UNIVERSITY of TASMANIA



Institute for Marine and Antarctic Studies

SUSTAINABLE MARINE RESEARCH COLLABORATION AGREEMENT ACTIVITY REPORT

2021 & 2022

UNIVERSITY of TASMANIA \_\_\_\_\_



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#### SMRCA ACTIVITY REPORT 2021 & 2022

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#### **INTRODUCTION FROM THE CHAIR**

Surrounded by ocean, people living in Tasmania have always had a strong connection with the marine resources in the sea country of our island state. Aboriginal, commercial and recreational fisheries, wild harvest and aquaculture all play a part in responsible use of Tasmania's marine resources. The Sustainable Marine Research Collaboration Agreement (SMRCA) aims to maximise these benefits over the long term.

The SMRCA is a partnership between the University of Tasmania and the Tasmanian Government, first established as the Tasmanian Aquaculture and Fisheries Institute (TAFI) in 1998. It was renewed in 2010 and again in 2023 for a further ten years. The SMRCA provides independent expert advice on the status of Tasmania's marine resources and their management, based on collaborative research with government, industry, and the community. This work informs Government decisions that impact on our wild fisheries and aquaculture industries. The joint SMRCA partnership provides a diverse stream of benefits to the University of Tasmania and the Tasmanian Government. The Government benefits from the intellectual expert contributions of university staff and student contributions to research. This highquality research has put the University at the top of Excellence in Research for Australia (ERA) for fisheries science and within the top 10 globally\* for fisheries, marine and freshwater biology, and oceanography. The Tasmanian government and broader community receive the benefit of cutting-edge research and education services. These benefits, in turn, contribute to improved national and global understanding of our ocean planet.

I would like to acknowledge the SMRCA for its excellent work in 2021 and 2022 and I look forward to seeing its continued success during the next decade.

#### **DEIDRE WILSON**

SMRCA Chair Deputy Secretary, Primary Industries and Water Department of Natural Resources and Environment Tasmania

\*The Centre for World University Rankings (CWUR) 2017

As a reflection of this institution's recognition of the deep history and culture of this island, the University of Tasmania wishes to acknowledge the *muwinina* and *palawa* peoples, the traditional owners and custodians of the land upon which this campus was built, and to pay respect to elders past, present and emerging.



Indigenous Tasmanian commercial abalone diver Bryan Denny preparing for a dive off his Shark Cat the kelati nuyina, meaning deep water spirit in palawa kani (Photo: Bryan Denny)

SMRCA ACTIVITY REPORT 2021 & 2022

OUR

## PURPOSE

#### **OUR PURPOSE**

The Sustainable Marine Research Collaboration Agreement (SMRCA) is a partnership between the Tasmanian State Government and the University of Tasmania through the Institute for Marine and Antarctic Studies (IMAS).

The SMRCA supports the effective and sustainable management of Tasmanian marine resources, to ensure the maximum benefit to Tasmania's environment, economy, and industries. Established in 1998, it was integral to the formation of the Tasmanian Aquaculture and Fisheries Institute (TAFI) joint venture between the State Government and the University of Tasmania.

IMAS has continued to provide research that supports sustainable growth of Tasmanian marine resources including through tracking the status of fish stocks, analyses on how to improve management, plus strategic projects to improve production. Today, our research recognises the different uses of marine resources, including by Tasmanian Aboriginal communities, and recreational and commercial use. Our activities focus on improving performance and yield, understanding population biology, and improving production methods and increasing efficiency. We also provide science-based advice on efficient management, regulation and governance.

Our researchers have wide-ranging expertise and work in multi-disciplinary teams across biology, ecology, sociology and economics, as we aim to maximise the long term benefits from marine resources to the Tasmanian community.

More information is available in the Sustainable Marine Research Collaboration Strategic Plan 2022-2026 – download here: bit.ly/SMRCA-Strategic-Plan Through the SMRCA partnership, IMAS is:

- undertaking leading, world-class research into temperate marine and coastal environments
- providing fisheries, aquaculture, estuarine and coastal environmental research and development services to the Crown, the University, and the fishing and aquaculture sectors
- building the capacity of people working in temperate marine research, including postgraduate students
- engaging with industry, encouraging partnerships, connections and integrated arrangements that will assist in achieving the aims of the agreement
- supporting the Crown's legislative and administrative obligations through research, data and advice
- promoting Tasmania's natural marine resources by encouraging and contributing to the development of new industries that are sustainable, now and into the future.

#### **REVIEWING 2021 AND 2022**



Under the SMRCA program, we bring together a diverse and dedicated team to deliver our vision for excellence in

fisheries and aquaculture research and education. In this report, we showcase some of our SMRCA teams' achievements in 2021 and 2022.

Our focus has always been on delivering research that makes a difference. We work to be relevant and reliable so that our research outcomes are extended into management decisions, helping promote sustainable industry and community interactions with our marine and coastal environments.

This includes developing innovative aquaculture production, investigating the environmental interactions of aquaculture, and delivering wild fisheries assessments, major national surveys,

fisheries modelling and mapping, and fish health and seafood safety research. We also investigate the human dimensions of the recreational and commercial fishing sectors.

The SMRCA is committed to providing the community with credible and balanced information about our marine resources. We communicate our science through mainstream, electronic and social media, and through stakeholder and public engagement such as exhibitions, events, student outreach programs, presentations, panel discussions, and more.

During 2021 and 2022, we have all lived and worked through the ongoing challenges caused by the COVID-19 pandemic. At IMAS, we made important changes to the way we operate to keep our research progressing, and to keep our people safe and healthy.

**PROFESSOR CALEB GARDNER Director, SMRCA** 



invested into SMRCA activities in 2021 and 2022 from NRE Tasmania, IMAS/UTAS and external funding bodies, making us one of Australia's largest and most successful fisheries and aquaculture programs

70

380

collective research days our

papers and reports

published 2021 and 2022

scientists spent on the water for core SMRCA fieldwork between July 2021 and June 2022

PhD Candidate research outputs relevant to the management and development of marine ecosystems and industries in 2021 and 2022, helping them build valuable skills in marine resource research

IMAS PhD candidates completed their theses in fisheries and aquaculture during 2021 and 2022

#### SMRCA ACTIVITY REPORT 2021 & 2022



SMRCA ACTIVITY REPORT 2021 & 2022

# PROGRAMS

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#### **OUR PROGRAMS**

Our fisheries and aquaculture research is conducted under five programs:

- Aquaculture Environment
- Environmental Interactions
- Wild Fisheries
- Fish Health, Biosecurity and Seafood Safety
- Human Dimensions and Modelling

Our research is supported by our state-of-the-art laboratory, aquaculture and boat and dive facilities.



Bringing together biology and technology for increasing the production of aquaculture species, including Atlantic salmon, rock lobster, oysters and seaweed

> Program leader: • Greg Smith

Teams: Molluscan Aquaculture

Lobster Aquaculture

Salmon Aquaculture



Research to understand and manage the interactions of aquaculture and other human activities with our coastal ecosystems

> Program leader: • Jeff Ross

Team: • Aquaculture Environment

#### SMRCA ACTIVITY REPORT 2021 & 2022



Sustainably increasing production and value to the community from recreational, traditional and commercial fisheries

> Program leader: • Sean Tracey

Teams: Recreational Fisheries Scalefish and Cephalapod Fisheries Dive Fisheries Crustacean Fisheries

Bivalve Fisheries

FISH HEALTH, BIOSECURITY AND SEAFOOD SAFETY

Research to protect the health of seafood consumers and aquatic organisms, including issues of toxic marine algae, biosecurity of farmed seafood, and disease

> Program leader: Alison Turnbull

Team: Fish Health, Biosecurity and Seafood Safety HUMAN DIMENSIONS AND MODELLING

Modelling, economic, governance and sociological approaches to optimise benefits to the community from fisheries and aquaculture

> Program leader: • Klaas Hartmann

Teams:

Human Dimensions
Modelling and Mapping

## AQUACULTURE PRODUCTION

Bringing together biology and technology for increasing the production of aquaculture species including Atlantic salmon, oysters, abalone and seaweed.

PROGRAM LEADER:

- Greg Smith
- RESEARCH TEAM LEADERS: MOLLUSCAN AQUACULTURE: Andrew Trotter LOBSTER AQUACULTURE: Greg Smith SALMON AQUACULTURE: Gianluca Amoroso

#### **OVERVIEW**

Our aquaculture production research brings together biology and innovative technology to improve profitability of production of Atlantic salmon, rock lobster, oysters, abalone and seaweed.

IMAS has developed a global reputation for advances in rock lobster aquaculture over the last 20 years. That research is not reported here because it occurs without SMRCA investment although other significant research on aquaculture industries in Tasmania is underway and detailed on the following pages.



#### **RESEARCH HIGHLIGHTS**

#### **Molluscan Aquaculture**

#### O Outcome focused research: working with our key oyster industry partners

In recent years research has centred around our key collaboration with Australian Seafood Industries (ASI), particularly in breeding stocks resistant to Pacific Oyster Mortality Syndrome (POMS). This critical research has been widely regarded for greatly reducing the impact POMS in Tasmania. During 2021-22 we again partnered with ASI on two FRDC research projects worth nearly \$1.5 million in total. First to tackle the remaining issue of POMS in young spat - with two approaches, selective breeding and immune priming. Broodstock from this work are now available to commercial hatcheries and we have significant interest from industry in the commercial application of immune priming in spat based on this study. Our second project is a first step towards transiting the breeding program to a genomics platform and aims to demonstrate an economic cost benefit, evaluate genotyping tools, methodology development, proof of concept for using artificial intelligence (AI) phenotyping meat condition for genomic selective breeding of Pacific Oysters. This is a highly collaborative project with long-term partners ASI and CSIRO, and with new collaborations with the Center for Aquaculture Technologies and Utas ICT. This work enable clear understanding of the

worth and pathways forward for genomic selective breeding of Pacific Oysters in Australia, hopefully leading to only the second genomics based breeding program for edible oysters globally.

#### Consolidating our commitment to Pacific Oyster farming: fostering collaboration and supporting research students

The SMRCA has long supported the Pacific Oyster research, particularly through the Pacific Oyster Breeding Program, and in 2022 the Committee approved a new project 'Shellfish Farming/Breeding' to continue this commitment.

This core project provides the industry confidence to invest further into the Breeding Program during its transition to a genomic platform. Additionally, this support has provided opportunities to build further expertise, collaborations and support student projects.

We are now working with international, national and local collaborators including lfremer, the Cawthron Institute New Zealand, the Center for Aquaculture Technologies, Blue Economy CRC, ANSTO, CSIRO, ASI, and DNRET Animal Health Laboratory, as well as working closely with the SMRCA Fish Health, Biosecurity and Seafood Safety team. This network provides a perfect environment for our research



IMAS and ASI worked together to selectively breed Pacific oysters for disease resistance to POMS

students, and for them to work directly with industry. Other Pacific Oyster research:

 Ernest Chuku (PhD candidate) joined us from University of Cape Coast, Ghana, following his Masters research on West African mangrove oysters. Ernest's PhD on shell development in Pacific Oysters has seeded a new collaboration with ANSTO and is funded by ASI, ANSTO and AINSE (scholarship). His project is also very closely aligned with industry. To better understand the importance of shell traits in oyster farming Ernest has interviewed 34 key stakeholders across hatcheries, farms, wholesalers and retailers with a total of 641 years of industry experience! His current fieldbased research comparing shell traits between estuaries is being hosted by the Tasmanian Oyster Co and Little Swanport Oysters, and he will be working with Blue Lagoon Oysters shortly to investigate the importance of growing height and handling on shell development.

Alex Pointon (Honours, Utas Engineering), supported by a TASRAC Scholarship and supervised by Dr Dean Giosio (Utas Engineering) and Dr Andrew Trotter (IMAS), developed a complete vision-based Al tool to measure oyster size and shape metrics. By training a custom Mask R-CNN instance segmentation algorithm, Alex was able to achieve object detection precision of 99.8% at eight times the speed of a human. This capacity to rapidly extract geometric data has received keen interest from industry, and we are now working with them to commercialise this technology.

#### **Salmon Aquaculture**

#### O Innovative science for a sustainable salmon aquaculture industry

Australian aquaculture continues to be dominated by salmonid production, so this industry remains a focus for our aquaculture research at IMAS – both directly with industry through traditional funding agencies, and through the new Blue Economy CRC.

Our salmon research has a strong focus on improving fish performance and welfare by looking into critical aspects like nutrition and health and links to physiology and molecular research. While salmon is produced globally, our research has benefits for aquaculture in Tasmanian environmental conditions, which tend to be warmer. Warmer seawater temperatures affect, for instance, how fish metabolise food.

Therefore, tailored diets are needed for the best growth with minimal waste. Furthermore, we are currently broadening our research capability to identify and address critical knowledge gaps in offshore and high-energy aquaculture to support the industry expansion to offshore sites. Our research is also used by industry for managing fish health and welfare, biosecurity, and more.





Atlantic Salmon

#### O Collaborating locally and around the world

Our research capacity in salmon aquaculture is enhanced through collaborative partnerships including with salmon growers Huon Aquaculture, Tassal, and Petuna, and the feed producers Skretting Australia, BioMar Australia, and Ridley Aquafeeds. More recently, we have started collaborative projects with the Tasmanian salmon industry's selective breeding program (SALTAS) to further understand Tasmanian stock genetic and phenotypic responses to local conditions, and to simulate harsher conditions, to address current and future effects of climate change.

Cross-sector collaboration is also vital to our research success. We work locally with the Tasmanian Institute for Agriculture and the Australian Maritime College through the Blue Economy CRC and with CSIRO, and many others. Some of our international collaborations include Skretting Norway, BioMar UK, DSM Nutritional Products and AQUI-S New Zealand, the Cawthron Institute New Zealand, New Zealand King Salmon, the University of Stirling UK, the University of California in San Diego, the University of Copenhagen in Denmark, the Norwegian Veterinary Institute.

#### O Better nutrition for reproduction performance and product quality

Recent research into the effect of temperature on salmon physiology has presented significant opportunities for modifying nutrition to improve reproduction performance and product quality.

Our nutrition studies encompass all freshwater stages, through smolt and to marine grow-out, and provide a unique opportunity to track performance across all life stages. Similarly, gill health studies are now conducted across all life stages, focusing on the long-term effect of gill health on fish performance.

#### O Informing feed design for specific conditions

We have helped develop feeds that are tailored to specific parts of the production process and had great success in the design of summer salmon feeds, following the development of the first experimental model to study Atlantic salmon's dietary carotenoid utilisation at high temperature in post-smolt and harvest size salmon. Ongoing research into the interactions between temperature, broodstock nutrition and condition, and larval success are informing improved management and maturation practices. Meanwhile, studies into optimising dietary phosphorus inclusion in early hatchery stages have redefined the use of dietary phosphorus for production efficiency and reducing skeletal anomaly in triploid salmon and have enabled us to improve the design of feeds for these salmon under Tasmanian conditions. Better feeds are not only good for improving growth rate and supporting the health of fish, but they also reduce fish excretion and waste which contributes to increasing the sustainability of the farming practices and the final product.

#### O Experimental Aquaculture Facility: building a future-ready industry together

Located at IMAS Taroona, the Experimental Aquaculture Facility (EAF) is the first of its kind in the Southern Hemisphere.

The EAF delivers targeted and commercially-relevant research that is essential for ensuring the economic and environmental sustainability of these important industries – for Tasmania, Australia, and the world.

Opened in October 2015, the EAF is a partnership between Huon Aquaculture, Skretting, IMAS, and the Tasmanian and Australian Governments. This dedicated facility has significant tank capacity, where environmental characteristics like temperature and dissolved oxygen can be controlled, and nutrition and other research can be done on large Atlantic salmon up to market size.

For salmonids, this capability accelerates economic, environmental, and animal welfare benefits by:

- enhancing research into performance, nutrition and aquafeeds
- reducing fish losses due to elevated seawater temperatures, and
- maintaining fish size and performance during those challenging periods
- enhancing research into animal health and welfare and in particular Amoebic Gill Disease management
- enhancing the sustainability of salmonid farming practices

#### O New scholarship honours Tasmanian aquaculture researcher

A new University of Tasmania PhD scholarship honouring Tasmanian aquaculture biologist Dr Harry King (pictured), who lost his battle with prostate cancer in 2019, will guide the next generation of aquaculture researchers.

The University and CSIRO are funding up to four PhD positions across five years as part of the Harry King Scholarship. This scholarship provides the opportunity for some of our brightest minds to begin their own careers in aquaculture and continue Dr King's work, bringing scientific solutions to life by working with leading researchers and industry.

It will bring together local industry and research organisations to achieve long lasting changes in salmon aquaculture, continuing Dr King's legacy of world-leading applied science, to advance our fundamental knowledge about salmon and contribute to sustainable aquaculture.

The scholarship aims to attract scientists who will seek every opportunity to develop their understanding of salmon aquaculture and ultimately follow in Dr King's footsteps.

They will be awarded in the field of aquaculture research, with an emphasis on genetics, physiology and production system science.



Tasmanian aquaculture biologist Dr Harry King

Each of the PhD positions will provide students with joint supervision between IMAS at the University of Tasmania and CSIRO Agriculture and Food. Students will also receive industry mentoring and a work placement with an industry partner. 15

## ENVIRONMENTAL INTERACTIONS

Research to understand and manage the interactions of aquaculture and other human activities with our coastal ecosystems.

PROGRAM LEADER:

Jeff Ross

RESEARCH TEAM LEADER: AQUACULTURE ENVIRONMENTAL: Camille White

#### OVERVIEW

The SMRCA has a large investment in research to understand and manage the interactions of aquaculture and other human activities with our coastal ecosystems.

Ensuring that the monitoring of the environment is based on scientifically robust methodology and measures of performance is pivotal to minimising the environmental effects of activities such as aquaculture.

Delivering the science to support the monitoring and management of salmon farming continues to be a major focus of the program.

Our research delivers the scientific knowledge to support a sustainable and productive future for Tasmania's aquaculture industry. We are delivering against three ongoing projects:

- Identifying and addressing research needs for developing and emerging industries
- Delivering the science to support planning for new and emerging aquaculture operations in Tasmania.
- Supporting the monitoring and ongoing
   management of salmonid farming operations
   in Tasmania, to ensure adequate monitoring
   practices and to recommend improvements.

We continue to lead and collaborate on other important research projects on the environmental interactions of salmon farming and other aquaculture sectors through key funding partners, including the Australian Government FRDC and CRC programs. These projects include:

- Assessing the environmental performance of aquaculture development in Storm Bay through the development and implementation of an observing system
- Assessing the ecosystem interactions of salmon farming in differing environments, to ensure that monitoring and assessment remain fit for purpose.
- Understanding oxygen dynamics and the importance for benthic recovery in Macquarie Harbour
- Addressing the challenges of offshore food and energy production, as part of the Blue Economy CRC
- Developing a sustainable, integrated multitrophic aquaculture model to support commercial seaweed production and deliver economic, environmental and community benefits, as part of the Seaweed Solutions for Sustainable Aquaculture CRC.

#### **RESEARCH HIGHLIGHTS**

Our Environmental Interactions team had an incredibly successful and rewarding period over the last two years. Some of our highlights include developing and conducting a trial of a spatial assessment decision support tool, playing a lead role in delivering the science on aquaculture expansion in Storm Bay, and monitoring of environmental conditions in Macquarie Harbour.



#### Exploring growth opportunities for salmon aquaculture in Tasmania

New research that identifies growth opportunities for salmon aquaculture in Tasmania has found that suitable locations for potential industry expansion would be in offshore waters along our south east and north coasts.

Researchers have finalised the Statewide Salmon Aquaculture Spatial Planning Exercise, which is a collaboration between IMAS, the University of Tasmania and the Department of Natural Resources and Environment Tasmania (NRE Tas).

The report serves as a spatial planning decisionsupport tool to help government better understand potential growth opportunities of salmon aquaculture in Tasmanian waters.

