing hydrodynamic and biogeochemical model for Lower Spencer Gulf.

The objectives of the pelagic and oceanographic component were to:

- Determine baseline values and the extent of environmental, chemical and biological variability in relation to water quality and planktonic ecosystem composition to assess past (if available) and future changes in the trophic state of the Boston Bay and the Lincoln (inner sector) aquaculture zones and connected coastal systems, and

- Use the collected data and aquaculture feed inputs to update and validate the oceanographic model for Spencer Gulf to assist in regional aquaculture planning and management.

The objectives of the benthic component were to:

- Determine if there is any regional scale effect of Tuna and Finfish aquaculture on infauna (animals living under the seafloor) in and around the Boston Bay and the Lincoln (inner sector) aquaculture zones,

- Determine if the infauna assemblages show any change between 2016 and 2018, the two years in which sampling was undertaken, and

- Analyse the time series of infauna data sampled for the Tuna and Finfish sectors between 2005 and 2014 to determine any temporal and spatial patterns in the data.

Results from the 2015-2019 regional AEMP found:

- Significant spatial and temporal variations in the physical environment, circulation, water quality and planktonic ecosystem composition, including:

    - Nutrients, chlorophyll *a*, phytoplankton abundance, and community composition, harmful algal bloom (HAB) species and frequency, and planktonic community size structure and composition, showed inshore sites within Boston and Louth Bay's differ significantly from offshore sites. Collectively, these trends are consistent with impacts expected from anthropogenic nutrient enrichment, of which there are a number of sources in the area including aquaculture. The results are supported by oceanographic modelling, which provides a greater understanding of natural and anthropogenic nutrient supply, connectivity, and dispersal in the region and at the scale of Spencer Gulf.

    - While nutrient and chlorophyll *a* concentrations at the regional scale were elevated above background levels, they were generally low and below ANZECC water quality guidelines 2000.

    - The planktonic assemblage and water quality results provide enough sensitivity to indicate that aquaculture is having a detectable impact on water quality and trophic state at the inshore sites within Boston and Louth Bay's. The results also provide a baseline and a set of multiple, complementary indicators for explaining future changes, natural or anthropogenic.

- Both spatial and temporal variation were detected in the infaunal assemblages in the Boston Bay and Lincoln (inner) aquaculture zones, but there was no indication that aquaculture has a significant impact on infauna. Instead, there were differences between control groups in both zones, consistent with a naturally occurring north-south gradient in infaunal assemblages. A similar result was found for time series analysis undertaken on samples collected between 2005 and 2014.

Given the pelagic and oceanographic results from the 2015-2019 AEMP indicated that aquaculture may be having an impact on the pelagic component of the ecosystem in the physically connected inshore regions of Boston and Louth Bay, the 2019–2023 AEMP is undertaking more detailed investigations into the fate and consequences of the nutrients being added to the system. In particular, how these nutrients might be affecting seagrass in the region. The benthic component of previous monitoring programs focused on infauna as an indication of ecosystem functioning and did not demonstrate an impact at compliance sites outside of lease boundaries, or on a regional scale and hence this component of the AEMP has been scaled back to approximately every five years. The 2019-2023 AEMP instead focuses on seagrass communities located within the bays near Port Lincoln and Louth Bay. Combined with pelagic (lower trophic) ecosystem, water quality, and oceanographic monitoring, and hydrodynamic and biogeochemical modelling, the current monitoring program (first sampling occurred in early 2020) will determine whether or not aquaculture is contributing to a sustained impact on key ecosystem assets in the region. All field sampling for the pelagic/oceanographic and seagrass monitoring components of the monitoring program have been completed and the final report for the 2019-2023 AEMP is expected to be completed late 2023. The results and outcomes will be summarised in the 2024 Zoning In report.

The results of these environmental monitoring programs will also become important to help quantify the benefits of the growing seaweed aquaculture industry in terms of nutrient offsets and Integrated Multi-trophic Aquaculture (IMTA) for example, which is discussed later in the report.

Annual environmental monitoring reports

Submission rates for EMPs for the Tuna sector were 100% in 2021-22. Note: the reporting period for the Tuna sector is from December 2021 to November 2022 to align with the Tuna production cycle.

Development

During the 2021-22 EMP reporting period, 8 Tuna licences reported to have farming structures (sea-cages) on site and seven actively farmed SBT (Lincoln inner sector). One Tuna licence in Arno Bay was used to hold a small amount of broodstock and was later converted to a Finfish licence. The remaining 6 licences (Boston Bay sector) were used as maintenance sites for storing of sea-cages between production periods.

Biomass

Wild caught juvenile SBT were moved to off-shore sea-pontoons between December 2021 and February 2022 at an average whole weight of 15.42 kilograms (kg). Harvesting of SBT largely occurred 6 months after stocking during July-August 2022. The average whole weight of farmed SBT at harvest in 2022 was 17.41 kg.

Standard licence conditions state that the maximum biomass of SBT held on an aquaculture site at any one time cannot exceed 6 t of stock per ha. In 2021-22, PIRSA and EPA approved all SBT licences to farm 8 t of stock per ha with a maximum biomass across all licences not to exceed the aquaculture zone biomass limit of 10 500 t. To ensure the zone biomass limit was not exceeded during the 2021-22 farming season, licensees were required to report total biomass (in tonnes) monthly. The maximum stocking density for each licence was not reached (highest recorded was 5.37 t per ha during May 2022) nor was the zone biomass limit. The maximum biomass of farmed SBT was recorded in May, totalling approximately 6 799 t (representing an average of 3.6 t per farmed ha).

Feed inputs

Farmed SBT are fed their natural diet of small whole baitfish, which is largely sourced locally from the commercial sardine fishery which operates in Spencer Gulf, Kangaroo Island and along South Australia's West Coast. This fishery is sustainably managed under the SASF Management Plan and is MSC certified. Approximately 55 376 t of baitfish were used by the SBT industry in 2021-22, of which 10% were imported. Imported baitfish are managed under strict biosecurity conditions stipulated by the Commonwealth Department of Agriculture, Water and the Environment. Feed conversion ratios are better than their wild counterparts due to farmed SBT not having to use high energy to escape predators or migrate.

Reported interactions and escapes

As part of marine licence EMP reporting requirements, licence holders are required to submit information regarding interactions with seabirds and large marine vertebrates that occurred on their licensed site during each reporting year. During the 2021-22 reporting period, one licensed Tuna aquaculture site reported an interaction with a Southern Right Whale. The Whale was unharmed during the interaction and was released from the Tuna cage. The licence holder reported the interaction to PIRSA, as required under regulation 27 of the *Aquaculture Regulations 2016*). For more information see Impacts on habitat and biodiversity.

The Tuna sector uses 3 m high seal jump fences, which are considered by the industry to be highly effective in minimizing interactions with Long-nosed fur seals and Australian sea-lions. Daily removal of any dead or sick SBT also contributes to a low level of interactions in the Tuna sector. There were no reported interactions with any seal species on licensed Tuna aquaculture sites during 2021-22.

Licence holders are also required to submit information regarding any stock escape events that occurred on their licensed sites (see Species selection and escapes). There were no escape events reported by the Tuna sector in 2021-22. There is some theft of stock reported by the industry, and this is reflected in annual audits of numbers of SBT in and out of the farms by the Australian Fisheries Management Authority.

Aquatic animal health management

Veterinary medicine use

Off-label approvals under *Aquaculture Regulations 2016*:

Two requests (veterinary prescriptions) for the use of Praziquantel from the Tuna sector were assessed and approved in 2021-22. Praziquantel is used by the industry, under veterinarian supervision, to successfully reduce parasitic blood fluke (*Cardicola forsteri*) infestations in SBT and maintain fish health. Since 2020, Praziquantel (used in medicines for humans and other

livestock industries) has reduced SBT mortalities from approximately 14% per year to less than 1% per year. Off-label use assists industry with data collection towards permitting or registration of the product with the APVMA.

Reported APVMA registered and permitted veterinary medicines:

There are two Minor Use Permits one for the substance “Parapraz Flukicide”, containing 42 grams per litre of Praziquantel as the only active constituent for the treatment of blood fluke in SBT (PER85738). A second Minor Use Permit for the use of praziquantel for the treatment of blood fluke in SBT has since been issued by the APVMA (PER88128). The permits are limited to the jurisdiction of South Australia and further limited to people employed by a SBT farm, who are using the product under the direction of a veterinarian.

The veterinary medicine Praziquantel was reported to be used by five Tuna licences during the 2021-22 EMP reporting period, as permitted by the APVMA.

Livestock translocations

No livestock translocations were applied for or approved during 2021-22 for the Tuna sector.

Disease management and surveillance

During the 2021-22, one unusually high mortality event (two Tuna licences) was reported to PIRSA. Notifiable and infectious disease ruled out as part of the investigation. With the available information, it is likely the mortality event was largely due to an algae bloom.

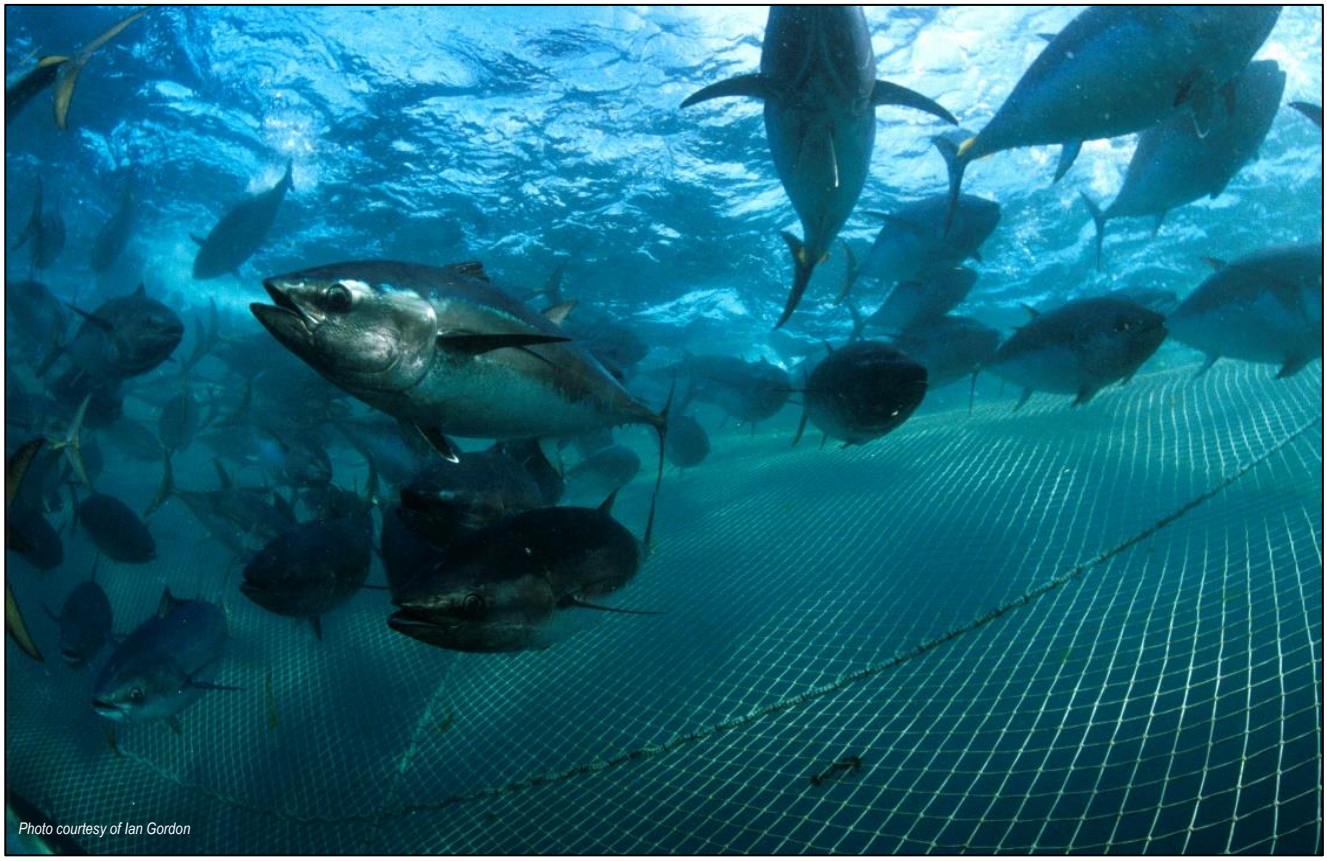


Photo courtesy of Ian Gordon

Finfish

Overview of the industry

The marine Finfish aquaculture sector is well established, with significant growth in production over the years. The species farmed by this sector is the Yellowtail Kingfish (YTK) (*Seriola lalandi)*.

Marine Finfish farming represents a high performing sector of the South Australian aquaculture industry. In 2021-22, there were 18 Finfish farms licensed by PIRSA, occupying 628 ha of water and operated by one company. Finfish licences were located in waters along the west coast of Spencer Gulf at Fitzgerald Bay, Arno Bay, and Louth Bay and Boston Bay near Port Lincoln. Individual Finfish aquaculture licences are listed in Appendix 1.

The industry is based on the on-growing of hatchery-reared YTK fingerlings from selectively bred broodstock originally caught in South Australian waters in accordance with the *Fisheries Management Act 2007*. Juveniles are moved to sea-pontoons (40-44 m diameter) where they are grown out to market size. Fingerlings are transferred to marine sea-pontoons at ~15-30 g, fed on specially formulated manufactured diets, and grown out at sea for ~12-32 months until they are harvested at either 1-1.5 kg or 4.5 kg. For a summary of production and value, and other key economic indicators and trends for the Kingfish aquaculture sector, see Marine Finfish farming Economic Indicators Dashboard 2021-22.

The environmental impacts of sea-pontoon Finfish farming have been investigated, including potential impacts on biogeochemical processes, seagrasses and benthic communities (Tanner and Bryars, 2007, Tanner et al., 2007). It was determined that kingfish farming was having minimal impact, with detectable changes associated with dissolved nutrients from fish metabolism and solid waste from faeces and excess feed which are predominantly dispersed in the water column (~85%), with the remainder deposited on the underlying seafloor. Recently, Clean Seas Seafood Limited, a YTK licence holder, formed a collaboration with CH4 Australia Pty Ltd, a company focused on the production and harvest of red seaweed *Asparagopsis* for methane mitigation in livestock, to farm red seaweed near YTK sea-cages which may assist with nutrient offsets for the industry.

Biomass limits for both individual sites and zone policies are developed to minimise the effects on the environment that the Finfish industry may have within their relative growing regions. The EMP process provides ongoing environmental monitoring information required to identify and control the occurrence of any impacts the Finfish sector may present on both individual sites and a whole of sector level. In addition, it is a legislative requirement for licence holders to fallow or move sea-pontoons each year to provide the seafloor time to recover unless otherwise approved by the Minister.

Environment

Site-specific environmental monitoring programs

The holders of Finfish aquaculture licences are required to undertake specific EMPs that are tailored to the area in which they operate. These EMPs are designed by PIRSA and the EPA. The specific purpose of the EMP varies with location and environmental characteristics but the overall aim is to monitor changes in the environment that may reflect an impact as a result

of Finfish aquaculture. In addition to site-specific EMPs, Finfish aquaculture licensees are required to provide a monthly report for each site, detailing total biomass, feed added and number of fish per cage.

The Boston Bay and Louth Bay EMPs aim to assess the impact of an increased biomass at a site and regional level. The site level EMPs comprise of benthic video to monitor the benthic habitat at and near the sea-cages for accumulation of debris, waste feed, build-up of harmful algal matts, and changes to the quantity and health of seagrass. The regional level EMPs, introduced in 2020-21, comprise of benthic video and are designed to specifically monitor changes to the quantity, condition and health of seagrasses that are in the plume of Finfish nutrients. Regional EMPs are also designed to be the same methodology as the regional aquaculture environmental monitoring program (AEMP) described below to improve the dataset collected for the AEMP.

The Boston Bay EMP has been in place since 2016, and results to date demonstrate no significant impact of Finfish farming at the site level. In 2021, the EMP was amended to increase the focus on off-site locations and seagrass health, while maintaining site specific monitoring. A Louth Bay EMP was implemented in October 2017 when the site was first used to hold stock, comprising benthic video on the site. An amended Louth Bay EMP was introduced in April 2020 in response to higher biomass held on the site. The new program includes site benthic video and regional benthic video that focusses on seagrass condition and density. Data from these programs will contribute to the regional AEMP detailed below.

The Arno Bay EMP was originally designed in 2019 to use benthic video footage to monitor changes in unidentified benthic matts (noting benthic algal matts are an environmental signal of nutrient enrichment) and changes to the small amount of seagrass that occur within the Arno Bay aquaculture zone. Two years of data collection and confirmation the unidentified matts were Mussel shell accumulation and not benthic algal matts, led to a revision of the Arno Bay EMP in 2021 to focus on site level video and areas where seagrass was previously identified. Site level video is designed to monitor the benthic habitat at and near sea-cages for accumulation of debris, waste feed, potential build-up of harmful algal matts, and changes to the quantity and health of seagrasses.

