ZONING IN: South Australian Aquaculture Report

2024

Government of South Australia
Department of Primary Industries and Regions

ZONING IN: South Australian Aquaculture Report 2024

Information current as of 25 February 2025

Disclaimer

Covering photo by PIRSA

All enquiries

Department of Primary Industries and Regions
2 Hamra Avenue, West Beach SA 5024
GPO Box 1671, Adelaide SA 5001
T 08 8207 5332
E pirsa.aquaculture@sa.gov.au

Key industry sector contacts

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

Australian Southern Bluefin Tuna Industry Association
E: daniel@absbtia.org

South Australian Oyster Growers Association
E: chairman@oysterssa.com.au

South Australian Mussel Growers Association
E: mussels@kinkawookamussels.com.au

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

Clean Seas Seafood Limited
E: rob.gratton@cleanseas.com.au

Foreword

Aquaculture is Australia's fastest growing livestock industry, with an annual growth rate of 13%, and is projected to reach $2.21 billion by 2028-29 to meet the rising global demand for seafood. South Australia is well-positioned to contribute to this growth. As a world leader in the ecologically sustainable development of aquaculture, South Australia has one of the most robust legislative frameworks in Australia, designed to protect and manage aquatic resources while encouraging investment, growth and maintaining social licence. The Department of Primary Industries and Regions (PIRSA) is the State Government agency responsible for regulating and monitoring the aquaculture industry, ensuring South Australian seafood meets high environmental standards through science-based policies, risk assessments for sustainable development, environmental monitoring, aquatic animal health programs and marine spatial planning. As of 9 December 2023, PIRSA's mandate now also includes marine-based tourism developments in aquaculture zones which promote or provide a benefit to the aquaculture industry.

Though aquaculture in South Australia began relatively recently, in the late 1980s with oyster farming in the Spencer Gulf, the industry has quickly diversified and established itself as a key contributor to the State's economy. Key commercial species include Southern Bluefin Tuna, Yellowtail Kingfish, Barramundi, Oysters, Mussels and Abalone. In 2022-23, South Australia's aquaculture industry accounted for 55% of the State's direct seafood economic output, valued at $264.4 million. Numerous secondary industries have grown alongside aquaculture, further boosting economic and employment opportunities, particularly in regional communities. The emerging marine algae (seaweed) sector also shows promise, offering further potential benefits for the State including the environment. Integrating seaweed aquaculture and bivalve aquaculture (e.g. Mussels, Oysters) adjacent to finfish and tuna farms also has the potential to provide broader environmental benefits and help improve water quality around farm sites and is an exciting area for further investigation.

The Government of South Australia invests heavily in research and innovation in the aquaculture industry. The South Australian Research and Development Institute (SARDI) is a global leader in seafood and aquatic species research, collaborating closely with industry to develop and commercialise new projects. The Fisheries Research and Development Corporation (FRDC) is a key co-funder of strategic research aimed at improving aquaculture management practices through enhanced environmental and planning knowledge, processes and technologies.

This annual report provides an in-depth profile of this vital industry during the 2022-23 licence holder reporting period, covering production and value, current practices, management requirements, sector activities and environmental monitoring. It highlights the Government's commitment to transparency and accountability in reporting on aquaculture activities.

Hon Clare Scriven MLC
Minister for Primary Industries and Regional Development
Minister for Forest Industries

25/ 2 / 2025

Contents

Foreword 3

Purpose 7

Background 7

- Scope 8
- Regulatory framework 8
- National Aquaculture Strategy 17
- Seafood Growth Strategy for South Australia 2021-2031 18

Aquaculture activity in South Australia 18

- Socio-economic data 18
- Industry licence holders 23
- Aquaculture applications processed by PIRSA 24

Aquaculture policies 24

- Summary of aquaculture zone policies in South Australia 24
- Zone policy development and review 26
- Public call for aquaculture tenure within zones 27
- Aquaculture zone policy tenure allocation 28
- Aquaculture outside of zones 29
- *Aquaculture (Standard Lease and Licence Conditions) Policy 2022* 29
- Changes to the *Aquaculture Act 2001* 30

Tuna 31

- Overview of the industry 31
- Environment 33
- Aquatic animal health management 34

Finfish 35

- Overview of the industry 35
- Environment 36
- Aquatic animal health management 38

Marine Abalone 40

Overview of the industry 40
Environment 41
Aquatic animal health management 41
Mussels 42
Overview of the industry 42
Environment 43
Aquatic animal health management 44
Oysters 45
Overview of the industry 45
Environment 46
Aquatic animal health management 48
Landbased 49
Overview of the industry 49
Environment 50
Aquatic animal health management 51
Marine algae (seaweed) 52
Overview of the industry 52
Environment 55
Aquatic health management 56
Aquaculture tourism and education 57
Compliance outcomes 58
Aquatic animal health and biosecurity 59
Fish kill and fish health investigations 59
Industry initiatives 60
Marine debris 60
Oyster Hub project 61
Oyster basket recycling 61
Seafood certification 62
Research 63
Historic research 64
Recently completed research 66

Current research 67

External factors or events affecting the aquaculture industry during 2022-23 69

Tuna quota 69

Oysters 70

References 71

Glossary 74

Appendix 1 - Aquaculture licences by industry sector during the 2022-23 reporting period 75

Appendix 2 - Aquaculture zone policy areas (zones and sectors) and percent tenure allocation as at December 2024 76

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.

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 2024). In 2021-2022, GVP of Australia's aquaculture sector increased by 13% to $1.94 billion (B), accounting for 56% of total fisheries and aquaculture GVP ($3.42 B; ABARES 2023). The real value of aquaculture is expected to continue its trend of increased overall contribution to seafood production, reaching $2.21 B by 2028-29 (ABARES 2024).

South Australia is considered to be one of Australia's most valuable aquaculture producing states, worth $264.4 million (M) in 2022-23 (BDO EconSearch 2024a). 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 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.

Scope

The South Australian Aquaculture Report 2024 (the report) provides an overview of marine and landbased aquaculture in South Australia within the 2022-23 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:

- 2022-23 BDO EconSearch Pty Ltd production and economic data (BDO EconSearch 2024a)
- 2022-23 Environmental Monitoring Program (EMP) data
- 2022-23 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 *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 marine spatial planning for the future of the aquaculture industry through the development/review of aquaculture zone policies
- Maintaining requirements for aquaculture leases and licences.

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.

Under the *Aquaculture Act 2001*, aquaculture development is ecologically sustainable if it is managed to ensure that communities provide for their economic, social and physical well-being while—

(a) natural and physical resources are maintained to meet the reasonably foreseeable needs of future generations; and

(b) biological diversity and ecological processes and systems are protected; and

(c) adverse effects on the environment are avoided, remedied or mitigated.

Further, in making decisions as to whether development is ecologically sustainable or to ensure that development is ecologically sustainable—

(a) long-term and short-term economic, environmental, social and equity considerations should be effectively integrated; and

(b) if there are threats of serious or irreversible environmental harm, lack of full scientific certainty should not be taken to justify the postponement of decisions or measures to prevent the environmental harm.

Leasing and licensing

The *Aquaculture Act 2001* provides that a person may not 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, namely marine aquaculture (aquaculture occurring in State waters) and landbased aquaculture.

For marine aquaculture, an aquaculture lease is required for 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 way 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 to operate. 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).

Annual environmental reporting

Under the *Aquaculture Regulations 2016*, all aquaculture licence holders are required to provide annual reporting on general environmental matters for each licensed site, through submission of Environmental Monitoring Program (EMP) reports to PIRSA. The information collected varies for each sector but each provides key information on how a licence holder has been using a site, which is vital to the continued sustainable management of the aquaculture industry. Generally, the information collected 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).

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 the Lower Eyre Peninsula. The program was designed over a four-year cycle with a review during the final 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. This was in recognition of the majority of nutrient waste from Finfish and Tuna licensed sites being dissolved in the water column and likely carried offsite. Results from the program also informed the development of suitable environmental triggers and management actions to reduce any negative impacts documented, and assessment of aquaculture development applications in the region. 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 (animals living under the seafloor) assemblages, all of which contribute to understanding impacts of aquaculture at a regional and zone scale and help validate existing hydrodynamic and biogeochemical modelling for the Lower Spencer Gulf. A copy of the report can be found here: www.pir.sa.gov.au/__data/assets/pdf_file/0007/360592/Aquaculture_Environmental_Monitoring_Program_2015-2019.pdf

In summary, 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:
    - Inshore sites within Boston and Louth Bay's differ significantly from offshore sites and the trends observed are consistent with impacts expected from anthropogenic nutrient enrichment, of which there are a number of sources in the area including aquaculture. 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.

Given the pelagic and oceanographic results from the 2015-2019 AEMP indicated that aquaculture may be having an impact on the pelagic ecosystem of the inshore regions of Boston and Louth Bay, the second 4-year AEMP (2019–2023) undertook more detailed investigations into the fate and consequences of the nutrients being added to the system. This program was also divided into a pelagic (oceanographic) component and a benthic (seafloor) component. However, given 15 years of infauna monitoring failed to demonstrate an impact from aquaculture, the benthic component switched from infauna to seagrasses.

In summary, results from the 2019-2023 regional AEMP found:

- Significant spatial and temporal variations in the physical, chemical and biological parameters investigated:
    - Trends for several plankton-based indicators of eutrophication suggest that the trophic status of the inshore waters of Louth Bay and Boston Bay are different from offshore waters and may be changing from mesotrophic to slightly eutrophic. The environmental

drivers responsible for the changes observed in the plankton and phytoplankton communities at the inshore sites included temperature, flushing timescales and, to a reduced extent, nutrients.

    - Collectively, these findings are consistent with nutrient observations and oceanographic modelling results and suggest the enrichment of inshore waters with nutrients sourced from aquaculture is likely to be in part responsible for the observed changes in the trophic state, particularly during cooler autumn periods.

    - Of note, it is not clear to what extent variability in the supply of nutrients from other sources in the region may also contribute to the differences in water quality and the composition of the plankton community observed at the inshore sites.

- Extensive spatial and temporal variation in the seagrass parameters investigated:

    - The only significant impact of aquaculture found on seagrass was on the amino acid composition of epiphytes.

    - Of note, seagrass sampling only began several decades after the commencement of aquaculture and that it is not possible to detect historical impacts with the methods that were used.

    - A general decline in epiphyte cover, however, biomass was more variable.

    - A general decline in seagrass, with a substantial decline at a control site in Tumby Bay.

The third 4-year AEMP (2023-2027) is based on the outcomes from the previous two AEMPs and will provide long-term monitoring required to assess key water-column and benthic ecosystem groups to better understand the localised and cumulative impacts of dissolved nutrients from Finfish aquaculture. Recent EPA data highlights several sites of concern in the Port Lincoln region and the locations are consistent with the modelled circulation which demonstrates connectivity between nutrient waste streams associated with aquaculture and areas of seagrass decline. This program will therefore include modelling nutrients at sites inside and outside of aquaculture zones in the Port Lincoln region as well as the status of seagrasses.

Changes to this AEMP relative to the previous two are a reduction in the number of sites monitored (from 5 to 4) due to their similarity with other sites and extending the current summer and autumn sampling events to include winter and spring. The additional seasonal sampling will close knowledge gaps regarding the annual cycle of water quality and pelagic ecosystems structure and function. Other changes include genomic sequencing of the bacterial community to improve information on presence of pathogens, indicators of eutrophication and shifts in over-all ecosystem state. Finally, historical imagery will be utilised to map changes in the distribution of nearshore seagrasses in the Port Lincoln area over time. Where suitable data is available, any losses will be investigated to determine if a correlation exists with the distribution of Tuna/Finfish aquaculture operations, as well as any other pertinent environmental data.

Results of these AEMPs will also be important to assist quantifying the benefits of the emerging seaweed aquaculture industry in terms of nutrient offsets and IMTA, discussed later in this report.

Aquaculture farming structure 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

construction or during 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 culture units in subtidal waters are kept at least 3 metres (m) above the seafloor at all times to prevent scouring, rubbing or shading of the seafloor unless the licence holder has authorisation to do otherwise.