The project involved a biophysical suitability assessment of State waters across Tasmania, generally extending to three nautical miles offshore, and a social, economic and environmental evaluation in key areas to evaluate their viability to host salmon aquaculture operations.

When considering biophysical suitability alongside other marine uses and ecological values, the report found most opportunities for salmon aquaculture generally reside in deeper offshore waters off Tasmania's coast.

This is because the biophysical suitability for salmon aquaculture was high in offshore environments, pending available infrastructure and cost-effective operations, and fewer conflicts with other marine users and ecological values were identified in these areas.

## Assessing reef health in the southern D'Entrecasteaux Channel

An increase in human activity in the southern D'Entrecasteaux Channel has triggered an investigation about how the related sustained lowlevel organic enrichment will affect the health and function of the region's rocky reef ecosystems.

Temperate reef ecosystems in south-eastern Tasmania have intrinsic natural biodiversity and conservation value. They are also important for tourism and recreation, and fisheries harvests such as abalone, rock lobster and scalefish.

To better understand the functional health of reefs in the lower Channel, IMAS researchers have established a baseline in this region against which future monitoring data can be measured. The ability to identify when temperate reefs are under stress is a significant challenge for managing these ecosystems. Our IMAS team has been developing and trialling methods to detect when reef ecosystems are changing due to organic enrichment, with a focus on regions where salmon farming is expanding.

We used a Rapid Visual Assessment (RVA) method and Abalone Recruitment Modules (ARMs), which both give important, but very different insights into aspects of reef function. The RVA method suits a more integrated assessment of reef health, while monitoring the recruitment of a commercially important species using ARMs addresses an industry focus.

Choosing the method to use in any ongoing reef monitoring program will depend on the management question of interest.

From the project, researchers have established new reference sites of importance to the abalone industry, including Mouldies, Black Reef, Middle Ground and George III, as well as building a baseline to detect any future change in the southern Channel region.

Ongoing monitoring of these sites could provide greater resolution of natural variability and help to develop indicator thresholds for a loss of ecosystem function.

#### Assessing the health of Port Arthur's rocky reef ecosystems

Researchers have assessed the condition of inshore rocky reef ecosystems at Port Arthur in Tasmania to understand potential nutrient enrichment from the salmon farm at the southern end of Long Bay.

IMAS scientists surveyed and sampled 12 sites in the Long Bay and Port Arthur region, from 100 metres to over three kilometres from the farm. The salmon farm in Long Bay is causing increased community concern.

Our 2021 surveys showed the salmon farm had a localised impact on adjacent reef communities at 100 metres from active pens.

These impacts were mainly in the form of nuisance red and green algae, and when we analysed the seaweed tissue, we found the biochemical signature was consistent with the uptake of farm-derived nitrogen.

Researchers also found an abundance of nuisance algae on the reefs to the north of the farm in Long Bay. However, it is difficult to attribute these effects to farming alone as low energy, more sheltered sites are inherently more susceptible to nuisance algae blooms. Blooms are common in these environments and are driven by a range of natural and humaninduced factors.



IMAS diver during an RVA survey 100m from the Long Bay salmon farm

Untangling these effects is a challenge in the absence of robust baseline information and that multiple lines of evidence, and repeat surveys are now critical to better understand the nature and longevity of nuisance algae in Long Bay.

This also highlights the importance of robust baseline information for all habitats exposed to salmon farm nutrients, something that we are now seeing implemented in more recently developed farming areas such as Storm Bay.

#### Evaluating environmental monitoring in new growing environments

An IMAS research project has found that while the methods used for environmental monitoring of Tasmanian salmon aquaculture sites is largely fit for purpose, there were differences in the responses between the different growing environments. Notably, in Macquarie Harbour the response to enrichment varies due the unique environmental conditions and benthic ecology, and in Storm Bay and the southern D'Entrecasteaux Channel the impact footprint is larger – but less acute – in these higher-energy environments compared to lower-energy inshore environments.

The purpose of this five-year research project, funded by the FRDC, was to assess whether current monitoring is fit for purpose in the new growing environments.

It followed salmon aquaculture expansion into new areas since the original monitoring science was undertaken on lower energy environments in 2004. These expansion areas include Macquarie Harbour, Storm Bay, and the southern D'Entrecasteaux Channel.

This latest research indicates that while current measures of environmental impact remain sensitive and

robust, there needs to be greater consideration to the local ecology and environmental conditions during monitoring assessments. This reinforces the importance of establishing robust baseline conditions prior to farming commencing and the ongoing monitoring of, and comparison with, reference conditions.

#### Monitoring environmental conditions in Macquarie Harbour

IMAS researchers have identified changes in the dynamics of water quality parameters in Macquarie Harbour as part of a long-term monitoring project.

Researchers assessed environmental changes in the harbour based on Broadscale Environmental Monitoring Program (MHBEMP) data collected from 2011-2020, highlighting the well documented decline in oxygen levels but also discovering a 1.5-20C increase in harbour bottom waters since the early 1990s.

The project, which assessed the harbour's environmental monitoring program, made some key recommendations on environmental trigger limits. This included noting that the current water quality parameters and depths used as indicator limits do not appear to be adequate for monitoring and protecting the harbour's environmental health. The work is part of IMAS' continued leading role in providing scientific advice to government on environmental conditions in Macquarie Harbour, based on ongoing monitoring of oxygen dynamics, benthic conditions on the bottom of the waterway, and the status of the endangered Maugean skate.

Surface buoys (bottom right) house the strings of environmental sensors that provide realtime data on the conditions and health of the harbour



#### Microbial communities in Macquarie Harbour

Our work in Macquarie harbour continues to highlight the pivotal role that microbial communities are likely to be playing in the harbour's ecosystem and how it responds to aquaculture.

A new paper has found microbes, which are linked to the consumption of organic matter, nitrogen and sulphur metabolism, inhabited the harbour's bottom waters and may be major players in oxygen consumption throughout its water column.

This study provides valuable insights into microbial community ecology and will improve knowledge on how microbial distribution may be influenced by a changing environment.

#### **Communicating the environmental science on salmon farming in Tasmania**

IMAS scientists are monitoring and assessing the interactions between salmon aquaculture, the environment and society, with their research informing the management and long-term sustainability of industry.

Our marine and social scientists and researchers are seeking to better understand the relationship between salmon aquaculture, the environment and society. We want our research activities and outcomes to be accessible to all Tasmanians.

To achieve this, we've updated our Salmon Interactions Team website, which was developed to outline the interactions between salmon farming and different marine environments, as well as local communities, in Tasmania.

The update includes a new section titled 'Research Insights', which covers a range of key topics and questions about salmon aquaculture. These include:

- understanding where salmon poo goes
- the impacts to inshore reefs
- the drivers of nuisance algal blooms
- the current health of Macquarie Harbour
- understanding environmental interactions in Storm Bay



Here Are Some Insights From Our Research Into Salmon Aquaculture Ecosystem Interactions



- mapping proposed farming zones
- modelling nutrient release from salmon farming operations.

IMAS research continues to make an important contribution to the management of salmon aquaculture in Tasmania.

Our research is crucial to understanding both the environmental and social interactions of salmon farming, which helps inform government and industry regulation and management.

This helps ensure that the right balance between environmental protection, social licence and the sustainable growth of industry is met through best practice.



## WILD FISHERIES

Sustainably increasing production and value to the community from recreational, traditional and commercial fisheries.

PROGRAM LEADER:

Sean Tracey

RESEARCH TEAM LEADERS: DIVE FISHERIES: John Keane CRUSTACEAN FISHERIES: Rafael Leon BIVALVE FISHERIES: Jayson Semmens RECREATIONAL FISHERIES: Sean Tracey SCALEFISH & CEPHALOPOD FISHERIES:

Alyssa Marshell

#### **OVERVIEW**

Wild fisheries provide community mainly through direct involvement with almost 25% of Tasmanians fishing at least once a year plus the economic impact of commercial fisheries, which are mainly for export markets (ABARES, 2020).

Our research is intended to help manage fishery harvests so that fisheries are not merely sustainable but providing optimal benefits. We study fish biology, the dynamics of fish populations and fleets, interactions with management controls, and resilience to environmental changes.

Activity is managed across teams in Dive Fisheries, Crustacean Fisheries, Scalefish and Cephalopod Fisheries, Bivalve Fisheries, and Recreational Fisheries. It is important to us that this research is not only excellent but also applied and useful. We're fortunate that the close relationship between IMAS research and management of marine resources at NRE Tas means that our activities make a difference in performance of wild fisheries.



Sand Flathead (Photo: Rick Stuart-Smith)

#### **RESEARCH HIGHLIGHTS**

#### **Dive Fisheries**

The IMAS Dive Fisheries team does research on abalone, urchins and periwinkles. An special area of expertise is in development of innovative software and equipment, such as NextGen GPS loggers for urchin and abalone fishers, and electronic abalone measuring boards with integrated weight recording and remote data transfer.

IMAS researchers are investigating options to reduce the impact of the range-extending and locally invasive Longspined Sea Urchins *Centrostephanus rodgersii* off Tasmania's East Coast reefs.

The urchins overgraze on kelp and seaweeds, resulting in barren areas that impact rock lobster and abalone habitats.

IMAS research is informing a range of measures fisheries managers are implementing to address the urchin problem and restore reefs and prevent healthy ones from becoming barren. This currently includes:

#### O Urchin stock surveys

We're leading fishery-independent surveys to monitor urchin stocks and barren coverage along the east coast.

#### O Urchin roe fishery and processing industries

Urchin harvesting is now averaging around 500 tonnes per year. IMAS research is used to direct the location of this harvest to regions of most importance through a harvest subsidy.

#### O Urchin fertiliser trials

We're trialling the use of urchin shell and gut waste (95% of the animal) as a commercial agricultural fertiliser. Trials on tomato plants, sunflowers, an apple orchard and a vineyard have shown promising results.

#### O Urchin culls

Commercial divers have also undertaken broadscale urchin culling along the east coast in locations important for abalone production but where urchin harvesting is less viable.

We track progress with these initiatives through our annual assessment of the commercial urchin fishery harvest, subsidised by NRE's Abalone Industry Reinvestment Fund.



Longspined Sea Urchin barren off St Helens on Tasmania's east coast



Longspined Sea Urchin roe

#### **Crustacean Fisheries**

Crustacean Fisheries research helps keep fishers engaged and data collection streamlined for resource management. Our work improves data collection, the efficient allocation of sampling efforts, and catch sampling programs. We also develop prototypes, such as the electronic calliper for fishers to measure lobsters on board.

#### O The future of rock lobster monitoring and regulation in Tasmania

Two IMAS papers released in 2022 investigated options to monitor and regulate rock lobster catches around Tasmania, both to help improve statewide fishery health and rebuild East Coast stocks.

One study assessed alternative catch monitoring systems and ways that the recreational catch could be limited in the heavily fished East Coast region, beyond traditional daily bag limit adjustments.

The second paper considered alternate size limit zones for rock lobster in northern, eastern and southern Tasmania, to improve lobster egg production and fishery performance. It can be viewed here (appendix three).

Both papers contributed to the Department of Natural Resources and Environment Tasmania's (NRE Tas) recent management changes to the Tasmanian rock lobster fishery.

#### O Research Pot Program revamped

Around 90 commercial rock lobster fishers joined our recently refreshed Research Pot Program for the 2021-22 fishing season (ending October 2022).

The program, a collaboration with NRE Tasmania, allows commercial fishers to carry two extra pots in return for collecting detailed catch data.

Fishers record and measure all lobsters captured by these two pots and can keep all legal-size lobsters caught. This gives us a range of size data that, along with information collected during annual IMAS research trips around Tasmania, allows us to carry out rock lobster stock assessments and help inform fishery management, including the setting of a total allowable catch (TAC).

An added benefit is that the data fishers collect comes from all around Tasmania and over the entire quota year, so researchers can better understand the spatial and temporal variations of lobster size.

A program revamp for the 2021/22 season increased participation and coverage around Tasmania.





Rock lobster pot

#### O Scientists find seismic surveys impact reflexes and moulting in young rock lobsters

New research into how marine seismic surveys impact lobster larvae and juveniles has confirmed the sensitivity of marine invertebrates to aquatic noise and revealed the range threshold of exposure. It has also paved the way for more practical seismic exposure studies in the future.

Scientists collected puerulus and juvenile lobsters and exposed them to the air gun signals of a full-scale commercial array, then assessed their righting reflex and their post-exposure development.

Exposure to the seismic survey impaired the ability of the lobsters to quickly right themselves, or to flip over when placed on their back.

This test is a way to measure the ability of the lobster to coordinate its sensory system and body movements, so slower righting suggests that this ability was impaired. Juvenile lobsters exposed at a very close range were found to experience the same long-lasting damage seen in adult lobsters, but showed recovery after moulting when exposed at a more moderate distance of 500 metres.

#### O Turning the lens on giant crabs for improved fishery management

Fisheries scientists are analysing images of giant crabs for shell colour patterns, size and sex data, which will contribute to better managing harvests in this important fishery.

Giant crab is a high-value species that supports small fisheries in Tasmania, South Australia and Victoria, but all three states face ongoing difficulties in collecting detailed data on the catch.

Crab size is a critical step in stock assessment modelling but collecting data at sea is especially difficult in this fishery, because conditions are often rough and only a small number of individual crabs are captured on most days. This means it's difficult to track the status of the stock.

To address data collection difficulties in the fishery, researchers are developing a low-cost image recognition system, which will take photos of the giant crabs' carapace, or top shell, and analyse the images to determine their length and sex.



Giant Crab

Automated computer formulas will also use the photos to identify individual crabs through colour patterns on their carapace. This speckled colouration remains unaltered after shell moulting, so is potentially equivalent to a unique fingerprint.

#### Scalefish and Cephalopod Fisheries

There a wide range of species in these fisheries so over the last two years we prioritised research on Banded Morwong, Sand Flathead, Southern Calamari, and the endangered Maugean Skate.

#### O Challenges for Sand Flathead in Tasmania

IMAS researchers have for the first time classified Sand Flathead as 'depleted' in Tasmanian waters in our Tasmanian Scalefish Fishery Assessment for 2020/21.

Sand Flathead is Tasmania's most popular recreational species, with recreational fishers taking more than 98% of caught fish.

Size and bag limit changes introduced in 2015 were initially believed to be supporting stock recovery, but new analysis showed that the biomass and reproductive potential of populations in most regions has declined below critical levels.

Heavy fishing pressure on Sand Flathead across Tasmania will prevent stock recovery in most regions, specifically where stock rebuilding is most needed – including the D'Entrecasteaux Channel, Frederick Henry-Norfolk Bay, and Great Oyster Bay.



Sand Flathead (Photo: IMAS)

There are low numbers of legally-sized and sexually mature fish in south east and eastern Tasmania, where populations are subject to these heavy fishing pressures.

Sand Flathead aren't reaching the 32cm minimum size limit in many areas and, once they grow to this size, they're generally caught within a short time period and don't have the opportunity to reproduce.

Fish that reach sexual maturity before reaching the minimum size limit produce substantially fewer eggs than faster-growing fish, and their offspring tend to have a reduced chance of survival. It's also important to note that females grow larger than males, so receive

less protection from size limits. Their protection relies more on regulations that control catch, like bag limits.

To address concerns about Sand Flathead stocks, IMAS is leading a research project involving the development of a new monitoring regime and stock assessment for Sand Flathead in Tasmania. This has funding from the Australian Government through the Fisheries Research and Development Corporation.

IMAS is also leading a broader investigation profiling recreational fishers to understand what they value about the Tasmanian recreational Sand Flathead fishery. This project is funded by the Tasmanian Government.

#### O Investigating the impact of salmon escapees on Tasmanian ecosystems

A new IMAS report has found that Atlantic Salmon involved in two large escape events in south east Tasmania during late 2020 do not appear to have caused significant ecological issues, with minimal feeding on native species impacting their ability to survive in the wild.

The recent study assessed potential environmental impacts caused by the escape of up to 180,000 salmon from two Huon Aquaculture pens in the D'Entrecasteaux Channel and Storm Bay in 2020.

The study involved surveying recreational fishers and sampling escaped salmon at different times post-



escape to understand their dispersal, feeding activity, size, condition and survival rates.

Catches dropped off six weeks after the escapes, due to dispersal and declines in the number of surviving fish. However, some salmon survived for almost four months.

There was very limited feeding on native species, meaning any ecological impacts caused by salmon preying on marine life were likely to be minimal.

Based on this lack of feeding and general declines in physical condition, it was likely surviving fish exhausted energy reserves and were effectively wasting away.



Escaped Atlantic Salmon (Photo: Will Thorp)

Australian Sardine (Image: NRE Tasmania)

#### O Sardine fishery could be established in Tasmania

A new IMAS report outlines how a potential sardine fishery could be established off Tasmania through appropriate management and research procedures, and balanced consideration of ecological, economic and social objectives.

The report on options for establishing a Tasmanian sardine fishery follows on from a recent IMAS paper that showed that the adult biomass of sardine off south-eastern Australia is larger than expected and is at least 185,000 tonnes, and likely more than 250,000 tonnes. This biomass could support a valuable and sustainable fishery.

The latest report identifies how a potential new fishery could be developed and managed by considering a range of issues, including:

- Evaluation of previous developmental framework established for sardine fishing in Tasmania
- Management options and structures, including key elements of a potential harvest strategy
- Stock research and monitoring
- Interactions with protected species
- Ecosystem considerations
- Social licence to operate

#### **Bivalve Fisheries**

Our Bivalve Fisheries team studies scallops and minor fisheries species such as native oysters, clams and cockles.

#### O D'Entrecasteaux Channel scallop fishery update

IMAS researchers have found that further rebuilding of adult Commercial Scallop stocks in the D'Entrecasteaux Channel is needed before the recreational fishery can be re-opened.

The 2022 Tasmanian Recreational Scallop Fishery Assessment saw researchers use video surveys to assess signs of scallop stock recovery in the D'Entrecasteaux Channel, and sample recreationally targeted fishing grounds at White Beach and Bull Bay in south east Tasmania.

The assessment builds on historic scallop surveys in the Channel, which have found low stock levels and poor juvenile recruitment to adulthood/legal size led to the 2011 closure of this local recreational only fishery.

Surveys in 2017 and 2020 found low Commercial Scallop densities in the channel, meaning the fishery hadn't recovered enough to re-open. However, there are positive signs that the population of each species is increasing.



Commercial Scallops

These increases are most noticeable in lower channel sites with high currents, including Middleton, Gordon, and Satellite Island, , a favoured habitat of Queen Scallops. Similarly, scallop abundance above the minimum legal-size has also increased.

While this is a positive sign that stocks are rebuilding, overall densities are still generally low. About 84% of the measured scallops were legally sized, which suggests that recruitment of juveniles to adulthood/ legal size continues to be at a low level.

Genetic studies suggest the channel's Commercial Scallop population is heavily reliant on larvae settling in their spawning habitat, or self-recruitment. As such, further rebuilding adult stocks is necessary as well as multiple year classes of both juvenile and adult scallops before any fishery could be justifiably re-opened.

#### **Recreational Fisheries**

Our research includes Australia-wide surveys such as the National Recreational Fishing Survey of Southern Bluefin Tuna. We are invited to participate in multiple international working groups, which ensure we are working at the cutting edge of recreational fisheries research. Other major surveys include Recreational Fishing (TAS) and Recreational Fishing for Rock Lobster and Abalone (TAS).

#### O Scientists assess southward-bound scalefish arriving in Tasmanian waters

IMAS researchers are predicting that the range extension of Yellowtail Kingfish, King George Whiting and Snapper into Tasmanian waters is likely to continue in future years, with their findings helping inform management of these emerging species in our state.

A new IMAS project has assessed these range extending species, which are moving south due to waters off Tasmania's north and east coasts warming faster than the global average. As a result, Tasmania has the most recordings of range shifting species in Australia.



Damon Sherriff with a Yellowtail Kingfish (Image: Damon Sherriff)

Under future climate change predictions, our modelling predicts that there will be an increase in suitable habitat for King George Whiting and Snapper across Tasmania, particularly during winter.