The Fitzgerald Bay EMP comprises site and regional monitoring through benthic video footage. The benthic habitat at the Fitzgerald Bay sites is sand, however, there are significant seagrass meadows near-by. Site level video is designed to monitor the benthic habitat at and near the sea-cages for accumulation of debris, waste feed and potential build-up of harmful algal matts. The regional level monitoring contributes to a research project being undertaken by SARDI on potential impacts of Finfish nutrients on seagrasses. The four-year research project, developed by SARDI, PIRSA, Clean Seas and the EPA, was approved by the FRDC and commenced in July 2019, with the first sampling undertaken in May 2020 (representing a baseline dataset). Finfish were reintroduced to Fitzgerald Bay aquaculture sites in September 2021. The next round of sampling was to be undertaken in May 2023 about two years after Finfish farming commenced in Fitzgerald Bay, however, farming ceased in this region in November 2022. The final sampling for the research project was undertaken in January 2023. Using benthic video, changes to the seagrass density, health and condition were monitored. For more information on EMPs, see the following links: www.pir.sa.gov.au/primary_industry/aquaculture/marine_aquaculture/finfish_fitzgerald_bay and www.frdc.com.au/project/2018-186.

Lower Eyre regional aquaculture environmental monitoring program (AEMP)

In 2015, a new regional aquaculture environmental monitoring program (AEMP) was developed for the Finfish and Tuna aquaculture sectors in lower Eyre Peninsula. The program is designed over a four year cycle with a review in the fourth year to inform the design of the next four-year cycle. The program is designed to describe the overall health of the region with respect to aquaculture impacts rather than monitoring at the site or lease scale, in response to recognition that the majority of nutrient waste from Finfish and Tuna licensed sites is dissolved in the water column and is carried offsite. The monitoring program was developed in consultation with the Tuna and Finfish aquaculture industries, PIRSA, the EPA and SARDI.

The program was divided into a pelagic (oceanographic) component and a benthic (seafloor) component. Information collected and analysed for the first four-year regional program (2015-2019) included water quality, oceanography, nutrients, bacteria and benthic infauna assemblages, all of which contribute to understanding impacts of aquaculture at a regional and zone scale and to help validate the existing hydrodynamic and biogeochemical model for Lower Spencer Gulf.

The objectives of the pelagic and oceanography component were to:

- Determine baseline values and the extent of environmental, chemical and biological variability in relation to water quality and planktonic ecosystem composition to assess past (if available) and future changes in the trophic state of the Boston Bay and the Lincoln (inner sector) aquaculture zones and connected coastal systems, and

- Use the collected data and aquaculture feed inputs to update and validate the oceanographic model for Spencer Gulf to assist in regional aquaculture planning and management.

The objectives of the benthic component were to:

- Determine if there is any regional scale effect of Tuna and Finfish aquaculture on infauna in and around the Boston Bay and the Lincoln (inner sector) aquaculture zones, and
- Determine if the infauna assemblages show any change between 2016 and 2018, the two years in which sampling was undertaken.
- Analyse the time series of infauna data sampled for the Tuna and Finfish sectors between 2005 and 2014 to determine any temporal and spatial patterns in the data.

Results from the 2015-2019 regional AEMP found:

- Significant spatial and temporal variations in the physical environment, circulation, water quality and planktonic ecosystem composition, including
    - Nutrients, chlorophyll *a*, phytoplankton abundance, and community composition, harmful algal bloom (HAB) species and frequency, and planktonic community size structure and composition, showed inshore sites within Boston and Louth Bay's differ significantly from offshore sites. Collectively, these trends are consistent with impacts expected from anthropogenic nutrient enrichment, which there are a number of sources in the area including aquaculture. The results are supported by oceanographic modelling, which provides a greater understanding of natural and anthropogenic nutrient supply, connectivity, and dispersal in the region and at the scale of the gulf.
    - While nutrient and chlorophyl *a* concentrations at the regional scale were elevated above background levels, they were generally low and below ANZECC water quality guidelines 2000.
    - The planktonic assemblage and water quality results provide enough sensitivity to indicate that aquaculture is having a detectable impact on water quality and trophic state at the inshore sites within Boston and Louth Bay's. The results also provide a baseline and a set of multiple, complimentary indicators for explaining future changes, natural or anthropogenic.
- Both spatial and temporal variation were detected in the infaunal assemblages in the Boston Bay and Lincoln (inner) aquaculture zones, but there was no indication that aquaculture has a significant impact on infauna. Instead, there were differences between groups of reference sites in both zones, consistent with a naturally occurring north-south gradient in infaunal assemblages. A similar result was found for time series analysis undertaken on samples collected between 2005 and 2014.

Given the pelagic and oceanographic results from the 2015-19 AEMP indicated that aquaculture may be having an impact on the pelagic component of the ecosystem in the physically connected inshore regions of Boston and Louth Bay, the 2019–2023 AEMP is undertaking more detailed investigations into the fate and consequences of the nutrients being added to the system. In particular, how these nutrients might be affecting seagrass in the region. The benthic component of previous monitoring programs focused on infauna and did not to demonstrate an impact at compliance sites outside of lease boundaries, or on a regional scale and hence this component of the AEMP has been scaled back to approximately every five years. The 2019-23 AEMP instead focuses on seagrass communities located within the bays near Port Lincoln and Louth Bay. Combined with pelagic (lower trophic) ecosystem, water quality, and oceanographic monitoring, and hydrodynamic and biogeochemical modelling, the current monitoring program (first sampling occurred in early 2020) will determine whether or not aquaculture is contributing to a sustained impact on key ecosystem assets in the region. All field sampling for the pelagic/oceanographic and seagrass monitoring components of the monitoring program have been completed and the final report for the 2019-2023 AEMP is expected to be completed late 2023. The results and outcomes will be summarised in the 2024 Zoning In report.

The results of these environmental monitoring programs will also become important to help quantify the benefits of the growing seaweed aquaculture industry in terms of nutrient offsets and Integrated Multi-trophic Aquaculture (IMTA) for example, which is discussed later in the report.

Annual environmental monitoring reports

Submission rates for EMPs for the Finfish sector were 100% in 2021-22. Note: the reporting period for the Finfish sector is from December 2021 to November 2022.

Development

Of the 18 reports submitted for the 2021-22 EMP reporting period, 15 licences were reported to be actively farming YTK and one site was used for maintenance of sea-cages.

Biomass

The maximum amount of YTK farmed across all sites within the marine Finfish sector was recorded in April (3 956 t) during the 2021-22 reporting period. Six of these licences were located within the Arno Bay aquaculture zone policy which reported Finfish on site during the month of November only (334 t). A further 9 licences were located within Lower Eyre Peninsula aquaculture zone policy and reported a maximum amount of Finfish on site during the month of April (1 734 t; Boston Bay) and August (1 365 t; Louth Bay). The remaining 3 licences were located in Fitzgerald Bay, however, only one of these licences were actively farming Finish during the 2021-22 reporting period and reported a maximum amount of Finfish on site during the month of August (1 299 t). The marine production cycle for YTK can take up to 32 months, therefore the stock on site at any one time does not necessarily reflect the total annual production sold (2 919 t in 2021-22).

Standard licence conditions state that the maximum biomass of Finfish held on an aquaculture site at any one time cannot exceed 15 t of stock per ha (unless otherwise approved by the Minister). In 2021-22, 4 of the 8 Finfish licences in Boston Bay aquaculture zone were approved to farm at 20 t (2 licences in the Boston Bay sector) or 41.25 t (2 licences in the Bickers Island sector) of stock per ha with a maximum biomass recorded across all sites (recorded in April– 1 734 t) not to exceed the aquaculture zone biomass limit of 1 750 t. In 2021-22, the Finfish licence located in Louth Bay was licensed to farm 40 t of stock per ha with a maximum biomass (recorded in August– 1 365 t) not to exceed the aquaculture zone biomass limit of 2 270 t. To ensure zone biomass limits were not exceeded during the 2021-22 farming season, licensees were required to report total biomass (in tonnes) monthly. No licences exceeded individual site or zone biomass limits during the 2021-22 reporting period.

Feed Inputs

Farmed YTK are fed commercially produced manufactured pellets. A total of approximately 8 338 t of pellets were used across all sites within the marine Finfish sector in 2021-22. Sites located within the Arno Bay, Fitzgerald Bay and Lower Eyre Peninsula aquaculture zone policies reported a total of 16 t, 2 581 t and 5 742 t, respectively.

Reported Interactions and escapes

As part of annual EMP reporting requirements for marine licences, licence holders are required to submit information regarding any adverse interactions with seabirds and large marine vertebrates that occurred on their licensed site during each reporting year (see Impacts on habitat and biodiversity). In addition to annual reporting, the Finfish sector is required to submit monthly reports on all interactions (considered ‘routine interactions’) at each licensed site. Reporting by industry has been very conservative with a total of 168 'routine interactions’ involving 258 Long-nosed fur seals (largely seals making holes in cage netting) and 9 Bronze Whaler Sharks on licensed sites in the Boston Bay and Louth Bay aquaculture zones. The seals and sharks escaped or were released from the Finfish cages unharmed and therefore there were no ‘adverse interactions’ reported on a licensed Finfish aquaculture site during 2021-22.

Licence holders are also required to submit information regarding any stock escape events that occurred on their licensed sites (see Species selection and escapes). On 4 February 2022, one Finfish escape event was reported for the Fitzgerald Bay aquaculture zone, resulting in a total of approximately 12 fish escaping. Of the escaped fish, 2 were reported to have been recaptured. A summary of Finfish escape events can be found at www://pir.sa.gov.au/aquaculture/monitoring_and_assessment/register_-_finfish_escape.

Aquatic animal health management

Veterinary medicine use

Off-label approvals under *Aquaculture Regulations 2016*:

A total of 32 requests (veterinary prescriptions) were assessed and approved in 2021-22. Two requests for the use of Praziquantel from the Finfish sector were 2021-22 were approved. Praziquantel has been used by the industry, under veterinarian supervision, to successfully reduce parasitic infestations. Three requests (veterinary prescription) for the antibiotic oxytetracycline and one request for erythromycin were also approved as a treatment to control bacterial infections. There were 26 requests (veterinary prescriptions) for the use of AQUI-S were approved for anaesthetic purposes (routine husbandry requirement).

Reported APVMA registered and permitted veterinary medicines

At the end of the 2021-22 reporting period, there were four of Minor Use Permits for the use in South Australian Yellowtail Kingfish aquaculture. Praziquantel (bathe to treat skin and gill flukes, PER87833 and PER91570), Praziquantel (in-feed to treat for blood flukes, PER87336) and hydrogen peroxide (bathe to treat skin and gill flukes, PER88576). A total of seven Finfish sites reported the use of the permitted veterinary medicine, as permitted by the APVMA. Praziquantel (in-feed to treat for blood flukes, PER87336) was not used in the reporting period.

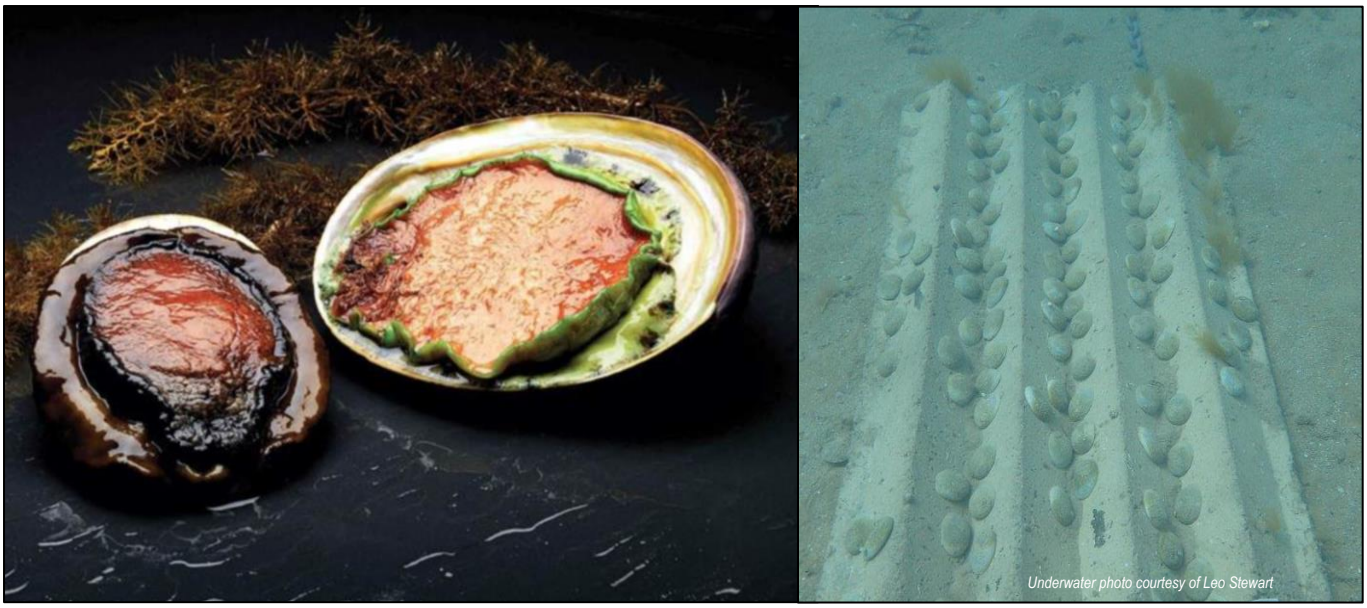
Livestock translocations

The existing licence holder within the Finfish sector supplies their own fingerlings from a purpose built hatchery located at Arno Bay. As such, no livestock translocation requests were approved during the 2021-22 period for the marine Finfish sector.

Disease management and surveillance

One unusually high mortality event was reported to PIRSA during the 2021-22 period for the Finfish sector, the cause was attributed to husbandry conditions. Notifiable and infectious disease ruled out as part of the investigation.

Marine Abalone



Overview of the industry

The sector is typically based on the grow-out of hatchery reared Greenlip Abalone (*Haliotis laevigata*) spat, which are moved to concrete benthic structures ('Abitats') where they are grown out to market size.

In 2021-22, there were five marine Abalone sites licensed by PIRSA which occupied 179 ha of water. Three sites reported to have farming structures on site, of which one was stocked with Abalone. One licence had no development and the remaining licence was relatively new and was in the process of building benthic farming structures. Individual marine Abalone aquaculture licences are listed in Appendix 1.

The marine Abalone sector is still trialling suitable benthic farming methods, and production in this sector in 2021-22 was minimal. It is anticipated Abalone would be held for a grow-out period of approximately three years and typically fed naturally occurring marine algae that drifts past the abalone. For a summary of production and value, and other key economic indicators and trends for the marine and landbased Abalone aquaculture sectors combined, see Abalone farming Economic Indicators Dashboard 2021-22.

Biomass limits for both individual sites and zone policies are developed to protect the environment from any ecological impacts that the marine Abalone sector may have. To protect the benthic environment, licence conditions on existing marine Abalone sites require the placement of benthic concrete structures to be at least 3 m from seagrass or sensitive habitat.

Site-specific monitoring programs are in place for the marine Abalone sector, however, as there is no commercial-scale production, these have not yet been implemented. The monitoring programs are comprised of benthic video and will provide ongoing environmental monitoring information required to adaptively identify and manage any impacts Abalone aquaculture may have. Specifically, monitoring is designed to assess any impacts to nearby seagrass species from feed inputs.

Environment

Annual environmental monitoring reports

Three of the five licences for the marine Abalone sector submitted an EMP in 2021-22, however, only one was received on time. Education about the importance of the information for regulating the aquaculture industry is promoted. However, failure to submit an EMP report where required may result in the matter being referred to the PIRSA Compliance Unit for further action.

Development

Three Abalone licences reported having farming structures on site during the 2021-22 reporting period as they were conducting trials.

Biomass

During the 2021-22 reporting period, only one site reported to have minimal stock on site (maximum amount recorded in June 2022; 1 199 individuals).

Feed Inputs

Farmed Abalone can be fed commercially produced manufactured pellets or naturally occurring drift algae. No feed was used during 2021-22.

Reported Interactions and escapes

No interaction or escape events were reported by the marine Abalone sector during 2021-22.

Aquatic animal health management

Veterinary medicine use

Off-label approvals under *Aquaculture Regulations 2016*:

No chemical use approvals were requested by the marine Abalone sector in 2021-22.

Reported APVMA registered and permitted veterinary medicines

No chemical use was reported by the marine Abalone sector in 2021-22.