There are multiple areas in South Australia where aquaculture is restricted and requires appropriate approvals. For example, 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 applies an aquaculture exclusion buffer around Australian Sea Lion (ASL) breeding and haul-out areas.

To ensure 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 which includes an assessment of the potential impacts to TEPS (e.g. sharks, dolphins, seals, seabirds) likely to 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 (as already exists for the Mussels sector) or apply on an individual (licensee) basis and must be approved by the Minister (under regulation 19 or 20 of the *Aquaculture Regulations 2016*). A sector-based strategy is currently being drafted for the Oyster sector. Licence holders are 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 section). 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 focused. 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 the protection of water quality are legislated under the *Environment Protection Act 1993* and the *Environment Protection (Water Quality) Policy 2015* which are 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 along with other matters (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 (i.e. seedstock and broodstock) may require approval under the *Fisheries Management Act 2007*. 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 section) 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. PIRSA is the principal government agency charged with monitoring and maintaining shellfish food safety in South Australia.

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. Shellfish are often consumed raw and, in this form, may be a vector of microbes or toxins that cause shellfish associated illnesses.

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 then 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 for 2022-23 has already reached above this value for the first time (BDO EconSearch 2024a) and as a result the strategy is currently under review.

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 applying the principles of the strategy in aquaculture management, including through development of sector-based aquaculture strategies as a means to simplify the regulatory environment, as well as provide opportunities for IMTA in the Lower Eyre Peninsula and other areas of the State.

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.


Photo credit Australian Fishing Enterprises

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 2022-23 was $476.8 M, of which aquaculture contributed over half ($264.4 M) and wild-catch fisheries (excluding Miscellaneous fisheries) contributing the balance ($212.3 M; note the value is $216 M when Miscellaneous fisheries are included) (Table 5.3, BDO EconSearch 2024b). The State's total aquaculture production in 2022-23 was 20,673 tonnes (t), with 2021-22 at 20,737 t. For comparison, the State's total wild-catch fisheries production in 2022-23 was 54,356 t, compared to 54,724 t in 2021-22 (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 2022-23 is shown in Figures 2 and 3.

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 3), which accounted for approximately 45% or $120 M of South Australia's gross value of aquaculture production in 2022-23 (Table ES-1, BDO EconSearch 2024a). The next three highest value sectors were Marine Finfish (23% or $59.9 M), Oysters (22% or $58.84 M), and Abalone (4% or $11.18 M) (Figure 3, Table 1).

The State's total value of aquaculture production in 2022-23 increased by 11% compared to 2021-22 ($237.90 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. Because of this, 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 2021/22 (US$0.73) and 2022/23 (US$0.67), with a decrease of 8 per cent (BDO EconSearch 2024a). However, total value of aquaculture production remained strong.

Table 1: South Australia aquaculture production and value for the years 2021-22 and 2022-23 (BDO EconSearch 2024a

	Weight ('000kg)			Value ($m)		
	2021/22	2022/23	Change	2021/22	2022/23	Change
Southern Bluefin Tuna	8,322	8,000	-4%	110.40	120.00	9%
Marine Finfish	2,919	3,354	15%	41.45	59.90	45%
Oysters						
adult [a]	4,929	5,748	17%	47.78	58.84	23%
on-grown [b]	796	724	-9%	2.61	2.62	0%
spat [c]	-	-	-	6.40	6.43	0%
Mussels	2,113	2,318	10%	4.65	5.10	10%
Abalone [d]	402	382	-5%	15.37	11.18	-27%
Freshwater Finfish	295	292	-1%	4.90	4.93	1%
Marron and Yabbies	4	3	-25%	0.20	0.15	-24%
Other [e]	1,753	577	-67%	13.15	4.33	-67%
Total [f]	**20,737**	**20,673**	**0%**	**237.90**	**264.44**	**11%**

[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 2021-22 and 2022-23 was mostly comprised of land-based Microalgae production.
[f] Totals may contain rounding errors.

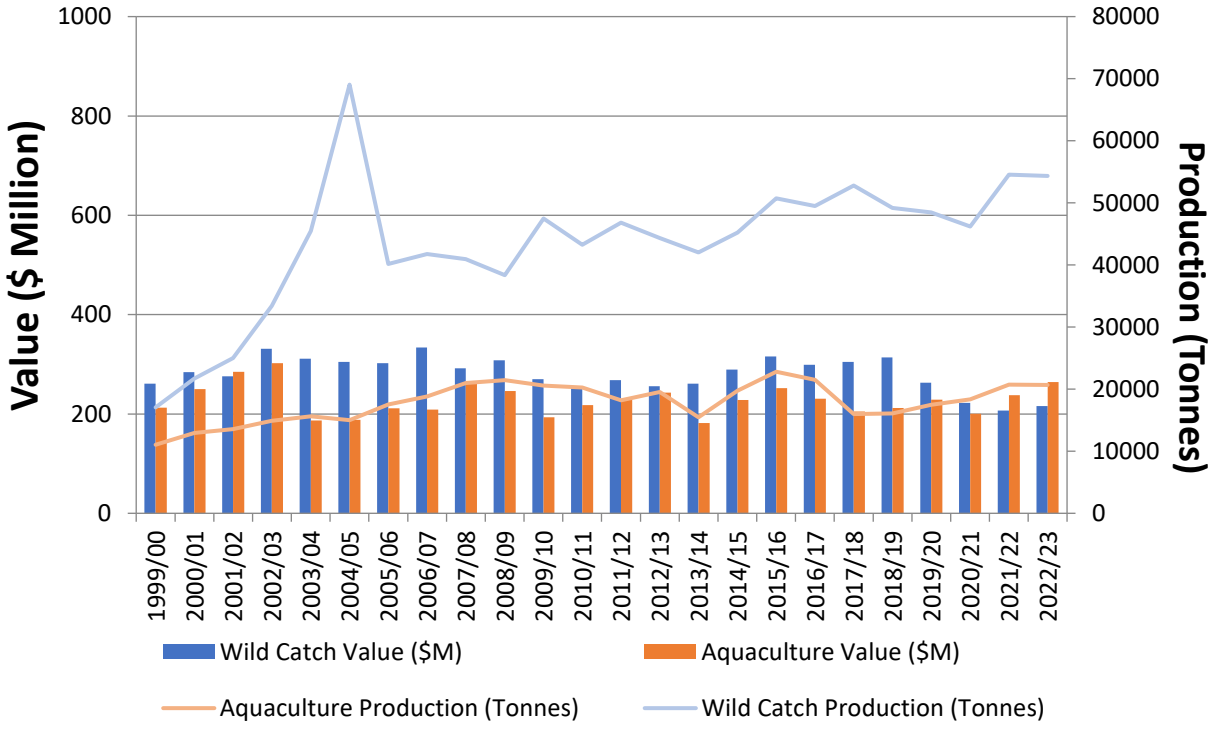


Figure 1: South Australian fisheries and aquaculture production (t) and value ($M) in 2022-23.

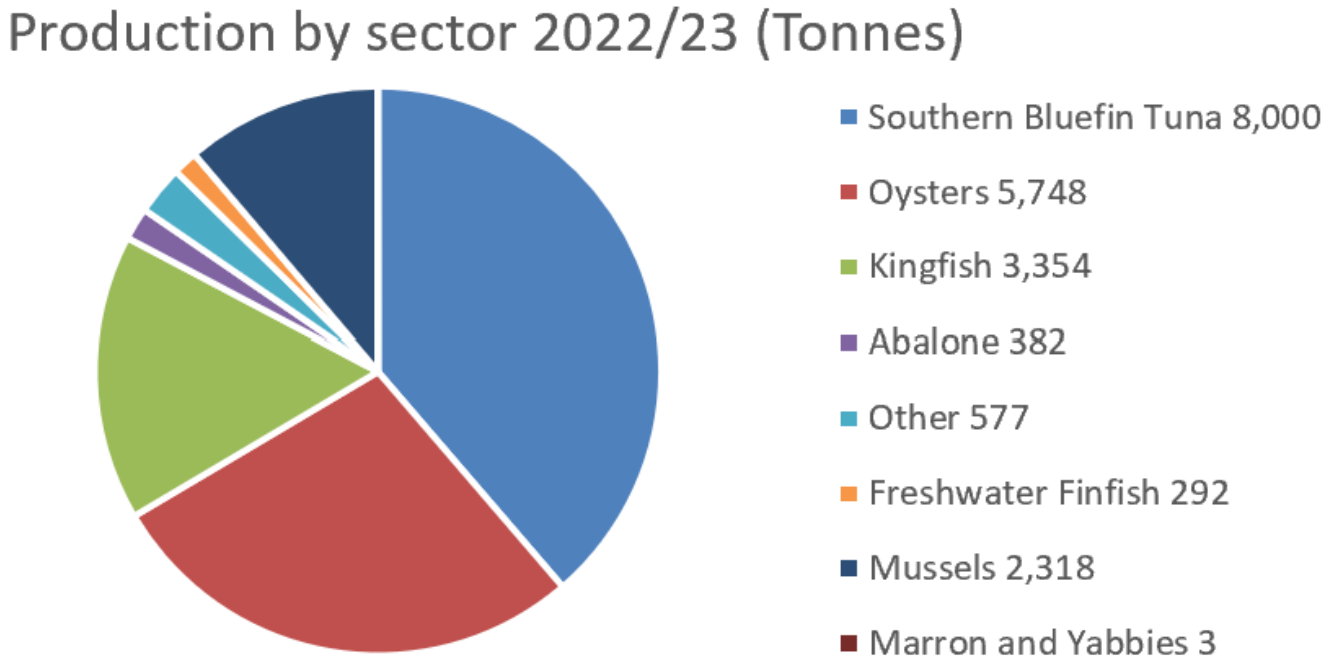


Figure 2: Contribution of each sector to the total production (t) of aquaculture in South Australia during 2022-23

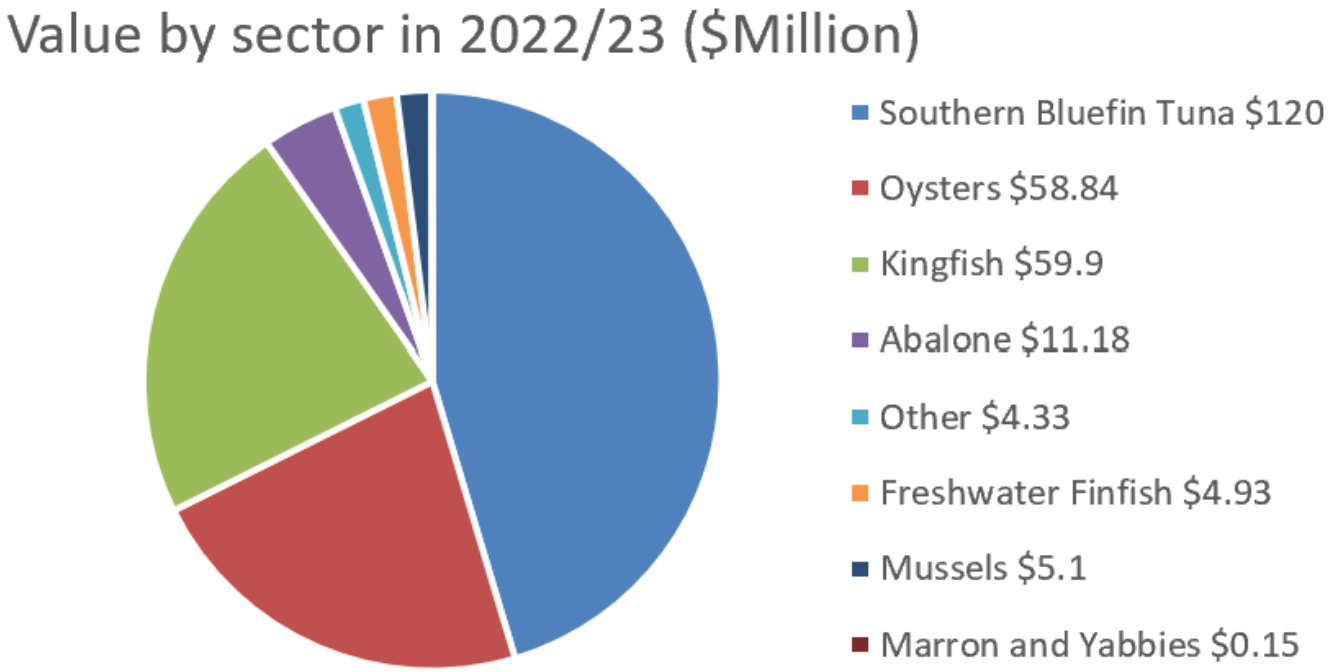


Figure 3: Contribution of each sector to the total value ($M) of aquaculture in South Australia during 2022-23.