These forecasts also indicate that the seasonal migration of Yellowtail Kingfish is likely to extend further south along Tasmania's north and east coasts, and last for a greater proportion of the year. Blacklip Abalone aggregation





#### Photo: Antonia Cooper, RLS

#### O Estimating recreational catch in Tasmania's rock lobster and abalone fisheries

The Tasmanian Recreational Rock Lobster and Abalone Fisheries Assessment involved researchers surveying 360 licensed rock lobster and abalone fishers about their catches between November 2021 and April 2022. This information was extrapolated to represent the activities of 30,000 licence holders.

Fishers were estimated to have caught nearly 79,400 lobster (86.3 tonnes) across Tasmania's eastern and western regions in 2021-22, an increase from 72,800 the previous year (81.6 tonnes).

This recreational catch represented about 51% of the 170-tonne total allowable recreational catch (TARC). It was also equivalent to about 7.1% of the 2021-22 total allowable catch (TAC) of 1,221 tonnes, which includes the total allowable commercial catch (TACC) of 1,051 tonnes.

#### **Extension and engagement**

#### O From Tasmania to the world...

Our Wild Fisheries team is working with communities to make a real impact with our research. Collecting samples is essential to our research, so the contribution of recreational fishers as citizen scientists is vital to bolster sample sizes.

Tasmanian fishers are helping us take samples through our Tassie Fish Frame Collection Program. The biological data collected underpins basic fisheries management, such as defining appropriate size limits. We are able to model the distribution of the species and how it might affect existing marine ecosystems, while the program also enhances engagement with major stakeholders in these fisheries.

We are also communicating our science and influencing behavioural change through engagement and education programs such as the Tuna Champions program. Meanwhile, after first making waves in Tasmania as an IMAS project, the Range Extension Database & Mapping (Redmap) project has now reached a national scale.

Our high-quality research has also led to broader national and international projects, including surveys such as the recent National Survey of Recreational Fishing for Southern Bluefin Tuna in Australia.



Southern Bluefin Tuna (Photo: Al McGlashan)

#### O Beyond bluefin: successful Tuna Champions program expands across Australia

The Tuna Champions program, a highly successful IMAS-led education and communication initiative focusing on the iconic Southern Bluefin Tuna (SBT) has been extended for three years, with the expansion to cover other tuna species, and new research and citizen science opportunities.

Tuna Champions, established in 2018, is an initiative of the Australian Recreational Fishing Foundation in collaboration with the Institute for Marine and Antarctic Studies (IMAS). It's funded by the Australian Government through the Fisheries Research and Development Corporation.

Due to the success of Tuna Champions, the Australian Government has committed \$800,000 through the FRDC towards a three-year extension of the program, which will boost engagement with fishers, chefs, consumers and communities across the country.

This funding will allow Tuna Champions to not only address SBTs but also Yellowfin, Longtail and other tuna species on Australia's east and west coasts and the Top End, including the Northern Territory.

#### O Rock Lobster Tag Lottery

Fishers who catch and report a tagged rock lobster to IMAS, you'll contribute to our research that's helping to keep the fishery sustainable – including the monitoring of lobster growth, population size and movement patterns. Plus they go into the draw to win great prizes through our <u>Rock Lobster Tag Lottery</u>. A series of quarterly prizes were given away to participants, along with annual grand prize winners.

In 2021 and 2022, IMAS received 1,107 tagged lobster reports from commercial fishers, recreational fishers, commercial processors, or people who've purchased tagged lobsters.

## FISH HEALTH, BIOSECURITY AND SEAFOOD SAFETY

Research to protect the health of seafood consumers and aquatic organisms, including issues of toxic marine algae, biosecurity of farmed seafood, and disease.

PROGRAM LEADER:

• Alison Turnbull

#### **OVERVIEW**

Animal disease, food safety incidents and market access failures can cause significant economic loss for fisheries and aquaculture sectors. Achieving the true value from seafood requires ensuring the animals are healthy and comply with market access requirements for biosecurity and food safety.

Amoebic gill disease (AGD) is the most significant health problem affecting Atlantic salmon aquaculture in Tasmania and increases cost of production by 10– 20%. We are currently identifying candidate vaccine antigens with our Australian Research Council (ARC) linkage partner, Ridley AquaFeeds. The aim is to produce an experimental vaccine against AGD that will benefit the Tasmanian and international Atlantic salmon aquaculture industries. In the seafood safety space, we have been researching paralytic shellfish toxin (PST) accumulation in Southern Rock Lobster and abalone, providing cost effective strategies to manage the risk associated with recurrent highly-toxic blooms of *Alexandrium catenella* on the east coast of Tasmania.

Through a combination of experimental and field studies, we are increasing our knowledge of prey sources, speed of uptake, seasonality of risk, and the variability of risk along the east coast. We are developing and validating new sampling and analysis techniques and have also been researching the impact of PST on lobster health to determine impacts on the productivity of the fishery. Our IMAS staff are part of SafeFish, a successful national food safety and market access research project that has been running for over 10 years. Current activities directly relevant to the Tasmanian seafood industry include:

- reviewing the national food standards regulatory limits for marine biotoxins for bivalve shellfish and bacteria in seafood, to ensure these are risk commensurate and aligned with international regulations, and
  - upskilling capability in industry, regulators and laboratories in Vibrio analysis and risk management, which is particularly relevant to Tasmania after a succession of vibriosis outbreaks traced to local oysters.

#### **RESEARCH HIGHLIGHTS**

#### Investigating disease solutions for improved fish health

#### O Building capability in food safety in Australian shellfish

The National Aquaculture Strategy aims to double the value of aquaculture production to \$2 billion per annum by 2027. To do this, there needs to be a simultaneous increase in personnel with food safety expertise both within and serving the aquaculture industry, particularly the high-risk bivalve shellfish sector.

The Building capability in food safety in Australian shellfish project aims to address these training needs for the shellfish sector. It is supported by Oysters Australia and by funding from the Fisheries Research and Development Corporation on behalf of the Australian Government.

#### O Preparing the seafood industry for the food safety challenges of the future

Recent global events have highlighted the need to build resilience within the seafood industry. Climate change, the COVID-19 pandemic and the war in Ukraine have all had impacts on seafood trade, particularly on food safety and market access. By working collaboratively with stakeholders to understand the causes, likelihood and consequences of risks, SafeFish is preparing industry to navigate an unpredictable future. SafeFish, a collaboration with the South Australian Research and Development Institute (SARDI), provides technical advice to support Australia's seafood trade and market access negotiations, and helps to resolve barriers to trade.

SafeFish has completed a risk register for the Australian seafood industry that identifies the top 32 risks facing industry with ability to impact on food safety and market access.

The critical risks identified were the increased presence, virulence and challenging risk management of Vibrio in seafood; inadequately adapting to climate change impacts such as increased pathogens, environmental effects and changing distributions of species; arbitrary trade sanctions and loss of products from geo-political uncertainty; increased harmful algal blooms and low awareness of biotoxins including ciguatera; and industry not adapting to traceability and authenticity technology and increased fraud.

The risk register helps industry and governments to focus on the highest priority risks affecting their sector and reduce exposure to such events as outbreaks, export bans, climate disruption and negative media.



The COVID-19 crisis triggered huge changes, damage and opportunities in Tasmania's fisheries and aquaculture sector (Photos: Emily Ogier)

SafeFish is now assisting industry to address these risks, starting with Vibrio. We are creating a road map for experts, resources and actions, working collaboratively across disciplines and organisations and building support networks to prepare for future events. We are also supporting a national Vibrio research strategy to address the many knowledge gaps that hamper risk management in this space.
#### O Protecting Tasmania's rock lobster fishery from the impacts of paralytic shellfish toxins

IMAS research is helping to better protect Tasmania's Southern Rock Lobster fishery from the impacts of paralytic shellfish toxins (PSTs), caused by harmful algae blooms, through improved risk management practices.

A new IMAS report has assessed how PSTs accumulate in rock lobster and impact the fishery. This has informed how stakeholders can manage fishery risks relating to public health and market access, and whether these marine biotoxins could adversely affect lobster performance (growth/ maturity), health and catchability.

We have improved understandings of PST accumulation and purging rates, variability between lobsters, the resilience of adult lobster to biotoxin uptake, and supply chain risks.

Importantly, we've also validated more cost-effective field monitoring using Neogen rapid test kits to detect PSTs in the lobster hepatopancreas that are above the maximum regulatory level for safe human consumption.



Sampling a Southern Rock Lobster for PSTs

# O Informing PST risk management in other marine species

IMAS researchers are undertaking other projects to determine whether Short and Longspined Sea Urchins and Periwinkles are at risk of PST contamination in Tasmania.

These projects include field sampling during highrisk bloom periods and laboratory exposures of Periwinkles to PST-producing microalgae.

This work, combined with surveys of human consumption habits (meal frequency and size), will deliver a detailed risk profile for PST in these species. This will ensure that Tasmanian marine biotoxin monitoring efforts are commensurate to risk.

In past research, we've found uptake of toxins does occur in Blacklip Abalone from direct exposure to algal cells and toxin consumption. Toxin uptake and purging in abalone operates on considerably different time scales to lobsters, so requires alternate risk management methods.

Our involvement with industry and regulators in the annual review of the Tasmanian marine biotoxin plans for Southern Rock Lobster and Abalone have led to continued improvement in the biotoxin monitoring programs for these species.



Dr Alison Turnbull sampling a Southern Rock Lobster for PSTs

#### O Harmful algae bloom (HAB) socioeconomic study

The socio-economic aspects of harmful algae blooms and marine biotoxin management in Tasmania is an important research area at IMAS.

A new project is considering these socio-economic challenges as part of a state-wide, integrated approach to risk management, covering all species that can accumulate toxins.

The aim is to understand the costs and benefits to stakeholder groups due to the current approach to HABs and seafood safety management. Initially, this will be in comparison to a "no-management" scenario.

Once these costs and benefits are understood, options for an integrated approach to HAB risk management in Tasmania will be considered. An integrated approach would include sharing resources such as sampling and analysis effort, expertise and research effort.

#### O Maximising oyster harvest

We are assisting the Tasmanian Government, Oysters Tasmania and the state's oyster farming industry to appropriately respond to environmental changes in growing areas through a sensor network.

The Oysters Tasmania project, supported by NRM South, NRE Tasmania, TasAg Innovation Hub, ShellMAP, IMAS and growers, involves rolling out 60 sensor monitoring sites at 30 growing areas across Tasmania between September 2022 and January 2023.



Australian Seafood Industries Pacific Oyster broodstock conditioning in Pipe Clay Lagoon, Tasmania (Photo: Lewa Pertl)



# HUMAN DIMENSIONS AND MODELLING

Modelling, economic, governance and sociological approaches to optimise benefits to the community from fisheries and aquaculture.

PROGRAM LEADER:

- Klaas Hartmann
- RESEARCH TEAM LEADERS: HUMAN DIMENSIONS: Emily Ogier MODELLING AND MAPPING: Katie Cresswell

#### OVERVIEW

Our Human Dimensions team focuses on the people side of fisheries and aquaculture, inclusive of communities, firms, economies, markets and institutions linked to marine systems.

Our research supports the SMRCA goal of sustainability of marine resources by understanding the ways people, markets and institutions interact with the marine resource and ecological system itself, as well how that interaction generates benefits and burdens for different users and communities.

Our Human Dimensions team both leads research activity in marine social sciences, economics and political studies as well as supports other IMAS teams in their projects with our human dimensions expertise and capability. Our role in national and international projects, such as the FRDC's Human Dimensions Research Coordination Program and the Science & Nature people Partnerships (SNAPP) working group on Governing Changing Oceans enhances our ability to holistically support the SMRCA program.

Our Modelling and Mapping team works on the quantitative side of fisheries and aquaculture, providing support to multiple areas and projects within IMAS, as well as leading many varied projects from stock assessment report publishing including website development to the definition and objectives of marine partially protected areas. Our research supports the SMRCA goal of management and stewardship of all commercial wild fisheries and marine aquaculture by undertaking yearly stock assessments and updating with latest models and data, as well as helping to transition commercial fisheries into the digital age for example by acquiring funding to build and deploy GPS and depth loggers on the commercial urchin divers in Tasmania.



#### HUMAN DIMENSIONS

Our Human Dimensions team focuses on the social and economic indicators for Tasmania's fisheries and aquaculture, community wellbeing, social acceptability, and effective governance.

#### Social and economic dimensions of Tasmania's fisheries and aquaculture

Our Human Dimensions team assesses the economic and social performance of Tasmanian **commercial fisheries** against a series of indicators. We are piloting a range of indicators for **recreational fisheries and for aquaculture sectors**. Our survey program targets different fisheries and aquaculture sectors each year. The survey data helps to understand current conditions and support management to enhance economic and social performance and generate greater benefits.

The surveys are run through the IMAS Economic and Social Data project and are supported by the Tasmanian Seafood Industry Council (TSIC), TARFish and the Department of Natural Resources and Environment Tasmania (NRE Tas). Through an FRDC Project, we undertook a focused study of the socio-economic characteristics of the commercial sector of the Tasmanian Scalefish Fishery. This analysis uncovered the extent and range of the local seafood supply chains and interactions with local economic sectors in Tasmania's regional areas.

#### Economic participation of Tasmanian Aboriginal communities through Cultural Fisheries

The Human Dimensions team recognises Tasmanian Aboriginal communities as the Traditional Custodians of Tasmania's marine waters and living marine waters. We partnered with the Tasmanian Regional Aboriginal Communities Alliance (TRACA), the Indigenous Land and Sea Corporation (ILSC) and NRE Tas in a project to assess the feasibility of a Cultural Fishery model utilising Abalone quota units.

# Community wellbeing, social acceptability and a fair return to community

Our Human Dimensions team is investigating the basis of social support for wild fisheries and aquaculture. Building and maintaining societal

support is vital for fisheries and aquaculture industries, but it calls for engagement with local communities and stakeholders to better understand shared and divergent values and interests through community-focused projects.

In one such community-focused project, we investigated **community futures linked to development of marine areas of North-West Tasmania** across 2019-2021. We asked North-West residents how they envisage development and wellbeing for their marine region, and how marine industries could better align with these values. Researchers concluded that both members of the community considered both wellbeing of place (marine and coastal environments) and communities (socio-economic) important in planning for marine industry development.

Our work also focuses on how returns from the use of Tasmania's living marine resources can deliver fair returns to the Tasmanian community in a variety of forms, from direct economic benefits to employment and recreational amenity. Through our work on the national FRDC project 2020-029 we are identifying options to adaptively manage Individual Transferal Quota systems to support these policies.

# **Opportunities for growth** through governance

Our Human Dimensions team is developing an economic model to assist in identifying the **costs and benefits** of genomic selection in Pacific Oyster selective breeding. We are developing a cost-benefit analysis framework to support social-economic analysis for biotoxin management in Tasmania.

We partnered with the Central Queensland University on a **nationwide oyster value chain** project, to provide advice on barriers and opportunities in value chain development at both national and state levels. We conducted interviews with Tasmanian oyster growers and organisations integral to the supply chain and contributing this data to the project. The value chain analysis compared value chain characteristics between Australian states, and provided information specific to Tasmania.

Understanding how COVID-19 affected Australia's seafood industry and using this knowledge to **prepare the sector to successfully navigate future shocks** is a key focus of our Human Dimensions team. Overall, our analysis of economic impact has shown the level of strength and resilience of the seafood industry, both in Tasmania and across Australia, across this highly disrupted period. We are interviewing key decision makers in both government and the seafood industry across Australia about the disruptions experienced across 2020 and 2021, as part of an FRDC project (2021-024). Through this analysis we are identifying to the range of effective responses available to better futureproof and adapt to economic shocks.

# Economic contribution of fisheries and aquaculture in Tasmania

IMAS research has found Tasmania's key fisheries and aquaculture sectors contributed close to \$900 million towards the state's economy in 2018/19, with the data set to help track the impacts of COVID-19 on industry in future years.

The Tasmanian Fisheries and Aquaculture Industry: Economic Contributions report, released in 2021, assesses the state's six key sectors, including salmon aquaculture, rock lobster and scalefish fisheries, wild abalone and abalone aquaculture, and Pacific oyster aquaculture.

By identifying the contribution of each sector to Tasmania's economy, this report can help contribute to the management of natural resources. This is important as these industries are all accessing a public resource. The report showed that these sectors contributed a total of \$878 million to the Tasmanian economy in 2018/19, known as gross value added (GVA). GVA is the value of all goods and services from an industry minus the cost of production.

These sectors also employed a total of 6,558 people, both directly and indirectly. Indirect employment is measured through associated industries like boat maintenance and fish feed supplies.

While the total GVA and employment numbers were good, it is important to see continued growth for our fisheries and aquaculture sectors. We note that as the 2018/19 data was pre-COVID, these negative impacts to the industry have not yet been recorded.

However, the report data can now act as a baseline to help track and manage impacts to these sectors caused by the pandemic. This includes changes in the way fishing or aquaculture businesses operate, changes to natural resource management, economic or policy implications, and global influences.

Estimates of 2020/21 are being prepared to help track the economic contributions of Tasmania's fisheries and aquaculture sectors across time and under changing environmental and economic conditions.

## **RESEARCH HIGHLIGHTS**

#### **Modelling and Mapping**

Our Modelling and Mapping team creates highresolution maps of the shape and composition of the seafloor. We contribute our skills to scientific assessments, to help manage fishery populations and evaluate management strategies, and we work closely with the Human Dimensions team on economic assessments and reports.

In particular, we have helped assess the success of interventions to help manage the invasive Longspined Sea Urchin. We have also contributed to research on recreational Rock Lobster fishing and the environmental impacts of fish farms.

# O Sustainably managing our marine environment through data

The Tasmania's Marine Atlas project aims to collate and make available sets of data about the state's coastal waters to ensure our marine environment is sustainably managed.

Extensive and reliable datasets about the biophysical state of the ocean and coast, and its human uses, are needed to ensure the sustainable use and management of the marine environment. This includes social, cultural, environmental, ecological and administrative data relevant to key locations in our coastal waters.

The data already exists within the Tasmanian context but are often not widely distributed, or are not formatted with the capacity of interacting with other data layers or analysis tools.

The Marine Atlas project, funded by the FRDC, will identify, compile, and standardise geographical datasets relevant to marine socio-ecological systems in Tasmanian waters. Informal consultations with data holders will help the research team ensure the Marine Atlas both captures all relevant information and is useful to stakeholders including industry, government, researchers, and other stakeholders.



The project will include a gap analysis process, where key geographical data gaps will be identified to inform future data collection projects. During the project, no new field-based data will be collected but a secondary analysis may create new datasets.

Additionally, the project will consider geographical decision-making tools The key output of this project will be an online platform, which will allow visualisation and possibly interaction with compiled datasets.

During mid-2022, our researchers held three forums around Tasmania to engaged the community in shaping the Atlas' development. This included government, industry, non-governmental organisations, interested citizens and community members, and researchers.

#### O The future of marine spatial planning

The Blue Economy CRC project, Marine Spatial Planning for a Blue Economy is a collaborative research effort focused on the future of marine spatial planning in Australia.

Griffith University is leading the project in collaboration with IMAS/University of Tasmania, CSIRO, University of Queensland, Tasmanian Government (NRE Tasmania and Department of State Growth), and several industry partners, including Tassal, Huon Aquaculture, Petuna Seafoods and Nexsphere.

The project, which is running from April 2022 until mid-2025, aims to advance marine spatial planning in Australia to support equitable, environmentally sustainable, and economically efficient outcomes. The project will develop decision-support frameworks to assist planning in offshore waters, with the objective of giving industries greater certainty of tenure and better management of risks.



The various interactions between salmon aquaculture, the environment and our community (Photo: IMAS Salmon Interactions Team)

# O The multiple values attained through partially protected areas

Researchers are reviewing definitions of the main objectives for (partially protected areas) PPAs across Australia and characterise their implementation across Australia. The researchers will then quantify the extent to which specific types of PPAs achieve their stated goals and use the results to develop evidence-based decision support tools, in conjunction with marine resource managers, to facilitate effective implementation of appropriate marine policies.