Livestock translocations

One livestock translocation approval was requested by the marine Abalone sector for 2021-22. Hatchery reared Greenlip Abalone were translocated from a South Australian landbased site to a South Australian in-sea site.

Disease management and surveillance

No unusually high and unexplained mortalities, nor suspected or confirmed notifiable diseases were reported to PIRSA during the 2021-22 period for the marine Abalone sector. No disease investigations or emergency disease responses were required for the sector during this period. One licence reported a number of Abalone had been eaten by Whelks and starfish and shells were kept for inspection.

On 4 May 2021, Abalone Viral Ganglioneuritis (AVG) was detected in wild abalone near Cape Nelson, Victoria. PIRSA formed an AVG Response Working Group led by the South Australian Chief Veterinary Officer (CVO) to monitor and respond to the Victorian AVG outbreak, which included reviewing risk assessments and predictive oceanography on the South Australia/Victoria boarder, implementing notices to restrict bait/berley use and increase restrictions on seafood imports under the *Livestock Act 1997* and *Fisheries Management Act 2007* and active surveillance of wild abalone in South Australia on reefs nearest the Victorian boarder. For more information see: Abalone viral ganglioneuritis - PIRSA

Mussels

Overview of the industry

The Mussel sector is well established in the waters of Boston and Louth Bays, near Port Lincoln, with 28 of the 32 farms covering 368 ha in 2021-22. The remaining four sites are located near Wallaroo covering a further 170 ha. Individual Mussel aquaculture licences are listed in Appendix 1. The species farmed by this sector is the Blue Mussel (*Mytilus galloprovincialis*), and trials are being undertaken for cultivating red algae (*Asparagopsis armata*). Blue Mussels are grown using long-line culture. Long-lining involves a system of horizontal ropes with buoys to provide flotation, to which vertical droppers are attached every 1–4 m, depending on site conditions. Long-lines are used for spat collection, as well as for on-growing juvenile Mussels to market size.

Currently, Blue Mussel spat are collected from the wild on spat collectors, which are fibrous, 'hairy' looking ropes hung from long-lines during the peak spawning season (June to September) in areas known to have good Mussel 'spatfall'. After ~6 months, juveniles (12 millimetres (mm) long) are transferred from the spat collectors to grow-out long-lines. The juvenile Mussels are separated from each other by passing them through a Mussel de-clumping machine and then feeding them through a funnel onto a grow-out rope. A cotton stocking, known as a 'mussock', is placed around the grow-out rope to hold the juvenile Mussels against the rope. As the Mussels grow, they re-attach themselves to the ropes. In time, the biodegradable mussock disintegrates leaving the Mussels to grow for a further 8–12 months. Mussels are generally harvested after a period of 18 months at ~10–11 centimetre (cm) length. For a summary of production and value, and other key economic indicators and trends for the Mussel aquaculture sector, see Mussel farming Economic Indicators Dashboard 2021-22.

Blue Mussel spat collection from the wild can be unreliable and inconsistent, and in poor collection seasons can impact the industry significantly. Many factors influence the number of spat collected, including water currents, climatic variations or bio-fouling on the ropes, which can all prevent spat from settling. On rare occasions and with the appropriate approvals, Blue Mussel spat can be brought in from interstate hatcheries to support spat supply for the SA sector.

Sector-based aquaculture strategy

A sector-based aquaculture strategy has been developed for subtidal mussel farming to support the future growth and prosperity of the industry in an ecologically sustainable way. Approved on 9 September 2022, it is the first sector-based aquaculture strategy approved under regulation 19 of the *Aquaculture Regulations 2016* and replaces the requirement for licence holders to submit (and have approved) individual aquaculture strategies. Because of this, all current and future aquaculture licence holders of the mussel sector must adopt the sector-based aquaculture strategy and make sure activities undertaken adhere to it.

For further information and a copy of the sector-based strategy, see Sector-based aquaculture strategy - subtidal mussels (pir.sa.gov.au)

Environment

Annual environmental monitoring reports

Submission rates for EMPs for the Mussel sector were 100% in 2021-22 and all submissions were on time.

Development

Of the 32 reports received for the 2021-22 EMP reporting period, 26 or 81% of the Mussel licences reported having farming structures and stock on the site. All active farming occurred within the Port Lincoln region.

Biomass

Standard licence conditions limiting the amount of Mussels farmed on a site relate to infrastructure not biomass, and state that the total length of backbone (the supporting structure on the surface for all underwater lines on which the Mussels are attached) held on site does not exceed 560 m per ha with no more than 15 m of submerged line per metre of backbone (unless otherwise approved by the Minister).

During the 2021-22 EMP reporting period, all licensees reported being within the total allowable length of backbone and submerged line on the site. On average, the length of backbone infrastructure across all farmed sites within the region during the 2021-22 reporting period was approximately 273 m of backbone per ha, and 6 m of submerged line per metre of backbone. The maximum length of backbone on an individual licence was 495 m per ha.

Feed Inputs

Mussels are filter feeders and do not require supplementary feed.

Reported Interactions and escapes

No interaction or escape events were reported during the 2021-22 reporting period.

Benthic Video

No additional reporting on the aquatic environment was required for the 2021-22 reporting period for the Mussel sector. Benthic video footage submitted by the Mussel sector as part of their 2020-21 EMP requirements demonstrated Mussel shell accumulation under farming structures at some sites. The cause of this is likely to be the additional weight of natural settlement of Mussel and Oyster spat on adult Mussels, resulting in Mussels falling off longlines. The Mussel sector is working with PIRSA to address the issue, including reviewing harvesting and settlement practices to avoid “double settlement” and loss of Mussels during the harvest process.

Aquatic animal health management

Veterinary medicine use

Off-label approvals under *Aquaculture Regulations 2016*:

No chemical use approvals were requested by the Mussel sector in 2021-22.

Reported APVMA registered and permitted veterinary medicines

No chemical use was reported by the Mussel sector in 2021-22.

Livestock translocations

No livestock translocation approvals were requested during 2021-22 for the Mussel sector.

Disease management and surveillance

No unusually high and unexplained mortalities, nor suspected or confirmed notifiable diseases were reported to PIRSA during the 2021-22 period for the Mussel sector. No disease investigations or emergency disease responses were required for the sector during this period.

Oysters

Overview of the industry

The Oyster sector is well established in South Australia. The majority of farmed Oysters are Pacific Oysters (*Magallana gigas*; note the scientific name change from *Crassostrea gigas* in 2021) with some farmers trialling Native Oysters (*Ostrea angasi*) and Razorfish (*Pinna bicolor*). Oysters are farmed in South Australia in seven main growing regions (Coffin Bay, Streaky Bay, Smoky Bay, Cowell, Denial Bay/Ceduna, Kangaroo Island, Yorke Peninsula) with 354 licensed sites covering approximately 975 ha in 2021-22. Individual Oyster aquaculture licences are listed in Appendix 1.

Up until January 2016, the majority (80%) of Pacific Oyster spat were sourced from Tasmania. However, an outbreak of POMS in Tasmania in January 2016 resulted in South Australia implementing a ban of Oyster imports from Tasmania (see Oysters

POMS and spat supply for more detail) as a biosecurity measure to protect South Australian Oyster stocks. Since then, the South Australian Government, Tasmanian Oyster hatcheries and South Australian Oyster farmers have developed or expanded their own hatcheries in South Australia to be able to provide locally grown stock. To facilitate this, the South Australian Government provided grants to two local South Australian Oyster hatcheries, increased capacity at SARDI to produce spat for the industry, and fast tracked two new Oyster hatchery developments.

South Australian Oysters are traditionally grown intertidally using a rack and rail system, a long-line system or a combination of both. Fixed 'rack and rail' culture systems have been shown to cause localised impacts to some seagrass species, as the racks and baskets are stationary and can shade the seagrass beneath. Now Oyster farmers largely use the Baker-Schultz-Turner (BST) long-line system developed by the Turner family of Cowell, to allow Oyster growers to alter the height of the free-swinging Oyster baskets in the water column to reduce exposure to storm events, high air temperatures and mudworm. This system creates minimal shading effect on seagrass.

Innovative new methods of farming Oysters have been tested in South Australia for use in subtidal waters (>2 m deep). Floating Oyster mesh bags and grow out tumblers attached to longlines are new farming methods developed by Zapco Aquaculture. The Oyster mesh bags expose Oysters to nutrient and oxygen rich surface water which enables the Oysters to grow much faster than traditional intertidal Oyster farming methods. The grow out tumblers rotate with the tide, promoting faster spat growth and allowing Oysters to develop a uniform shape. Similarly, Flip Farm Systems have developed a basket system attached to a single longline that is extremely robust and efficient. The rotation system uses a mechanical action device mounted to the side

of a boat to flip baskets as the boat moves along the line. These new farming methods are less labour intensive and rely on less infrastructure (e.g. posts) in comparison to current systems. A reduced number of posts means less physical disturbance to the benthic environment and associated sedimentation effects on surrounding habitats. The long-lines also move with the tide which reduces the effect of prolonged shading from Oyster baskets or bags on seagrass habitat. PIRSA is considering developing an industry wide aquaculture strategy (pursuant to regulation 19 of the *Aquaculture Regulations 2016*) to include both traditional and new oyster farming methods. The strategy will be a resource for all licence holders that have been approved, or intend to be approved, for oyster farming in SA.

Typically, Oyster spat are placed into baskets at ~5-15 (mm) shell length and on-grown for ~12-24 months. During this time, Oysters are removed from the baskets and graded several times before they are sold. Grading the Oysters minimises shell fouling and helps the development of optimal shell quality for marketing. Since 2016 until 2020-21, the local hatcheries were having difficulty in producing spat larger than 3 mm for on-growing which has had longer term issues with survivability of the spat and overall production of mature Oysters. Local hatcheries have now improved spat survivability by on-growing small spat on Oyster leases to achieve larger sizes prior to being grown on commercial leases.

Oyster growers across various regions are actively involved in community projects that support the environment. For example, several growers were involved in installing artificial nest platforms for the endangered Osprey and Kangaroo Island Shellfish were involved in deploying artificial reef modules near Kingscote and American river (Kangaroo Island) to restore reef habitat for the native flat Oyster. For more information see: Friends of Osprey Sth Aus | Facebook and Landscape South Australia - Kangaroo Island | Kangaroo Island Oyster…

Environment

Annual environmental monitoring reports

Submission rates for EMPs for the Oyster sector were 97% in 2021-22; however, 9% of these were up to 6 months late. The remaining 3% did not submit an EMP report for 2021-22 because there was either no development on site or they had transferred the licence to another party and were therefore no longer responsible for the licence.

PIRSA follow up all late or non-submitted EMP reports with licence holders. Education about the importance of the information for regulating the aquaculture industry is promoted. However failure to submit an EMP report where required may result in the matter being referred to the PIRSA Compliance Unit for further action.

Development

Of the reports received for the 2021-22 EMP reporting period, 295 (88%) reported having farming structures and 288 (86%) reported having stock (Pacific Oyster and/or Native Oysters) on the site.

Biomass

Standard licence conditions limiting the amount of Oysters farmed on a site relate to infrastructure (which in turn limit biomass), and state that the licence holder must ensure that the structures used to farm Oysters on a site does not exceed a specified amount per ha (e.g. does not exceed 3 km of longline per ha and/or 1 km of baskets on racking per ha).

Of the reports received for the 2021-22 EMP reporting period, 87 licence holders (or 26%) reported having exceeded the total allowable length of line on the site. While this does not necessarily translate to an environmental impact, PIRSA has been working with the South Australian Oyster Growers Association (SAOGA) to address the issue and have developed the *Standard Lease and Licence Condition Policy* (see page 28 for more information) that addresses new biomass limits for some of the Oyster growing regions, based on historical use and previous research undertaken by SARDI to determine carrying capacity (biomass) in Oyster growing regions.

Feed Inputs

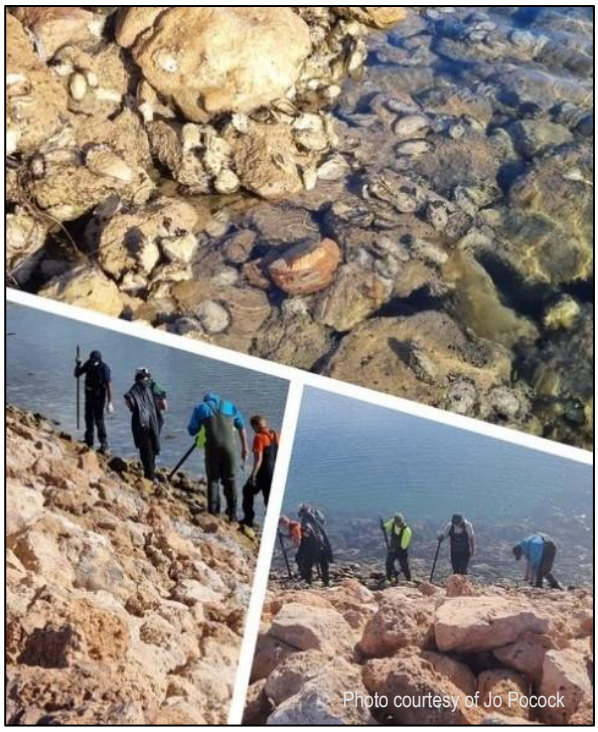
Oysters are filter feeders and do not require supplementary feed.

Reported Interactions and escapes

During the 2021-22 reporting period, no interactions with large marine vertebrates (e.g sharks, whales, dolphins, seals) and seabirds were reported.

Feral Oysters

Of the reports received for the 2021-22 EMP reporting period, 33 (10%) stated feral Oysters (wild Pacific Oysters) were found in the lease area. All feral Oysters were reported to have been removed from the area and disposed of at landbased facilities. Feral Oyster populations within, and adjacent to, growing regions pose a potential POMS risk to the Oyster industry. To reduce this potential risk of disease, the growing regions participate in a feral Oyster monitoring and management program. Led by SAOGA, feral Oyster knock down events (see image below) are organised as needed to reduce feral Oyster numbers in the growing region.



Aquatic animal health management

Veterinary medicine use

Off-label approvals under *Aquaculture Regulations 2016*:

No chemical use approvals were requested by the Oyster sector in 2021-22.

Reported APVMA registered and permitted veterinary medicines

No chemical use was reported for the Oyster sector in 2021-22.

Livestock translocations

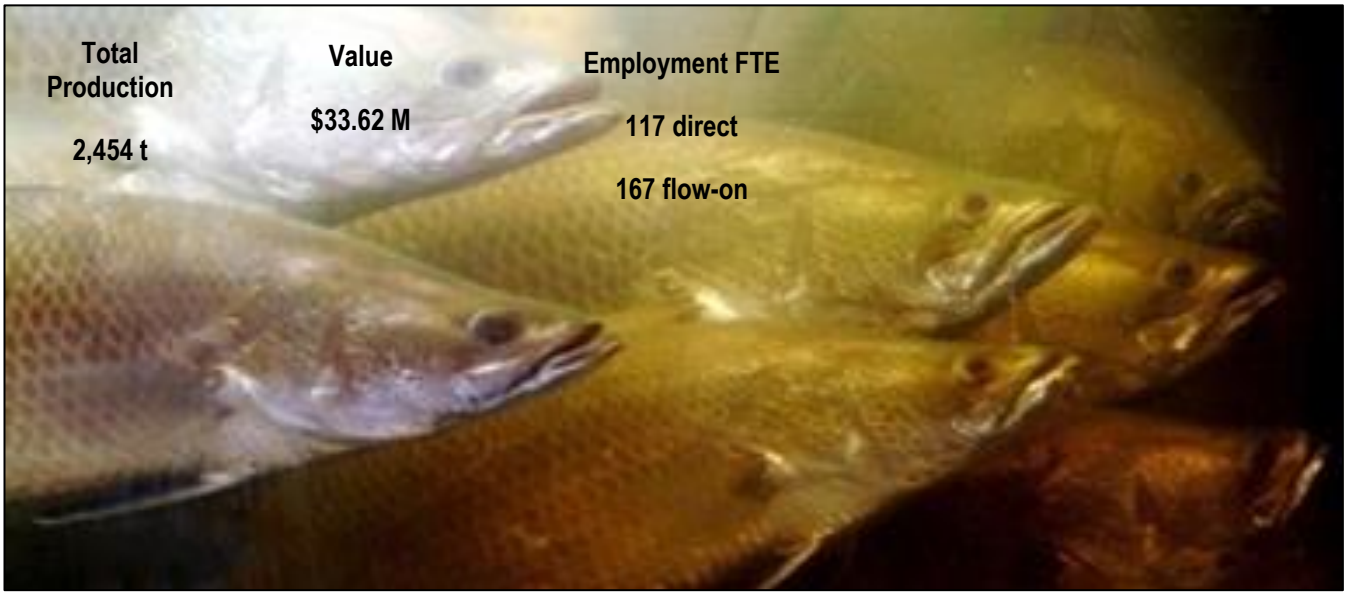
There were two translocation approvals during 2021-22 for the Oyster sector. Native Oysters (*Ostrea angasi*) were translocated from a licence holder to the hatchery at South Australian Research and Development Institute, Aquatic Sciences.