The overall increase in total value of aquaculture production was driven by Tuna ($120 M or 9% change), Oysters ($58.84 M or 23% change), Marine Finfish ($59.90 M or 45% change), and Mussel ($5.10 or 10% change) aquaculture sectors (Table 1, BDO EconSearch 2024a). For detailed information on the change in total value of aquaculture production between 2021/22 and 2022/23 see [The Economic Contribution of Aquaculture in the South Australian State and Regional Economies, 2022-23 (pir.sa.gov.au)]

In 2022-23, aquaculture's total contribution to Gross State Product (GSP) of $386.3 M represented 0.27% of the total GSP for South Australia ($142.0 B). Around 77% of the contribution to GSP was generated in regional South Australia. Direct employment was estimated to be 1,285 Full Time Equivalent (FTE) jobs (855 on-farm and 430 in downstream activities) through direct employment and 1,196 flow-on jobs, giving total employment of 2,481 FTE (BDO EconSearch, 2024a). Approximately 73% of these jobs were generated in regional South Australia (Figure 4), 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. The production of remaining aquaculture species (i.e. Abalone, Freshwater Finfish and Marron/Yabbies) is more widely distributed across South Australia (BDO EconSearch, 2024a).

Figure 4: Distribution of aquaculture sectors in South Australia, predominantly located in the regions

In addition to producing The Economic Contribution of Aquaculture in the South Australian State and Regional Economies, 2022-23 (pir.sa.gov.au), BDO EconSearch has developed South Australia Aquaculture Economic Indicators Dashboards for 2022-23, 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, Kingfish, Mussels, Oysters, Abalone, Freshwater Finfish, Marron and Yabbies, and Other). For an overview of south Australian aquaculture; see Summary economic indicators dashboard 2022-23 (pir.sa.gov.au)

Values for South Australian aquaculture production, and value of production between 1999-2000 and 2022-2023 is shown in Figure 5. Factors that have historically influenced aquaculture production and value in South Australia include:

- Fluctuating dollar against the Japanese yen which impacts 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.

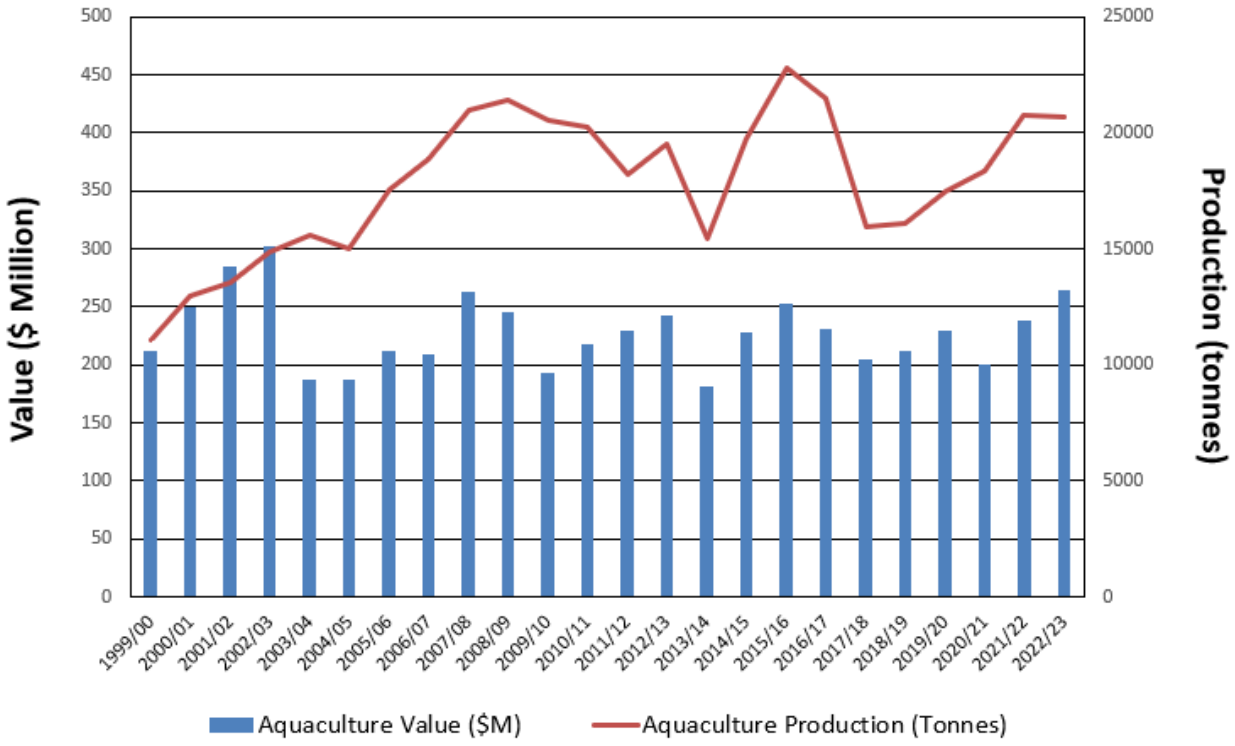


Figure 5: South Australia aquaculture production (t) and value ($M) from 1999-00 to 2022-23.

Industry licence holders

The total number of active aquaculture licences in South Australia during 2022-23 reporting period was 476 comprising 418 marine sites and 58 landbased sites (Figure 6). Included in these numbers are 6 marine maintenance sites operated by the Tuna sector for the purpose of holding and maintaining empty sea-cages. A full list of the aquaculture licences for which this report relates is provided in Appendix 1.

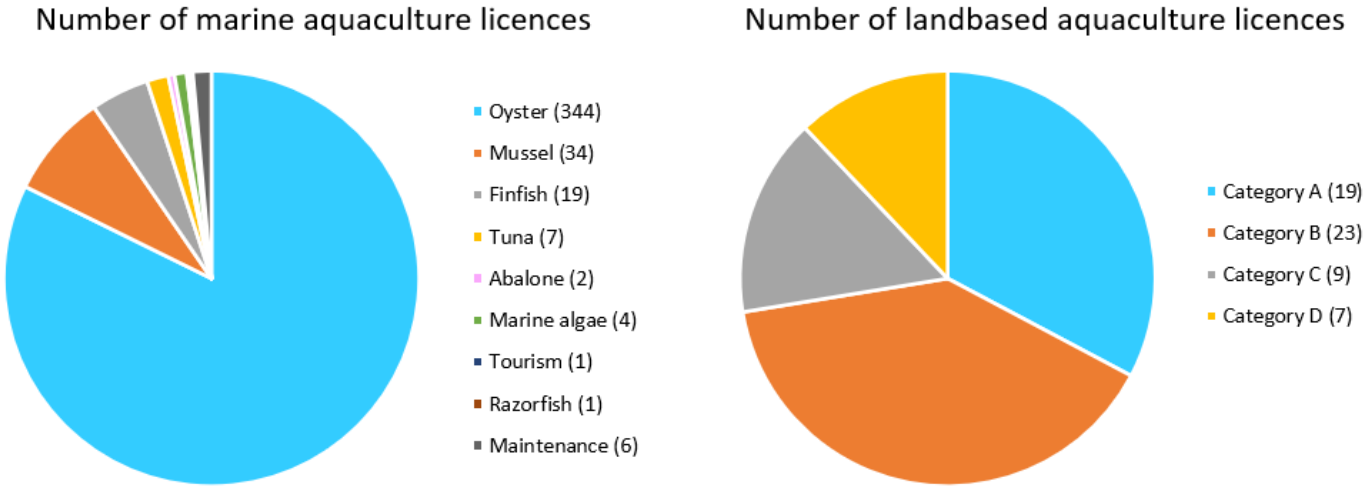


Figure 6: A summary of South Australian marine and landbased aquaculture licences 2022-23

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 283) and type of application completed by PIRSA in 2022-23.

Table 2: Summary of aquaculture-related applications completed in 2022-2023

Application type	Amount
New lease and licence	5
Lease and licence movement	20
Licence variation	10
Lease and/or licence division	4
Lease and/or licence amalgamation	9
Lease and/or licence transfer	40
Lease renewal	194
Lease/ licence surrender	0
Change of specified person/s	1

Aquaculture policies

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 may be leased and the class of species permitted for the purposes of aquaculture. Dependent on the species considered, a maximum biomass (tonnage) may 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.

There are 12 statutory aquaculture zone policies prescribed in South Australia which occupy approximately 425 024 ha, or 7% of State waters (Appendix 2). Of these zone policies, ten 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 (Figure 7). Each prescribe areas (zones) where aquaculture is either excluded or permitted, noting 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).

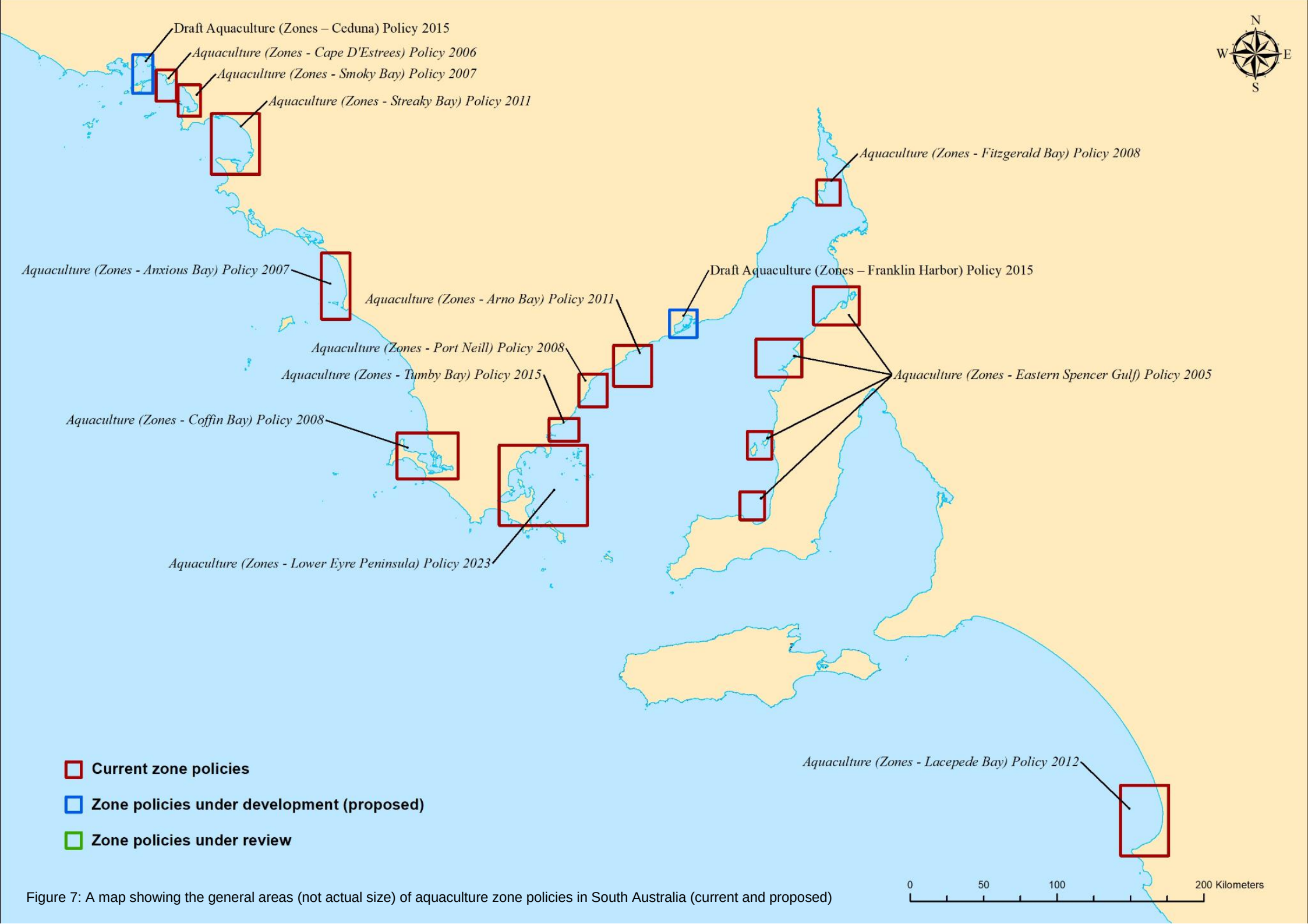


Figure 7: A map showing the general areas (not actual size) of aquaculture zone policies in South Australia (current and proposed)

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 5-15% 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.