#### O Larval dispersal for Southern Rock Lobster and Longspined sea urchin to support management decisions

This project aims to examine larval dispersal patterns for Southern Rock Lobster, *Jasus edwardsii*, and Long-spined sea urchin, *Centrostephanus rodgersii*, remain poorly understood. Understanding spatial dispersal patterns is essential for spatial management of these species. Likewise, inter-annual variability in dispersal can lead to low lobster recruitment with large fishery consequences whilst increases in larval dispersal may be responsible for the establishment of Long-spined sea urchin in Tasmania.

#### SMRCA ACTIVITY REPORT 2021 & 2022

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# OUR PEOPLE

# **OUR PEOPLE**

The SMRCA brings together a diverse and dedicated team of research scientists, academics, cross-discipline researchers such as economists and sociologists, and highly-skilled professional staff.

We aim to integrate inclusion and diversity into our daily work practices, to create an inclusive culture where everyone can contribute and develop regardless of differences.

Together, our people deliver our vision for excellence in fisheries and aquaculture research and education.

## TAKING THE NEXT STEP...

We are dedicated to passing on our knowledge and passion for great research to the next generation of scientists, industry leaders and policy makers.

Our students contribute outstanding research outcomes and work with us on many of our projects.

During 2021 and 2022, IMAS PhD Candidates delivered 70 research outputs that were relevant to the management and development of marine ecosystems and industries, helping them build valuable skills in marine resource research. While generally financially supported by sources, these students add value to, and gain benefits from, the collaboration with SMRCA projects.

In 2021 and 2022, we saw 17 PhD candidates graduate from SMRCA-funded research. See our graduands in Appendix I.



PhD graduate Barrett Wolfe (Mechanisms underpinning a marine predators' poleward range extension) with his supervisor, Professor Gretta Pecl.

## COMINGS AND GOINGS

Over the past two years we've seen many new faces on our team, and we have wished several other staff all the best as they embark on the next exciting phase of their lives. We make special mention of some who have made a substantial contribution to the SMRCA over many years.



#### Senior Research Scientist, Associate Professor Jeremy Lyle

After more than 20 years in

the fisheries space at IMAS/TAFI, Jeremy retired in May 2021. His main focus was on fisheries ecology and biology, particularly understanding fish population dynamics, the impacts of fishing on fish stocks and the characteristics of the recreational as well as commercial fishing sectors. He worked on a variety of commercial fisheries, including offshore trawlers, small pelagics and coastal fisheries, and conducted recreational fishing surveys.



#### Senior Lecturer, Dr Karen Alexander

Karen joined us in 2016 from Scotland. She brought her knowledge and skills in human geography research

and applied them to investigate conflict in marine and coastal resources, and to develop our understanding of marine spatial planning and the transition to a blue economy. Karen has taken up a position as Assistant Professor in Marine Governance and Blue Economy at Heriot Watt University in Scotland.



#### Senior Technical Officer, David Mossop

David had a lasting impact on the Fisheries and Aquaculture team at IMAS, with his legacy

being the Tasmanian Fish Frame Collection Program. The program has been instrumental in the collection of a range of scalefish data to inform fisheries assessments. Dave leaves us for a communications officer role at NRE Tas.



#### Principal Field Technical Officer, Mike Porteus

Mike retired from IMAS in late 2021 following many years of service to the technical

team, conducting countless field trips for staff and students, including boating, diving, terrestrial and aquaculture-based trips. He played a key role in community engagement events, including Agfest, the Australian Wooden Boat Festival and work experience at IMAS Taroona. Mike was also involved in managing and maintaining our vessel fleet, vehicles and field equipment. Good luck in your retirement, Mike!

#### Quantitative Marine Science (QMS) Senior Lecturer, Dr Simon Wotherspoon

Simon, our long-term statistics guru, departed IMAS in January 2022 for a role with the Australian Antarctic Division. While based in the Ecology and Biodiversity team through the QMS, many fisheries and aquaculture researchers benefited from collaborating with Simon.

#### **Technical Officer, Ed Forbes**

Ed was one of our longest serving technical officers, working in a range of research fields including fisheries sciences, marine resource management, marine and estuarine ecology, fish physiology and genetics, and aquaculture. He departed IMAS in early 2022 for new challenges with the shellfish team at NRE Tas.

#### Aquaculture Technical Officer, Toby Bolton

Toby departed IMAS in June 2022 after a longstanding history with the institute. He served as the inaugural IMAS Salamanca Laboratory Manager and played a key role in making the building and facilities what they are today. More recently, he managed aquarium and lab facilities at IMAS Taroona.



#### Senior Technical Officer, Graeme Ewing

Graeme departed IMAS in September 2022 as the longest-serving Senior

Technical Officer at the Taroona Marine Laboratories – 25 years to be exact (either side of a stint at the AAD). Graeme has been instrumental in providing research support to a range of areas, including the successful fisheries-based research of over 20 scalefish and cephalopod species, as well as rock lobster and scallop fisheries. Good luck in your retirement on Bruny Island, Graza!

#### Research Assistant, Jason Beard

Jason departed IMAS Taroona after 15 years in October 2022. His expertise focused on crustacean aquaculture, marine and estuarine ecology, resource management, genetics, phycology and environmental monitoring.

#### UTAS/IMAS Senior Client Services Officer, Antony Cave

After nearly 10 years providing IT support to IMAS,

Ant departed for a role in UTAS Finance Services in September 2022. Ant has played major roles in a range of IMAS events, most recently the Longspined Sea Urchin and Red Handfish exhibitions and will be greatly missed.



#### Principal Diving Officer, Simon Talbot

Simon departed IMAS in December 2022 after serving 25 years as a Dive Officer

(among many other roles). He takes with him a wealth of diving knowledge and expertise, which he's imparted on our field teams. These skills will be sorely missed.

#### **RECOGNITION FOR RESEARCH EXCELLENCE**

# Genetic solutions for alien invasions

IMAS Adjunct researcher Dr Lokman Norazmi made an impression in the international Falling Walls lab season, where researchers and early-career professionals pitch their innovative idea in just three minutes. This involves showcasing a breakthrough that creates a positive impact on science and society.

Lokman took out the First Runner Up and the People's Choice in the NSW category for his talk on finding genetic solutions for 'alien invasions'. He shared the advances to combat the menace of Gambusia holbrooki (mosquito fish), a noxious alien pest fish invading the freshwater ecosystems across Australia's mainland states.

Despite recent advances in synthetic biology, a genetic solution centred on Trojan Chromosome Carriers is the best way to combat alien invasive fish at continental scales. With one of the shortest reproductive cycles of fish species, G. holbrooki is an ideal candidate to demonstrate the feasibility of these genetic technologies.



Dr Lokman Norazmi



Dr Alison Turnbull

# Improving oyster and rock lobster food safety

IMAS researcher Alison Turnbull's innovative work to help improve oyster and rock lobster food safety and market access saw her recognised with the Seafood Research and Development award at the Tasmanian Seafood Industry Council awards in October 2021.

The honour acknowledges Alison's research to improve risk management techniques for microbial and biotoxin contamination in the seafood industry, which is influencing policy change and assisting with market access.

Currently, Alison is helping the oyster industry with managing risk during environmental events and working to open up new seafood markets. She's also focusing on managing the impact of biotoxins in both the oyster and rock lobster sectors.



Graeme Ewing

#### Our Swiss Army Knife: the career of IMAS Technical Officer, Graeme Ewing

Graeme Ewing is widely regarded as the 'Swiss Army Knife' of researchers – such is the diversity of his scientific and technical skillset.

For nearly three decades Graeme has been a fisheries research stalwart. Either side of a stint at the Australian Antarctic Division (AAD), he's spent 25 years as a technical officer and research scientist at IMAS and its predecessors at our Taroona Marine Laboratories.

As a technical officer, Graeme has been instrumental in providing research support to a range of areas, including the successful fisheries-based research of over 20 scalefish and cephalopod species, as well as rock lobster and scallop fisheries. This work has helped underpin sustainable management of Tasmania's marine resources.

And for these achievements in the technical support of marine science, Graeme was recognised with the Australian Marine Sciences Association (AMSA) Technical Award in August 2022 – an accolade made sweeter by the fact it's come in the year of his retirement. Graeme has been involved in countless field trips involving diving and equipment deployment; data collection, management and analysis; laboratory work involving fish dissection and ageing, tissue histology, microscopy, and image analysis; and numerous scientific papers and reports.

Graeme has also forged productive relationships with resource managers, commercial and recreational fishers, school students and members of the general public. His passion for science communication has allowed him to both promote the role of research in achieving sustainable fishing practices and facilitate citizen science contributions to research.

He's even mentored and trained numerous junior research staff and postgraduate students in field and laboratory skills.

Incredibly, Graeme has worked at the Taroona site across its transformation from Tasmanian Government fisheries laboratories to the current collaborative structure of IMAS – and has contributed to this evolution. These changes have brought broader funding and collaboration opportunities which have enhanced our research and educational outcomes in sustainable fisheries management.

Graeme closed the chapter on his marine science degree, retiring from IMAS in September 2020, leaving a significant legacy – and knowledge gap – behind.

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# **OUR IMPACT**

Our fisheries and aquaculture research is always focused on achieving useful outcomes that make a difference to the sustainable use of marine resources. Commercial, recreational and indigenous fishers harvest these important resources, and each group has different needs. The key to our success is working with fishers across all sectors, which enables us to gather data from many different sources and locations.

Along with community collaboration and data collection, we are developing leading technology to assist with monitoring efforts, and working with industry to combat threats such as Pacific Oyster Mortality Syndrome (POMS).

Through our research, rigorous data is driving management, fish stocks such as lobster are increasing, and ecosystems are being monitored. Our aquaculture research is also contributing to building a sustainable source of nutrition and food for populations worldwide, and has the potential to fill gaps in food security into the future.

# SCIENCE IN PROGRESS

As a research institute of excellence in temperate marine research, IMAS works in collaboration with the Tasmanian Government in the Sustainable Marine Research Collaboration Agreement (SMRCA) to help improve management of Tasmania's marine resources and industries. This includes providing fishery assessments, management advice and tactical projects on current fishery issues.

For planning and reporting, our SMRCA activities are divided into Tier 1 and Tier 2 needs and projects. Tier 1 projects are of the highest priority and tend to have a longer funding horizon, with funds committed from the Tasmanian Government and/or the University of Tasmania. Tier 2 projects are externally-funded research projects which receive a contribution of resources from the SMRCA.

The SMRCA receives both cash and in-kind contributions from its partners, the Tasmanian Government and IMAS at the University of Tasmania. When successful, additional funding is also received from external funders as grants and consultancies.

See Appendix III for our projects and funding, and Appendices IV and V for our research grants.

# OUTCOMES IN PRINT

Our scientists and students publish many significant reports and papers, often with international collaborators. Putting our research into the international scientific literature is not merely an academic exercise – it achieves two important outcomes.

Firstly, publication exposes our work to anonymous international critique, which improves the quality and objectivity of our research. Secondly, it enhances our engagement with research around the world, which means Tasmania can benefit from the latest developments, and our researchers can contribute to better global use of marine resources.

Appendix VI for our publications.

#### Beyond the lab...

At the SMRCA, we have a strong focus on communicating our science in simple and engaging ways, accessible to everyone in the community – from the young to the young at heart.

While some events were cancelled in 2021 due to COVID-19 restrictions, we were able to host and take part in many others.

# CODE RED

Tasmania's red handfish in the spotlight at new IMAS exhibition

Research into the critically endangered Red handfish was showcased during an exhibition at the IMAS Salamanca Gallery from May-August 2022. The free exhibition shared the story of the Red handfish, the many challenges it faces, and the science of restoring wild handfish populations here in Tasmania.

Red handfish are only found in Tasmanian waters and there are only around 100 adults left in the wild. These are only found at two small reefs in Frederick Henry Bay near Hobart. Red handfish live among the seaweed and seagrass of shallow reefs but have been significantly impacted by various threats to their habitat, from climate change and native urchins overgrazing on seaweeds, to pollution, coastal development and direct human disturbance.

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They're also particularly susceptible to disturbance due to factors like vulnerable egg clutches, the limited dispersal of adults and juveniles, and small populations.

In the hope of saving Tasmania's Red, Spotted and Ziebell's handfish, the National Handfish Recovery Team (NHRT) established the joint IMAS and CSIRO Handfish Conservation Project in 2018.

We're working hard to address the threats to Red handfish survival through wild handfish monitoring,

habitat assessment, urchin removal, diver and community education, and a captive rearing and juvenile release program.

Saving Tasmania's Red handfish

SED

Approximately 500 people visited the exhibition, including 50 at the launch event. Notable visitors included: Vice Chancellor Rufus Black, CoSE Executive Dean Terry Bailey, Labor MPs Janie Finlay and Sarah Lovell, Greens MP Rosalie Woodruff, students from six schools, NRE Tasmania staff, Handfish Conservation Project donors, Beaker Street Crawl participants and various other stakeholders and researchers.

We also showcased a condensed version of the exhibition at the stem\_next expo at Taroona High School in November 2022.

What lies beneath



# URCHINS BEWARE! ....WE'RE COMING FOR YOU!

We highlighted research into the invasive Longspined Sea Urchin during our Urchins Beware exhibition at IMAS Salamanca from November 2021 until February 2022.

The exhibition told the story of the urchin invaders, including the problem, the science and the solution.

Visitors discovered the history of urchins in Tasmania and understand what's being done to control this invasive species. This included learning about our research into managing urchins and preventing urchin barrens from forming, which will allow our reefs to thrive again.

Longspined urchins were once rare outside NSW, but warming waters and a strengthening East Australian Current has seen them extend their range south, causing devastation to sections of Tasmania's east coast reefs. They were first reported in the waters off St Helens in 1978 and now, 43 years later, there is an estimated population of 18 million on eastern Tasmanian reefs between larapuna/Eddystone Point and the Tasman peninsula.

Longspined Sea Urchins can live for more than 40 years. They are voracious consumers of seaweeds and can turn healthy reefs into expansive urchin barrens. Urchin barrens impact rocky reef species such as abalone, rock lobster and fish, which depend on reefs for habitat and food. Barrens have also resulted in the local loss of habitat for over 150 species living in east coast kelp beds.

IMAS scientists have been studying urchin ecology and their impacts on reefs and kelp beds for many years, and this has set an evidence-based foundation for managing and limiting the spread of urchins. Now research is turning its focus on urchin control mechanisms and how effective those controls are. We're surveying urchin populations and the extent of barrens, assessing predation by rock lobsters, evaluating targeted urchin culling and removal, and conducting wild harvest fishery assessments.

With over 450 tonnes of Longspined Sea Urchins now harvested each year from Tasmania's waters, IMAS scientists are monitoring the impact on the environment. In the heavily fished areas, we're seeing kelps and seaweeds grow back – the ecosystem is showing signs of recovery.

We're also working with commercial urchin roe processors to improve the profitability of the industry. This involves investigating ways to use the urchin processing waste, powdered shells and gut, as an organic fertiliser in the agriculture sector. We hope that soon people will be able to apply this nutrient rich product on their home gardens.

Approximately 100 people viewing the exhibition, including during a launch event. We also showcased a condensed version of the exhibition at the stem\_ next expo at Taroona High School in November 2021.

#### Agfest

We returned to Agfest in August 2022 with exhibits showing how we age different marine species to inform fishery management, including scalefish, rock lobster, abalone, urchins, squid, octopus, sharks, rays and skates.

We also showcased: fish tagging, the Tassie Fish Frame Collection Program, the Rock Lobster Tag Lottery, melanisation in Sand Flathead, Redmap, the Handfish Conservation Project, Tuna Champions and Longspined Sea Urchin research.



IMAS Technical Officer Stuart Isles talking to punters about our fisheries research at Agfest

#### Fisheries and Aquaculture Forums

We held our first Fisheries and Aquaculture forum at IMAS Salamanca in November 2021. This saw IMAS researchers share some insights into our fisheries and aquaculture work with NRE Tas staff. Our scientists discussed the research behind fisheries assessments in Tasmania, rock lobster predation of longspined sea urchins, the economic value of Tasmanian fisheries and the impact of marine industries on marine and coastal wellbeing in the North West.

We delivered a second forum at NRE Tasmania's offices in December 2022, with presenters discussing the research and management underpinning artificial reefs, fish aggregating devices and Tasmania's rock lobster fishery.

#### **UTAS Open Day**

Our researchers also took part in UTAS Open Day events in November 2021 and September 2022. In 2021, this involved showcasing the Urchins Beware exhibition, sharing salmon aquaculture research to high school science teachers during speed dating event, and a visit from interstate students to IMAS Taroona. They received insights into rock lobster, oyster and seaweed aquaculture, captive handfish breeding and the Experimental Aquaculture Facility for Atlantic salmon and lobster. In 2022, prospective students got glimpse at how we age different marine species to inform fishery management, like at Agfest.

#### Working on Water

While TSIC's Working on Water event for Year 9 and 10 students was cancelled due to a snap COVID-19 lockdown in November, Fisheries and Aquaculture PhD candidates involved in speed dating event. When the event returned in October 2022, students visited IMAS Taroona where we delivered presentations on the Red Handfish and rock lobster aquaculture, showcased our vessel fleet and our underwater video technologies.





Tasmanian Year 9 and 10 students tour the IMAS Taroona research vessel sheds during TSIC's Working on Water

# Salmon aquaculture research events

IMAS salmon aquaculture researchers have been busy, sharing our important research on the environmental interactions of salmon farming:

- September 2021: sharing our research during the Salmon Farming in Tasmania: Fact, Fiction or Spin forum
- November 2021: discussing our ongoing research in Macquarie Harbour at the West Coast Community Aquaculture Forum in Strahan
- June 2022: hosted a salmon aquaculture community open day in Hobart, alongside the FRDC and CSIRO.
- September 2022: Associate Professor Jeff Ross attended a Beer Aquatic event and spoke about the science behind understanding the effects of salmon aquaculture on the marine environment, with over 200 people attending.

#### Other presentations and events by our SMRCA researchers

- A photography exhibition at Smithton in
  September 2021 showcased how particular
  marine environments have wellbeing benefits for
  communities on Tasmania's North West Coast.
  This was based on a study on marine industries
  in the region.
- A series of community workshops on the development of Tasmania's Marine Atlas were held in 2022. The online mapping platform aims to preserve our marine environment by making data on Tasmania's coastal waters and marine activities available to stakeholders and the community
- Research on Southern Rock Lobster prey choice presented to the Tasmanian Combined Dive Clubs Weekend at Bicheno in June 2022. The research found that lobsters prefer to eat native prey options far more than range-extending Longspined Sea Urchins. This finding has implications for urchin management.