Disease management and surveillance

One mortality event was reported to PIRSA during the 2021-22 period for the sector. In response to this event, the PIRSA Pacific Oyster Mortality Syndrome (POMS) Disease Response Plan was enacted and the event was investigated. No notifiable or infectious diseases were detected through laboratory testing (PIRSA's primary role as hazard leader for animal disease emergency responses).

In 2017, PIRSA developed a surveillance strategy for POMS to enhance early detection and rapid response to the disease. Since this time, Oysters have been regularly submitted to the South Australian veterinary laboratory for testing as part of the state-wide early detection of POMS. In 2021-22, ~3600 Oysters from across South Australia (hatcheries, nurseries, grow-out and feral Oysters in growing regions) (n = 759 samples) were processed and tested negative OsHV-1 (microvariant, which is the virus that causes POMS). For further information on the Tasmanian outbreak of POMS and the indirect effect on South Australia's Oyster industry, see External factors or events affecting the aquaculture industry in South Australia.

Landbased



Overview of the industry

The landbased sector is the most diverse of the South Australian aquaculture industry in terms of farming systems and culture species (see below for species farmed). In 2021-22, there were 61 landbased aquaculture licences in South Australia, comprising of Category A (21), B (24), C (10) and D (6). Licences include private businesses, hatcheries (Abalone, Oysters and Finfish), microalgae production, educational and research facilities, as well as Tourism and hobby farm businesses. Individual landbased aquaculture licences are listed in Appendix 1.

The landbased Abalone, Oyster and Finfish hatcheries contribute significantly to regional economies, creating the majority of the 117 direct jobs in 2021-22, and producing the spat and/or juvenile stock used for other landbased operators and marine based aquaculture activities. For a summary of production and value, and other key economic indicators and trends for the landbased aquaculture sector, see the 2021-22 Economic Indicators Dashboards for Abalone, Freshwater Finfish, Marron and Yabby, and Other farming.

Landbased aquaculture licences are located all over South Australia including the Eyre Peninsula, Yorke Peninsula, Kangaroo Island, Adelaide Hills, Murraylands, Fleurieu Peninsula and the South East. A number of production systems are used by the landbased aquaculture sector. The most popular systems are pond culture, recirculating aquaculture systems and flow-through systems.

PIRSA regulate the landbased sector by categorising each licence based on the level of work required by PIRSA to manage the risks associated with the activity. The criteria for each category are listed below:

Category A: Small scale operators, which do not discharge wastewater off site, and require minimal aquatic animal health legislation requirements and environmental monitoring e.g. Yabby and marron.

Category B: Small scale operators, which may potentially discharge some waste water off-site, or farm a species with applicable aquatic animal health legislation e.g. Native Finfish.

Category C: Intensive and/or large-scale operators with waste water discharge off-site and/or farm a species with applicable aquatic animal health legislation e.g. Oyster hatcheries.

Category D: Intensive and/or large-scale operators with waste water discharge off-site into the marine environment and/or farm a species with applicable aquatic animal health legislation e.g. Abalone farms.

Environment

Annual environmental monitoring reports

Of the 61 landbased aquaculture licences in 2021-22, 48 (or 79%) EMPs were submitted and a majority of these were on time. PIRSA follow up all late or non-submitted EMP reports with licence holders. Education about the importance of the information for regulating the aquaculture industry is promoted. However failure to submit an EMP report where required may result in the matter being referred to the PIRSA Compliance Unit for further action

Development

Of the reports received for the 2021-22 EMP reporting period, 52 (85%) reported having stock at the facility.

Species farmed

In 2021-22, the landbased species farmed included the following:

- Barramundi (*Lates calcarifer*)
- Brown Trout (*Salmo trutta*)
- Golden Perch (*Macquaria ambigua*)
- Greenlip Abalone (*Haliotis laevigata*)
- Hairy Marron (*Cherax tenuimanus*),
- Smooth Marron (*Cherax cainii*)
- Tandanus Catfish (*Tandanus tandanus*)
- Goldfish (*Carassius auratus*)
- Murray Cod (*Maccullochella peelii peelii*)
- Pacific Oyster (*Magallana gigas*)
- Rainbow Trout (*Oncorhynchus mykiss*)
- Silver Perch (*Bidyanus bidyanus*)
- Yabby (*Cherax destructor*)
- Yellowtail Kingfish (*Seriola lalandi*)
- Microalgae (*Dunaliella salina*)

These species were provided with either manufactured or natural aquaculture feed.

Reported escapes

No escape events were reported during the 2021-22 reporting period.

Aquatic animal health management

Veterinary medicine use

Off-label approvals under *Aquaculture Regulations 2016*:

A total of 22 requests (veterinary prescriptions) were assessed and approved in 2021-22 for the landbased sector. There were 18 requests for the use of AQUI-S to address husbandry issues in Finfish hatcheries and three requests were for the use of toltrazuril to treat scuticociliate infections. The remaining request was for the use of benzocaine.

Reported APVMA registered and permitted veterinary medicines

The use of APVMA veterinary medicine products by the landbased sector were reported in annual EMPs for nine sites in 2021-22. These included the APVMA registered chemical products 2-Phenoxyethanol (Aquatic Anaesthetic; PER83233), Magnesium Sulphate (PER86963), Magnesium Chloride (PER83238), Formaldehyde (PER87759), Abamectin (PER88497), Ovaprim (PER13800), LHRHa (PER13069) and Epinephrine Bitartrate (PER80085).

Livestock translocations

Five livestock translocations were requested and approved during 2021-22 for the landbased sector. Species included Rainbow Trout ova, Brown Trout ova and Barramundi.

Disease management and surveillance

No unusually high and unexplained mortalities, nor suspected or confirmed notifiable diseases were reported to PIRSA during the 2021-22 period for the landbased sector. No disease investigations or emergency disease responses were required for the sector during this period.

In 2021-22, Oysters from the landbased Oyster sector (hatcheries) were submitted to the South Australian veterinary laboratory as part of the state-wide early detection of POMS. A total of 66 samples from the landbased Oyster sector (hatcheries) tested negative for OsHV-1 microvariant, which is the virus that causes POMS.

On 4 May 2021, AVG was detected in wild abalone near Cape Nelson, Victoria. PIRSA formed an AVG Response Working Group led by the South Australian CVO to monitor and respond to the Victorian AVG outbreak, which included reviewing risk assessments and predictive oceanography on the South Australia/Victoria boarder, implementing notices to restrict bait/berley use and increase restrictions on seafood imports under the the *Livestock Act 1997* and *Fisheries Management Act 2007* and active surveillance of wild abalone in South Australia on reefs nearest the Victorian boarder.

Marine algae (seaweed)

Overview of the industry

There is a significant global demand for seaweed for a diverse range of uses including food, fertiliser, nutraceuticals, pharmaceuticals, cosmetics, carbon sequestration, nutrient offset, livestock and aquafeeds, bioremediation, biofuels, bio-plastics and bio-polymers. A recent paper suggests the new seaweed aquaculture sector has the potential to address several United Nations Sustainable Development Goals (SDGs) (Spillias et al., 2022). The Australian Seaweed Industry Blueprint outlines the extensive economic, social, and environmental benefits that could be realised through developing an Australian seaweed industry. The blueprint also identifies the various opportunities, barriers and research needed to grow such an industry (see The Official Blueprint for Seaweed in Australia — Australian Seaweed Institute). An Australian seaweed industry peak body has been formed which includes a number of seaweed companies (for more information see Australian Sustainable Seaweed Alliance).

The development of a South Australian seaweed industry has been viewed as advantageous for some time, and recent research has brought South Australia closer to realising the environmental and economic benefits of such an industry. The sustainable wild harvest of the required levels of seaweed is unlikely and therefore a seaweed industry needs to be based on aquaculture. South Australia is uniquely positioned to take advantage of the growing international interest in seaweed aquaculture as the State has:

- Seaweed endemic to our waters,
- Marine areas and coastal land available for farming,
- A world class regulatory framework for aquaculture development,
- International reputation for high-quality seafood, and
- State of the art research and development capabilities.

In recent years, there has been an increasing focus on farming seaweed on land (e.g. tanks, ponds, raceways) or at sea (e.g. floating backbones/longlines; similar structures used by the Mussel aquaculture sector) for commercial purposes in South Australia. In particular, the farming of a red seaweed *Asparagopsis* for its bioactive compound (Bromoform) which has shown to reduce methane emissions in the livestock industry when a small amount of the seaweed is added to livestock feed. A reduction in methane emissions results in a significant reduction of the total greenhouse gas' in the atmosphere, with the goal of mitigating global climate change. Farming seaweed in the marine environment can also sequester carbon, help reverse the growing levels of excess carbon dioxide in the ocean and reduce ocean acidification.

A key benefit of seaweed aquaculture in South Australian waters is the reduction in coastal anthropogenic dissolved nitrogen (via absorption by the culture stock), including from waste products produced by aquaculture stock. Farming seaweed adjacent to Tuna and Finfish farms will allow excess nutrients to be taken up by the algae and reduce the overall nutrient load from the sectors. In addition to improving water quality, seaweed aquaculture provides a range of other positive ecosystem services such as provision of habitat, restorative strategies and practices (e.g. coastal protection, siting farming to provide additional water filtration and denitrification, stock genetics) and climate mitigation (e.g. reduced ocean acidification, carbon capture and storage resulting in a reduction of atmospheric carbon dioxide) and increased water oxygenation (Alleway et al., 2018; Weitzman 2019; Gentry et al., 2020; Zhu et al., 2020; Duarte et al., 2021; Naylor et al., 2021; Xiao et al., 2021). By linking seafood from aquaculture to broader environmental benefits supports the development of climate-friendly aquaculture practices that in turn generate sustainable ecological, social (i.e. climate friendly seafood) and economic outcomes (Tlusty et., 2019).

Integrating bivalve aquaculture (e.g. Mussels, Oysters) with seaweed aquaculture also provides additional environmental benefits. Bivalves and seaweeds are extractive species, meaning they use the organic and inorganic materials and by-products from other species (e.g. Tuna and Finfish farms), from different levels of the food chain, for their own growth. This increases the cycling and uptake of excess, anthropogenic nutrients from the water (Rose et al., 2014). Otherwise known as “Integrated Multi-trophic Aquaculture (IMTA)”, the development of such systems will provide a more sustainable whole of region aquaculture ecosystem and reduce the industry’s environmental ‘footprint’ in South Australia.

Seaweed is a new and emerging sector within the South Australian aquaculture industry. To date, PIRSA has assessed and approved 48 marine and 5 landbased aquaculture licence applications (new and variations to existing licences) to farm seaweed (primarily *Asparagopsis*) across several growing regions (e.g. Eyre Peninsula, Kangaroo Island, Yorke Peninsula) and are currently assessing a number of other licence applications. Four of the marine aquaculture licences and 3 of the landbased aquaculture licences that are approved to farm seaweed are dedicated seaweed licences.

The first two dedicated seaweed (*Asparagopsis*) aquaculture leases/licences were granted in early 2021 in the Point Pearce (east and west) aquaculture zone near Port Victoria (*Aquaculture (Zones – Eastern Spencer Gulf) Amendment Policy 2017*). In 2022, PIRSA granted a further two dedicated seaweed (*Asparagopsis*) aquaculture leases/licences in the Boston Bay and Louth Bay aquaculture zones (*Aquaculture (Zones - Lower Eyre Peninsula) Policy* 2013) at Port Lincoln. During late 2022 and early 2023, PIRSA granted the first three dedicated seaweed landbased aquaculture licences located in Arno Bay, Port Broughton (Yorke Peninsula) and Green Patch (near Port Lincoln, Eyre Peninsula). As seaweed farming is still predominantly under trial, commercial production on all sites is yet to commence and therefore no production results are available. Individual Marine algae aquaculture licences for the 2021-2022 reporting year are listed in Appendix 1.

PIRSA also recently approved a Tuna licence holder to collect naturally occurring seaweed (biofouling) on floating longlines (similar farming structures to the Mussel sector) located adjacent to Tuna cages for on-growing and harvesting (see image below). Cultivating seaweed next to Tuna or Finfish Farms results in significant environmental benefit as the seaweed can assimilate nitrogen, carbon, and phosphorus that is potentially discharged from these farms. The seaweed will be made into liquid fertiliser and a natural pigment, with the remining solids turned into chicken feed.

Macroalgae Management Areas (MMA)

PIRSA supports the sustainable growth of the emerging seaweed aquaculture industry. Recent ESD risk assessments completed for new licences – or for the variation of existing licences – to culture seaweed have identified potential risks related to seaweed biosecurity (pest and disease) and population genetics, primarily through stock translocation if they were to occur. These risks have highlighted the need to control seaweed translocations into and within South Australia to protect the industry and the marine environment. In response, PIRSA has developed specified Macroalgae Management Areas (MMAs) to ensure seaweed seedstock or broodstock collection (see Broodstock and seedstock collection permits - PIRSA) is undertaken in a manner where aquatic ecosystems and genetic diversity are maintained. Based on the State's marine bioregions and biounits (Edyvane, 1999) and scientific advice, the management areas broadly represent the key habitat distributions along the coast of South Australia and the likely growing areas for seaweed species, and therefore provide a suitable foundation for delineating areas for managing activities relating to seaweed collection for aquaculture and the movement of stock between licences. This includes ensuring seaweed stock originates from the same MMA as the licensed area (or discharge point for landbased aquaculture sites). Also considered during the development of the MMAs were the location (currently known) of seaweeds of interest for aquaculture (e.g. *Asparagopsis*), dispersion potential of seaweed and location of aquaculture zones. A map of the MMAs along with location descriptions for each management area is available on the PIRSA website - www.pir.sa.gov.au/primary_industry/aquaculture/marine_aquaculture.

To complement the new management areas, aquaculture licences permitted to culture seaweed have conditions applied for managing the potential biosecurity and genetic risks. The need for conservative management of disease and genetic risks for the rapidly developing seaweed industry is common across Australia, as identified by the national Seaweed Aquaculture Working Group (under the national Aquaculture Committee), until further research is available. There are a number of research projects occurring around the country to address key knowledge gaps to inform policy and regulation. In South Australia, SARDI has been awarded funding from FRDC to undertake a project to develop biomass assessment approaches, harvest methodologies and biosecurity knowledge for wild-harvest of seaweeds. For further information on this project and other research being undertaken by SARDI to support the development of a seaweed industry (through production and processing of a variety of species), see Research section of this report.

A new seaweed industry is estimated to be worth $140 M in the next three years and has the capacity to create an additional 3,000 jobs. The industry is likely to contribute significantly to regional South Australia, with increased job opportunities in farming and processing of product, with further jobs created in transport and other flow-on activities. Revenue from processing could add a further $250 M per year to the State's economy. Local aquaculture operators continue to be interested in exploring this diversification opportunity.

In early 2023, PIRSA presented at the International Seaweed Symposium and World Aquaculture Conference (see https://iss2023.net/ and www.was.org/meeting/code/WA2023) on the sustainable development of a seaweed industry in South Australia. Positive feedback on the strategies implemented to manage the rapidly developing seaweed sector were received and greater interest in farming seaweed in South Australia was generated.

Environment

Annual environmental monitoring reports

Development

Two of the 4 licences for the Marine algae sector submitted an EMP in 2021-22. The remaining 2 licences did not submit an EMP report because the licences were recently approved and there was no development on site.

Biomass

The amount of seaweed that can be farmed on a site relates to infrastructure not biomass, as per individual licence conditions. For example, the total length of backbone (i.e. longline on the surface supporting vertical lines which seaweed is attached) per ha or contained and/or uncontained longline per ha. If a combination of farming methods is used, to prevent overstocking the length of each farming method (expressed as a percentage of the maximum permitted length) must be equal to or less than 100 at all times.

During the 2021-22 EMP reporting period, seaweed farming was still under trial and therefore only a small amount (50 m) of backbone was developed on one of the licences.

Feed inputs

Seaweed farmed in the marine environment absorb natural light and nutrients for photosynthesis and growth and does not require supplementary feed.

Reported interactions and escapes

No escape events or interactions were reported during the 2021-22 reporting period.

Aquatic health management

Veterinary medicine use

No chemical use or approvals were reported for the 2021-22 reporting period.

Livestock translocations

No livestock translocation approvals were requested during 2021-22 for the Marine algae sector.