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.

Zone policy development and review

Policy development

There were no new zone policies finalised in 2022-23, 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.

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 ensured the Zone Policy continued to maximise the use of marine resources for the purpose of aquaculture and provided 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 new 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 and approval occurring on 2 November 2023 as per the requirements of the *Aquaculture Act 2001*. The new Policy includes greater capacity for bivalve and seaweed aquaculture and increases Tuna and Finfish biomass in areas further from shore, which was based on published carrying capacity modelling. Conservative measures were used to determine biomass limits, which importantly result in average nutrient concentrations reaching background levels in receiving environments at the boundary of the respective zones/sectors.

Public call for aquaculture tenure within zones

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, corresponding licences and the requirements of authority holders under the *Aquaculture Act 2001* and *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 (only for Tuna as this zone is primarily 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 2023. There was no public calls made during 2022-23.

Lease applications are assessed by the ATAB who then make 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 2023.

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	0
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.

Aquaculture zone policy tenure allocation

PIRSA monitors the tenure (leasable ha) and biomass allocated to leases and their corresponding licences against limits prescribed within each zone policy to ensure allocations are within limits prescribed for each policy. An indication of the tenure available for each of the zone policies is listed in Appendix 2.

Aquaculture outside of zones

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 that is approved outside of an aquaculture zone must initially operate under an aquaculture pilot lease and corresponding licence, and after a period of three years, can be converted into a production lease.

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.

From 18 August 2022, aquaculture lease and licence holders are required to abide by conditions contained within the Policy and also individual lease and licence certificates. Between 2022-23, implementation of the SLLC Policy commenced, including the process to reissue lease and licence certificates to reflect the standardised conditions of that 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. This includes compliance inspections by Fisheries Officers to ensure the conditions are being adhered to.

On 14 March 2024, clause 42(5) of the Policy, relating to Oyster perpendicular farming method licence conditions, was amended at the request of the Oyster industry. The amendment provides further equity to Oyster growers in terms of maximum biomass limits between different farming methods and growing regions. 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, PIRSA made amendments to the *Aquaculture Act 2001* in 2019 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 to capital for 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 provisions of the *Aquaculture (Tourism Development) Amendment Act 2021* came into effect on the second anniversary of the date of assent on 9 December 2023. The amendments streamline the assessment and approval process for proponents of marine-based tourism developments located within aquaculture zones, which complement, promote, or are of benefit to aquaculture undertaken within respective aquaculture zones. Stakeholders are no longer 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*. PIRSA is currently undertaking a review of all administrative processes required 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 2022-23, there were 7 Tuna farms licensed by PIRSA which occupied 1804.8 ha of water. All of these were located within the Lincoln inner sector. Five of these actively farmed SBT (1522.27 ha). There were also 6 maintenance (Miscellaneous) sites for storing of sea-cages between production periods. Tuna aquaculture licences and Miscellaneous sites 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 is 7,295 t which is due to a 17% increase in quota which is likely to further increase starting 2027 (EconSearch 2024). 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 2022-23 (pir.sa.gov.au).

Farmed Tuna are South Australia's largest aquaculture export. Historically, exports were largely sent 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 below water quality values of the 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 Aquaculture Environmental Monitoring Program (AEMP)

During 2022-23, the Tuna aquaculture sector contributed to the 2019–2023 AEMP through a Service Level Agreement for cost recovery of the program. See Lower Eyre regional aquaculture environmental monitoring program (AEMP) for further information and results.

Annual environmental monitoring reports

Submission rates for EMPs for the Tuna sector were 100% in 2022-23. Note: the reporting period for the Tuna sector is 1 December 2022 to 30 November 2023, aligning with the Tuna production cycle.

Development

During the 2022-23 EMP reporting period, 5 Tuna licences reported to have farming structures (sea-cages) on site and 5 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 2 licences (Lincoln Inner sector) were used as grow-out sites.

Biomass

Wild caught juvenile SBT were moved to off-shore sea-pontoons between December 2022 and February 2023 at an average whole weight of 10.6 kilograms (kg). Harvesting of SBT largely occurred 6 months after stocking during July-August 2023. The average whole weight of farmed SBT at harvest in 2023 was 20.95 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 2022-23 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 4.6 t per ha during May 2023) and the zone biomass limit was not exceeded. The maximum biomass of farmed SBT was recorded in May, totalling approximately 6,286 t (representing an average of 3.48 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. An approximate total of 60,970 t feed (baitfish) was used by the SBT industry in 2022-23. Any 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 2022-23 reporting period, one licensed Tuna aquaculture site reported an interaction with a White Shark in a tuna cage. The shark was released alive.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 three-metre high seal jump fences, which are considered by 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 2022-23.

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 2022-23. 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

No off-label (outside approved label or permit) chemical approvals (under *Aquaculture Regulations 2016*) were requested by the Tuna sector during the 2022-2023 reporting period.

Reported use of APVMA permitted products

Five licence holders in the Tuna sector reported permitted product use (use in accordance with APVMA approved agricultural or veterinary chemical labels or permits) during the 2022-2023 reporting period. Permitted products included Praziquantel (PER92045 and PER88128) to treat parasite (blood fluke) infections.

Livestock translocations

No livestock translocation approvals were requested by the Tuna sector during the 2022-23 reporting period.

Disease management and surveillance

No unusually high or unexplained mortalities, nor suspected or confirmed notifiable diseases were reported to PIRSA during the 2022-23 period for the marine Tuna sector. No disease investigations or emergency disease responses were required for the sector during this period.

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 (*Seriola lalandi*).

Marine Finfish farming represents a high performing sector of the South Australian aquaculture industry. In 2022-23, there were 19 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, noting licence areas are managed as a single site when abutting.

The industry is based on the growout of hatchery-reared Yellowtail Kingfish (YTK) fingerlings from broodstock originally taken in South Australian waters in accordance with the *Fisheries Management Act 2007*. Fingerlings are transferred to marine sea-pontoons (44 m diameter) at ~30 g, fed on specially formulated manufactured diets, and grown out at sea for ~28 months until they are harvested at 4.2 kg. For a summary of production and value, and other key economic indicators and trends for the Kingfish aquaculture sector, see Kingfish economic indicators dashboard 2022-23 (pir.sa.gov.au)

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 YTK 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%), and the remainder deposited on the underlying seafloor.

Biomass limits for individual site and aquaculture zone levels are developed to minimise the effects the Finfish aquaculture industry may have on the environment of different growing regions. The EMP process provides ongoing environmental monitoring information required to identify and manage the occurrence of potential impacts the Finfish sector may have on both individual and a whole of zone 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 site specific EMPs. These EMPs are designed by PIRSA and the EPA and are tailored to suit specific locations and environmental characteristics. However, the overall aim is to monitor changes in the environment that may reflect an impact from Finfish aquaculture. In addition to site-specific EMPs, Finfish aquaculture licensees are required to provide monthly reporting for each site detailing total biomass, feed added and number of fish per cage.

The site level component of the 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 mats, and changes to the quantity and health of seagrass. The broadscale (regional) component of the 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 flow direction modelled for Finfish nutrients. Regional EMPs are also designed to reflect methodology utilised in the regional aquaculture environmental monitoring program (AEMP) described below, to help build the dataset collected for the AEMP.

A 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. This Louth Bay EMP was revised 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 continue to contribute to the regional AEMP detailed below.

An Arno Bay EMP was originally designed in 2019 to use benthic video footage to monitor the presence of, and changes to, unidentified benthic mats (noting benthic algal mats 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 confirmed the unidentified mats were Mussel shell accumulation and not benthic algal mats, which 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 for the accumulation of debris, waste feed, potential build-up of harmful algal mats, and changes to the quantity and health of seagrasses at and near sea-cages.

Finfish were reintroduced to Fitzgerald Bay aquaculture sites in September 2021, so a Fitzgerald Bay EMP was implemented and comprised of site and regional monitoring through benthic video footage. The benthic habitat beneath Fitzgerald Bay sites comprises predominantly sand. However, there are significant seagrass meadows nearby. Site level video components of the Fitzgerald Bay EMP 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 mats. The regional level component of the EMP contributes to a research project being undertaken by SARDI with respect to potential impacts of Finfish nutrients on seagrasses. The four-year research project, developed by SARDI, PIRSA, Clean Seas Seafood Limited 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). 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.

Regional Aquaculture Environmental Monitoring Program (AEMP)

During 2022-23, the Finfish aquaculture sector contributed to the 2019–2023 AEMP through a Service Level Agreement for cost recovery of the program. In addition, the Finfish aquaculture sector collected remote video transects under the site-specific EMPs, to assist in the seagrass monitoring component of the AEMP and provide greater temporal context. See Lower Eyre regional aquaculture environmental monitoring program (AEMP) for further information and results.

Annual environmental monitoring reports

Submission rates for EMPs for the Finfish sector were 100% in 2022-23. Note: the reporting period for the Finfish sector is 1 December 2022 to 30 November 2023.

Development

Of the 19 reports submitted for the 2022-23 EMP reporting period, 15 licences had farming structures on site, 10 licences 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 June (1 533 t) during the 2022-23 reporting period. Of note, the three licences located in Fitzgerald Bay were not actively farmed and therefore not stocked during 2022-23.

Subject to any licence specific conditions providing otherwise, standardised licence conditions state that the maximum biomass of Finfish held on an aquaculture site at any one time must not exceed 15 t per licensed ha. To ensure biomass limits are not exceeded during a reporting period, licensees of the Finfish sector are required to provide monthly reporting on total biomass (in tonnes). No zone biomass limits were exceeded during the 2022-23 reporting period.

During 2022-23, four of the eight Finfish licences in Boston Bay aquaculture zone were licensed to farm above 15 t per licensed ha; 20 t for two licences in the Boston Bay sector and 41.25 t for two licences in the Bickers Island sector. A maximum biomass of 1,207 t in April 2023 was recorded across sites within the Boston Bay aquaculture zone, below the relevant zone biomass limit of 1,750 t. However, monthly biomass reports did on two occasions exceed the maximum (individual) stocking rate permitted across a 43-ha harvesting area in Boston Bay comprising three licences. The first was in August 2023 (exceeded slightly by 39 t, due to delays in harvesting fish) and the second was in December 2023 (exceeded by 180 t, due to the licensee towing pontoons into the area for a harvest reduction process being undertaken at the time but vessels required to transport fish out were late to arrive). In these instances, no further compliance action was taken with consideration of the reduced feed inputs at the site, but the licensee was reminded of their obligation to ensure biomass held on a site remain within licensed limits.

During 2022-23, the Finfish licence located in Louth Bay was licensed to farm 40 t per ha with a maximum biomass of 1,307 t recorded in December 2023, below the relevant zone biomass limit of 2,270 t.

During 2022-23, the six Finfish licences located in Arno Bay (inner sector) were licensed to farm 15 t per ha with a maximum biomass of 1,533 t recorded across the sites in June 2023, below the relevant sector biomass limit of 2,900 t. However, the biomass reported did exceed the maximum amount of biomass

permitted across the 100-ha area (comprising five licences) because of inclement weather delaying pontoon tows. In this instance, no further compliance action was taken.