# **APPENDICES**

## APPENDIX I GRADUATES 2021 & 2022

| Nick Hill                | PhD | Prevalence of Data-limited Fisheries in Australia and Options to Improve their Management   |
|--------------------------|-----|---|
| Barrett Wolfe            | PhD | Physiological and Behavioural Mechanisms Underpinning the Climate-driven Range Extension of Snapper Chrysophrys auratus in Southeast Tasmania   |
| Paolo Campus             | PhD | Optimising the Fishery of the Under-exploited Edible Sea Urchin, Centrostephanus rodgersii  |
| Sandra Curin Osorio      | PhD | Embracing Uncertainty in Fisheries Stock Assessment and Management: A comparison of statistical methods for quantifying uncertainty, improving<br>population model parameterization and evaluation of robust harvest strategies |
| Hannah Fogarty           | PhD | Climate Ready: Identifying adaptation preparedness in Australia s state fisheries   |
| Bianca Haas              | PhD | Regional Fisheries Management Organizations and Sustainable Development Goal 14: Opportunities and challenges   |
| Kaitlyn Higgins          | PhD | Social Behaviour, Aggression and the Indirect Effects of Competition and Predation in the Fish Species Galaxias maculatus and Gambusia holbrooki  |
| Seyed Mousavi            | PhD | Sex Differentiation and Determination in the Invasive Fish, Gambusia holbrooki  |
| Kieran Murphy            | PhD | Exploring Macroecology of Cephalopods in a Changing Climate through Trait-based Approaches  |
| Patricia Peinado Fuentes | PhD | Integrating Physiology, Behaviour and Molecular Mechanisms to Understand Impacts of Ocean Warming on Southern Calamari (Sepioteuthis australis)   |
| Renzo Tascheri Oyaneder  | PhD | Management Plans for Marine Benthic Resources: A new governance institution for Chilean coastal benthic fisheries   |
| Alison Turnbull          | PhD | Paralytic Shellfish Toxins in Southern Rock Lobster: Physiological impact and improving public health risk management   |
| Coco Cullen-Knox         | PhD | Media and Environmental Conflict over Salmon Aquaculture: Investigating the local and the transnational   |
| Julian Manning           | PhD | Spatio-temporal Planning within the Framework of Ecosystem Approach to Aquaculture  |
| Joel Slinger             | PhD | The Branchial Microbiome and Neoparamoeba perurans Infection  |
| Chun Kit Ooi             | PhD | Relationship Between Heavy Metal Levels and Muscle Melanisation in Sand Flathead (Platycephalus bassensis) from Tasmania, Australia   |
| Chantelle Reid           | PhD | Atlantic Salmon Microbiome: Impacts of environment and diet   |

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#### **APPENDIX II VISITORS TO TAROONA 2021 & 2022**

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Guests from the Indonesian Consulate, who visited IMAS Taroona, including the Experimental Aquaculture Facility. The group was hosted by SMRCA Director, Professor Caleb Gardner.

- Fisheries Research and Development Corporation Board – visit to IMAS (April 2021)
- ABC Hobart's Leon Compton visit to IMAS Taroona to discuss handfish breeding program with Dr Jemina Stuart-Smith and Dr Andrew Trotter (September 2021)
- Tasmanian Liberal Senator media opportunity for seaweed aquaculture grant hosted by Dr Catriona MacLeod (November 2021)
- Interstate students tour IMAS Taroona aquaculture facilities as part of UTAS Open Day events (November 2021)
- Indonesian Consulate General tour of IMAS Taroona facility hosted by Prof Caleb Gardner (December 2021)
- Representatives from the Tristan da Cunha islands visited the IMAS Taroona ARC Rock Lobster Hub, met with IMAS researchers and government and industry stakeholders, and held a seminar on their rock lobster fishery (June 2022)

- A delegation from Kiribati toured IMAS Taroona, including the ARC Rock Lobster Hub, Experimental Aquaculture Facility and handfish aquarium. They also received tours of IMAS teaching facilities and ran a seminar on fisheries management (July 2022)
- Students participating in TSIC's Working on Water Program visited IMAS Taroona. They toured the boat sheds and dive stores, hearing about Red Handfish and rock lobster aquaculture research and learnt about BRUV and ROV technology. They also learnt about F&A courses
  - A group of French rock lobster fishers toured the ARC Rock Lobster Hub at IMAS Taroona and met with our rock lobster researchers (October/ November 2022)
- Japanese sea urchin company Kita-Sanriku visited IMAS to discuss opportunities for increased commercial urchin harvesting in Japan (November 2022)

#### APPENDIX III PROJECTS 2021 & 2022

Our research investments are prioritised with government and other stakeholder input through Research Advisory Groups (RAGs). These are a formal requirement of the SMRCA Agreement and occur at least once per year to discuss research needs and how to resource these. Current RAGs include:

- Crustacean and Rock Lobster
- Abalone
- Scalefish, Scallops & Minor Species
- Shellfish Aquaculture
- Finfish Aquaculture
- Recreational Fishery.

Projects that have been underway since 2021 are detailed below, including information on funding source. Projects are nominally placed into categories of marine resource, although in many cases there will be an overlap between categories.

#### **Dive fisheries**

#### Fishery Assessment: Abalone

Led by Dr Craig Mundy, this annual assessment for the Tasmanian Abalone Fishery summarised updated abalone stocks in the various blocks around the state, using logbook and electronic dive logger data, and made recommendations for sustainable total allowable catch (TAC). NRE Tasmania and the TACL used the assessment for management decisions for each zone.

#### Fishery Data: Abalone Processor Sampling

Led by Dr Jaime McAllister, this project provided size composition data used in the Abalone Fishery Assessment, gathered from the sampling at commercial abalone catches at processing factories. Factory staff measured 100 randomly-selected abalone from a fishers' catch, from all abalone quota zones and across seasons. In addition, several commercial abalone divers also collected length frequency data while actively fishing at sea. Length frequency catch data provide the size structure information needed to determine the relative contribution of different size classes in supporting the fishery, and in assessing the resilience of the fishery to sustain different levels of fishing pressure. It also focused on sampling catches from the Eastern Zone in response to declining catches and environmental stresses, which indicated this zone is becoming increasingly reliant on new recruits entering the fishery. This project also involved a sampling program for the Longspined Sea Urchin, which provided catch size structure information for research, modelling and assessment of the urchin fishery. There has also been some sampling of Shortspined Sea Urchin.

#### **Dive fisheries (continued)**

# Fishery Data: Fisheries Dependent e-Data Collection

Led by Dr Craig Mundy, this project used state of the art technology data loggers, fitted with 4G modems, to collect fine-scale data on fishing activity. This is critical for assessing fishery performance, understanding changes in utilisation of productive reefs, and tracking shifts in the way the fleet operates in response to management action. The data was used as spatial indicators of fishery performance to capture changes in fishing strategy as indicators of change in stock levels. The data was also used to quantify the reef area supporting the commercial abalone fishery, the proportion of the known fishable reef used annually, and any changes in the way the fleet operates across or within years.

# Fishery Data: Inshore Water Temperature Monitoring

Led by Dr Craig Mundy, this project involved collection of in situ water temperature data from up to 20 sites around Tasmania annually. The data are used to establish a water temperature time series, to support validation of SST modelling for climate change research, and is freely available to students and researchers if required.

#### Population Biology: Abalone

Led by Dr Craig Mundy, this project obtained broad biological information required to provide sustainable advice, and underpins the abalone diving-based research program. This included annual surveys of abundance, measurements of growth rates, patterns in size at reproductive maturity and reproductive biology and sampling to examine the effects of warming and climate change on abalone physiology.

# Can spatial fishery-dependent data be used to determine stock status in a spatially structured fishery?

Led by Dr Jaime McAllister, this project investigated key abalone fishery performance indicators, developing metrics for detecting hyper-stability, Management Strategy Evaluation of four alternate Abalone fishery Harvest Strategies, and involved development of a defensible strategy for assigning stock status to abalone fisheries for the SAFS framework.

# Drawing strength from each other - Simulation testing of Australia's abalone harvest strategies

This project addressed the need to write Management Strategy Evaluation code that will be usable for the future and in other jurisdictions. It tested this code on two abalone stocks, one blacklip and one greenlip, to assist in this need for code generality. The final product is freely available on a version control site such as GitHub with detailed guides on how it is best used.

#### Mapping abalone habitat impacted by Centrostephanus on the east coast of Tasmania

This work involves a high-resolution survey of rocky reefs in the 0-40 m depth range on the rapidly warming east coast of Tasmania. It will produce data to create a high-resolution bathymetric map from which seafloor habitats can be defined. The acoustic survey will include water column data that allows for 3D estimates of vegetation cover to be quantified.

# Effect of temperature on abalone condition as a function of season, location and rate of change

This project sought to understand the physiological basis for the observed symptoms (and consequences) of thermal stress, and to identify potential threshold temperatures for northern and southern Tasmanian abalone populations.

# Nutritional quality of kelp as a key driver of commercial abalone productivity

This project quantified latitudinal trends in kelp nutritional quality as a primary determinant of commercial abalone productivity. The project also examined the relationship between abalone resilience to post-harvest stress and nutritional quality of available food types.

#### **Dive fisheries (continued)**

# Utilising Furneaux abalone quota for the benefit of Tasmania's Indigenous community Phase 1

This project combined fisheries resource economic analysis of the abalone quota trade operations and market, with abalone market research, and with community development social research. An analysis of the feasibility and viability of fishery quota holdings for the purposes of generating benefits for the holding entity – a Tasmanian Indigenous organisation – has not been undertaken previously.

#### Scalefish and Cephalopods

#### **Fishery Assessment: Scalefish**

Led by Dr Nils Krueck, this project combined data on catch and fishing effort with information from fisheryindependent biological surveys, to assess the status of Tasmanian Scalefish Fishery species. This is a complex fishery, comprising multiple data-poor species in coastal waters, that are harvested by both commercial and recreational fishers using various gear types.

#### **Population Biology: Scalefish**

Led by Associate Professor Sean Tracey, this project generated biological information required for managing the Tasmanian Scalefish Fishery. An important component of this program was the collection of fish frames from both commercial and recreational fishers, which were used to provide important biological information. In particular, otoliths (fish ear bones) were extracted and analysed to assess the age of the fish. This provided insights into the resilience of a stock as it is used to assess the contribution of different age classes of fish to a population. The project also involved targeted fisheryindependent sampling where information on different aspects of a fishery, such as the reproductive biology of a particular species, were assessed. This assists in determining the best timing for spawning season closures, and for ensuring that minimum legal sizes are appropriate so a good proportion of fish can spawn before they are potentially harvested.

#### **Tasmanian Sardine Fishery Research Report**

This report assessed how a new sardine fishery could be established off Tasmania through appropriate management and research procedures, and balanced consideration of ecological, economic and social objectives. Adult biomass of sardine off south-eastern Australia is larger than expected at 185,000 tonnes, and potentially more than 250,000 tonnes. This biomass could support a valuable and sustainable fishery.

#### **Tasmanian Octopus Fishery Assessment**

This report assessed catch and effort statistics by block and zone; research pot sampling data; catch-only stock assessment methods, ecosystem interaction (bycatch, protected species, ecosystem and habitat interactions including summary of new research and response to EA reporting requirements if applicable) and social and economic data.

# Understanding the movement, behaviour and post-release survival rate of recreationally caught Swordfish in Australia.

Led by Associate Professor Sean Tracey, this project was an extension of a pilot study funded by FRDC, TARFish, the State Government and the Game Fishing Association of Australia. It investigated postrelease survival, movement and migration behaviour and factors effecting ethical capture of Swordfish by recreational fishers. This application was designed to increase sample size of satellite tagged fish around Australia, moving the study from a pilot to a full, publishable research project.

# Opportunities and impacts of range-extending scalefish species

This project combined a citizen science angler logbook program initiative to engage with recreational fishers to provide catch information and biological samples of identified key range-extending species and two contemporary modelling techniques to improve our understanding of the implications, opportunities and future potential of the presence of these species in Tasmanian waters.

#### Finding Large Oceanic Pelagic Predators Environmental Distribution (FLOPPED)

The ongoing FLOPPED project has 2 objectives: 1/ to provide scientific knowledge on the spawning grounds of billfish at the scale of the Indian Ocean; 2/ estimate the abundance of spawners in the different breeding areas.

#### Tuna Champions v2.0 Bluefin and beyond

This new funding injection will facilitate the need to broaden the Tuna Champions program to the next level by increasing the scope of the project to now focus on more key tuna species in Australia, including Yellowfin Tuna and Longtail Tuna.

#### Socio-economic characterisation of a smallscale commercial fishery: opportunities to improve viability and profitability in the Tasmanian Scalefish Fishery

This project was an in-depth social and economic assessment of the Tasmanian Scalefish Fishery. This included improved understanding of fisher dynamics, supply chains and opportunities to improve industry performance with a focus on social, economic and environmental outcomes.

#### Improving assessment approaches for deepwater species

The project estimated productivity of Orange Roughy stocks and involved a risk assessment that incorporates the uncertainty in Orange Roughy natural mortality and steepness of the stock recruitment relationship. The project also reviewed the characteristics and discarding practices of species in the Deepwater shark basket (multiple species are assessed as a single complex).

#### Developing a cost-effective monitoring regime and stock assessment for Sand Flathead in Tasmania

This ongoing project will address the need for a comprehensive sand flathead stock monitoring approach throughout the state that can support the development of a spatially explicit quantitative stock assessment model. There is also a need to determine the appropriate spatial resolution to apply to the stock assessment model.

#### Estimating the spawning fraction of Blue Mackerel off eastern Australia

The size of the Blue Mackerel stock is estimated by a method called "daily egg production method" which involves sampling of plankton down eastern Australia and counting the density of eggs. These counts are linked to mackerel biomass by information like spawning frequency. A weakness in the method is that there have been very few spawning females sampled and they're surprisingly difficult to catch. This project worked to fix that weakness in the data.

#### Monitoring and assessment of Small Pelagic Fishery (SPF) quota species 2022-24

This ongoing project will conduct monitoring and assessment of quota species in the SPF for the 2021/22 to 2023/24 fishing seasons. The four objectives of this project will be addressed using fishery-dependent catch/effort and size/age data from the SPF and information on the distribution and abundance of quota species obtained from recent fishery-independent surveys.

#### **Rock Lobster and Giant Crab**

#### Fishery Assessment: Rock Lobster

Led by Dr Klaas Hartmann, this project assessed egg production and recruitment to measure the biological sustainability of Tasmania's rock lobster fishery. Both fishing effort and biological parameters vary dramatically from region to region, presenting major challenges for fishery assessment and management. We used a spatially explicit stock assessment model that considered different assessment areas separately and informed harvest strategies that incorporate regional differences.

#### Fishery Data: Commercial Catch Sampling

Led by Dr Rafael León, this project was our primary source of length-frequency data collection for stock assessment and involved fishery-dependent and independent data collection. The information recorded includes location, specimen data (e.g. sex, size, maturity stage), and bycatch species. An updating process for electronic data collection is also being investigated.

#### **Population Biology: Rock Lobster**

Led by Dr Rafael León, this project generated biological information required for management, such as reproductive research for some fish species to review their relative risk status as bycatch species in the Tasmanian rock lobster fishery. The research also answered questions from the industry or Fishery Authority, such as evaluating the viability of rock lobster larvae when berried females are exposed to cold-temperature shock in winter catch.

#### Fishery Assessment: Giant Crab

Led by Dr Rafael León, this project involved carrying out an annual assessment to estimate a total allowable catch (TAC), reviewing the stock status, and assessing fishery performance against indicators (limit reference or trigger points). This assisted the Fisheries Authority to allocate individual quotas to fishers and to take action if any limit reference point or trigger point has been exceeded. It also involved a series of other projects, such as improving length-frequency data collection and assessing the potential interaction with other fishing sectors (bottom trawling), which can result in conflict due to competition for access to shared fishing grounds.

#### Examining the potential impacts of seismic surveys on octopus and larval stages of Southern Rock Lobster

This project is using a field and laboratory experimental approach to provide a thorough assessment of the potential impacts of seismic surveys on octopus pallidus (the primary species captured in the fishery) in the natural environment, as a model species for octopus fisheries. Additionally, the project will examine the potential impact of the seismic survey on octopus catches and catch rates.

#### Improving the Southern Rock Lobster on-vessel handling practices, data collection and industry tools for lobster quality assessment

This project involves investigating the impacts of on-vessel and maintenance practices on live SRL post-harvest performance.

# Recreational Southern Rock Lobster tagging program

Researchers assessed current data and modelling assumptions and approaches to establish a robust stock estimate. This project involved an in-depth survey of the Victorian recreational rock lobster fishery and catch from the 2020/21 season. In consultation with VFA and stakeholders this project will improve and direct the development of the Victorian rock lobster tagging program.

#### Larval dispersal for Southern Rock Lobster and Longspined Sea Urchin to support management decisions

This project is providing the first attempt to capture the dispersal of Longspined Sea Urchin and Southern Rock Lobster larvae using contemporary oceanographic models and the first to incorporate vertical movement of larvae. It will allow a calculation of which reefs are the most likely sources for large recruitment events and link this to egg production estimates for reefs. The model can also be used to predict whether Tasmanian populations are now likely to be self-recruiting.

#### Lose home or eat more: comparative prey choice and consumption of different rock lobster species on barren forming sea urchins

This PhD project is using field and lab work to determine spatial and size variability in lobster diet around Tasmania.

# Can novel seismic survey sources mitigate potential impacts to fisheries?

This project will provide a thorough assessment of the potential impacts of each seismic source type and assist all stakeholders to make informed decisions on the potential for these alternate sources to be used commercially and to mitigate potential seismic impacts to fisheries. It will directly benefit the Southern Rock Lobster fisheries in Southern Australia and the Tasmanian, Victorian and Commonwealth commercial scallop fisheries by providing robust data on the impact seismic survey activities may have on their fisheries and provide evidence for whether areas important to fisheries should be excluded for surveys.

# Stable isotopes: a rapid method to determine lobster diet and trace lobster origin

This project is assessing lobster feeding preference and the use of stable isotope in determining catch location.

#### Victorian Rock Lobster and Giant Crab Assessments 2019-2021

Researchers conducted the Giant Crab and Southern Rock Lobster stock assessments for the Victorian Fisheries Authority. They also reviewed a new stock assessment model and ran sensitivity analyses across the range of input parameters. IMAS will also conduct ongoing work on developing the harvest strategy to meet these needs.

#### Giant Crab Enhanced Data Collection -Innovative approaches to enhance data collection in the Victorian, South Australian and Tasmanian Giant crab fisheries

This project is addressing identified shortcomings in the quality of data currently available for Giant Crab stock assessment and fisheries management (Tas, Vic and SA). This project will look to develop a method for fishers to images of crabs on the vessel. The images will be processed using Visual Intelligence methods to determine length, sex and unique ID for each crab. This data will be used in stock assessment models to make more accurate assessment. Hopefully this process will be rolled out across the Giant Crab fishery and a database of images can be collected and stored in a central repository.

#### **Bivalve fisheries**

#### Fishery Assessment: Commercial Scallop

Led by Professor Jayson Semmens, this assessment supported the Tasmanian Scallop Fishery's harvest strategy, by undertaking surveys to estimate abundance and size frequency distributions. This allowed decisions to be made on opening or closing fishing areas, with total allowable catches based on the estimated abundance.

# Fishery Assessment: Sheltered Coastal Waters Scallop

Led by Associate Professor Sean Tracey, this research involved surveying the abundance of scallops in the D'Entrecasteaux Channel to determine whether there is sufficient biomass to open the recreational fishery in the area.

#### Wider investigation of the use of video survey techniques to determine commercial scallop abundance in inshore and offshore waters, closed areas and juvenile beds

This project is providing a better understanding and knowledge of the scallop distribution and abundance in inshore waters that may contribute towards recruitment to waters available to the commercial scallop fishery. It aims to development of a towed video process to supplement commercial dredge surveys to assist with the identification of presence of very small scallops.

#### **Recreational fisheries**

# Fishery Data: Sand Flathead Independent Surveys

This project continued a series of fishery-independent surveys, undertaken annually since 2012, to identify trends in the sand flathead populations off southeastern Tasmania.

#### Assessing the effectiveness of artificial reefs and FADs in creating recreational opportunities for Tasmania's recreational fishers

The Tasmanian Government has committed funds to install five Fish Aggregating Devices (FADs) and two artificial reefs (ARs) in Tasmanian waters as part of an Election Commitment. It is unknown if the unique game fish off the east coast of Tasmania that are targeted by recreational fishers will interact with FADs, or if coastal ARs have the capability to provide nursery habitats or recruit juveniles. This project is monitoring the direct and indirect benefits of these installations for the recreational fishery and other multi-sector users.

#### Review of regulation and policy guiding use of artificial reefs and Fish Aggregating Devices (FAD) in Australian waters

This project involves:

- Identification of the current regulatory and policy frameworks in all Australian jurisdictions that guide or impact the deployment and use of FADs and artificial reefs in State, Territory and Commonwealth waters.
- Identification of the current and projected use of FADs and artificial reefs in Australian jurisdictions.