Disease management and surveillance

Commercial production of seaweed is yet to commence as farming is still predominantly under trial. Therefore, no unusually high and unexplained mortalities, nor suspected or confirmed notifiable diseases were reported to PIRSA during the 2021-22 period for the Marine algae sector. No disease investigations or emergency disease responses were required for the sector during this period.

The lead SA

Tourism and education

Photo courtesy of Oceanic Victor

Aquaculture, as well as a primary food source, has an important role in Tourism and education. Aquaculture facilities provide opportunity for students and the public to learn directly about marine and freshwater aquatic environments through a hands-on approach. The Cowell Area School has a current aquaculture program comprising an operating Oyster farm and associated Landbased facilities. There are also a number of other licensed schools and educational facilities (Port Lincoln, Ceduna, Kingston, Lucindale and Kangaroo Island Community Education) that include aquaculture in their curriculum.

In 2021-22, there was one licensed marine aquaculture tourism site (Encounter Bay, near Victor Harbor). This site provides the opportunity for the general public to view, swim with and learn about various marine species found locally in South Australian waters such as Tuna, Abalone, Snapper, Rock Lobster and Yellowtail Kingfish within the safe confines of a sea-cage and floating pontoon equipped with touch tanks. Due to the global COIVD-19 pandemic and resulting lockdowns and travel restrictions, as well as structural work on the Granite Island causeway limiting access to the site for the public, there were no visitors to this site in 2020-21. It is expected this aquaculture tourism operation will be receiving visitors in 2023-24.

In recent years, there has been growing demand for local tourism experiences as a result of an increase in local travel. This has led to some Oyster farmers developing floating pontoons or fixed platforms on their sites for tourists to visit, and experience aquaculture produce and learn about how they are farmed. The *Aquaculture (Tourism Development) Amendment Act 2021* will streamline the assessment and approval process for these types of developments (see "Changes to the *Aquaculture Act 2001*" section for further information).

Photos courtesy of Oyster farm tours – Coffin Bay

Compliance outcomes

PIRSA staff monitor and investigate potential breaches of the *Aquaculture Act 2001*, *Aquaculture Regulations 2016* or other relevant legislation (e.g. environmental), based on random and targeted inspections, information received by the public (e.g Fishwatch), other government agencies and other stakeholders (including recreational marine resource users), in an efficient and timely manner.

PIRSA aims to work in collaboration with the industry to address and rectify any issues that arise. Subject to the circumstances of any reported non-compliance, PIRSA will apply the most appropriate measures such as education of licence holders, consider changes in licence conditions where appropriate, direction to carry out work or further enforcement actions if required.

During 2021-22, Finfish (Boston Bay, Proper Bay and Fitzgerald Bay), Oysters (Nepean Bay, Port Vincent, Wardang Island, Point Pearce, Franklin Harbor, Todd river, Kellidie Bay, Point Longnose, Dutton Bay, Haslam, Perlubie, Streaky Bay), Mussel (Boston Bay, Proper Bay, Louth Bay), Tuna (Port Lincoln), and Landbased (Riverland, Adelaide) aquaculture sites were inspected by PIRSA staff, with a particular focus on compliance to navigation requirements (marine), condition of leases (requirement to be in good working order), annual reporting (EMP and Production returns), rehabilitation of unused sites (marine), species farmed (landbased) and following up information and reports attributed to farming operations.

Results from these site inspections indicated most marine sites demonstrated good to high compliance in relation to navigational requirements (e.g. location and marking of navigational structures, and aquaculture farming structures within the boundaries of the site), and were observed to be in good condition. A majority of landbased sites were compliant with licence conditions. Where there was evidence of non-compliance (e.g. incorrect marking of navigation structures, failure to rehabilitate a site, outstanding annual reports), lease and licence holders were contacted, areas requiring attention were identified and education on their obligations was provided. Follow-up inspections of non-compliant sites were undertaken to ensure actions had been taken to address the issue, with the majority of licence and lease holders completing the required action to restore their site(s) to compliance status.

In addition to targeted inspections, Fisheries Officers continued to collect feral Pacific Oyster samples as part of the POMS surveillance program from sites including Ceduna, Coffin Bay, Lucky Bay and other areas across the State. A number of questions relating to Oyster biosecurity related rules and preventative measures including translocation risks were received from growers and the general public. The Regional Manager (West) regularly reiterated biosecurity and POMS prevention measures via ABC Radio on the Eyre Peninsula, with an aim of raising awareness among the community. POMS signage was also maintained within the Port River system.

Furthermore, Fisheries Officers undertook the following:

- Responded to reports of alleged escapes of Finfish including liaising with the impacted grower and conducting follow up investigations on each occasion.
- Continued to conduct extensive monitoring of Port Lincoln based catch landing sites, sale outlets and joint monitoring activities with SAPOL to assist Industry deal with the annual Tuna theft issue at Port Lincoln. Reports received during the 2021-22 ranching season were considerably less than previous years. The Regional Manager (West) continued to liaise with growers in relation to this issue.
- Followed up reports of aquaculture related debris including collecting or securing items or liaising with local landowners and licence holders to promptly recover items.

Fishwatch 1800 065 522

Government of South Australia
Primary Industries and Regions SA

Aquatic animal health and biosecurity

Fish kill and fish health investigations

This section provides a comparison between aquaculture mortality or disease investigations (reported above) and wild fish kill or wild fish health investigations conducted by PIRSA.

For 2021-22, there were three aquaculture related mortality events investigated and 13 wild fish kill investigations reported and investigated (Figure 17). Aquaculture related mortality events and wild fish mortality events were primarily due to environmental or natural occurrences (e.g. harmful algae bloom, water quality, weather event and unusually high or low water temperature). As of 30 June 2023, South Australia has 59 notifiable diseases pursuant to the *Livestock Act 1997*, which are required to be reported if suspected or detected. No notifiable diseases were detected as a result of fish kill (or fish health) investigations.

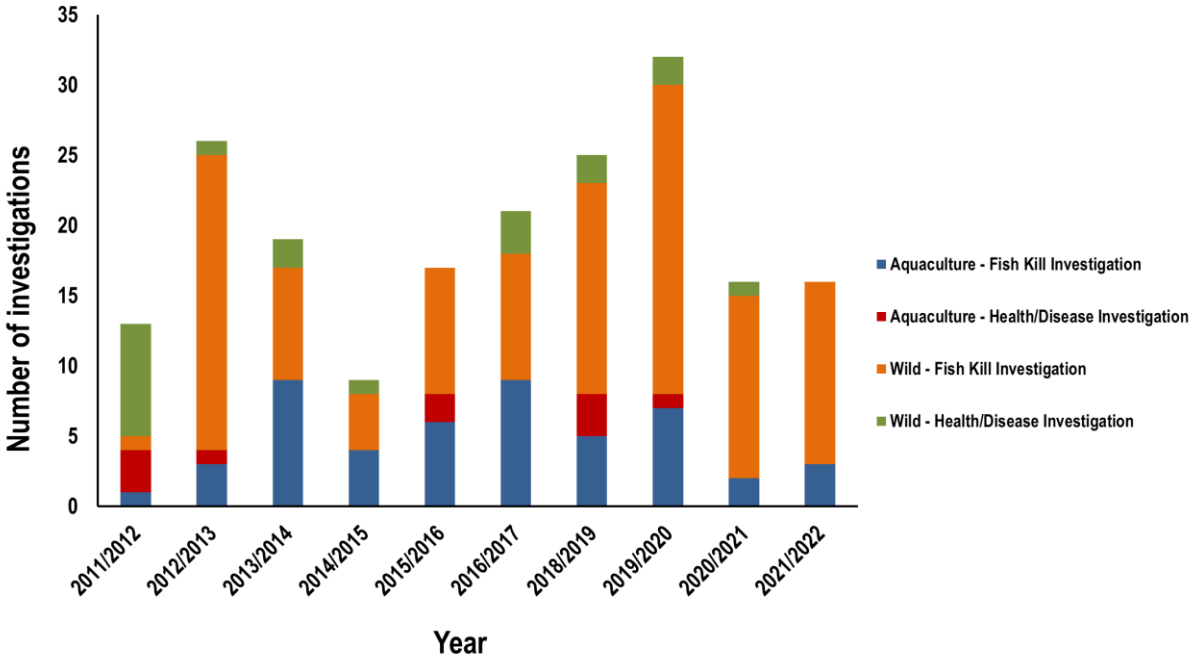


Figure 17. A summary of South Australia fish kill (mortality) and fish health (disease) investigations in wild fish and aquaculture sectors from 2011-12 to 2021-22.

Industry initiatives

Marine debris

Adopt-a-Beach Program

A need for a collaborative approach to the regular collection of debris from local beaches on the Eyre Peninsula was identified in 2011 and the local aquaculture industry agreed to undertake marine debris beach clean ups.

Led by the Australian Southern Bluefin Tuna Industry Association (ASBTIA) and supported by the Finfish and Mussel industries, the Adopt-a-Beach Program is a debris clean-up program that covers a coastal area of approximately 160 km located in the Lower Spencer Gulf region, from MacLaren Point to Cape Euler. It includes a number of islands within the Boston Bay area and Spilsby Island (Sir Joseph Banks Group), with the area divided into 15 individual zones which are assigned to/adopted by individual Tuna, Finfish and Mussel companies. Adopted areas range from 6 to 19 km (see www:pir.sa.gov.au/aquaculture/monitoring_and_assessment/adopt_a_beach_program).

Beach clean ups are undertaken a minimum of four times a year, with clean-up data collected and submitted to the ASBTIA for collation and reporting to PIRSA. Information collected for each “beach” includes the five most common types of items, unusual items and total weight. Debris collected predominantly consists of rope, plastic, drink containers, household rubbish and

buoys/floats. While some debris, such as ropes and some plastics may be attributed to aquaculture, it is clear that debris originated from a range of sources including commercial and recreational fishing, landbased operations, commercial shipping and the general public. The program also encompasses the collection of non-aquaculture related debris and its disposal in a responsible manner.

South Australian Oyster Growers Association (SAOGA) - Coastline Debris Recovery Program

To address legislative requirements, the South Australian Oyster industry cleans up debris from the coastline near their farming sites. This has been an ad hoc process with little documentation of what has been achieved. A number of these clean-ups have been coordinated and carried out with the Department for Environment and Water (DEW) staff. The clean-ups are somewhat targeted with some sites identified from DEW marine debris surveys and mapping.

A need for a more collaborative, coordinated, documented and efficient approach to regular debris collection from the local coastline was identified. In September 2015, SAOGA developed a clean-up program called the 'Coastline Debris Recovery Program' in collaboration with PIRSA and DEW. This program was again reviewed in 2022.

This Coastline Debris Recovery Program involves clean-ups in eight different regions between Coffin Bay and Denial Bay, South Australia. Hot spots were identified through DEW staff and Oyster growers, specifically Coffin Bay, Ceduna and Smoky Bay. Coordinated clean-ups are to occur approximately two times per year. Recent clean ups by growers have occurred at Coffin Bay, Cowell, and Smoky Bay. In addition, growers in Streaky Bay regularly walk the local beaches to collect debris. While some of the items recently collected can be attributed to aquaculture, many of them originate from a variety of sources including commercial and recreations fishing, landbased activities and the general public. Yorke Peninsula farming area covers a small section of the coast between Port Vincent and Stansbury and growers regularly monitor for debris during their farming activities. No debris has been sighted along the coast for some time. Kangaroo Island growers also regularly monitor beaches for debris and have recently undertaken an extensive beach patrol, but no documentation is available on what debris (if any) was collected.

This program is the responsibility of SAOGA, as well as Oyster licensees, and will be supported and monitored by the South Australian Government to achieve its desired outcomes.

Oyster Hub project

The Oyster Hub project was developed to provide a web-based tool for the effective management of Oyster stock such as grow-out, conditioning, mortality and translocation. It provides a framework for farmers to record key information for better decision making and dissemination to maximise production efficiency through improved husbandry methods.

The Oyster Hub project is now complete with miShell managing the system, which is being used by many growers in South Australia and interstate. MiShell has since provided a number of updates to the program and has recently been awarded a grant to support the implementation of a traceability program that will be linked to stock management to trace stock once it has left the farm.

Oyster basket recycling

In 2013, the EPA, working collaboratively with the South Australian Oyster sector, Regional Development Australia Whyalla and Eyre Peninsula, and the Department for Manufacturing, Innovation, Trade, Resources and Energy, undertook a feasibility study into the recycling of plastic Oyster baskets (see www.epa.sa.gov.au/files/477882_Oyster_basket_study.pdf).

The aim of the South Australian Oyster Basket Recycling Feasibility Study was to 'identify cost-effective Oyster basket recycling options that will value add to the efficient operation of the industry as a whole'. The Oyster industry uses 2.5 million baskets annually. Each year about 5-10%, or 150-200 t, of these plastic baskets reach their end of life and must be disposed. Instead of sending the baskets to landfill, many Oyster growers have been stockpiling them on their properties until more environmentally sustainable disposal by recycling option becomes available.

The Oyster industry developed an Expression of Interest to identify recycling companies that would be interested in taking the baskets at zero cost to industry. One company was identified and commenced a trial of collecting, mulching and recycling the baskets at the agreed zero cost. However, China changed its policy on taking recycled waste in 2018 and it was not financially viable for that company to continue. Since this time, the industry has continued to recycle plastic baskets by using a portable plastic shredder on the back of a truck but it comes with a cost to growers. The shredder is currently undergoing repairs but

once fixed, the shredded plastic will be sent to Sarah Prime from Shadowbox (a local Eyre Peninsula entrepreneur) who is building a recycling facility at Wharminda. This is the preferred option to dumping the plastic at a landfill facility but also occurs a cost. The method of shredding is also very labour intensive as all baskets need to be free of any contaminants (i.e. metals and non-shredding plastics). SAOGA and South Australian Oyster Research Council (SAORC) will continue to work with Sarah Prime to implement the recycling program.

Seafood certification

Third-party aquaculture certification schemes not only provide consumers assurance that their seafood is sustainably and ethically produced, but also provide producers in some instances with greater market access, whilst encouraging them to implement and maintain responsible farming practices throughout their operations. There are multiple worldwide certification programs available to aquaculture, with the South Australian industry successful in achieving certification to some that are considered some of the most robust, reputable and recognised programs in the world.

Friend of the Sea Sustainable Aquaculture certification has been achieved for many of the South Australian aquaculture companies (Clean Seas Seafood Ltd (Australia), Angel Oysters Australia Pty Ltd, Australian Southern Bluefin Tuna Industry Association and all the Tuna companies, and Eyre Peninsula Seafoods Pty Ltd; see www.friendofthesea.org/ for information about this certification). The Friend of the Sea Sustainable Aquaculture certification provides independent assurance to markets that the product has been produced in a healthy, safe and sustainable environment. It involves a rigorous environmental sustainability performance assessment that assesses the whole supply chain from the catch in the wild, through the value adding aquaculture process to final harvesting.

The Aquaculture Stewardship Council (ASC) is an independent, global, non-profit organisation whose role is to recognise, via a certification program, responsibly farmed seafood and to harness consumer preference for seafood products bearing the ASC label of approval. Successful certified aquaculture companies are audited annually to ensure they maintain the ecological sustainable standards of the ASC. The accreditation process is extensive, and Cleans Seas Seafoods Ltd achieved certification from the ASC for their conformance to the ASC Seriola 2016 Standard in 2019, with annual reviews to ensure continuance of compliance (see www.asc-aqua.org/find-a-farm/ASC01211/). In 2021, Yumbah Aquaculture Ltd achieved ASC certification for their Kangaroo Island and Port Lincoln Abalone farms (www.asc-aqua.org/find-a-farm/ASC01633/ and www.asc-aqua.org/find-a-farm/ASC01634/).

Research

As part of its commitment to supporting industry growth and developing an adaptive resource management framework, PIRSA plays a key role in supporting a number of strategic research initiatives. Many of these projects are led and conducted by SARDI, the research division of PIRSA which offers an integrated research and development (R&D) capability to sustainably create, nurture and grow aquaculture industries.

SARDI and PIRSA work closely with the aquaculture sector to produce applied research outcomes and their timely delivery. SARDI's aquaculture research program is uniquely set up to provide support across the whole spectrum of industry research needs, including:

- Developing novel cultivation technologies and culture of new species.
- Aquaculture site selection and suitability.
- Environmental assessment, monitoring, oceanography and carrying capacity modelling.
- Improving hatchery technology for improved success in spawning, larval and juvenile rearing of commercially important species.
- Novel molecular and biotechnological tools and techniques to augment aquaculture production.
- Developing and evaluating improved, cost-effective and sustainable feeds.
- Providing advice and support on selective breeding programs and aligned molecular technologies.
- Optimisation of grow-out systems and husbandry practices in aquaculture farms.
- Enhancing algal production and systems to produce biomass for a diverse range of products and environmental services.
- Addressing disease and pest issues, through support with chemical registration, monitoring and surveillance, evaluation of therapeutics and development of improved husbandry practices.
- Pre- and post-harvest product safety and quality, including developing novel products, value addition and packaging.
- Circular economy and sustainability in aquaculture production systems.
- Restorative aquaculture.