Feed Inputs

Farmed YTK are fed commercially manufactured, pelletised feed. A total of approximately 10,147 t of manufactured feed was used across all sites within the marine Finfish sector during the 2022-23 reporting period. Farmed sites located within the Arno Bay and Lower Eyre Peninsula aquaculture zone policy areas reported a total of 3,057 t and 7,090 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 section). 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 days of 'routine interactions' involving 257 Long-nosed fur seals (maximum of 5 seals per day, primarily making holes in cage netting or swimming within pontoon cages) on licensed sites in the Boston Bay and Louth Bay aquaculture zones. The seals were released from the Finfish cages unharmed and therefore there were no 'adverse interactions' reported on a licensed Finfish aquaculture site during 2022-23.

Licence holders are also required to submit information regarding any stock escape events that occurred on their licensed sites (see Species selection and escapes section). On 24 January 2023, a finfish escape event was reported due to a shark chewing a hole in a net, with 5 fish escaping. On 15 March 2023, 40 fish escaped when equipment failed harvesting fish. Furthermore, on 23 October 2023, 3,500 finfish (55 g each) escaped during transit of fish from one zone to another with no fish reported as recaptured. An up-to-date 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


Photo courtesy of cleanseas.com.au

Veterinary medicine use

Off-label approvals

Twenty-three off-label (use outside approved label or permit) chemical approvals (under *Aquaculture Regulations 2016*) were requested by the Finfish sector during the 2022-2023 reporting period. Of these, there were two praziquantel approvals, one oxytetracycline hydrochloride approval and 20 AQUI-S approvals. All approvals were issued for use on YTK stock. AQUI-S approvals were for use of an anesthetic during routine stock monitoring and general husbandry. Praziquantel was for treatment of parasite infections and oxytetracycline hydrochloride was for treatment of *Photobacterium* infections.

Reported use of APVMA permitted products

Seven licences in the Finfish sector reported permitted product use (use in accordance with APVMA approved agricultural or veterinary chemical labels or permits) during the 2022-2023 reporting period. Permitted products used included Hydrogen peroxide (PER88576) and Praziquantel (PER87833) to treat parasite infections in YTK stock.

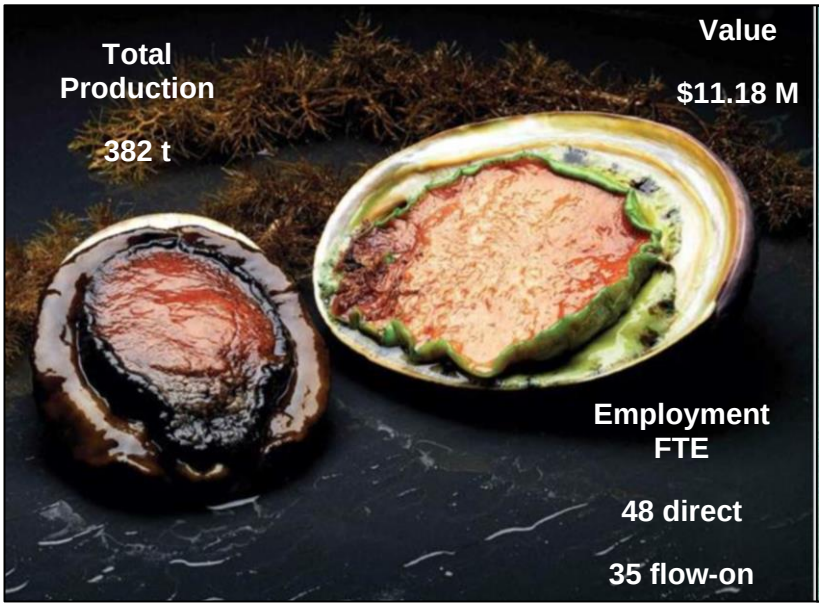
Livestock translocations

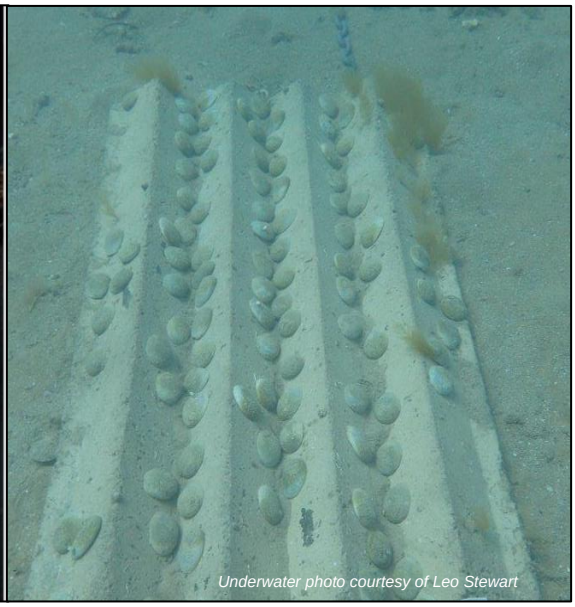
The Finfish sector supplies their own fingerlings from a purpose-built hatchery located at Arno Bay. As such, no livestock translocation approvals were requested by the Finfish sector during the 2022-23 reporting period.

Disease management and surveillance

No unusually high or unexplained mortalities, nor suspected or confirmed notifiable diseases were reported to PIRSA during the 2022-23 period for the Finfish sector. No disease investigations or emergency disease responses were required for the sector during this period.

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 2022-23, there were two marine Abalone sites licensed by PIRSA which occupied 149 ha of water. One site reported to have farming structures on site, one of which was stocked with Abalone. One licence had no development. Individual marine Abalone aquaculture licences are listed in Appendix 1.

The marine Abalone sector is still trialling suitable benthic farming methods, and production by this sector in 2022-23 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 2022-23.

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

Both licences for the marine Abalone sector submitted an EMP in 2022-23 and both were submitted 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

One Abalone licence reported having farming structures on site during the 2022-23 reporting period.

Biomass

During the 2022-23 reporting period, only one site reported to have minimal stock on site (maximum amount recorded in July 2022; 406 individuals), with the other site remaining unstocked due to being unable to transfer juvenile stock from the hatchery to site due to genetic differences.

Feed Inputs

Farmed Abalone can be fed commercially produced manufactured pellets or naturally occurring drift algae. No feed was used during 2022-23.

Reported Interactions and escapes

No interaction or escape events were reported by the marine Abalone sector during 2022-23.

Aquatic animal health management

Veterinary medicine use

Off-label approvals

No off-label (outside approved label or permit) chemical approvals (under *Aquaculture Regulations 2016*) were requested by the Marine Abalone sector during the 2022-2023 reporting period.

Reported use of APVMA permitted products

No permitted product use (in accordance with APVMA approved agricultural or veterinary chemical labels or permits) was reported by the Marine Abalone sector during the 2022-2023 reporting period.

Livestock translocations

No livestock translocation approvals were requested by the marine Abalone sector during the 2022-23 reporting period.

Disease management and surveillance

No unusually high or unexplained mortalities, nor suspected or confirmed notifiable diseases were reported to PIRSA during the 2022-23 period for the marine Abalone sector. No disease investigations or emergency disease responses were required for the sector during this period.

Mussels

Overview of the industry

The Mussel sector is well established with 34 licenced sites in 2022-23. The waters of Boston Bay and Point Boston cover 330 ha, Louth Bay 10 ha, Wallaroo 170 ha and Proper Bay 59 ha. Of these licences, 26 farmed during the 2022-23 reporting period. Individual Mussel aquaculture licences are listed in Appendix 1. The species farmed by this sector is the Blue Mussel (*Mytilus galloprovincialis*), and trials have been 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 2022-23.

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 which is in place, 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 2022-23 and 88.2% were submitted on time.

Development

Of the 34 reports received for the 2022-23 EMP reporting period, 27 or 79.4% 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 2022-23 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 2022-23 reporting period was approximately 211.4 m of backbone per ha, and 6.9 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 2022-23 reporting period.

Loss of equipment

There were 29 reports of lost equipment (mussel floats and corner marks) during the 2022-23 reporting period, predominately from storm events. Majority of these were found on beaches and recovered.

Benthic Video

No additional reporting on the aquatic environment was required for the 2022-23 reporting period for the Mussel sector.

Aquatic animal health management

Veterinary medicine use

Off-label approvals

No off-label (outside approved label or permit) chemical approvals (under *Aquaculture Regulations 2016*) were requested by the Mussel sector during the 2022-2023 reporting period.

Reported use of APVMA permitted products

No permitted product use (in accordance with APVMA approved agricultural or veterinary chemical labels or permits) was reported by the Mussel sector during the 2022-2023 reporting period.

Livestock translocations

No livestock translocation approvals were requested by the Mussel sector during the 2022-23 reporting period.

Disease management and surveillance

No unusually high or unexplained mortalities, nor suspected or confirmed notifiable diseases were reported to PIRSA during the 2022-23 reporting 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 345 licensed oyster sites (including 1 razorfish site) covering approximately 973 ha in 2022-23. 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

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-Schutz-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 traditional 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.

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…

Sector-based aquaculture strategy

PIRSA is currently developing a sector-based aquaculture strategy with the Oyster sector. The strategy will be a resource for all licence holders primarily farming oysters in the State. This will replace the requirement for individual licence holders to submit (and have approved) individual aquaculture strategies.

Environment

Annual environmental monitoring reports

Submission rates for EMPs for the Oyster sector were 99.7% in 2022-23; however, 22.4% of these were up to 3 months late. PIRSA follows 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 2022-23 EMP reporting period, 305 (88.7%) reported having farming structures and 287 (83.2%) reported having stock (Pacific Oyster and/or Native Oysters, Razorfish) 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 2022-23 EMP reporting period, 27 licence holders (or 7.8%) reported having exceeded the total allowable length of line and/or racking 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 2022-23 reporting period, no adverse interactions with large marine vertebrates (e.g. sharks, whales, dolphins, seals) or seabirds were reported.

Feral Oysters

Of the reports received for the 2022-23 EMP reporting period, 34 (9.9%) 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 above) are organised as needed to reduce feral Oyster numbers in the growing region.

Aquatic animal health management

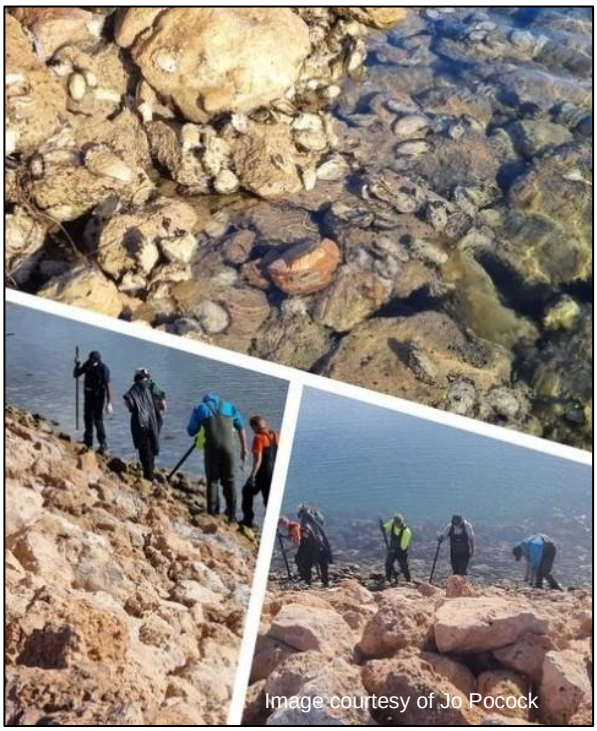


Image courtesy of Jo Pocock

Veterinary medicine use

Off-label approvals

No off-label (outside approved label or permit) chemical approvals (under *Aquaculture Regulations 2016*) were requested by the Oyster sector during the 2022-2023 reporting period.

Reported use of APVMA permitted products

No permitted product use (in accordance with APVMA approved agricultural or veterinary chemical labels or permits) was reported by the Oyster sector during the 2022-2023 reporting period.

Livestock translocations

There were two translocation approvals requested by the Oyster sector for the 2022-23 reporting period. Native oysters were translocated from intertidal licences to the hatchery at South Australian Research and Development Institute, Aquatic Sciences.