#### Exploring recreational fishing data for use in Harvest Strategies: NSW Department of Primary Industries (DPI) research collaboration

This project involved researchers working with NSW DPI to mine and analyse a plethora of recreational fishing data to find aspects that will be useful in fisheries Harvest Strategy Management plans.

# Integrating recreational fishing information into harvest strategies for multi-sector fisheries

Researchers used a combination of desktop research, stakeholder workshops, quantitative survey techniques, along with a modelling framework (FishPath) to develop guidelines to formally integrate recreational fishing into harvest strategies for multisector fisheries, using a range of NSW fisheries as case studies.

# **Recreational fisheries** (continued)

Evaluation of a smart-phone application to collect recreational fishing catch estimates, including an assessment against an independent probability-based survey, using South Australia as a case study

Researchers are conducting a probability-based survey of recreational fishing in South Australia over a 12-month period to provide estimates of catch and effort for key fish and invertebrate species. The project will also assess the potential of using novel and contemporary survey methods such as phone application survey methods.

#### **Urchin fisheries**

# Effects of urchin fishing on urchin populations and recovery of kelp

This project will determine the effects of high fishing pressure on urchin populations and the quantify kelp recovery in heavily fished areas in North East Tasmania. Field data collection will combine a combination of dive surveys, video surveys, and urchin processing.

# Understanding Centrostephanus Age, Growth and Size of Maturity

This project refined and determined key biological parameters of age, growth and size at maturity of Centrostephanus along the Tasmanian east coast.

#### Lobster predation re-survey

The proposed project will re-survey baseline sites established during a previous Fisheries Research Development Corporation project which investigated the effectiveness of rebuilding large lobsters to mitigate risk of urchin overgrazing.

#### **Commercial Sea Urchin Fertiliser Project**

This project is investigating the commercial upscaling of processing sea urchin waste for use as an agricultural fertiliser, including trials of urchin fertiliser on commercial crops.

# Fisheries biology of Shortspined Sea Urchins in Tasmania

Led by Dr John Keane, this project provided scientific knowledge of short-spined urchin growth and reproduction to allow for sustainable management of the fishery. Additional research on roe quality will optimise harvesting strategies and profitability the fishery, while scientific support of farming trials will assist in the management and development of a new industry.

#### **Seafood safety**

#### SafeFish 2021-2025

SafeFish is a food safety market access research program supported by a wide variety of industry stakeholders. The program conducts technical work on international and domestic food safety standards for seafood, prioritises issues for the seafood industry, builds capability in seafood food safety and market access, and provides technical support during food safety incidents. Essentially, our researchers deliver food safety research and advice to industry and regulators around Australia.

An extension of this project involves surveying four species of rock lobster around the Australian coastline for heavy metals of public health and market access significance.

# Improved risk management of paralytic shellfish toxins (PST) in Southern Rock Lobster

Led by Dr Alison Turnbull, this project, is assessing impacts of Southern Rock Lobster seasonal closures in Tasmania due to PST contamination of hepatopancreas (HP), notably in the St Helens and Maria Island regions, and up to Flinders Island, with an estimated lost revenue cost of \$780,000. The proposed work will refine monitoring tools to reduce the costs associated with PST biotoxin risk management of rock lobster, including the application of cheaper and faster PST testing and also explore whether tests can be conducted in a nondestructive manner.

#### Risk profile for the paralytic shellfish toxins from Alexandrium catenella in Tasmanian sea urchins

This project involves conduct a risk profile for paralytic shellfish toxin (PST) accumulation in urchins, addressing the following questions:

- What is the risk of paralytic shellfish toxin accumulation in *Heliocidaris erythrogramma* and *Centrostephanus rodgersii* on the east coast of Tasmania as a result of Alexandrium catenella blooms?
- 2. If risk management is necessary, what are suitable options, and what are the knowledge gaps?

# Risk profile for paralytic shellfish toxins in Tasmanian Periwinkles

The project involves assessing PST risk in Periwinkles.

# Building capability in food safety in Australian shellfish

This project is supporting the development of the bivalve shellfish industry through providing training in this niche technical area.

#### Field validation of the Neogen rapid screening paralytic shellfish toxin (PST) test kit for abalone foot

This project involves validating the use of PST rapid test kits in abalone.

#### Economic analysis for DST testing regimes

This project involves an economic analysis for Diarrhetic Shellfish Toxin (DST) testing regimes to identify what contexts are likely to maximise the economic benefits of the proposed testing practices.

#### Salmonid farming

#### Aquaculture Environment Interactions: Planning

Led by Dr Myriam Lacharite and Associate Professor Jeff Ross, this ongoing research provided scientific support for the planning of new and developing salmon aquaculture operations in Tasmania. We synthesized marine data and provide seafloor mapping products to assist spatial planning and further develop marine zone assessments of aquaculture sites.

# Aquaculture Environment Interactions: Emerging Issues, Social Science and Communication

Led by Dr Camille White and Associate Professor Jeff Ross, this ongoing research explored a range of emerging issues in salmon aquaculture, such as environmental monitoring of salmon farming in both a regulatory and operational management context, and approaches for informing the community about aquaculture planning and development. We have developed a series of reviews on the ecological effects of aquaculture, and launched a new website salmoninteractionsteam.org which provides updates and learnings about the interactions between salmon aquaculture, the environment, and society.

#### Aquaculture Environment Interactions: Monitoring and Management

Led by Associate Professor Jeff Ross, this ongoing research supported the monitoring and ongoing management of current salmon farming operations in Tasmania. It ensured current monitoring practices are adequate and makes recommendations for improvement where necessary.

# Storm Bay Observing System: Assessing the Performance of Aquaculture Development

This study supports the design and implementation of an effective, efficient and reliable monitoring program, providing expert advice on sampling locations, timelines and strategies and testing this data over 3-4 years to refine and improve the program.

# Aquaculture-Community Futures: North West Tasmania

This project is helping understand the regional development and well-being futures envisaged by residents of North West Tasmania and how salmonid farming can contribute to meeting these shared values.

# Tasmanian salmonid farming socio-economic assessment

This project provides a confidential advice note in relation to Tasmania's salmonid industry, specifically relating to:

- Macro scale socio-economics of the industry in Tasmania;
- 2. Presence and extent of any economic rent;
- Discussion on model/s to collect a return to the community;
- Macro level effects of changes to fees or charges on the industry.

#### **Biofouling Challenges and Possible Solutions**

As finfish aquaculture expands into new areas and moves offshore, knowledge of how biofouling communities are likely to respond and behave will be key in mitigating the problem. The key objectives of this BECRC supported PhD project are i) the characterise biofouling communities associated with salmon farming in the waters around Tasmania and ii) determine how changes in environmental conditions and/ or farm management practises might influence the development and impact of these communities.

#### Macquarie Harbour String Maintenance

There are three real-time environmental monitoring strings deployed in Macquarie Harbour as part of FRDC project 2016-067. This ongoing project involves regular the maintenance of these strings and provision of the data on the dashboard following the FRDC.

# Optimising feeds to support characterising shell aquaculture

This project assesses the global and local consequences of changing feeds in aquaculture by developing a new interdisciplinary sustainability assessment framework. The project is generating new methods to understand and predict local farmto-ecosystem changes and global environmental footprints under contrasting feed and climate scenarios by integrating field data with novel experiments, modelling techniques and global mapping of terrestrial and marine feed raw materials and their impacts. Expected outcomes include new methods to assess ecological, social and economic trade-offs under different feeds to inform decisionmaking support of an ecosystem-based approach to aquaculture spanning global to local scales.

#### Shellfish

#### **Shellfish Farming**

Led by Dr Andrew Trotter, this project supported continuation of the national Pacific oyster breeding program, which aims to complete the breeding for POMS resistance in young spat and recommence breeding for traditional commercial traits (i.e. growth rate, meat condition, shell shape and nonspecific survival).

#### Oysters Tasmania biotoxin risk assessment

This project reviewed historic biotoxin data and risk assessment to inform future sampling strategies.

# Assessing the risk of pathogenic vibrio species in Tasmanian oysters

Oysters in Tasmania growing areas are being surveyed for pathogenic vibrio species to assess risk to human health. Relationships are sought with environmental parameters such as salinity and temperature to inform potential risk management strategies.

#### Characterising shell development of the Pacific oyster using the novel application of nuclear technologies

The aim of this research is to characterise variations in the shell biology of Pacific oysters according to different estuarine environments, husbandry techniques, and genetic traits, using advanced nuclear technologies. It is expected that this characterisation will greatly enhanced knowledge of Pacific oyster biology, ecology and farming practises. This will empower oyster farmers with more informed decisions on management and husbandry practices, aimed at improving profitability and sustainability. This advanced characterisation of Pacific oyster shell biology will represent an important step in our longerterm goal of developing phenotyping tools to select for oyster shell traits in selective breeding.

#### Developing the tools and articulating the value proposition for genomic selection in Pacific oyster selective breeding

Genomic selection is a new applied breeding technology that is being used in commercial animal and plant breeding program with significant, and times large, economic benefits. However, there are no commercial applications in oyster breeding. This project is a preliminary step intended to demonstrate an economic cost benefit, evaluate genotyping tools methodology development, proof of concept for phenotyping, thereby providing information to assist a decision about moving this to operational breeding.

#### National Pacific Oyster Breeding Program: Completing POMS Resistance in Spat and Transition to Selection for Traditional Commercial Traits

This project proposal represents a continuation of the national breeding program with the primary aim of developing high disease resistance to POMS in young spat; which is not yet completed and is critical for the industry. The proposed investment will have a high probability of solving the systematic outbreak of POMS, which continues to damage an important regionally based industry.

#### **Seaweed farming**

#### Planning for seaweed aquaculture in Tasmania: A preliminary evaluation of biophysical potential and co-location with existing aquaculture

NRE Tasmania has identified a need to spatially resolve the potential for the sustainable growth of the emerging seaweed aquaculture industry in Tasmania. This project will address this need by: 1) synthesizing the current state of knowledge on the biophysical requirements and geographic extent of key seaweed species with the most potential for commercialization, 2) pending data availability, conducting a biophysical assessment of the potential for seaweed aquaculture in Tasmanian State waters, and 3) determining the potential for co-location with established aquaculture species, e.g., Atlantic Salmon.

#### Seaweed solutions for sustainable aquaculture

Researchers working on this project are developing a sustainable Integrated Multi Trophic Aquaculture (IMTA) model that supports commercial seaweed production.

#### **Vulnerable and endangered species**

Maugean Skate monitoring – Macquarie Harbour This ongoing project involves:

- Assessing the potential use of size composition data from Maugean Skate research gillnet catches as an indicator of population change, in particular recruitment variability
- Assessing the feasibility of using novel technologies (LiDAR and synthetic aperture sonar) as a survey method to provide direct estimates of Maugean skate abundance
- Undertaking a desk top study to identify potential alternative and non-invasive approaches to estimating population size
- Providing recommendations on options and sampling design suitable to provide an ongoing assessment of Maugean Skate population status.

# Life-history and reproductive behaviour of the vulnerable Melbourne Skate to inform fisheries management and conservation

Given that large skate species are more prone to local extinction compared to smaller species, coupled with the already observed population declines, its high susceptibility to fishing pressure, and the lack of biological and ecological information, the large Melbourne Skate may be particularly vulnerable to local extinction. As such, this ongoing PhD project is important as it addresses this lack of information to provide a starting point for conservation efforts for this vulnerable species. Specifically, we aim to define the species' (i) life history (age, growth, and reproduction), (ii) distribution and abundance in south-east Australia, (iii) population productivity, (iv) use of inshore protected areas, (v) candidate egg laying and nursery grounds and (vi) extinction risk and make this information available to resource managers.

#### **Red Handfish Conservation 2022**

This work was requested by the Australian Government threatened species unit to resurvey Red Handfish populations and trial new approaches for identifying new populations.

#### Vulnerable and endangered species (continued)

#### Baby steps: head-starting captive juvenile Red handfish to urgently recover a wild population on the brink of extinction

This ongoing research is focusing on bolstering Red Handfish population numbers by continuing a head-starting conservation strategy (collecting eggs from the wild and raising young in captivity, until their return to the wild). It will include temperature manipulation experiments to determine best conditions for growing juveniles and allow us to learn more about the thermal requirements for the species (which will aid future conservation work).

#### Investigating the use of germ cell transplantation as an insurance tool for the conservation of the endangered Maugean Skate

This underway project aims to investigate if germ cell transplantation has potential for providing an additional tool for aiding elasmobranch conservation, which would address one of the biggest marine conservation issues the world currently faces.

#### Assessing the role of restored and natural kelp forests in protecting against coastal erosion and ocean acidification

This project is currently testing the role of the dominant kelp species from south-eastern Australia, *Ecklonia radiata* in providing vital ecosystems services of reducing the threat of coastal erosion by dampening storm waves and alleviating the pressure of ocean acidification by buffering pH2.

#### Environmental Offsets Feasibility Assessment for the Live-bearing Seastar *Parvulastra vivipara* at the Sorell Causeways

This project is providing advice on the feasibility of a range of environmental offset options for loss of habitat of the threatened seastar *Parvulastra vivipara* (resulting from the duplication of causeways at Sorell in Tasmania for the South East Traffic Solution Program). It is also identifying additional data needs and strategies required to progress the feasibility assessment and the development of an environmental offsets proposal on the basis of any feasible approaches identified.

#### Seastar captivity trial

This project involves preliminary trials to look at different treatments for housing seastars in captivity (*P. vivipara*, and also first with a surrogate species, *P. exigua*) as part of the Sorell causeway project (which will require moving the population of *P. vivipara*, a threatened species, from the causeway during planned roadworks).

#### Industry wide projects

#### **Tasmania's Marine Atlas**

This project, due for completion at the end of 2023, will draw together spatially-resolved datasets required for ecosystem-based marine management using marine spatial planning, for Tasmanian State waters, and will identify gaps which may support future data collection campaigns.

#### Marine Spatial Planning for a Blue Economy

This project, still underway, will advance marine spatial planning that supports equitable, environmentally sustainable and economically efficient outcomes. We will (i) develop a framework for planning approaches, (ii) characterize the data needs, (iii) characterize resources and sites for development, and (iv) assess cross-sector interactions and mitigation activities.

# A novel approach to measuring the depositional footprint of the Blue Economy

This project is (1) developing a novel protocol for the assessment of offshore farm footprints combining two sediment–seawater solute exchange measurement techniques, (2) using such measurements to define thresholds in the metabolic response of offshore sediment ecosystems, and (3) exploring their integration in lease-scale biogeochemical models and regulatory frameworks.
#### Industry wide projects (continued)

#### **Risks & Opportunities for the Blue Economy**

Cataloguing hazards and characterising risks associated with the Blue Economy is the most challenging step of any risk identification process. This project will deliver an integrative characterisation of risk across all parts of the Blue Economy CRC – engineering and technology, production, energy, sustainability and policy.

## Blue Economy Explorations of Risk using behavioural economics

The purpose of this ongoing project is to use behavioural economics approaches to explore and analyse the perceptions and trade-offs people are willing to make in order to expand the Blue Economy. In particular, the project will explore what shapes up ideas of risk and what can be done to manage risk. This work will provide a deep understanding of the factors underpinning decision-making and perceptions of what is an acceptable management of risk. These insights will contribute to understanding appropriate policy and institutional arrangements to manage these risks and ensure societal objectives are met by future Blue Economy relevant policies.

# Responding to unintended consequences – evaluating changes to fisheries under ITQ systems

This project evaluated the performance and outcomes of ITQs and identified adjustment options that address the unintended and unwanted consequences of such systems.

#### Statewide Assessment to determine Victorian marine planning areas and priorities, supporting implementation of the Marine Spatial Planning Framework

Marine spatial planning (MSP) has emerged in recent years as a tool for sea use management. However, MSP requires adequate and accurate information on the biophysical state and usage of the marine environment. Such data often exists, but generally not in a format which allows planning areas and priorities to be easily identified. This proposal was developed in response to a Request for Quote by the Centre for Marine Socioecology for the Department of Environment, Land, Water and Planning Victoria, to undertake a Statewide Assessment as detailed in the title.

#### Socio-economic research

## Fishery Data: Economic and Social Data Collection and Management

Led by Dr Emily Ogier, this project filled gaps in Tasmanian fisheries assessments relating to social and economic performance. Tasmanian fisheries are managed to ensure ecological sustainability, and to take account of the community's needs and interest in living marine resources (LMRMA 1995).

Assessment of social and economic performance has started with identifying relevant indicators, and using available data, to produce preliminary assessments of Tasmania's major fisheries and aquaculture sectors. Relevant indicators include those that measure fleet-wide and public benefits arising from the use of these fisheries resources. They include trends in how much economic yield these fisheries generate, what level of benefits are private (industry) and public, who participates, and who derives livelihoods from these activities.

The project also aims to establish regular collection and ongoing management of social and economic data, in partnership with industry associations and the Tasmanian Government.

# Socio-economic research (continued)

#### An economic and social assessment of the outcomes of individual transferable quota (ITQ) fisheries and how to improve benefits to Tasmania

Led by Dr Steven Rust, this project focused on the Rock Lobster and Abalone (RLA) fisheries.

#### It helped:

- Understand changes in the economic resilience of the harvesting sector, quota market (e.g. accumulation of market power) and fishing community (e.g. fleet size, employment) dynamics, and any other unintended consequences
- Identify indicators for ongoing monitoring of extent and effects of individual transferable quota systems
- Develop capability for scenario analysis for comparing business-as-usual with alternate management strategies for the Crustacean and Abalone Fisheries Advisory Committee.

# Impacts of COVID on the Australian seafood industry: Extending the assessment to prepare for uncertain futures

This project completed an assessment of impact of COVID-19 on Australia's commercial, recreational and charter fisheries and aquaculture sectors for the period July 2020 to June 2021.

#### Profile of recreational fishers in Tasmania: understanding experiences, behaviours, drivers, communication needs and change factors

This research, currently underway, will generate a novel understanding of the flathead recreational fishing community in Tasmania through segmentation and profiling based on yet-to-be analysed data on fisher motivations, attitudes, and behaviour as well as a profiling survey to be developed as a part of the project.

## Social-economic analysis of the Tasmanian Commercial Dive Fishery

The project involved developing a comprehensive understanding of the contribution of the commercial dive industry to the Tasmanian economy, both at the Statewide and regional levels. This data is important for industry and policy makers to target measures that enhance regional employment, and the viability of small business within Tasmania.

# Other marine environment research

## The multiple values attained through partially protected areas

This project is reviewing definitions of the main objectives for partially protected areas (PPAs) across Australia and characterise their implementation across Australia. We will then quantify the extent to which specific types of PPAs achieve their stated goals and use the results to develop evidencebased decision support tools, in conjunction with marine resource managers, to facilitate effective implementation of appropriate marine policies.

## Mapping warming reefs for management strategy evaluation

The work involves conducting a high-resolution survey of rocky reefs in the 0-40 m depth range on the rapidly warming east coast of Tasmania between Eddystone Point and Tasman Island. These results will provide Tasmanian managers with vital data to underpin decision support tools for finescale ecosystem-based management, including ecosystem-based fishery management.