- Extractive aquaculture and Integrated Multi-Trophic Aquaculture.
- Trade and market access.

The outcomes of such initiatives are integrated into decision making processes such as those associated with aquaculture zoning, disease control, managing interactions with protected wildlife species and environmental management. A summary of these research activities are outlined below. A large number of other aquaculture related research projects have been undertaken over the years, most of which can be found at: www.pir.sa.gov.au/research/research_specialties/aquatic_sciences and www.frdc.com.au/.

Historic research

Innovative Solutions for Aquaculture Planning and Management

A strategic research initiative is the Innovative Solutions for Aquaculture Planning and Management suite of projects (IS). Commenced in 2004, this program was a joint initiative between PIRSA and the FRDC to fund research to foster the continued sustainable development of the South Australian aquaculture industry. Stage One of IS involved a site or species focus. Projects included an environmental audit of marine aquaculture, spatial impacts and carrying capacity for Finfish aquaculture, Finfish parasites, seal interactions and the development of rapid environmental assessment and monitoring techniques. In addition, a communication and extension strategy was developed to disseminate project outcomes to industry. The particular focus of the second stage of the IS program was to facilitate further economic growth of the aquaculture industry and to provide information to improve the management of aquaculture resources. Projects completed under Stage Two (2009-2012) have included oceanic and biological modelling of Spencer Gulf, biosecurity, new technologies and new species and improving programs for environmental monitoring. More on these projects can be found here: www.frdc.com.au/project/2003-223, www.frdc.com.au/project/2004-203, www.frdc.com.au/project/2004-201, www.frdc.com.au/project/2003-222

Finfish

During 2015-19, as part of the Rural Research and Development for Profit Program (Department of Agriculture and Water Resources, Australian Government), SARDI was a research partner in a project “Growing a profitable, innovative and collaborative Australian YTK aquaculture industry: bringing ‘white’ fish to the market”. The project focused on growing the key existing Australian YTK industry participants, as well as the industry as a whole, and directly addressed FRDC's strategic plan to build Australian sustainable aquaculture development through the activities of the new 'New and Emerging Aquaculture Opportunities' (NEAO) Subprogram. The project built on earlier R&D on YTK undertaken through the FRDC and the Australian Seafood Cooperative Research Centre (ASCRC) to deliver outcomes specifically for the industry partners of this project, and also provide benefits to the broader Finfish aquaculture industry, particularly the sectors targeting the production of 'white' fish (e.g. Barramundi and Cobia). The final report can be found at www.frdc.com.au/sites/default/files/products/2016-200-DLD.pdf

In 2018, a project investigating interactions of sharks with marine activities (e.g. aquaculture and fisheries) in southern Spencer Gulf was finalised (Rogers and Drew 2018). The project focused on the movement dynamics of two pelagic sharks, the White Shark (*Carcharadon carcharias*) and Bronze Whaler (*Carcharinhus brachyurus*), in South Australia. Specific aims were to: (1) determine if aquaculture activities correlated with patterns on fidelity and migration; and (2) assess and compare the use of natural foraging areas and areas used during human marine activities. Additional objectives included the development of industry guidelines for removal and release of pelagic sharks from Tuna/Finfish aquaculture pontoons, involving industry workshops and meetings and input from an earlier industry workshop on sharks and aquaculture (Murray-Jones, 2004), and social-based surveys to collect baseline information on public perceptions of shark associations with aquaculture and other marine activities. The final report can be downloaded at www.frdc.com.au/project/2014-020. Key findings from this project were:

- Negligible overlap between sharks and aquaculture activities in Spencer Gulf, suggesting that aquaculture does not lead to aggregations of sharks to an area. It is noteworthy independent research undertaken by Flinders University of South Australia on shark interactions around the tourism aquaculture site at Victor Harbor demonstrated a similar outcome (Huveneers et al., 2022).
- ‘Industry guidelines for managing white sharks’ were developed and are now regulated under regulation 18 and 20 of the *Aquaculture Regulations 2016* (see Interactions with sharks). The guidelines include practical approaches, such as creating temporary gates from existing netting (based on if the shark is swimming on the surface or near the bottom), and using bait to encourage the shark to swim free. If this approach is unsuccessful, the guidelines recommend that

industry representatives work with SARDI and PIRSA Fisheries and Aquaculture to capture and remove the White Shark from the pontoon. Formal advice regarding alternative approaches is recommended if capture is unsuccessful.

- The social surveys found that the public were generally not concerned about sharks being attracted by aquaculture or fishing activities. The relationships between sharks and aquaculture were not perceived to exist in isolation, nor were they considered to be high priorities. Other marine issues (such as marine protected areas, local economies, individual and community activities, and engagement with the coast) mattered the most to interviewees. Participants did not link sharks with aquaculture or view them as connected. There was a general support of aquaculture developments, but the types of aquaculture venture mattered to interviewees. Media portrayals of shark interactions with humans was found to significantly influence public perception.

Oysters

The Future Oysters CRC-P program was developed in conjunction with the Oyster industry, FRDC, and the Commonwealth Government to undertake the research needed to rebuild and evolve the Australian Oyster aquaculture industry in the face of POMS and other diseases affecting Oysters. The research focused on breeding disease resistant Oysters, improved disease management, increased productivity and profitability, diversifying risks to allow the industry to grow and supply domestic markets and a growing global consumer demand for seafood. Improved diagnostic technologies for POMS are being developed, including more efficient approaches to area surveillance, a test using flow cytometry for better quantification of the POMS virus in water, and a better understanding of sampling to test for POMS. This program also investigated the causes and approaches to managing Winter Mortality in Sydney Rock Oysters and mortalities of unknown cause in the South Australian Pacific Oyster industry. More on this project can be found at https://www.frdc.com.au/project/2016-807 or www.Oystersaustralia.org/current-crcp

Recently completed research

Aquatic Animal Health (AAH)

In 2019, PIRSA's AAH Unit completed a project to improve early detection surveillance and emergency disease response to POMS using a hydrodynamic model to predict the dispersion of OsHV-1. This project provided a case study for how such a model can predict pathogen spread to underpin improved surveillance designs, effective emergency disease response (identified disease management areas around the State) and appropriate biosecurity zoning for translocation protocols. More on this project can be found at www.frdc.com.au/project/2018-090.

In June 2020, PIRSA's AAH Unit completed another project which developed national guidelines to provide the Australian sea-cage Finfish (non-salmonid) industry with the tools and templates to create an auditable farm biosecurity plan. Consideration was given to the current farming of Yellowtail Kingfish (*Seriola lalandi*), Southern Bluefin Tuna (*Thunnus maccoyii*) and Cobia (*Rachycentron canadum*). More on this project can be found at www.frdc.com.au/project/2019-088.

In June 2022, PIRSA's AAH Unit completed FRDC project 2019-147 which investigated risk factors and management strategies associated with summer mortality in Australian abalone. The project summarised current abalone health and summer mortality research and retrospective mortality investigations and laboratory submissions of Australian abalone. The project also developed a case definition for summer mortality and investigated summer mortality events during the life of the project to rule out primary pathogens and infectious agents, in both control and affected abalone populations. Results from this project have now been published in a scientific journal; see www.sciencedirect.com/science/article/abs/pii/S0044848623007020?via%3Dihub

Seaweed

In 2019, SARDI's Algal Production Group commenced FRDC project 2019-144 "Cultivation trials of the red seaweed *Asparagopsis armata* and *A. taxiformis*" in collaboration with CH4 Australia Pty Ltd. Under this project prospecting and field collections were undertaken in Gulf St Vincent and Spencer Gulf, developed and optimised an analytical technique for the quantification of bromoform, developed propagules *of A. taxiformis* from vegetative fragments, undertook nutrient uptake and assimilation trials for the two life-history stages of *A. armata* and *A. taxiformis*, trailed different land-based and 'at-sea' cultivation systems, and undertook postharvest processing trials of the harvested biomass of *A. taxiformis* and *A. armata*. The final report for this project was submitted in June 2023. More information on this project can be accessed at https://www.frdc.com.au/project/2019-144

In 2022, SARDI in partnership with Dinko Tuna Farmers secured funding from Agrifutures Australia under the Agrifutures Emerging Industries Grant for the project "Sustainably sourced natural colour pigments from cultivated native marine macroalgae for the plant-based meat industry". This project was completed in June 2023 and is being scoped into a project for the establishment of a pilot plant. For more information, see Seaweed | AgriFutures Australia.

Current research

Molluscs

A current project underway is aiming to identify the feeding requirements of Pacific Oysters, Cockles and Mussels, investigate the factors influencing food availability in South Australian Oyster farming regions and improve our understanding of the relationship between food availability, bivalve feeding and farm production/productivity, and the potential implication of aquaculture development on different species. More information on this project can be found at www.frdc.com.au/project/2014-027.

Finfish

During 2019-2022, an FRDC project assessing the capacity for sustainable Finfish aquaculture in the vicinity of seagrasses was undertaken. The project was prompted by the re-establishment of Yellowtail Kingfish aquaculture in Fitzgerald Bay. The outcomes of the project aimed to assess the influence of Finfish aquaculture derived nutrients on seagrasses, develop a predictive modelling ability to estimate carrying capacity and allow scenario analysis of future aquaculture developments and how it might affect seagrasses and develop a range of cost-effective indicators for monitoring the effects of aquaculture on adjacent seagrass beds. The unexpected cessation of Finfish aquaculture in Fitzgerald Bay in November 2022 meant that the final sampling in Autumn 2023 did not capture the period of high feed inputs expected. A draft final report is due by the end of 2023. More information can be found at www.frdc.com.au/project/2018-186.

Aquatic Animal Health (AAH)

PIRSA's AAH Unit has commenced (2021) project FRDC 2020-094 "Improving the availability of safe and effective veterinary medicines for Australia's seafood industry". This project aims to document a safe and effective process for off-label use of veterinary medicines, facilitate progress of priority veterinary chemical products in aquaculture, determine options for a framework and/ or business case for future coordination and develop and implement a communication and awareness strategy for safe and effective veterinary medicine use. For an overview and update on the project, see: www.frdc.com.au/streamlined-process-improves-access-aquaculture-medicines. More information on the project can be found at www.frdc.com.au/project/2020-094.

Seaweed

FRDC now provide an overview of seaweed related research in Australia to facilitate coordination and information sharing: Seaweed Aquaculture in Australia | FRDC

In 2020, a pilot research trial for seaweed aquaculture (*Asparagopsis*) led by SARDI / PIRSA, was awarded funding of $223,340 from FRDC with a co-investment of $329,331 from CH4 Global. The research team has made significant progress with development of an in-house protocol for testing the bioactive compound bromoform responsible for reducing ruminant methane production, hatchery technology and production infrastructure designs and trials of farming seaweed. Both 'at-sea' and landbased trials have taken place at Port Lincoln, Port Victoria and West Beach, respectively.

In 2021, a $1.5 M project (over 2 years) funded under the Economic and Business Growth Fund (EBGF) and led by SARDI commenced to help better engage with the private sector to attract new companies into the local aquaculture industry and grow commercial seaweed opportunities through scientific support. The project aims to foster the engagement between commercial industry companies, technical experts and researchers in order to enhance the understanding of seaweed as a raw material along with identifying and resolving constraints that currently exist to large scale seaweed production. SARDI has already partnered with five South Australian based industry partners across the value chain, that will see at-sea and on-land cultivation of seaweeds for a variety of applications in Port Lincoln, Port Victoria, Dry Creek and West Beach.

The Federal Government has invested $59 M (2021) into the Marine Bioproducts Cooperative Research Centre (MB CRC), which will help establish South Australia as an international leader in commercial seaweed. The State Government is also

investing $2.6 M over the next 10 years into the MB CRC, including contributions from PIRSA ($2 M) and the Department for Industry, Innovation and Services (providing $600,000 to SARDI). A 2-year project on 'Biodynamic liquid fertiliser from seaweeds and fish processing wastes' has been developed by SARDI in collaboration with Australian Marine Bioproducts Ltd / Dinko Tuna Farmers. This project is underway with 0.75 ha of seaweed settlement lines currently deployed next to tuna farms in Port Lincoln (see Marine algae (seaweed)) The first harvest of about 2 tonnes of seaweeds was undertaken in December 2022. About 0.5 tonnes of tuna processing wastes and utilisable pilchard wastes have been aggregated in Port Lincoln awaiting enzyme transformation into liquid fertiliser at SARDI.

In 2022, a local Tuna farmer and SARDI received an AgriFutures grant to develop natural colour pigments from cultivated native seaweeds for the plant based meat industry. SARDI and Dinko Tuna Farmers are seeking funding to scale this project into a pilot plant. Additionally, SARDI in partnership with three industry groups and a R&D partner received $247,054 from the Department of Agriculture, Water and the Environment to develop a multi-species seaweed hatchery under the Agricultural Innovation Hubs Program to support the seaweed industry

In 2022, SARDI commenced a project on 'Hatchery development for commercially important native seaweeds' funded by the Department of Agriculture, Water and the Environment under the Agricultural Innovation Hubs Program. The collaborative partnership with three industry groups and a R&D group saw the establishment and operation of an *Ecklonia radiata* hatchery at West Beach with work underway on protoplast cultures of *Asparagopsis*. First seeded lines of *Ecklonia* will be deployed in Port Lincoln at the end of August 2023 and in September 2023 at Kangaroo Island. Scale-up of the protoplast cultures are also underway. This project will be completed in September 2023. For more information, see Innovation activities - SA Drought Hub.

In 2023, SARDI commenced project FRDC 2021-112 "Developing biomass assessment approaches, harvest methodologies and biosecurity knowledge for wild-harvest of seaweeds in southern Australia". While much of the focus is on the development of a seaweed aquaculture industry, this needs to be supported by the wild harvest of seedstock, at least in the early years, and there is also some interest in wild-harvest for product. As the knowledge base and tools available for PIRSA to regulate this emerging industry are limited, this project aims to start filling in some of these gaps and develop a rapid assessment tool for species specific subtidal macroalgal biomass, such as *Asparagopsis armata*, *A. taxiformis* and *E. radiata.* More information on the project can be found at https://www.frdc.com.au/project/2021-112.



External factors or events affecting the aquaculture industry in South Australia

Coronavirus (COVID-19)

In March 2020, the Coronavirus (COVID-19) was declared a global pandemic which resulted in the closure of restaurants and food outlets, and a reduction or loss in access to domestic and export markets for South Australian seafood industries. For example, the Mussel and Oyster industries were significantly impacted from the restrictions of access to export markets and dampening of domestic food service consumption. To assist the recovery of the South Australian aquaculture industry from the significant impacts of COVID-19, the collection of 2020-21 aquaculture sector fees were deferred for six months and any outstanding 2019-20 fees were also deferred. The next round of fees were not collected until January 2021.

The demand for South Australian Oysters in Australia has now soared since growers were forced to innovate and diversify during the COVID-19 pandemic. Growers shifted from international exports to local retail and tourism opportunities, including online and pop-up shops, and Oyster experiences on floating pontoons. Growers have experienced record sales for the past few quarters which has been attributed to more people spending money on local experiences, produce and tourism, and good spat survivability. Restaurant orders have almost returned to pre COVID-19 levels and with a highly successful local market, the Oyster industry is flourishing again.

Tuna quota

Southern Bluefin Tuna (SBT) are a highly migratory species found in several parts of the Southern Ocean, including the Great Australian Bight in South Australia and Western Australia. SBT migratory patterns mean international agreements are required to ensure sustainable global management of this species throughout its full range of distribution. The Commission for the Conservation of Southern Bluefin Tuna (CCSBT) manages SBT stock levels under an international agreement. Its objective is to ensure, through appropriate management, the conservation and optimum utilisation of SBT. CCSBT members include Australia, South Africa, Indonesia, Japan, Republic of Korea, New Zealand, the Fishing Entity of Taiwan and the European Union. The CCSBT's primary management tool is a global total allowable catch that is allocated to members following recommendations from an independent Scientific Committee. For more information about the CCSBT see www.ccsbt.org/en

Following recommendations from the independent Scientific Committee, the CCSBT set the Australian Total Allowable Catch (TAC) allocation at 6 165 t per annum for 2018 to 2020, an increase from 5 665 t in 2017.

In October 2020, the CCSBT further increased Australia's TAC to 6 238 t per annum for the 2021-2023 period. In setting the quota, the Scientific Committee and CCSBT used data from two new genetic techniques to estimate the spawning stock (close-kin DNA matching) and recruitment to the fishery (gene tagging). The TAC of 6 238 tonnes for 2023 was ratified (confirmed) at the 29th meeting of the CCSBT in October 2022.