Disease management and surveillance

One unusually high and unexplained mortality in the Oyster sector was reported to PIRSA during the 2022-23 period. PIRSA investigated this event. Notifiable or infectious diseases or harmful algae were not detected.

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 2022-23, 2812 to 4462 Oysters from across South Australia (hatcheries, nurseries, grow-out and feral Oysters in growing regions) (*n* = 704 samples) were processed and tested negative for 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.


Photos courtesy of oysterssa.com.au

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 2022-23, there were 58 landbased aquaculture licences in South Australia, comprising of Category A (19), B (23), C (9) and D (7). Licences include private businesses, hatcheries (abalone, oysters and finfish), microalgae production, macroalgae 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 115 direct jobs in 2022-23, 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 2022-23 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 effort involved in the administration and enforcement of the *Aquaculture Act 2001* and associated *Aquaculture Regulations 2016* in relation to the aquaculture authorised by the licence. Indicative criteria for each landbased licence 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. yabbies and marron).
- **Category B:** Small scale operators, which may potentially discharge some wastewater 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 wastewater 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 wastewater 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 58 landbased aquaculture licences in 2022-23, 53 (or 91.4%) EMPs were submitted and 73.6% 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 2022-23 EMP reporting period, 46 (86.8%) reported having stock at the facility.

Species farmed

In 2022-23, the aquatic species farmed by the landbased sector included:

Barramundi (*Lates calcarifer*)

Brown Trout (*Salmo trutta*)

Golden Perch (*Macquaria ambigua*)

Greenlip Abalone (*Haliotis laevigata*)

Hairy Marron (*Cherax tenuimanus*),

Sea Urchin (*Heliocidaris erythrogramma*)

Sea Lamington (*Tripneustes gratilla*)

Smooth Marron (*Cherax cainii*)

Eel-tailed Catfish (*Tandanus tandanus*)

Goldfish (*Carassius auratus*)

Mulloway (*Argyrosomus japonicus*)

Murray Cod (*Maccullochella peelii peelii*)

Native Oyster (*Ostrea angasi*)

Pacific Oyster (*Magallana gigas*)

Rainbow Trout (*Oncorhynchus mykiss*)

Silver Perch (*Bidyanus bidyanus*)

Snapper (*Pagrus auratus*)

Yabbies (*Cherax destructor*)

Yellowtail Kingfish (*Seriola lalandi*)

Red algae (*Asparagopsis armata, A. taxiformis*)

Green algae (*Ulva* sp.)

Microalgae (*Dunaliella salina*)

Feed Inputs

Species were provided with either manufactured (or fertiliser in the case of *Asparagopsis*) or natural aquaculture feeds.

Reported escapes

No escape events were reported during the 2022-23 reporting period.

Aquatic animal health management

Veterinary medicine use

Off-label approvals

Ten off-label (outside approved label or permit) chemical approvals (under *Aquaculture Regulations 2016*) were requested by the Landbased sector during the 2022-2023 reporting period. All requests were for the use of AQUI-S as an anaesthetic during routine stock monitoring and general husbandry in finfish hatcheries.

Reported use of APVMA permitted products

Fourteen licence holders in the Landbased sector reported permitted product use (use in accordance with APVMA approved agricultural or veterinary chemical labels or permits) during the 2022-2023 reporting period. Permitted products included sodium hypochlorite (PER14029), Abamectin (PER88497), Benzocaine (PER92731), Tréidlia Custom Strep Vaccine (Injectable) (PER14534), Luteinising Hormone Releasing Hormone Analogue (PER13069), Ovaprim (PER13800), Magnesium Chloride hexahydrate (PER83238), Magnesium Sulphate Heptahydrate (PER86963), and 2-Phenoxyethanol (PER83233).

Livestock translocations

Twelve livestock translocations were requested by the Landbased sector and approved during the 2022-23 reporting period. Species included Barramundi, Brown Trout (ova), Rainbow Trout (ova), Silver Perch and algae species (*Asparagopsis taxiformis* and *A. armata*).

Disease management and surveillance

One mortality event was reported to PIRSA in the Landbased sector during the 2022-23 period. Notifiable or infectious diseases or harmful algae were not detected through laboratory testing.

In the 2022-23 reporting year, 2812 to 4462 oysters from across South Australia (hatcheries, nurseries, grow-out and feral oysters in growing regions) (*n* = 704 samples) were processed and tested negative for OsHV-1 (microvariant, which is the virus that causes POMS).


Photo courtesy of Yumbah.

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. Sustainable wild harvest of seaweed at the required levels is unlikely but aquaculture can further this industry. 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, farming of the 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 al., 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 55 licences (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. 4 of the marine aquaculture licences and 4 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 2022-2023 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 right). Cultivating seaweed next to Tuna or Finfish farms can provide significant environmental benefit through the assimilation of nitrogen, carbon, and phosphorus that is produced from these farms. The seaweed will be made into liquid fertiliser and a natural pigment, with the remaining solids formulated into chicken feed.

Macroalgae Management Areas

PIRSA supports the sustainable growth of the emerging seaweed aquaculture industry. Recent 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 through the below link.

www.pir.sa.gov.au/primary_industry/aquaculture/marine_aquaculture.

To complement the MMAs, 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 Australian jurisdictions, 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

All four licences for the Marine algae sector submitted an EMP in 2022-23, however, they were all submitted late. 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.

Biomass

The amount of seaweed that can be farmed on a marine 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 2022-23 EMP reporting period, seaweed farming was still under trial and therefore only a small amount (600 m total) of backbone was developed across two 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 2022-23 reporting period.

Aquatic health management

Veterinary medicine use

Off-label approvals

No off-label (outside approved label or permit) chemical approvals (under *Aquaculture Regulations 2016*) were requested by the Marine Algae sector during the 2022-2023 reporting period.

Reported use of APVMA permitted products

No permitted product use (in accordance with APVMA approved agricultural or veterinary chemical labels or permits) was reported by the marine Algae sector during the 2022-2023 reporting period.

Livestock translocations

No livestock translocation approvals were requested by the Marine Algae sector during the 2022-23 reporting period.

Disease management and surveillance

No unusually high or unexplained mortalities were reported to PIRSA during the 2022-23 period for the Marine Algae sector. No disease investigations or emergency disease responses were required for the sector during this period.

Aquaculture tourism and education

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 the industry and 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.

Photo courtesy of Oceanic Victor.

In 2022-23, there was one licensed marine aquaculture tourism site near Victor Harbor which provides opportunity for people to view, swim with and learn about various marine species within the safe confines of a sea-cage and floating pontoon equipped with touch tanks. Species included those found locally in South Australian waters, such as Tuna, Abalone, Snapper, Rock Lobster and Yellowtail Kingfish. There were no visitors to this site in 2022-23 due to the global COVID-19 pandemic and resulting lockdowns and travel restrictions, as well as structural work on the Granite Island causeway limiting access to the site.

Photo courtesy of SA Premium Oyster Farm Tours

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 the "Changes to the *Aquaculture Act 2001*" section for further information).

Photo 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. Actions are based on a variety of information sources and include reports received by the public (e.g Fishwatch), other government agencies and other stakeholders (including recreational marine resource users), PIRSA aims to work in an efficient and timely manner in collaboration with the industry to address and rectify 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, issuing directions to carry out work on a lease and or licence, or further enforcement actions if required.

Fisheries Officers spent considerable time working with growers (Coffin Bay oyster growers in particular) to provide education on their requirements under the *Aquaculture (Standard Lease and Licence Conditions) Policy 2022*, which came into effect August 2022. This included but was not limited to attending meetings with growers at West Beach, Cowell, Smoky Bay, Coffin Bay, Wangary, Port Lincoln, Kingscote and Stansbury, and compilation and distribution of a targeted information package to further assist growers.

During 2022-23, Fisheries Officers inspected finfish sites at Boston Bay and Proper Bay, oyster sites at Point Longnose, Dutton Bay, Kellidie Bay, Streaky Bay, Port Vincent, Wardang Island and Point Pearce, mussel sites at Boston Bay, southern bluefin tuna sites at Boston Bay, land-based marron sites on Kangaroo Island and in the Adelaide Hills, abalone sites at Louth Bay and Kingscote, and algae sites at Proper Bay and Louth Bay.

Where appropriate, lease and licence holders were provided with advance notice of site inspections. Sites were inspected to determine compliance with lease and licence requirements, with particular focus on compliance with navigational 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.

Majority of marine sites demonstrated good compliance in relation to navigational requirements (e.g. location and marking of navigational structures, and aquaculture farming structures within the boundaries of the licensed site), and most marine sites were observed to be in good condition. Majority of land-based 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 any compliance related issues, 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 from sites including Ceduna, Coffin Bay, Franklin Harbor, Lucky Bay and other areas across the State as part of the POMS surveillance program.

Growers and the public raised a number of questions relating to Oyster biosecurity related rules and preventative measures including translocation risks. POMS signage was also maintained within the Port River system.

Furthermore, Fisheries Officers—

- Responded to reports of reported escapes of Finfish – including one escape that allegedly occurred during transit of fish from one zone to another – and liaised with the licence holder and conducting a follow up investigation.
- Responded to reports of broken lines, oyster baskets and other debris washing up on a beach adjacent a growing site at Kangaroo Island.
- Took enforcement action to progress clean-up of a site in disrepair at Fitzgerald Bay.
- Responded to reports provided by growers and the public of alleged non-compliance of other sites in their area.
- Clarified with growers and the public rules relating to the use of aquaculture farmed species as berley.

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 2022-23, there were three aquaculture related mortality events investigated and 14 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. high rainfall, salinity or water quality). As of 30 June 2023, South Australia has 59 notifiable aquatic diseases pursuant to the *Livestock Act 1997*, which are required to be reported if suspected or detected. No notifiable diseases were detected during fish kill (or fish health) investigations.

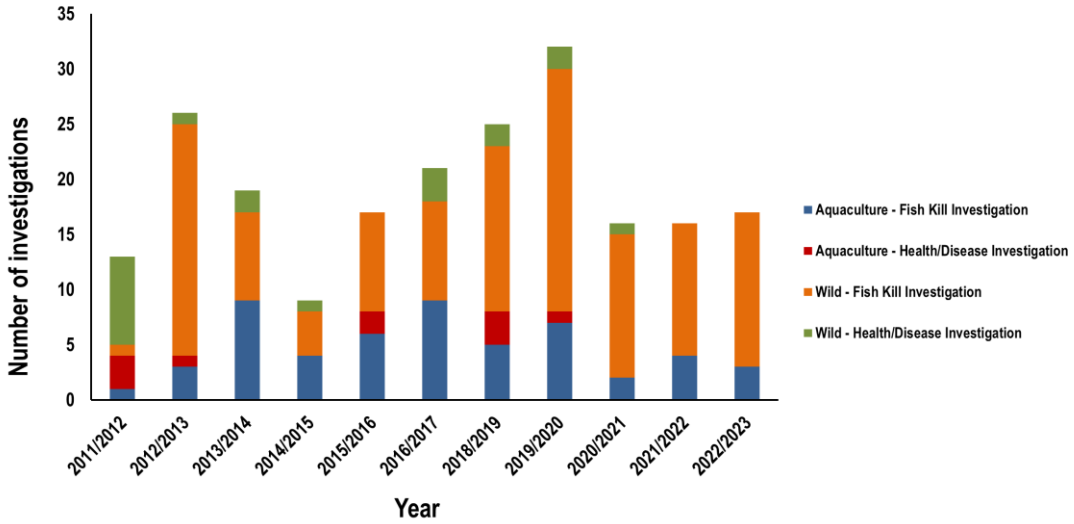


Figure 8: A summary of South Australian fish kill (mortality) and fish health (disease) investigations in wild fish and the aquaculture industry from 2011-12 to 2022-23.

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.

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).

The Adopt-a-Beach Program was previously led by the Australian Southern Bluefin Tuna Industry Association (ASBTIA) for a number of years. The program is now (2024) led by Clean Seas Seafood Limited (finfish industry) and supported by the Tuna and Mussel industries.