### **APPENDIX IV RESEARCH GRANTS 2021**

| CHIEF<br>INVESTIGATOR | PROJECT NAME  | TOTAL SMRCA<br>INVESTMENT<br>2021 | 2021<br>INCOME | 2021<br>IMAS/UTAS<br>IN-KIND | FUNDING<br>BODY                                   |
|-----------------------|---|-----------------------------------|----------------|------------------------------|---|
| Tracey                | Understanding the movement, behaviour and post-release survival rate of recreationally caught Swordfish in Australia                    | 0                                 | 8,055          | 6,927                        | VFA   |
| Keane                 | Fisheries biology of short-spined sea urchins (Heliocidaris erythrogramma) in Tasmania  | 0                                 | 23,087         | 19,855                       | FRDC  |
| Ogier                 | Lever opportunities under the Aquatic Resources<br>Management Act WA: benefit sharing, re-allocation, and co-<br>management in practise | 24,817                            | 129,976        | 133,122                      | FRDC  |
| Hallegraeff           | Improved risk management of paralytic shellfish toxins in Southern Rock Lobster   | 28,935                            | 70,000         | 85,084                       | FRDC  |
| Mundy                 | Can spatial fishery-dependent data be used to determine stock status in a spatially structured fishery?                                 | 1,672                             | 112,925        | 98,553                       | FRDC  |
| Alexander             | Aquaculture-Community Futures: North West Tasmania  | 926                               | 35,013         | 30,908                       | FRDC  |
| MacLeod               | CRC Project: Seaweed solutions for sustainable aquaculture  | 139,808                           | 489,865        | 541,519                      | Department of Industry,<br>Innovation and Science |
| Tracey                | Opportunities and impacts of range extending scalefish species  | 54,343                            | 122,587        | 152,160                      | FRDC  |
| Gardner               | Science to support Australia's Southern Ocean Fisheries 2018-2020   | 0                                 | 315,000        | 270,900                      | FRDC (AAD Toothfish)                              |
| White                 | Derwent Estuary Program Reef Monitoring   | 0                                 | 15,000         | 12,900                       | Derwent Estuary Program                           |
| Hartmann              | Victorian Rock Lobster and Giant Crab Assessments 2019-2021   | 13,583                            | 221,623        | 202,278                      | VFA   |
| Ross                  | Storm Bay Observing System: Assessing the Performance of<br>Aquaculture Development   | 402,552                           | 921,393        | 1,138,593                    | FRDC  |

| CHIEF<br>INVESTIGATOR | PROJECT NAME   | TOTAL SMRCA<br>INVESTMENT<br>2021 | 2021<br>INCOME | 2021<br>IMAS/UTAS<br>IN-KIND | FUNDING<br>BODY                        |
|-----------------------|--|-----------------------------------|----------------|------------------------------|--|
| Semmens               | Examining the potential impacts of seismic surveys on octopus and larval stages of Southern Rock Lobster   | 11,460                            | 569,770        | 499,858                      | FRDC                                   |
| Lyle                  | Socio-economic characterisation of a small scale commercial fishery: opportunities to improve viability and profitability in the Tasmanian Scalefish Fishery | 88,708                            | 151,923        | 206,943                      | FRDC                                   |
| Keane                 | Commercial upscaling of urchin fertiliser  | 3,372                             | 129,259        | 114,063                      | AIRF                                   |
| Ling                  | Lobster predation re-survey  | 0                                 | 9,000          | 7,740                        | AIRF                                   |
| Semmens               | Life-history and reproductive behaviour of the vulnerable<br>Melbourne skate to inform fisheries management and<br>conservation                              | 52,921                            |                | 45,512                       | Sea World Research & Rescue Foundation |
| Semmens               | Understanding population structure and dynamics of<br>Victoria's developing Octopus fishery  | 19,664                            | 119,917        | 120,040                      | FRDC                                   |
| Strain                | Assessing the role of restored and natural kelp forests in protecting against coastal erosion and ocean acidification  | 192                               |                | 165                          | Australian Academy of Science          |
| Fitzgibbon            | Improving the Southern Rock Lobster on-vessel handling practices, data collection and industry tools for lobster quality assessment                          | 105,631                           | 174,572        | 240,974                      | FRDC                                   |
| Turnbull              | Oysters Tasmania biotoxin risk assessment  | 0                                 | 22,998         | 19,778                       | Oysters Tasmania                       |
| Turnbull              | SafeFish Project   | 28,186                            | 59,865         | 75,724                       | SARDI                                  |
| Tracey                | Exploring recreational fishing data for use in Harvest Strategies: NSW DPI research collaboration  | 24,920                            | 32,373         | 49,272                       | NSW DPI                                |
| Mundy                 | Drawing strength from each other - Simulation testing of<br>Australia's abalone harvest strategies   | 0                                 | 142,055        | 122,167                      | FRDC                                   |
| Krueck                | Fish Forever MA+R Design and Assessment Extension  | 2,029                             | 57,845         | 51,492                       | Rare                                   |
| Turnbull              | Field validation of the Neogen rapid screening paralytic shellfish toxin test kit for abalone foot   | 17,354                            | 0              | 14,925                       | NRE Tasmania                           |

| CHIEF<br>INVESTIGATOR | PROJECT NAME   | TOTAL SMRCA<br>INVESTMENT<br>2021 | 2021<br>INCOME | 2021<br>IMAS/UTAS<br>IN-KIND | FUNDING<br>BODY   |
|-----------------------|--|-----------------------------------|----------------|------------------------------|---|
| McDonald              | Recreational Southern Rock Lobster tagging program.<br>Assessing current data and modelling assumptions and<br>approaches to establish a robust estimate   | 38,341                            | 99,084         | 118,185                      | FRDC  |
| Keane                 | Effects of urchin fishing on urchin populations and recovery of kelp   | 61,840                            | 0              | 53,183                       | AIRF  |
| Turnbull              | Assessing the risk of pathogenic vibrio species in Tasmanian oysters   | 308                               | 3,420          | 3,206                        | SARDI   |
| Turnbull              | Risk profile for the paralytic shellfish toxins from Alexandrium catenella in Tasmanian sea urchins  | 14,646                            | 16,580         | 26,854                       | NRE Tasmania  |
| Ross                  | Macquarie Harbour String Maintenance – Rolling agreement   | 0                                 | 63,000         | 54,180                       | TSGA  |
| Cresswell             | Larval dispersal for Southern Rock Lobster and Longspined sea urchin to support management decisions   | 52,281                            | 171,081        | 192,091                      | FRDC  |
| Trotter               | Characterising shell development of the Pacific oyster using the novel application of nuclear technologies   | 0                                 | 2,500          | 2,150                        | Australian Institute<br>of Nuclear Science &<br>Engineering |
| Ugalde                | Blue economy: Valuing the carbon sequestration potential in oyster aquaculture   | 42,985                            | 148,288        | 164,495                      | ACIAR   |
| Lucieer<br>(Keane)    | Mapping warming reefs for management strategy evaluation   | 7,126                             | 4,553          | 10,044                       | Department of Premier and Cabinet                           |
| Keane                 | Lose home or eat more: comparative prey choice and<br>consumption of different rock lobster species on barren<br>forming sea urchins   | 10,315                            | 6,375          | 14,353                       | Holsworth WRE   |
| Tracey                | Evaluation of a smart-phone application to collect recreational<br>fishing catch estimates, including an assessment against an<br>independent probability based survey, using South Australia as<br>a case study | 0                                 | 111,739        | 96,096                       | FRDC  |
| Turnbull              | SafeFish (SARDI subcontract)   | 2,975                             | 58,043         | 52,475                       | SARDI   |

| CHIEF<br>INVESTIGATOR | PROJECT NAME   | TOTAL SMRCA<br>INVESTMENT<br>2021 | 2021<br>INCOME | 2021<br>IMAS/UTAS<br>IN-KIND | FUNDING<br>BODY                        |
|-----------------------|--|-----------------------------------|----------------|------------------------------|--|
| Gardner               | Utilising Furneaux abalone quota for the benefit of Tasmania's Indigenous community Phase 1  | 8,988                             | 52,891         | 53,216                       | Indigenous Land and Sea<br>Corporation |
| Swarts (Keane)        | FRDC Sea Urchin Fertiliser Project   | 1,930                             | 42,499         | 38,209                       | FRDC                                   |
| Ugalde                | Contextualising shellfish food safety in Northern Australia  | 14,983                            | 136,000        | 129,845                      | FRDC                                   |
| Turnbull              | SafeFish extension – lobsters  | 33,793                            | 1,000,000      | 889,062                      | FRDC                                   |
| Keane                 | Understanding Centrostephanus Age, Growth and Size of Maturity   | 18,908                            | 37,581         | 48,580                       | AIRF                                   |
| Alexander             | Tasmania's Marine Atlas  | 61,737                            | 126,371        | 161,773                      | FRDC                                   |
| Lucieer               | Mapping abalone habitat impacted by Centrostephanus on the east coast of Tasmania  | 19,992                            | 82,351         | 88,015                       | AIRF                                   |
| McAllister            | Effect of temperature on abalone condition as a function of season, location and rate of change.   | 80,570                            | 93,869         | 150,017                      | AIRF                                   |
| Ross                  | A novel approach to measuring the depositional footprint of the Blue Economy   | 4,362                             | 45,568         | 42,939                       | Blue Economy CRC                       |
| Tracey                | Developing a cost-effective monitoring regime and stock assessment for Sand Flathead in Tasmania   | 147,960                           | 127,733        | 237,096                      | FRDC                                   |
| Seger                 | The Detection of Ciguatera Toxins in NSW Spanish Mackerel  | 0                                 | 117,673        | 101,199                      |  |
| Lacharite             | Risks & Opportunities for the Blue Economy   | 13,061                            | 25,345         | 33,029                       | Blue Economy CRC                       |
| Trotter               | National Pacific Oyster Breeding Program: Completing POMS<br>Resistance in Spat and Transition to Selection for Traditional<br>Commercial Traits | 58,567                            | 130,832        | 162,883                      | FRDC                                   |
| Rust                  | Economic analysis for DST testing regimes  | 0                                 | 8,997          | 7,737                        | University of Technology<br>Sydney     |

| CHIEF<br>INVESTIGATOR        | PROJECT NAME   | TOTAL SMRCA<br>INVESTMENT<br>2021 | 2021<br>INCOME | 2021<br>IMAS/UTAS<br>IN-KIND | FUNDING<br>BODY                         |
|------------------------------|--|-----------------------------------|----------------|------------------------------|---|
| Stuart-Smith, J<br>(Trotter) | Red Handfish Conservation  | 0                                 | 45,455         | 39,091                       | Department of<br>Environment and Energy |
| Stuart-Smith, J<br>(Trotter) | Baby steps: head-starting captive juvenile Red handfish to urgently recover a wild population on the brink of extinction   | 5,805                             | 52,063         | 49,766                       | National Geographic<br>Society          |
| Semmens                      | Towards conservation of the vulnerable Melbourne Skate:<br>Assessing life-history and reproductive behaviour   | 0                                 | 2,000          | 1,720                        | Oceania Chondrichthyan<br>Society       |
| Hatton Mcdonald<br>(Ogier)   | Blue Economy Explorations of Risk using behavioural Economics  | 1,484                             | 41,067         | 36,594                       | Blue Economy CRC                        |
| Hadley                       | Giant Crab Enhanced Data Collection - Innovative approaches<br>to enhance data collection in the Victorian, South Australian<br>and Tasmanian Giant crab fisheries       | 32,475                            | 83,441         | 99,687                       | FRDC via VFA                            |
| Strain                       | Environmental Offsets Feasibility Assessment for the Live-<br>bearing Seastar Parvulastra vivipara at the Sorell Causeways   | 0                                 | 12,000         | 10,320                       | Pitt & Sherry                           |
| Blanchard<br>(MacLeod)       | Optimising feeds to support ecosystem-based aquaculture  | 31,357                            | 200,000        | 198,967                      | ARC                                     |
| Krueck                       | Improving assessment approaches for deep-water species   | 1,367                             | 10,500         | 10,206                       | CSIRO                                   |
| Trotter                      | Characterising shell development of the Pacific oyster using the novel application of nuclear technologies   | 0                                 | 4,102          | 3,528                        | Australian Seafood<br>Industries        |
| Keane                        | Stable isotopes: a rapid method to determine lobster diet and trace lobster origin?  | 40,553                            | 12,227         | 45,391                       | FRDC                                    |
| Turnbull                     | SafeFish 2021-2025   | 125,821                           | 364,920        | 422,038                      | FRDC                                    |
| Day                          | Wider investigation of the use of video survey techniques<br>to determine commercial scallop abundance in inshore and<br>offshore waters, closed areas and juvenile beds | 6,514                             | 35,000         | 35,702                       | FRDC                                    |
| Semmens                      | Life-history and Reproductive Behaviour of the Vulnerable<br>Melbourne Skate to Inform Fisheries Management and<br>Conservation  | 6,264                             | 6,375          | 10,870                       | Holsworth WRE                           |

| CHIEF<br>INVESTIGATOR | PROJECT NAME  | TOTAL SMRCA<br>INVESTMENT<br>2021 | 2021<br>INCOME | 2021<br>IMAS/UTAS<br>IN-KIND | FUNDING<br>BODY   |
|-----------------------|---|-----------------------------------|----------------|------------------------------|---|
| Day                   | Can novel seismic survey sources mitigate potential impacts to fisheries?   | 481,923                           | 518,212        | 860,116                      | FRDC  |
| Semmens               | Investigating the use of germ cell transplantation as an insurance tool for the conservation of the endangered Maugean Skate Zearaja maugeana | 30,686                            | 38,500         | 59,500                       | Winifred Violet Scott<br>Charitable Trust                   |
| Ziegler               | Science to support Australias Southern Ocean Fisheries 2021-2023  | 2,199                             | 222,000        | 192,811                      | FRDC  |
| Ugalde                | Assessing the effectiveness of artificial reefs and FADs in creating recreational opportunities for Tasmanias recreational fishers            | 47,335                            | 0              | 40,708                       | FRDC  |
| Mundy                 | Nutritional quality of kelp as a key driver of commercial abalone productivity  | 3,788                             | 186,712        | 163,830                      | AIRF  |
| Ogier                 | Tasmanian salmonid farming socio-economic assessment  | 0                                 | 50,000         | 43,000                       | NRE Tasmania  |
| Tracey                | FLOPPED Finding Large Oceanic Pelagic Predators<br>Environmental Distribution   | 8,340                             | 15,586         | 20,576                       | French Institute Search<br>Pour L'exploitation De<br>La Mer |
| Ogier                 | Human Dimensions Research Coordination Program 2021-<br>2024  | 0                                 | 70,000         | 60,200                       | FRDC  |
| Wright                | Seaweed Aquaculture Reviews   | 600,000                           |                | 516,000                      |   |
| Wright                | ARC: Seagrass Restoration   | 15,000                            |                | 12,900                       | ARC   |
| White                 | BE Biofouling Challenges and Possible Solutions   | 2,777                             | 50,224         | 45,581                       | Blue Economy CRC  |
| Gardner               | Responding to unintended consequences - evaluating changes to fisheries under ITQ systems   | 104,054                           | 88,227         | 165,362                      | FRDC  |
|                       | TOTAL SMRCA INVESTMENT  | 3,264,483                         | 8,755,085      | 10,336,828                   |   |

### **APPENDIX V RESEARCH GRANTS 2022**

| CHIEF<br>INVESTIGATOR | PROJECT NAME   | TOTAL SMRCA<br>INVESTMENT<br>2022 | 2022<br>INCOME | 2022<br>IMAS/UTAS<br>IN-KIND | FUNDING<br>BODY |
|-----------------------|--|-----------------------------------|----------------|------------------------------|-----------------|
| Tracey                | Understanding the movement, behaviour and post-release survival rate of recreationally caught Swordfish in Australia   | 0                                 | 8,055          | 6,927                        | VFA             |
| Keane                 | Fisheries biology of short-spined sea urchins (Heliocidaris erythrogramma) in Tasmania   | 0                                 | 23,087         | 19,855                       | FRDC            |
| Hallegraeff           | Improved risk management of paralytic shellfish toxins in Southern Rock Lobster  | 16,880                            | 70,000         | 74,717                       | FRDC            |
| Mundy                 | Can spatial fishery-dependent data be used to determine stock status in a spatially structured fishery?  | 1,672                             | 77,925         | 68,453                       | FRDC            |
| Alexander             | Aquaculture-Community Futures: North West Tasmania   | 0                                 | 1,020          | 877                          | FRDC            |
| MacLeod               | CRC Project: Seaweed solutions for sustainable aquaculture   | 44,160                            | 304,603        | 299,936                      | DollS           |
| Tracey                | Opportunities and impacts of range extending scalefish species   | 0                                 | 77,587         | 66,725                       | FRDC            |
| Hartmann              | Victorian Rock Lobster and Giant Crab Assessments 2019-2021  | 16,100                            | 172,148        | 161,893                      | VFA             |
| Ross                  | Storm Bay Observing System: Assessing the Performance of<br>Aquaculture Development  | 207,813                           | 1,121,459      | 1,143,174                    | FRDC            |
| Semmens               | Examining the potential impacts of seismic surveys on octopus and larval stages of Southern Rock Lobster   | 0                                 | 117,356        | 100,926                      | FRDC            |
| Lyle                  | Socio-economic characterisation of a small scale commercial fishery: opportunities to improve viability and profitability in the Tasmanian Scalefish Fishery | 37,881                            | 62,715         | 86,512                       | FRDC            |
| Keane                 | Commercial upscaling of urchin fertiliser  | 0                                 | 242,361        | 208,430                      | AIRF            |
| Semmens               | Understanding population structure and dynamics of<br>Victoria's developing Octopus fishery  | 19,641                            | 101,602        | 104,269                      | FRDC            |

| CHIEF<br>INVESTIGATOR | PROJECT NAME   | TOTAL SMRCA<br>INVESTMENT<br>2022 | 2022<br>INCOME | 2022<br>IMAS/UTAS<br>IN-KIND | FUNDING<br>BODY                        |
|-----------------------|--|-----------------------------------|----------------|------------------------------|--|
| Fitzgibbon            | Improving the Southern Rock Lobster on-vessel handling practices, data collection and industry tools for lobster quality assessment  | 108,622                           | 183,039        | 250,829                      | FRDC                                   |
| Lyle                  | Integrating recreational fishing information into harvest strategies for multi-sector fisheries  | 1,457                             | 6,797          | 7,098                        | FRDC/NSW DPI                           |
| Mundy                 | Drawing strength from each other - Simulation testing of<br>Australia's abalone harvest strategies   | 0                                 | 124,430        | 107,010                      | FRDC                                   |
| Turnbull              | Field validation of the Neogen rapid screening paralytic shellfish toxin test kit for abalone foot   | 5,217                             | 0              | 4,487                        | NRE Tasmania                           |
| Turnbull              | Assessing the risk of pathogenic vibrio species in Tasmanian oysters   | 3,892                             | 3,420          | 6,288                        | SARDI                                  |
| Turnbull              | Risk profile for the paralytic shellfish toxins from Alexandrium catenella in Tasmanian sea urchins  | 10,444                            | 16,580         | 23,241                       | NRE Tasmania                           |
| Ross                  | Macquarie Harbour String Maintenance – Rolling agreement   | 0                                 | 52,302         | 44,980                       | TSGA                                   |
| Cresswell             | Larval dispersal for Southern Rock Lobster and Longspined sea urchin to support management decisions   | 64,883                            | 84,245         | 128,250                      | FRDC                                   |
| Ugalde                | Blue economy: Valuing the carbon sequestration potential in oyster aquaculture   | 14,691                            | 69,973         | 72,811                       | ACIAR                                  |
| Keane                 | Lose home or eat more: comparative prey choice and consumption of different rock lobster species on barren forming sea urchins   | 4,166                             | 0              | 3,583                        | Holsworth WRE                          |
| Tracey                | Evaluation of a smart-phone application to collect recreational<br>fishing catch estimates, including an assessment against an<br>independent probability based survey, using South Australia<br>as a case study | 0                                 | 111,739        | 96,096                       | FRDC                                   |
| Gardner               | Utilising Furneaux abalone quota for the benefit of Tasmania's Indigenous community Phase 1  | 0                                 | 21,514         | 18,502                       | Indigenous Land and Sea<br>Corporation |
| Swarts (Keane)        | FRDC Sea Urchin Fertiliser Project   | 3,859                             | 97,498         | 87,167                       | FRDC                                   |