The Commonwealth Government, through the Australian Fisheries Management Authority, has responsibility for all catch of SBT and is leading the development of a national approach to resource sharing. The approach is aimed at ensuring all catch is covered by Australia's allocation from CCSBT and will involve state and federal government collaboration. To achieve this the Commonwealth Government legislated in 2020 that 5% of Australia's TAC will be allocated to manage recreational catch for the long term.

Mussel industry

Eyre Peninsula (EP) Seafoods produces about 45 per cent of Australia's Mussel product and was formed in July 2016 from an amalgamation of businesses Kinkawooka Shellfish and SA Seafoods, the State's two main Mussel producers. In November 2017, the Port Lincoln based Mussel company was awarded a $500,000 State Government grant to help build a wet store holding facility. It is a first in Australian technology allowing higher production value and supply throughout the year. The new technology means that EP Seafoods can pursue markets in the United States and Canada along with keeping up with demand, as the new facility meant broken or damaged stock would no longer go to waste. Produce could be stored on site with the ability to hold up to 40 t of product fresh and alive for weeks if needed, meaning no wastage and ensuring there was still product to harvest despite inclement weather.

Oysters

POMS and spat supply

POMS is a disease which affects Pacific Oysters and has not been detected in South Australian Oyster growing regions to date. POMS causes rapid and high mortalities in farmed Oysters (up to 100% within days of being detected) and can spread quickly if introduced. There are no human health implications associated with POMS. South Australia produces some of the finest Pacific Oysters on the market and table Oysters purchased from retailers, restaurants and fish processors are safe to eat. For more information about POMS see:www://pir.sa.gov.au/aquaculture/aquatic_animal_health/pacific_Oyster_mortality_syndrome.

In February 2016, POMS was detected in Tasmania causing a significant economic impact to that state and South Australia. Previously, South Australia received 80% of spat (juvenile Oysters) from health certified hatcheries in Tasmania, however a South Australia ban now exists for live Oysters, including spat, from Tasmania to prevent the risk of POMS entering South Australia.

PIRSA's response to the detection of POMS in Tasmania included substantial resources and financial assistance for the rapid expansion and establishment of a secure Oyster spat supply in South Australia. This included PIRSA providing emergency financial assistance ($320,000) for equipment and infrastructure upgrades to two small SA Oyster hatcheries on the Eyre Peninsula (EP Shellfish and Sustainable Aquatic Industries). In addition, SARDI was commissioned by PIRSA ($150,000) to produce spat for industry, condition Oyster brood-stock and produce micro-algae, as an emergency measure for South Australian hatcheries. PIRSA also fast tracked the assessment and granting of two new landbased Oyster hatcheries, Eyre Shellfish Pty Ltd (Cowell) and Cameron of Tasmania Pty Ltd (Port Lincoln), to provide more spat to the South Australian Oyster industry. These contribute significantly to PIRSA's financial assistance to industry by providing additional spat to the South Australian industry.

Continuation of support for recovery of the Oyster sector was estimated to be over $1.3 M in 2018-19. This continued into 2019-20, with further resources estimated to be over $1 M provided, including the waiving of annual fees ($0.53 M) and application fees for farmers ($0.16 M), assistance in the supply of spat, financial support to the POMS resistant breeding program, State-wide POMS early detection surveillance, hatchery biosecurity, feral Oyster destruction in the Port Adelaide River and Outer Harbor, and an Oyster Industry Liaison Officer and Aquatic Animal Health Officer, both based within PIRSA. As an example, the PIRSA Regional Development Fund provided Eyre Shellfish Pty Ltd $267,500 to assist with biosecurity enhancements to the hatchery, nursery and dam construction, and $250,000 to Yumbah Hatchery to assist with expanding their facility.

It has taken a few years but South Australian Oyster growers are now able to source spat locally within the State. The enhanced South Australian spat production capacity not only safeguards the supply of spat for the South Australian Oyster industry but facilitates South Australia becoming the Oyster capital of Australia.

Vibrio parahaemolyticus

In November 2021, the production areas of Coffin Bay were temporarily closed by PIRSA as a precautionary measure as part of an ongoing investigation into the rise in *Vibrio parahaemolyticus* (Vibrio) cases from the consumption raw Oysters. Vibrio is a bacterium found in marine, coastal and tidal waters that can cause gastroenteritis (gastro) after improper handling or consumption of raw or inadequately cooked shellfish and fish. Environmental factors such as a change in temperature and/or salinity are thought to contribute to Vibrio outbreaks. The potential impact of Vibrio on the oyster industry was estimated to be worth $0.5 – 1.6 M from stock being either recalled or disposed of. SAOGA initiated a Vibrio Working Group, who assisted PIRSA to develop and implement control measures and initiate research to minimise the potential risks to the industry. The members of this group included South Australian Oyster Growers Association (SAOGA), PIRSA, SARDI, SA Health, SafeFish and SASQAP. SAOGA also developed a best practice guide for growers and PIRSA funded the required extensive testing for Vibrio (as specified by SA Health) so that the SA Health Emergency Order ad PIRSA closure notice in Coffin Bay could be lifted. For more information on Vibrio, see
www.pir.sa.gov.au/alerts_news_events/news/ministerial_releases/coffin_bay_Oyster_harvesting_area_closed



Contacts

Department of Primary Industries and Regions
Fisheries and Aquaculture
Phone: (08) 8207 5333
Email: pirsa.aquaculture@sa.gov.au

Australian Abalone Growers Association
Email: eo@aagai.com.au

Australian Southern Bluefin Tuna Industry Association
Email: CEO@asbtia.org
Email: info@asbtia.org

South Australian Oyster Growers Association
Phone: 8364 3831
Email: saoga.saorc@bigpond.com

South Australian Mussel Growers Association
Phone: 8682 3065
Email: mussels@kinkawookamussels.com.au

Australian Sustainable Seaweed Alliance
Email: info@seaweedalliance.org.au

CleanSeas Seafood Limited
Phone: 8621 2900
Email: rob.gratton@cleanseas.com.au

References

ABARES (2022a). Australian fisheries and aquaculture: Outlook to 2026–27. March 2022. https://daff.ent.sirsidynix.net.au/client/en_AU/search/asset/1033321/0

ABARES (2022b). Australian Fisheries and Aquaculture Statistics 2021, December 2021. www.daff.ent.sirsidynix.net.au/client/en_AU/search/asset/1032481/0

Alexander, K. A. (2022). A social licence to operate for aquaculture: Reflections from Tasmania. Aquaculture, 550.

Alleway, H.K., Waters, T.J., Brummett, R., Cai, J., Cao, L., Cayten, M.R., Costa-Pierce, B.A., Dong, Y.-W., Brandstrup Hansen, S.C., Liu, S., Liu, Q., Shelley, C., Theuerkauf, S. J., Tucker, L., Wang, Y., and Jones, R. C. (2023). Global principles for restorative aquaculture to foster aquaculture practices that benefit the environment. Conservation Science and Practice, 5 (8), e12982. *https://doi.org/10.1111/csp2. 12982*

BDO EconSearch (2023). The Economic Contribution of Aquaculture in the South Australian State and Regional Economies, 2021/22. A report prepared for PIRSA Fisheries and Aquaculture. www.pir.sa.gov.au/__data/assets/pdf_file/0006/434067/economic-contribution-aquaculture-2021-22.pdf

Duarte, C. M., Bruhn, A., & Krause-Jensen, D. (2021). A seaweed aquaculture imperative to meet global sustainability targets. Nature Sustainability, 5, 185–193.

FAO (2018a). The state of World Fisheries and Aquaculture 2018 – Meeting the sustainable developmental goals. Food and Agriculture Organization of the United Nations, Rome 2018.

FAO (2018b). Statistics—introduction, Fisheries and Aquaculture Department, Food and Agriculture Organization of the United Nations, Rome 2018.

FAO (2022). The State of World Fisheries and Aquaculture 2022. Towards Blue Transformation. Rome, FAO. https://doi.org/10.4060/cc0461en.

Fernandes, M., Lauer, P., Cheshire, A., and Angove, M. (2007a). Preliminary model of nitrogen loads from southern bluefin tuna aquaculture. *Marine Pollution Bulletin* 54 (2007): 1321-1332.

Fernandes, M., Lauer, P., Cheshire, A., Svane, I., Putro, S., Mount, G., Angove, M., Sedawie, T., Tanner, J., Fairweather, P., Barnett, J., and Doonan, A. (2007b). Aquafin CRC – Southern Bluefin Tuna Aquaculture Subprogram: Tuna Environment Subproject – Evaluation of Waste Composition and Waste Mitigation. Technical report, Aquafin CRC Project 4.3.2, FRDC Project 2001/103. SARDI Publication No. RD03/0037-9. SARDI Research Report Series No. 207 (Ed. M. Fernandes). Aquafin CRC, Fisheries Research & Development Corporation and South Australian Research & Development Institute (Aquatic Sciences), Adelaide. 289 pp.

Edyvane, K.S. (1999). Conserving marine biodiversity in South Australia, part 1, Background, status and review of approach to marine biodiversity conservation in South Australia, report 38, South Australian Research and Development Institute (Aquatic Sciences), Adelaide.

Fletcher, W., Chesson, J., Fisher, M., Sainsbury, K. and Hundloe, T. (2004). National ESD Reporting Framework: The "How To" Guide for Aquaculture. Version 1.1 FRDC, Canberra, Australia 88 pp.

Gentry, R. R., Alleway, H. K., Bishop, M. J., Gillies, C. L., Waters, T., & Jones, R. (2020). Exploring the potential for marine aquaculture to contribute to ecosystem services. Reviews in Aquaculture, 12(2), 499–512. https://doi.org/10.1111/raq. 1232

Huveneers, C., Niella, Y., Drew, M., Dennis, J., Clarke, T. M., Wright, A., Bryars, S., Braccini, M., Dowling, C., Newman, S. J., Butcher, P., and Dalton, S. (2022). Are sharks attracted to caged fish and associated infrastructure? *Marine and Freshwater Research*. 73 (11) 1404-1410.

Jones A.R., Alleway, H.K,, McAfee, D., Reis-Santos, P., Theuerkauf, S.J, Jones, R.C (2022). Climate-Friendly Seafood: The Potential for Emissions Reduction and Carbon Capture in Marine Aquaculture. Bioscience. 25;72(2):123-143.

Murray-Jones, S. (2004). Workshop on shark interactions with aquaculture. Proceedings of the shark interactions with aquaculture workshop and discussion paper on Great White Sharks. FRDC project Number 2002/040.

Naylor, R. L., Hardy R.W., Buschmann, A.H., Bush, S.R., Cao, L., Klinger, D.H., Little, D.C., Lubchenco, J., Shumway, SE., Troell, M. (2021). A 20-year retrospective review of global aquaculture. *Nature* 591, 551–563.

Roberts, S.D., Van Ruth, P.D., Wilkinson, C., Bastianello, S.B., Bansemer, M.S. (2019) Marine heatwave, harmful algae blooms and an extensive fish kill event during 2013 in South Australia. Frontiers in Marine Science - Impact of Ocean Warming and Acidification on Marine Fish Health Special Edition. *Front. Mar. Sci.* 6:610. doi: 10.3389/fmars.2019.00610 .

Roberts, S., James, C., Bansemer, M., Colberg, F., Aijaz, S., Jakaitis, K., Schulz E., Middleton J. (2020). Improving early detection surveillance and emergency disease response to Ostreid herpesvirus using a hydrodynamic dispersion model: updating disease management areas for the South Australian Oyster industry. FRDC Project No 2018-090. PIRSA, Adelaide, 86pp.

Rogers, P. and Drew, M. (2018). Movement, residency and habits use of pelagic sharks in Spencer Gulf: resolving overlaps with marine industries and community activities. South Australian Research and Development Institute (Aquatic Sciences), Adelaide. FRDC project 2014/020.

Rose, J. M., Bricker, S. B., Tedesco, M. A., & Wikfors, G. H. (2014). A role for shellfish aquaculture in coastal nitrogen management. Environmental Science & Technology, 48(5), 2519–2525. https://doi.org/10.1021/es4041336.

Smith, K.E., Burrows, M.T., Hobday, A.J., King, N.G., Moore, P.J., Gupta, A.S., Thomsen, M.S., Wernberg, T. and Smale, D.A (2023). *Annual Review of Marine Science*. 15:119-45.

Spillias, S., Cottrell, R.S., Kelly, R., O'Brien, K.R, Adams, J., Bellgrove, A., Kelly, B., Kilpatrick, C., Layton, C., Macleod, C., Roberts, S., Stringer, D., McDonald-Madden, E. (2022). Expert perceptions of seaweed farming for sustainable development. Journal of Cleaner Production. 368:1-14. https://doi.org/10.1016/j.jclepro.2022.133052

Tanner, J.E. Clark, T.D., Fernandes, M. and Fitzgibbon, Q. (2007). Innovative Solutions for Aquaculture: Spatial Impacts and Carrying Capacity – Further Developing, Refining and Validating Existing Models of Environmental Effects of Finfish Framing. South Australian Research and Development Institute (Aquatic Sciences), Adelaide, 126 pp.

Tanner, J.E. and Bryars, S. (2007). Innovative Solutions for Aquaculture Planning and Management – Project 5, Environmental Audit of Marine aquaculture Developments in South Australia. FRDC Project 2003/223. Fisheries Research and Development Corporation and South Australian Research and Development Institute (Aquatic Sciences, Adelaide, SARDI Research Report No.190.

Tanner, J.E. and Volkman, J. (2009). Aquafin CRC – Southern Bluefin Tuna Aquaculture Subprogram: Risk and Response – Understanding the Tuna Farming Environment. Technical Report, Aquafin CRC Project 4.6, FRDC Project 2005/059. Aquafin CRC, Fisheries Research and Development Corporation and South Australian Research and Development Institute (Aquatic Sciences, Adelaide, SARDI Research Report Series No.344, 287 pp.

Tlusty, M.F., Tyedmers, P., Bailey., M., Ziegler., F. (2019). Reframing the sustainable seafood narrative. Global Environmental Change. 59: 101991.

Weitzman, J. (2019). Applying the ecosystem services concept to aquaculture: A review of approaches, definitions, and uses. Ecosystem Services, 35, 194–206.

Xiao, X., Agustí, S., Yu, Y., Huang, Y., Chen, W., Hu, J., Li, C., Li, K., Wei, F., Lu, Y., Xu, C., Chen, Z., Liu, S., Zeng, J., Wu, J., & Duarte, C. M. (2021). Seaweed farms provide refugia from ocean acidification. Science of the Total Environment, 776, 145192. https://doi.org/10.1016/j.scitotenv.2021.145192

Zhu, L., Huguenard, K., Zou, Q.-P., Fredriksson, D.W., and Xie, D. (2020). Aquaculture farms as nature-based coastal protection: Random wave attenuation by suspended and submerged canopies. Coastal Engineering *160*, 103737. 10.1016/j.coastaleng.2020.103737

Glossary

AMR	Antimicrobial Resistance Strategy
ASCRC	Australian Seafood Cooperative Research Centre
APVMA	Australian Pesticides and Veterinary Medicines Authority
ASBTIA	Australian Southern Bluefin Tuna Industry Association
ATAB	Aquaculture Tenure Allocation Board
AVG	Abalone Viral Ganglioneuritis
BST	Baker-Schultz-Turner
CCSBT	Commission for the Conservation of Southern Bluefin Tuna
DEW	Department for Environment and Water
DIT	Department for Infrastructure and Transport
DPTI	Department of Planning, Transport and Infrastructure
EBGF	Economic and Business Growth Fund
EMP	Environmental Monitoring Program
EPA	Environment Protection Authority
EPPs	Environment Protection Policies
ESD	Ecologically Sustainable Development
FAO	Food and Agriculture Organisation
FCR	Food Conversion Ratio
FRDC	Fisheries Research and Development Corporation
FTE	Full Time Equivalent
GSSI	Global Sustainable Seafood Initiative
HABs	Harmful Algal Blooms
IMTA	Integrated Multitrophic Aquaculture
MMA	Macroalgae Management Areas
OsHV-1	Oyster Herpesvirus-1 microvariant
OIE	World Organisation for Animal Health
PIRSA	Primary Industries and Regions South Australia
POMS	Pacific Oyster Mortality Syndrome
SAOGA	South Australian Oyster Growers Association
SAORC	South Australian Oyster Research Council
SARDI	South Australian Research and Development Institute Aquatic Sciences
SASQAP	South Australia Shellfish Quality Assurance Program
SBT	Southern Bluefin Tuna
TEPS	Threatened, Endangered and Protected Species
UV	Ultra-violet
YTK	Yellowtail Kingfish