Beach clean ups are undertaken a minimum of four times a year, with clean-up data collected and submitted to Clea Seas Seafood Limited 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 this non-aquaculture related debris and its disposal in a responsible manner.

SAOGA coastline debris recovery program

To address legislative requirements, the South Australian Oyster industry cleans up debris from the coastline near 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 by growers and National Parks and Wildlife. In addition, growers in Streaky Bay and Cowell 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 recreational fishing, landbased activities and the general public. The 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 farmers, 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. The industry continued for a while to recycle plastic baskets by using a portable plastic shredder on the back of a truck but it came with a cost to growers. 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). Next Gen Waste Co, located at Wharminda on Eyre Peninsula, developed a business model to recycle plastics from agriculture and aquaculture farms. With the old plastic shredder currently not in use, there was a gap identified by QMechanical, located in Port Lincoln, to build a new plastic shredding machine. This machine will be ready for trials late 2024. SAOGA, Next Gen Waste Co and QMechanical are collaborating to combat the issue.

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 the commitment to support industry growth through an adaptive resource management framework, PIRSA plays a key role in 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 the aquaculture industry.

SARDI and PIRSA work closely with the aquaculture sectors to produce meaningful 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 species aquaculture.
- Aquaculture site selection and suitability assessment.
- Environmental assessment, monitoring, oceanography and carrying capacity modelling.
- Improving hatchery technology for optimizing success in spawning, larval and juvenile rearing and growout of commercially important finfish and shellfish 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 and cellular 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 bioproducts 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 assessment and 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 the 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, the Commonwealth Government, and other research providers 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. Now, the Pacific Oyster broodstock with high POMS resistant estimated breeding value (~100% for one year only spat) are available for commercial hatchery production in Australia. 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. More on this project can be found at https://www.frdc.com.au/project/2016-807 or www.Oystersaustralia.org/current-crcp

Aquatic Animal Health

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

Recently completed research

Molluscs

Recently, SARDI in partnership with South Australian Oyster Research Council, South Australian Oyster Growers Association and Flinders University has completed the FRDC 2013-029 project which aims to identify the feeding requirements of Pacific Oysters, Cockles and Mussels, investigate the factors influencing food availability in key 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. The research has elucidated local food sources, their spatial and temporal variability, and their importance in terms of Pacific Oyster performances in Coffin Bay and Franklin Harbour, SA, respectively. It also revealed differences in food particle size selection preferences, fatty acid profiles and assimilation rates among Pacific Oysters (*Crassostrea gigas*), Cockles (*Katelysia rhytiphora*) and Mussels (*Mytilus galloprovincialis*), implying the ability to farm multiple species on a single lease to make greater use of the food resources available, particularly Cockles with Mussels or Pacific Oysters. Coffin Bay and Franklin Harbour had distinct biotic profiles, which indicates that unique management strategies will likely need to be considered for each bay. The report has been approved by SARDI and FRDC and will be available soon. More information on this project can be found at www.frdc.com.au/project/2014-027

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

SARDI is working with Australian Seafood Industries (ASI) to support the ASI South Australian selective breeding program to improve the spat mortalities of unknown cause in the South Australian Pacific Oyster industry and at the same time maintain or further improve the genetics of other traits of economic importance, especially POMS resistance. The project (FRDC 2019-039: South Australian Pacific Oyster selective breeding program: Building POMS resistance to reduce risk for the South Australian oyster industry) is co-funded by SARDI, ASI and FRDC, which is further extended with the funding from ASI. The FRDC 2019-039 project final report will be available by the end of 2024. More information on this project can be found at https://www.frdc.com.au/project/2019-039. Currently SARDI is working with South Australian Oyster Research Council to secure the funding to optimise the technique for tetraploid Pacific Oyster broodstock induction in SA so that enough all-triploid spat required by the industry can be produced by local hatcheries.

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 final report is due by the end of 2024. More information can be found at www.frdc.com.au/project/2018-186.

Aquatic Animal Health

PIRSA's AAH Program commenced project FRDC 2020-094 "Improving the availability of safe and effective veterinary medicines for Australia's seafood industry" in 2021. This three-year project aimed to document a safe and effective process for off-label use of agricultural or veterinary (agvet) chemical products, facilitate progress of priority agvet products in aquaculture, determine options for future coordination and develop and implement a communication and awareness strategy for safe and effective agvet product 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 4.5 ha of seaweed settlement lines currently deployed next to tuna farms in Port Lincoln (see Marine algae (seaweed)). The first harvest of about 2.5 tonnes of seaweeds was undertaken in December 2022. About 1 tonne of tuna processing wastes and utilisable pilchard wastes have been aggregated in Port Lincoln and will be transformed into liquid fertiliser/biostimulants at SARDI by October 2024.

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*. Seeded lines of *Ecklonia* will be deployed in Port Lincoln and Kangaroo Island by October 2024. 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.

SARDI is hosting the temperate node of the National Seaweed Hatchery Network (NHN) in partnership with the Australian Sustainable Seaweed Alliance (ASSA). The project seeks to develop hatchery technology for the red seaweeds *Asparagopsis armata*. The validated hatchery technology is expected to be published in a hatchery manual in 2025. For more information see https://www.frdc.com.au/project/2023-081

Integrated multitrophic aquaculture (IMTA)

PIRSA and SARDI in affiliation with Flinders University secured funding for FRDC funded project (2023-051) “Ecologically sustainable aquaculture growth through Integrated Multitrophic Aquaculture (IMTA) – Incorporating IMTA nutrient modelling into regulatory frameworks”. The $1.5 million three-year project will include development of a national IMTA policy guideline to inform regulatory frameworks that supports IMTA and ecological sustainable growth in Australian aquaculture. Additional funding was also provided by the Blue Economy CRC. https://www.frdc.com.au/project/2023-051

External factors or events affecting the aquaculture industry during 2022-23

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. In October 2023, the CCSBT further increased Australia's TAC to 7,295 t per annum for the 2024-26 period.

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.

Oysters

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 – $1.5 M from stock being either recalled or disposed of (BDO EconSearch 2023). 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 and PIRSA closure notice in Coffin Bay could be lifted.

Current status of South Australian shellfish harvesting areas (provided by SASQAP) can be found at the below link:

https://pir.sa.gov.au/biosecurity/food_safety/shellfish_sasqap/harvesting_statuses

References

ABARES (2024). Australian fisheries and aquaculture: Outlook to 2028–29. March 2024. https://daff.ent.sirsidynix.net.au/client/en_AU/search/asset/1033321/0

ABARES (2023). Australian Fisheries and Aquaculture Statistics 2022. December 2023. 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. https://www.pir.sa.gov.au/__data/assets/pdf_file/0020/425027/economic_impact_report_2020-21.pdf

BDO EconSearch (2024a). The Economic Contribution of Aquaculture in the South Australian State and Regional Economies, 2022/23. A report prepared for PIRSA Fisheries and Aquaculture. https://pir.sa.gov.au/__data/assets/pdf_file/0005/465476/SA_Aquaculture_Economic_Contributions_Report_2022-23.pdf

BDO EconSearch (2024b). Economic Indicators for the Commercial Fisheries of South Australia, 2022/23. A report prepared for PIRSA Fisheries and Aquaculture. https://www.bdo.com.au/en-au/insights/advisory/economics/south-australian-commercial-fisheries-and-aquaculture-reports

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-Schutz-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 by industry sector during the 2022-23 reporting period

Industry sector	Licence category	Number of licences	Licence numbers
Tuna	N/A	7	AQ00030, AQ00047, AQ00053, AQ00057, AQ00060, AQ00169, FB00079
Finfish	N/A	19	AQ00015, AQ00016, AQ00017, AQ00018, AQ00139, AQ00140, AQ00214, AQ00234, AQ00235, AQ00255, AQ00292, AQ00302, AQ00396, AQ00397, FB00078, FF00037, FF00085, FF00090, FH00003
Marine Abalone	N/A	2	AQ00290, AQ00467
Marine Algae	N/A	4	AQ00463, AQ00464, AQ00473, AQ00474
Mussels	N/A	34	AQ00067, AQ00101, AQ00108, AQ00109, AQ00141, AQ00190, AQ00192, AQ00193, AQ00209, AQ00215, AQ00470, AQ00471, FS00011, FS00012, FS00013, FS00014, FS00015, FS00016, FS00019, FS00020, FS00021, FS00022, FS00023, FS00029, FS00038, FS00042, FS00071, FS00072, FS00073, FS00082, FS00084, FS00095, FS00097, FS00102
Landbased	Category A	19	AQ00132, AQ00211, AQ00260, AQ00305, AQ00462, FT00014, FT00133, FT00166, FT00323, FT00372, FT00487, FT00493, FT00502, FT00505, FT00523, FT00545, FT00685, FT00701, FT00738
	Category B	23	AQ00246, AQ00270, AQ00280, AQ00361, AQ00364, AQ00408, AQ00429, AQ00482, AQ00483, FT00007, FT00013, FT00069, FT00185, FT00365, FT00459, FT00464, FT00604, FT00607, FT00611, FT00633, FT00687, FT00735, FT00745
	Category C	9	AQ00131, AQ00353, AQ00409, FT00036, FT00040, FT00135, FT00158, FT00676, FT00736
	Category D	7	AQ00485, FT00423, FT00558, FT00560, FT00620, FT00634, FT00702
Tourism	N/A	1	AQ00315
Miscellaneous	Maintenance	6	FH00001, AQ00114, AQ00116, AQ00118, AQ00120, AQ00271
Oysters	Subtidal	20	AQ00034, AQ00035, AQ00036, AQ00042, AQ00043, AQ00103, AQ00104, AQ00198, AQ00322, AQ00323, AQ00324, AQ00393, AQ00392, AQ00068, AQ00465, AQ00466, AQ00041, FS00085, FS00079, FS00080
	Intertidal	324	AQ00001, AQ00002, AQ00005, AQ00009, AQ00012, AQ00039, AQ00071, AQ00091, AQ00094, AQ00099, AQ00100, AQ00102, AQ00105, AQ00106, AQ00107, AQ00127, AQ00133, AQ00137, AQ00145, AQ00146, AQ00147, AQ00148, AQ00149, AQ00150, AQ00152, AQ00153, AQ00155, AQ00156, AQ00157, AQ00158, AQ00159, AQ00160, AQ00161, AQ00162, AQ00163, AQ00164, AQ00165, AQ00167, AQ00168, AQ00172, AQ00173, AQ00175, AQ00176, AQ00177, AQ00178, AQ00180, AQ00183, AQ00186, AQ00188, AQ00197, AQ00199, AQ00220, AQ00221, AQ00222, AQ00223, AQ00243, AQ00244, AQ00256, AQ00257, AQ00263, AQ00277, AQ00278, AQ00282, AQ00284, AQ00295, AQ00297, AQ00312, AQ00313, AQ00317, AQ00329, AQ00335, AQ00350, AQ00351, AQ00366, AQ00367, AQ00368, AQ00369, AQ00378, AQ00380, AQ00381, AQ00383, AQ00386, AQ00387, AQ00388, AQ00389, AQ00390, AQ00391, AQ00399, AQ00400, AQ00401, AQ00402, AQ00403, AQ00405, AQ00410, AQ00411, AQ00412, AQ00413, AQ00416, AQ00417, AQ00418, AQ00419, AQ00421, AQ00422, AQ00423, AQ00424, AQ00425, AQ00426, AQ00427, AQ00428, AQ00430, AQ00431, AQ00432, AQ00433, AQ00435, AQ00436, AQ00437, AQ00438, AQ00439, AQ00440, AQ00441, AQ00442, AQ00443, AQ00448, AQ00449, AQ00450, AQ00451, AQ00452, AQ00455, AQ00456, AQ00457, AQ00458, AQ00459, AQ00460, AQ00468, AQ00469, AQ00475, AQ00476, AQ00477, AQ00478, AQ00479, AQ00480, AQ00481, AQ00487, FH00002, FM00015, FM00017, FM00018, FM00019, FM00023, FM00024, FM00025, FM00027, FM00028, FM00031, FM00032, FM00033, FM00034, FM00035, FM00036, FM00038, FM00039, FM00040, FM00044, FM00046, FM00047, FM00060, FM00062, FM00064, FM00065, FM00068, FM00069, FM00072, FM00075, FM00076, FM00082, FM00088, FM00094, FM00095, FM00099, FM00101, FM00117, FM00139, FM00140, FM00144, FM00145, FM00146, FM00149, FM00151, FM00153, FM00154, FM00155, FM00156, FM00160, FM00162, FM00163, FM00165, FM00166, FM00167, FM00170, FM00171, FM00173, FM00177, FM00178, FM00212, FM00217, FM00221, FM00307, FM00309, FM00315, FM00316, FM00324, FM00325, FM00326, FM00328, FM00330, FM00331, FM00332, FM00335, FM00336, FM00347, FM00348, FM00349, FM00351, FM00352, FM00353, FM00355, FM00358, FM00366, FM00373, FM00374, FM00375, FM00376, FM00377, FM00380, FM00382, FM00384, FM00385, FM00387, FM00389, FM00391, FM00392, FM00393, FM00400, FM00401, FM00402, FM00403, FM00404, FM00405, FM00406, FM00407, FM00410, FM00416, FM00417, FM00420, FM00422, FM00423, FM00424, FM00425, FM00426, FM00427, FM00428, FM00432, FM00434, FM00436, FM00437, FM00439, FM00440, FM00441, FM00443, FM00450, FM00451, FM00452, FM00453, FM00454, FM00455, FM00456, FM00457, FM00458, FM00459, FM00461, FM00462, FM00463, FM00464, FM00465, FM00466, FM00467, FM00468, FM00471, FM00474, FM00476, FM00477, FM00478, FM00479, FM00480, FM00482, FM00484, FM00485, FM00498, FM00500, FM00504, FM00510, FM00514, FM00515, FM00517, FM00518, FM00519, FM00520, FM00521, FM00524, FM00525, FM00531, FM00532, FM00539, FM00542, FM00543, FM00544, FM00546, FM00547, FM00550, FM00552, FM00553, FM00554, FM00555, FM00556
Razorfish	N/A	1	AQ00453

Appendix 2 - Aquaculture zone policy areas (zones and sectors) and percent tenure allocation as at December 2024

Policy	Zone	Sector	Total area (ha)	Leasable (ha)	Percent allocated	Permitted species or class of aquaculture
Aquaculture (Zones – Cape D'Estrees) Policy 2006	Cape D'Estrees (inner) subtidal aquaculture zone	NA	145	60	0	Molluscs (other than filter feeding molluscs) and algae
	Cape D'Estrees (middle) subtidal aquaculture zone	NA	198	60	0	Molluscs (other than filter feeding molluscs) and algae
	Cape D'Estrees (outer) subtidal aquaculture zone	NA	392	60	6.7	Molluscs (other than filter feeding molluscs) and algae
	Laura Bay aquaculture exclusion zone	NA	534	Nil	NA	NA
Aquaculture (Zones – Smoky Bay) Policy 2007	Eyre Island intertidal aquaculture zone	NA	81	21	99.19	Bivalve Molluscs (other than mussels) and research
	Missiessey intertidal aquaculture zone	NA	108	24	95.83	Bivalve Molluscs (other than mussels) and research
	Saddle Peak intertidal aquaculture zone	NA	62	21	95.24	Bivalve Molluscs (other than mussels) and research
	Smoky Bay aquaculture emergency zone	NA	171	Undefined	0	Bivalve Molluscs (other than mussels)
	Smoky Bay (holding) intertidal aquaculture zone	NA	4	0.35	100	Holding Bivalve Molluscs (other than mussels)
	Smoky Bay intertidal aquaculture zone	NA	73	20.9	95.22	Bivalve Molluscs (other than mussels) and research
	Smoky Bay north subtidal aquaculture zone	NA	2 166	40	0	Bivalve Molluscs (other than mussels)
	Smoky Bay south subtidal aquaculture zone	NA	1 621	40	100	Bivalve Molluscs (other than mussels)
	Vinya intertidal aquaculture zone	NA	180	62	98.39	Bivalve Molluscs (other than mussels) and research
	Eyre Island aquaculture exclusion zone	NA	9 784	Nil	NA	NA
Aquaculture (Zones – Streaky Bay) Policy 2011	Blanche Port aquaculture zone	NA	2 799	77.5	51.6	Bivalve molluscs (other than mussels)
	Haslam (north bank) aquaculture zone	NA	342	50	95.1	Bivalve molluscs (other than mussels)
	Perlubie (south bank) aquaculture zone	NA	224	40	60	Bivalve molluscs (other than mussels)
	Point Gibson aquaculture zone	NA	265	70	99.7	Bivalve molluscs (other than mussels)
	Streaky Bay aquaculture zone	NA	45 334	40	0	Bivalve molluscs (other than mussels) and Abalone
	Streaky Bay aquaculture exclusion zone	NA	3 748	Nil	NA	NA
Aquaculture (Zones – Anxious Bay) Policy 2007	Anxious Bay aquaculture zone	NA	452	120	100	Molluscs (other than mussels or oysters) and algae
	Anxious Bay aquaculture exclusion zone	NA	8 634	Nil	NA	NA
Aquaculture (Zones – Coffin Bay) Policy 2008	Frenchman Bluff aquaculture zone	NA	388	90	0	Supplementary fed organisms (other than finfish) that involves regular feeding, algae and research
	Kellidie Bay aquaculture zone	NA	732	23	99.2	Bivalve molluscs (other than mussels), storage and research
	Mount Dutton Bay aquaculture zone	NA	601	32	100	Bivalve molluscs (other than mussels) and research
	Point Longnose aquaculture zone	NA	379	63	96.83	Bivalve molluscs (other than mussels), algae and research
	Port Douglas (central) aquaculture zone	NA	446	50	100	Bivalve molluscs (other than mussels) and research
	Port Douglas (east) aquaculture zone	NA	34	4	100	Bivalve molluscs (other than mussels) and research
	Port Douglas (west) aquaculture zone	NA	90	10	100	Bivalve molluscs (other than mussels) and research
	Coffin Bay aquaculture exclusion zone	NA	15 686	Nil	NA	NA
Aquaculture (Zones - Lower Eyre Peninsula) Policy 2023	All aquaculture zones	NA	NA	105	48.57	Unstocked farming structures
	Boston Bay aquaculture zone	Bicker Isles sector	243	80	75	All aquatic organisms (excluding prescribed wild caught tuna)

Policy	Zone	Sector	Total area (ha)	Leasable (ha)	Percent allocated	Permitted species or class of aquaculture
		Boston Bay sector	2 755	273	100	All aquatic organisms, prescribed wild caught tuna (research, education, tourism only)
		Boston Bay (outer)	15 316	2 000	0	All aquatic organisms (excluding prescribed wild caught tuna)
	Lincoln aquaculture zone	Lincoln (inner)	17 883	2 100	72.49	Prescribed wild-caught tuna and algae * The Lincoln (inner south) sector is not active and can only be activated at a future time if deemed appropriate by Gazette notice
		Lincoln (outer)	20 061	3 500	0	
		Lincoln (inner south)*	2 540	375	NA	
	Louth Bay aquaculture zone	NA	7 465	530	20.6	All aquatic organisms (excluding prescribed wild caught tuna)
	Murray Point aquaculture zone	NA	72	4	50	Bivalve molluscs (excluding mussels) and algae
	Proper Bay aquaculture zone	Proper Bay (east)	970	89.3	98.8	Bivalve molluscs and algae
		Proper Bay (west)	1 378	40	0	
	Tod River aquaculture zone	NA	743	38	21.1	Bivalve molluscs (excluding mussels; biosecurity prescribed criteria applies)
	Point Boston aquaculture zone	Point Boston (north)	1 415	141	74.5	All aquatic organisms (excluding prescribed wild caught tuna and finfish)
		Point Boston (south)	1 512	100	20	
	Lincoln aquaculture exclusion zone	NA	29 557	Nil	NA	NA
	Sir Joseph Banks aquaculture exclusion zone	NA	52 487	Nil	NA	NA
	Buffalo Reef aquaculture exclusion zone	NA	1 038	Nil	NA	NA
	Dangerous Reef aquaculture exclusion zone	NA	7 801	Nil	NA	NA
Aquaculture (Zones - Tumby Bay) Policy 2015	Tumby Bay aquaculture zone	NA	10 324	1 300	0	Supplementary fed organisms (other than wild-caught tuna), bivalve molluscs (i.e. mussels), algae and research
	Tumby Bay aquaculture exclusion zone	NA	13 765	Nil	NA	NA
Aquaculture (Zones - Port Neill) Policy 2008	Port Neill aquaculture zone	NA	4 913	565	0	Prescribed wild-caught tuna broodstock, supplementary fed organisms (other than wild-caught tuna), bivalve molluscs, research and algae
	Port Neill aquaculture exclusion zone	NA	7 227	Nil	NA	NA
Aquaculture (Zones - Arno Bay) Policy 2011	Arno Bay aquaculture zone	Arno Bay (outer)	2 209	80	0	Prescribed wild-caught tuna broodstock and supplementary fed organisms (other than wild-caught tuna)
		Arno Bay (inner)	3 494	200	100	Supplementary fed organisms (other than wild-caught tuna)
Aquaculture (Zones – Fitzgerald Bay) Policy 2008	Fitzgerald Bay aquaculture zone	Eastern Fitzgerald	2 849	550	33.25	Supplementary fed organisms (other than wild-caught tuna), bivalve molluscs and algae
		Western Fitzgerald	1 705		100	
	Fitzgerald Bay (north) aquaculture zone	NA	10	10	0	Bivalve molluscs and algae
	Fitzgerald Bay aquaculture exclusion zone	NA	2 148	Nil	NA	NA
Aquaculture (Zones – Eastern Spencer Gulf) Amendment Policy 2017	Hardwicke Bay (inner) subtidal aquaculture zone	NA	420	60	0	Molluscs and algae
	Hardwicke Bay (middle) subtidal aquaculture zone	NA	1 053	60	0	Molluscs and algae
	Hardwicke Bay (outer) subtidal aquaculture zone	NA	1 402	60	0	Molluscs and algae
	Port Broughton intertidal aquaculture zone	NA	356	65	0	Bivalve molluscs and algae
	Tickera intertidal aquaculture zone	NA	512	45	0	Bivalve molluscs and algae
	Tickera subtidal aquaculture zone	NA	2 398	60	0	Bivalve molluscs and algae

Policy	Zone	Sector	Total area (ha)	Leasable (ha)	Percent allocated	Permitted species or class of aquaculture
	Wallaroo (East) aquaculture zone	NA	1 394	350	50	Supplementary fed organisms (other than tuna) that involves regular feeding, algae, filter feeding bivalve molluscs and algae
	Wallaroo (West) aquaculture zone	NA	500	50	0	Bivalve molluscs and algae
	Point Pearce (East) intertidal aquaculture zone	NA	135	20	100	Bivalve molluscs and algae
	Point Pearce (West) intertidal aquaculture zone	NA	365	40	100	Supplementary fed organisms (other than finfish and abalone) that involves regular feeding, filter feeding bivalve molluscs and algae
	Point Riley aquaculture exclusion zone	NA	9 639	Nil	NA	NA
	Port Broughton aquaculture exclusion zone	NA	4 384	Nil	NA	NA
	Port Hughes aquaculture exclusion zone	NA	3 407	Nil	NA	NA
	Wallaroo aquaculture exclusion zone	NA	10 889	Nil	NA	NA
Aquaculture (Zones – Lacepede Bay) Policy 2012	Cape Jaffa aquaculture zone	NA	1 316	40	0	Supplementary fed organisms (other than wild-caught tuna and abalone)
	Kingston aquaculture zone	Kingston (holding)	416	5	0	Supplementary fed organisms (other than wild-caught tuna and abalone)
		Kingston (inner)	25 560	80	0	Supplementary fed organisms (other than wild-caught tuna and abalone)
		Kingston (outer)	14 899	200	0	Supplementary fed organisms (other than wild-caught tuna and abalone)
	Kingston aquaculture exclusion zone	NA	4 712	Nil	NA	NA

Government of South Australia

Department of Primary Industries and Regions