Appendix 1 Aquaculture licences in South Australia in 2021-22 by sector

Tuna sector (includes 6 *maintenance sites**)								
Reporting year	**Number of licences**	**Licence numbers**						
2021-22	14	AQ00030 AQ00047	AQ00053 AQ00057	AQ00060 AQ00169	FB00078 FB00079	AQ00114* AQ00116*	AQ00118* AQ00120*	AQ00271* FH00001*

Finfish sector								
Reporting year	**Number of licences**	**Licence numbers**						
2021-22	18	AQ00015 AQ00016 AQ00017	AQ00018 AQ00139 AQ00140	AQ00214 AQ00234 AQ00235	AQ00255 AQ00292 AQ00302	AQ00396 AQ00367 FF00037	FF00085 FF00090 FH00003	

Marine abalone sector								
Reporting year	**Number of licences**	**Licence numbers**						
2021-22	5	AQ00290	AQ00327	AQ00467	FA00008	FA00016		

Marine algae sector								
Reporting year	**Number of licences**	**Licence numbers**						
2021-22	4	AQ00463	AQ00464	AQ00473	AQ00474			

Subtidal Mollusc (Mussel) sector								
Reporting year	**Number of licences**	**Licence numbers**						
2021-22	32	AQ00067 AQ00101 AQ00108 AQ00109 AQ00141	AQ00190 AQ00192 AQ00193 AQ00209 AQ00215	FS00011 FS00012 FS00013 FS00014 FS00015	FS00016 FS00019 FS00020 FS00021 FS00022	FS00023 FS00029 FS00038 FS00042 FS00071	FS00072 FS00073 FS00082 FS00084 FS00095	FS00097 FS00102

Landbased sector (includes Landbased, Abalone, Finfish and Oyster hatcheries)								
Reporting year	**Landbased category**	**Number of licences**	**Licence numbers**					
2021-22	Category A	21	AQ00132 AQ00211 AQ00248 AQ00260	AQ00305 AQ00462 FT00014 FT00133	FT00166 FT00253 FT00323 FT00372	FT00487 FT00493 FT00502 FT00505	FT00523 FT00545 FT00685 FT00701	FT00738
2021-22	Category B	24	AQ00246 AQ00270 AQ00280 AQ00361	AQ00364 AQ00408 AQ00429 FT00007	FT00013 FT00069 FT00123 FT00185	FT00365 FT00402 FT00459 FT00464	FT00478 FT00604 FT00607 FT00611	FT00633 FT00687 FT00735 FT00745
2021-22	Category C	10	AQ00131 AQ00353 AQ00409 FT00036	FT00040 FT00135 FT00158 FT00676	FT00736 FT00385			
2021-22	Category D	6	FT00423 FT00558 FT00560 FT00620	FT00634 FT00702				

Tourism sector			
Reporting year	**Number of licences**	**Licence numbers**	
2021-22	1	AQ00315	

Intertidal Mollusc (Razorfish)			
Reporting year	**Number of licences**	**Licence numbers**	
2021-22	1	AQ00453	

Intertidal & Subtidal Mollusc (Oyster) sector								
Reporting Year	**Number of licences**	**Licence numbers**						
2021-22	354	AQ00001 AQ00002 AQ00005 AQ00009 AQ00012	AQ00180 AQ00183 AQ00186 AQ00188 AQ00197	AQ00410 AQ00411 AQ00412 AQ00413 AQ00416	FM00018 FM00019 FM00023 FM00024 FM00025	FM00177 FM00178 FM00181 FM00212 FM00217	FM00422 FM00423 FM00424 FM00425 FM00426	FM00531 FM00532 FM00538 FM00539 FM00542

Intertidal & Subtidal Mollusc (Oyster) sector								
		AQ00034	AQ00198	AQ00417	FM00027	FM00221	FM00427	FM00543
		AQ00035	AQ00199	AQ00418	FM00028	FM00307	FM00428	FM00544
		AQ00036	AQ00220	AQ00419	FM00031	FM00309	FM00432	FM00546
		AQ00039	AQ00221	AQ00420	FM00032	FM00315	FM00434	FM00547
		AQ00041	AQ00222	AQ00421	FM00033	FM00316	FM00436	FM00550
		AQ00042	AQ00223	AQ00422	FM00034	FM00324	FM00437	FM00552
		AQ00043	AQ00227	AQ00423	FM00035	FM00325	FM00439	FM00553
		AQ00068	AQ00228	AQ00424	FM00036	FM00326	FM00440	FM00554
		AQ00071	AQ00243	AQ00425	FM00038	FM00328	FM00441	FM00555
		AQ00091	AQ00244	AQ00426	FM00039	FM00329	FM00443	FM00556
		AQ00094	AQ00256	AQ00427	FM00040	FM00330	FM00450	FS00079
		AQ00099	AQ00257	AQ00428	FM00044	FM00331	FM00451	FS00080
		AQ00100	AQ00263	AQ00430	FM00046	FM00332	FM00452	FS00085
		AQ00102	AQ00277	AQ00431	FM00047	FM00335	FM00453	
		AQ00103	AQ00278	AQ00432	FM00059	FM00336	FM00454	
		AQ00104	AQ00282	AQ00433	FM00060	FM00347	FM00455	
		AQ00105	AQ00284	AQ00435	FM00062	FM00348	FM00456	
		AQ00106	AQ00295	AQ00436	FM00064	FM00349	FM00457	
		AQ00107	AQ00297	AQ00437	FM00065	FM00351	FM00458	
		AQ00110	AQ00312	AQ00438	FM00068	FM00352	FM00459	
		AQ00127	AQ00313	AQ00439	FM00069	FM00353	FM00461	
		AQ00133	AQ00317	AQ00440	FM00072	FM00355	FM00462	
		AQ00137	AQ00322	AQ00441	FM00075	FM00358	FM00463	
		AQ00138	AQ00323	AQ00442	FM00076	FM00359	FM00464	
		AQ00145	AQ00324	AQ00443	FM00082	FM00366	FM00465	
		AQ00146	AQ00329	AQ00444	FM00088	FM00373	FM00466	
		AQ00147	AQ00335	AQ00445	FM00094	FM00374	FM00467	
		AQ00148	AQ00350	AQ00446	FM00095	FM00375	FM00468	
		AQ00149	AQ00351	AQ00447	FM00099	FM00376	FM00471	
		AQ00150	AQ00366	AQ00448	FM00101	FM00377	FM00474	
		AQ00152	AQ00367	AQ00449	FM00117	FM00380	FM00476	
		AQ00153	AQ00368	AQ00450	FM00139	FM00382	FM00477	
		AQ00155	AQ00369	AQ00451	FM00140	FM00384	FM00478	
		AQ00156	AQ00378	AQ00452	FM00144	FM00385	FM00479	
		AQ00157	AQ00380	AQ00455	FM00145	FM00387	FM00480	
		AQ00158	AQ00381	AQ00456	FM00146	FM00389	FM00482	
		AQ00159	AQ00383	AQ00457	FM00149	FM00391	FM00484	
		AQ00160	AQ00386	AQ00458	FM00151	FM00392	FM00485	
		AQ00161	AQ00387	AQ00459	FM00153	FM00393	FM00498	
		AQ00162	AQ00388	AQ00460	FM00154	FM00400	FM00500	
		AQ00163	AQ00389	AQ00468	FM00155	FM00401	FM00504	
		AQ00164	AQ00390	AQ00469	FM00156	FM00402	FM00510	
		AQ00165	AQ00391	AQ00473	FM00160	FM00403	FM00514	
		AQ00167	AQ00392	AQ00474	FM00162	FM00404	FM00515	
		AQ00168	AQ00393	AQ00476	FM00163	FM00405	FM00517	
		AQ00172	AQ00399	AQ00477	FM00165	FM00406	FM00518	
		AQ00173	AQ00400	AQ00481	FM00166	FM00407	FM00519	

Intertidal & Subtidal Mollusc (Oyster) sector								
		AQ00175 AQ00176 AQ00177 AQ00178	AQ00401 AQ00402 AQ00403 AQ00405	FH00002 FM00015 FM00017	FM00167 FM00170 FM00171 FM00173	FM00410 FM00416 FM00417 FM00420	FM00520 FM00521 FM00524 FM00525	

Appendix 2 Aquaculture zone policies in South Australia

Policy	Zone	Sector	Total area (ha)	Leasable (ha)	Species
Aquaculture (Zones – Cape D'Estrees) Policy 2006	Cape D'Estrees (inner) subtidal aquaculture zone	NA	145	60	Molluscs (other than filter feeding molluscs) & algae
	Cape D'Estrees (middle) subtidal aquaculture zone	NA	198	60	Molluscs (other than filter feeding molluscs) & algae
	Cape D'Estrees (outer) subtidal aquaculture zone	NA	392	60	Molluscs (other than filter feeding molluscs) & algae
	Laura Bay aquaculture exclusion zone	NA	534	Nil	NA
Aquaculture (Zones – Smoky Bay) Policy 2007	Eyre Island intertidal aquaculture zone	NA	81	21	Bivalve Molluscs (other than mussels) & research
	Missiessey intertidal aquaculture zone	NA	108	24	Bivalve Molluscs (other than mussels) & research
	Saddle Peak intertidal aquaculture zone	NA	62	21	Bivalve Molluscs (other than mussels) & research
	Smoky Bay aquaculture emergency zone	NA	171	Not defined	Bivalve Molluscs (other than mussels)
	Smoky Bay (holding) intertidal aquaculture zone	NA	4	0.35	Holding Bivalve Molluscs (other than mussels)
	Smoky Bay intertidal aquaculture zone	NA	73	20.9	Bivalve Molluscs (other than mussels) & research
	Smoky Bay north subtidal aquaculture zone	NA	2 166	40	Bivalve Molluscs (other than mussels)
	Smoky Bay south subtidal aquaculture zone	NA	1 621	40	Bivalve Molluscs (other than mussels)
	Vinya intertidal aquaculture zone	NA	180	62	Bivalve Molluscs (other than mussels) & research
	Eyre Island aquaculture exclusion zone	NA	9 784	Nil	NA
Aquaculture (Zones – Streaky Bay) Policy 2011	Blanche Port aquaculture zone	NA	2 799	77.5	Bivalve molluscs (other than mussels)
	Haslam (north bank) aquaculture zone	NA	342	50	Bivalve molluscs (other than mussels)
	Perlubie (south bank) aquaculture zone	NA	224	40	Bivalve molluscs (other than mussels)

Policy	Zone	Sector	Total area (ha)	Leasable (ha)	Species
	Point Gibson aquaculture zone	NA	265	70	Bivalve molluscs (other than mussels)
	Streaky Bay aquaculture zone	NA	45 334	40	Bivalve molluscs (other than mussels) & Abalone
	Streaky Bay aquaculture exclusion zone	NA	3 748	Nil	NA
Aquaculture (Zones – Anxious Bay) Policy 2007	Anxious Bay aquaculture zone	NA	452	120	Molluscs (other than mussels or Oysters) & algae
	Anxious Bay aquaculture exclusion zone	NA	8 634	Nil	NA
Aquaculture (Zones – Coffin Bay) Policy 2008	Frenchman Bluff aquaculture zone	NA	388	90	Supplementary fed organisms (other than finfish) that involves regular feeding, algae & research
	Kellidie Bay aquaculture zone	NA	732	23	Bivalve molluscs (other than mussels), storage & research
	Mount Dutton Bay aquaculture zone	NA	601	32	Bivalve molluscs (other than mussels) & research
	Point Longnose aquaculture zone	NA	379	63	Bivalve molluscs (other than mussels), algae & research
	Port Douglas (central) aquaculture zone	NA	446	50	Bivalve molluscs (other than mussels) & research
	Port Douglas (east) aquaculture zone	NA	34	4	Bivalve molluscs (other than mussels) & research
	Port Douglas (west) aquaculture zone	NA	90	10	Bivalve molluscs (other than mussels) & research
	Coffin Bay aquaculture exclusion zone	NA	15 686	Nil	NA
Aquaculture (Zones - Lower Eyre Peninsula) Policy 2013	Boston Bay aquaculture zone	Bicker Isles sector	243	368	Supplementary fed species (i.e. wild-caught tuna, finfish, abalone etc.), bivalve molluscs & algae
		Boston Island (east) sector	855		
		Boston Bay sector	2 702		
	Lincoln aquaculture zone	Lincoln (inner) sector	18 447	1825	Prescribed wild-caught tuna & algae
		Lincoln (outer) sector	35 024	5000	
	Louth Bay aquaculture zone	NA	9 443	270	Supplementary fed organisms (other than wild-caught tuna), bivalve molluscs & algae
	Murray Point aquaculture zone	NA	72	2	Bivalve molluscs (other than mussels)
	Proper Bay aquaculture zone	NA	2 356	60	Bivalve molluscs & algae
	Tod River aquaculture zone	NA	747	38	Bivalve molluscs (other than mussels)

Policy	Zone	Sector	Total area (ha)	Leasable (ha)	Species
	Lincoln aquaculture exclusion zone	NA	27 383	Nil	NA
	Sir Joseph Banks aquaculture exclusion zone	NA	96 723	Nil	NA
	Buffalo Reef aquaculture exclusion zone	NA	1 255	Nil	NA
Aquaculture (Zones - Tumby Bay) Policy 2015	Tumby Bay aquaculture zone	NA	10 324	1300	Supplementary fed organisms (other than wild-caught tuna), bivalve molluscs (i.e. mussels), algae & research
	Tumby Bay aquaculture exclusion zone	NA	13 765	Nil	NA
Aquaculture (Zones - Port Neill) Policy 2008	Port Neill aquaculture zone	NA	4 913	565	Prescribed wild-caught tuna broodstock, supplementary fed organisms (other than wild-caught tuna), bivalve molluscs, research & algae
	Port Neill aquaculture exclusion zone	NA	7 227	Nil	NA
Aquaculture (Zones - Arno Bay) Policy 2011	Arno Bay aquaculture zone	Arno Bay (outer) sector	2 209	80	Prescribed wild-caught tuna broodstock & supplementary fed organisms (other than wild-caught tuna)
		Arno Bay (inner) sector	3 494	200	Supplementary fed organisms (other than wild-caught tuna)
Aquaculture (Zones – Fitzgerald Bay) Policy 2008	Fitzgerald Bay aquaculture zone	Eastern Fitzgerald sector	2 849	550	Supplementary fed organisms (other than wild-caught tuna), bivalve molluscs & algae
		Western Fitzgerald sector	1 705		
	Fitzgerald Bay (north) aquaculture zone	NA	10	10	Bivalve molluscs & algae
	Fitzgerald Bay aquaculture exclusion zone	NA	2 148	Nil	NA
Aquaculture (Zones – Eastern Spencer Gulf) Amendment Policy 2017	Hardwicke Bay (inner) subtidal aquaculture zone	NA	420	60	Molluscs & algae
	Hardwicke Bay (middle) subtidal aquaculture zone	NA	1 053	60	Molluscs & algae
	Hardwicke Bay (outer) subtidal aquaculture zone	NA	1 402	60	Molluscs & algae
	Port Broughton intertidal aquaculture zone	NA	356	65	Bivalve molluscs & algae
	Tickera intertidal aquaculture zone	NA	512	45	Bivalve molluscs & algae
	Tickera subtidal aquaculture zone	NA	2 398	60	Bivalve molluscs & algae
	Wallaroo (East) aquaculture zone	NA	1 394	350	Supplementary fed organisms (other than tuna) that involves regular feeding, algae, filter

Policy	Zone	Sector	Total area (ha)	Leasable (ha)	Species
					feeding bivalve molluscs & algae
	Wallaroo (West) aquaculture zone	NA	500	50	Bivalve molluscs & algae
	Point Pearce (East) intertidal aquaculture zone	NA	135	20	Bivalve molluscs & algae
	Point Pearce (West) intertidal aquaculture zone	NA	365	40	Supplementary fed organisms (other than finfish & abalone) that involves regular feeding, filter feeding bivalve molluscs & algae
	Point Riley aquaculture exclusion zone	NA	9 639	Nil	NA
	Port Broughton aquaculture exclusion zone	NA	4 384	Nil	NA
	Port Hughes aquaculture exclusion zone	NA	3 407	Nil	NA
	Wallaroo aquaculture exclusion zone	NA	10 889	Nil	NA
Aquaculture (Zones – Lacepede Bay) Policy 2012	Cape Jaffa aquaculture zone	NA	1 316	40	Supplementary fed organisms (other than wild-caught tuna & abalone)
	Kingston aquaculture zone	Kingston (holding) sector	416	5	Supplementary fed organisms (other than wild-caught tuna & abalone)
		Kingston (inner) sector	25 560	80	Supplementary fed organisms (other than wild-caught tuna & abalone)
		Kingston (outer) sector	14 899	200	Supplementary fed organisms (other than wild-caught tuna & abalone)
	Kingston aquaculture exclusion zone	NA	4 712	Nil	NA

Government of South Australia

Department of Primary Industries and Regions