| CHIEF<br>INVESTIGATOR        | PROJECT NAME   | TOTAL SMRCA<br>INVESTMENT<br>2022 | 2022<br>INCOME | 2022<br>IMAS/UTAS<br>IN-KIND | FUNDING<br>BODY                |
|------------------------------|--|-----------------------------------|----------------|------------------------------|--------------------------------|
| Ugalde                       | Contextualising shellfish food safety in Northern Australia  | 24,740                            | 40,000         | 55,676                       | FRDC                           |
| Turnbull                     | SafeFish extension - lobsters  | 0                                 | 30,000         | 25,800                       | FRDC                           |
| Keane                        | Understanding Centrostephanus Age, Growth and Size of Maturity   | 0                                 | 11,274         | 9,696                        | AIRF                           |
| Alexander                    | Tasmania's Marine Atlas  | 67,543                            | 158,817        | 194,670                      | FRDC                           |
| McAllister                   | Effect of temperature on abalone condition as a function of season, location and rate of change.   | 7,814                             | 112,643        | 103,592                      | AIRF                           |
| Ross                         | A novel approach to measuring the depositional footprint of the Blue Economy   | 95,445                            | 33,140         | 110,583                      | Blue Economy CRC               |
| Tracey                       | Developing a cost-effective monitoring regime and stock assessment for Sand Flathead in Tasmania   | 16,845                            | 172,024        | 162,427                      | FRDC                           |
| Seger                        | The Detection of Ciguatera Toxins in NSW Spanish Mackerel  | 0                                 | 93,343         | 80,275                       |                                |
| Lacharite                    | Risks & Opportunities for the Blue Economy   | 7,037                             | 17,425         | 21,037                       | Blue Economy CRC               |
| Trotter                      | National Pacific Oyster Breeding Program: Completing POMS<br>Resistance in Spat and Transition to Selection for Traditional<br>Commercial Traits                   | 79,416                            | 46,778         | 108,527                      | FRDC                           |
| Stuart-Smith, J<br>(Trotter) | Baby steps: head-starting captive juvenile Red handfish to urgently recover a wild population on the brink of extinction   | 41,321                            | 0              | 35,536                       | National Geographic<br>Society |
| Hatton Mcdonald<br>(Ogier)   | Blue Economy Explorations of Risk using behavioural Economics  | 1,529                             | 29,867         | 27,000                       | Blue Economy CRC               |
| Hadley                       | Giant Crab Enhanced Data Collection - Innovative approaches<br>to enhance data collection in the Victorian, South Australian<br>and Tasmanian Giant crab fisheries | 36,121                            | 32,402         | 58,930                       | FRDC via VFA                   |
| Carter                       | The effects of sustained swimming on long-term changes to Chinook salmon form and composition  | 3,363                             | 14,000         | 14,932                       | Blue Economy CRC               |
| Strain                       | Environmental Offsets Feasibility Assessment for the Live-<br>bearing Seastar Parvulastra vivipara at the Sorell Causeways   | 0                                 | 9,883          | 8,499                        | Pitt & Sherry                  |

| CHIEF<br>INVESTIGATOR | PROJECT NAME   | TOTAL SMRCA<br>INVESTMENT<br>2022 | 2022<br>INCOME | 2022<br>IMAS/UTAS<br>IN-KIND | FUNDING<br>BODY   |
|-----------------------|--|-----------------------------------|----------------|------------------------------|---|
| Trotter               | Characterising shell development of the Pacific oyster using the novel application of nuclear technologies   | 0                                 | 4,102          | 3,528                        | Australian Seafood<br>Industries Pty Ltd                    |
| Keane                 | Stable isotopes: a rapid method to determine lobster diet and trace lobster origin?  | 12,774                            | 19,663         | 27,896                       | FRDC  |
| Turnbull              | SafeFish 2021-2025   | 128,614                           | 412,158        | 465,064                      | FRDC  |
| Day                   | Wider investigation of the use of video survey techniques<br>to determine commercial scallop abundance in inshore and<br>offshore waters, closed areas and juvenile beds | 99,330                            | 170,033        | 231,652                      | FRDC  |
| Krueck                | Assessing the spawning characteristics and reproductive biology of pearl perch (Glaucosoma scapulare) in Queensland  | 5,459                             | 7,500          | 11,144                       | Queensland Department of Fisheries                          |
| Semmens               | Life-history and Reproductive Behaviour of the Vulnerable<br>Melbourne Skate to Inform Fisheries Management and<br>Conservation  | 3,132                             | 0              | 2,694                        | Holsworth WRE   |
| Day                   | Can novel seismic survey sources mitigate potential impacts to fisheries?  | 197,026                           | 601,990        | 687,154                      | FRDC  |
| Semmens               | Investigating the use of germ cell transplantation as an insurance tool for the conservation of the endangered Maugean Skate Zearaja maugeana                            | 31,137                            | 0              | 26,778                       | Winifred Violet Scott<br>Charitable Trust                   |
| Ugalde                | Assessing the effectiveness of artificial reefs and FADs in creating recreational opportunities for Tasmanias recreational fishers                                       | 47,335                            | 233,500        | 241,518                      | FRDC  |
| Mundy                 | Nutritional quality of kelp as a key driver of commercial abalone productivity   | 11,616                            | 95,571         | 92,181                       | AIRF (NRE Tasmania)   |
| Ogier                 | Tasmanian salmonid farming socio-economic assessment   | 0                                 | 5,000          | 4,300                        | NRE Tasmania  |
| Tracey                | FLOPPED Finding Large Oceanic Pelagic Predators<br>Environmental Distribution  | 323                               | 8,969          | 7,991                        | French Institute Search<br>Pour L'exploitation De<br>La Mer |

| CHIEF<br>INVESTIGATOR | PROJECT NAME  | TOTAL SMRCA<br>INVESTMENT<br>2022 | 2022<br>INCOME | 2022<br>IMAS/UTAS<br>IN-KIND | FUNDING<br>BODY  |
|-----------------------|---|-----------------------------------|----------------|------------------------------|--|
| Ogier                 | Human Dimensions Research Coordination Program 2021-<br>2024  | 0                                 | 100,000        | 86,000                       | FRDC   |
| Ogier                 | Impacts of COVID19 on the Australian Seafood Industry:<br>Extending the assessment to prepare for uncertain futures<br>(2021-042)         | 5,125                             | 139,564        | 124,433                      | FRDC   |
| Gardner               | Responding to unintended consequences – evaluating changes to fisheries under ITQ systems   | 108,027                           | 198,844        | 263,909                      | FRDC   |
| Strain                | Assessing the use of different benthic imagery techniques for monitoring the effects of organic pollution on deep reefs                   | 0                                 | 6,750          | 5,805                        | Holsworth WRE  |
| Tracey                | Tuna Champions v2.0 Bluefin and beyond  | 28,832                            | 400,000        | 368,796                      | FRDC   |
| Trotter               | Seastar captivity trial   | 21,657                            | 0              | 18,625                       | NRE Tasmania   |
| White                 | BE Biofouling Challenges and Possible Solutions   | 27,258                            | 27,000         | 46,662                       | Blue Economy CRC   |
| Stuart-Smith, J       | Red Handfish Conservation 2022  | 41,912                            | 124,295        | 142,938                      | Department of<br>Agriculture, Water and<br>the Environment |
| Lacharite             | Marine Spatial Planning for a Blue Economy  | 18,014                            | 110,338        | 110,382                      | Blue Economy CRC   |
| Bennett (Strain)      | Upscaling the restoration of endangered giant kelp forests in Tasmania  | 0                                 | 185,663        | 159,670                      | Sea Forest Foundation                                      |
| Ugalde                | Review of regulation and policy guiding use of artificial reefs and Fish Aggregating Devices (FAD) in Australian waters                   | 10,000                            | 10,000         | 17,200                       | FRDC   |
| Trotter               | Developing the tools and articulating the value proposition for genomic selection in Pacific oyster selective breeding                    | 198,967                           | 185,485        | 330,629                      | FRDC   |
| Phillips              | The multiple values attained through partially protected areas  | 43,819                            | 13,706         | 49,472                       | FRDC   |
| Lacharite             | Planning for seaweed aquaculture in Tasmania: A preliminary evaluation of biophysical potential and co-location with existing aquaculture | 9,682                             | 65,000         | 64,226                       | NRE Tasmania   |
| Seger                 | Risk profile for paralytic shellfish toxins in Tasmanian<br>Periwinkles   | 32,760                            | 60,000         | 79,774                       | FRDC   |

| CHIEF<br>INVESTIGATOR | PROJECT NAME  | TOTAL SMRCA<br>INVESTMENT<br>2022 | 2022<br>INCOME | 2022<br>IMAS/UTAS<br>IN-KIND | FUNDING<br>BODY  |
|-----------------------|---|-----------------------------------|----------------|------------------------------|------------------|
| Turnbull              | Building capability in food safety in Australian shellfish  | 67,827                            | 104,661        | 148,340                      | FRDC             |
| Rust                  | Profile of recreational fishers in Tasmania: understanding experiences, behaviours, drivers, communication needs and change factors                       | 3,993                             | 28,225         | 27,708                       | NRE Tasmania     |
| Ward                  | Estimating the spawning fraction of Blue Mackerel off eastern<br>Australia: Stage 1 Developing a sampling method(s) and<br>identifying sampling locations | 7,593                             | 167,353        | 150,454                      | AFMA             |
| Ward                  | Monitoring and assessment of SPF quota species 2022-24  | 4,083                             | 78,449         | 70,978                       | AFMA             |
| Rust                  | Social-economic analysis of the Tasmanian Commercial Dive Fishery   | 15,198                            | 62,384         | 66,720                       | NRE Tasmania     |
| McAllister            | Building capacity to infer shell length from abalone meat samples   | 0                                 | 31,420         | 27,021                       | TAC              |
| McAllister            | Development of a field sampling tool for improving in situ length-based data capture methods for abalone fishery surveys                                  | 0                                 | 48,390         | 41,615                       | TAC              |
| McAllister            | Expanding the Commercial Catch length frequency data program across the Tasmanian abalone fishery: Part B. Diver Measuring Boards                         | 0                                 | 53,460         | 45,976                       | TAC              |
| McAllister            | Expanding the Commercial Catch length frequency data program across the Tasmanian abalone fishery: Part A - Factory Measuring Boards                      | 0                                 | 48,390         | 41,615                       | TAC              |
| Trotter               | Opportunities and challenges for the Oyster Industry in the Blue Economy  | 10,225                            | 5,341          | 13,387                       | Blue Economy CRC |
| Turnbull              | Abalone biotoxin response 2022  | 0                                 | 10,000         | 8,600                        | TAC              |
| Wright                | Seaweed Aquaculture Reviews   | 600,000                           |                | 516,000                      |                  |
| Wright                | ARC: Seagrass Restoration   | 15,000                            |                | 12,900                       | ARC              |
|                       | TOTAL SMRCA INVESTMENT  | 3,066,569                         | 9,237,867      | 10,581,815                   |                  |

### **APPENDIX VI PUBLICATIONS & PRESENTATIONS 2021 & 2022**

#### **Reports**

Broadhurst, M and Earl, J and Duffy, R and Krueck, N, Black Bream *Acanthopagrus butcheri* (2020), Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021)

Broadhurst, M and Krueck, N and Roelofs, A, "Luderick *Girella tricuspidata* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021)

Cresswell, K and Hartmann, K and Gardner, C and Keane, J, Tasmanian Longspined Sea Urchin Fishery Assessment 2020/21, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania (2022)

Day, R.D., Fitzgibbon, Q.P., McCauley, R.D. and Semmens, J.M. (2021). The Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania. Examining the potential impacts of seismic surveys on Octopus and larval stages of Southern Rock Lobster - PART A: Southern Rock Lobster. FRDC project 2019-051. 2021.

Earl, J and Duffy, R and Krueck, N, "Greenback Flounder *Rhombosolea tapirina* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021) Emery, T and Liggins, G and Krueck, N, "Jackass Morwong *Nemadactylus macropterus* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021)

Emery, T and Liggins, G and Krueck, N, "Redfish *Centroberyx affinis* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021)

Emery, T and Liggins, G and Krueck, N, "Tiger Flathead *Platycephalus richardsoni* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021)

Evans, K and Grewe, P and Foster, S and Gunasekera, R and Lansdell, M and Meredith, S and Sarau, S and Tracey, S and Wichman, M, "Connectivity of broadbill swordfish targeted by the Australian Eastern Tuna and Billfish Fishery with the broader Western Pacific Ocean", Seventeenth regular session of the Western and Central Pacific Fisheries Commission Scientific Committee, SC17-SA-SA-IP-12 (2021)

Fowler, A and Chick, RC and Krueck, N and Fairclough, D and Emery, T and Roelofs, A and Fisher, E , "Silver Trevallies *Pseudocaranx georgianus, Pseudocaranx sp.* 'dentex' & *Pseudocaranx wrighti, Pseudocaranx dinjerra* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021)

Fraser, K and Hartmann, K, Krueck, N, and Haddy, J, Tasmanian Scalefish Fishery Assessment 2021/21, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, August (2022)

Fraser, K and Hartmann, K and Krueck, N, Tasmanian Scalefish Fishery Assessment 2019/20, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, August (2021)

Gardner, C and Ogier, EM and Rust, SA and Hartmann, K and Leon, RI, "IMAS Submission to the Senate Inquiry on ITQs", Australian Senate, Hobart, Tasmania, 11 March (2021)

Graba-Landry, A, Lyle, JM and Ewing, F and Ewing, G and Tracey, S, "Tasmanian Recreational Rock Lobster and Abalone Fisheries: 2021-2022 Fishing Season", Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, November (2022)

Hall, K and Emery, T and Krueck, N, "Eastern School Whiting *Sillago flindersi* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021) Hill, N and Krueck, N and Hartmann, K, Tasmanian Octopus Fishery Assessment 2021/22, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, January (2022)

Keane, J, "2021 Small bivalve fishery assessment: *Katelysia scalarina* - Ansons Bay", Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, December (2021)

Keane, J, "2021 Small bivalve fishery assessment: *Ostrea angasi* - Georges Bay", Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, August (2021)

Keane, JP, "Resetting urchin barrens: liming as a rapid widespread urchin removal tool", Final contracted report for the Abalone Industry Reinvestment Fund (AIRF Project 2019-21), Institute for Marine and Antarctic Studies, November (2021)

Keane, JP and Campus, P and Swarts, N, "Waste to profit in urchin fisheries: developing business opportunities to ensure fishery sustainability and safeguard reef dependent fisheries from destructive urchin grazing", Fisheries Research and Development Corporation, Australia, FRDC Project No 2016-208, October (2021)

Krueck, N and Fowler, A and Hughes, J, "Bluethroat Wrasse *Notolabrus tetricus* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021) Krueck, N and Hall, K and Noriega, R and Drew, M, "Southern Calamari *Sepioteuthis australis* (2020)", Status of Australian Fish Stocks Report, Fisheries Research and Development Corporation, Canberra (2021)

Krueck, N and Hill, N and Hartmann, K and Fraser, K, Tasmanian Octopus Fishery Assessment 2019/20, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, February (2021)

Krueck, N and Rogers, P and Hill, N and Hall, K, "Pale Octopus *Octopus pallidus* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021)

Krueck, N and Smoothey, A and Emery, T and Drew, M, "Bastard Trumpeter *Latridopsis forsteri* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021)

Krueck, N and Stewart, J and Lewis, P and Steer, M, "Snook *Sphyraena novaehollandiae* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021)

Lacharite, M and Ross, J and Adams, VM and Bush, FB and Byers, R, Statewide Finfish Aquaculture Spatial Planning Exercise: Investigating growth opportunities for finfish aquaculture in Tasmanian coastal waters, IMAS Technical Report, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, December (2021) Lucieer, V and Keane, J and Shelamoff, V and Nau, A and Ling, S, Mapping abalone habitat impacted by Centrostephanus on the east coast of Tasmania: Final contracted report for the Abalone Industry Reinvestment Fund (AIRF Project 2021) and Tasmanian Climate Change Office (Climate Research Grants Program 2021), Institute for Marine and Antarctic Studies, UTAS, December (2021)

Ling, S and Keane, J, IMAS Submission to the Senate Inquiry into Climate-Related Marine Invasive Species", Australian Senate, Hobart, Tasmania, October (2022)

Ling, S and Keane, J, Decadal resurvey of long-term lobster experimental sites to inform *Centrostephanus* control, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, August (2021)

Lyle, JM and Ewing, F and Ewing, G and Tracey, S, "Tasmanian Recreational Rock Lobster and Abalone Fisheries: 2020-2021 Fishing Season", Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, July (2021)

Lyle, JM, "Fishing for Atlantic salmon: inferences about dispersal, survival and ecological impacts following two large-scale escape events", Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, December (2021)

Lyle, J and Krueck, N and Stacy, B, "Banded Morwong *Cheilodactylus spectabilis* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021) McCoubrey, D-J and Turnbull, A, Assessing the risk of marine biotoxins in Tasmanian commercial shellfish, Milestone Report No. 2, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, June (2021)

McDonald, J, Gardner, C, and Feehely F, The risks and benefits of a Deed of Agreement for the Tasmanian Rock Lobster Fishery, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, May (2021)

Moreno, D, Patil, J, Deagle, B and Semmens, JM, Application of environmental DNA to survey Bathurst Harbour (Tasmania) for the Endangered Maugean Skate, August (2022)

Mundy, C and McAllister, J, Tasmanian Abalone Fishery Assessment 2021, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania May (2022)

Mundy, C and McAllister, J, Tasmanian Abalone Fishery Assessment 2021, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania June (2021)

Noriega, R and Krueck, N and Hall, K, "Gould's Squid *Nototodarus gouldi* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021)

Norriss, J and Moore, A and Krueck, N and Rogers, P, "Bight Redfish *Centroberyx gerrardi* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021) Norriss, J and Blake, S and Bailleul, F and Smoothey, A and Krueck, N, "Blue Morwong *Nemadactylus valenciennesi* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021)

Norriss, J and Krueck, N and Rogers, P, "Southern Sand Flathead *Platycephalus bassensis* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021)

Ross, J and Beard, J and Wild-Allen, K and Andrewartha, J and Stehfest, K and Durand, A and Semmens, JM and Davey, A and Hortle, JA and Pender, AJ and Quigley, BT and MacLeod, CK and Moreno, DA, Understanding oxygen dynamics and the importance for benthic recovery in Macquarie Harbour, Fisheries Research and Development Corporation, Australia, March, FRDC 2016/067 (2021)

Ross, J and Macleod, C and White, C and Hadley, SA and Moreno, DA and Bush, FB and Barrett, NS, Managing ecosystem interactions across differing environments: building flexibility and risk assurance into environmental management strategies, Fisheries Research and Development Corporation, Australia, December, FRDC 2015/024 (2021)

Ross, J and Moreno, DA and Bell, JD and Mardones, J and Beard, J, Assessment of the Macquarie Harbour Broadscale Environmental Monitoring Program (BEMP) data from 2011-2020, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, March (2022) Ross, J and Strain, E, "Annual Broadscale Environmental Monitoring Program – Environmental License 10180/1 Marine Farming Lease No. 281 at Yellow Bluff 2019/2020", Report to Huon Aquaculture Company Pty Ltd, August (2021)

Seger, A and Dowsett, N and Turnbull, AR, "*Ciguatera* (fish) Poisoning in Australia Frequently Asked Questions", Fisheries Research Development Corporation, Australia (2021)

Seger, A and Turnbull, A, "Milestone report - 2020 monitoring of paralytic shellfish toxins in abalone tissues on the east coast of Tasmania", Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, 02 February (2021)

Seger, A and Turnbull, A, "Milestone report - 2020 monitoring of paralytic shellfish toxins in sea urchins on the east coast of Tasmania", Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, 26 February (2021)

Seger, A and Turnbull, A, "Raising awareness of ciguatera fish poisoning in Australia: a survey of recreational fishers", Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, 31 March (2021)

Smoothey, A and Krueck, N and Fowler, A and Emery, T , "Ocean Jacket *Nelusetta ayraudi* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021) Stacy, B and Krueck, N, Tasmanian Banded Morwong Fishery Assessment 2021/22, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, August (2022)

Stacy, B and Krueck, N, Tasmanian Banded Morwong Fishery Assessment 2020/21, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, February (2022)

Stewart, J and Krueck, N, "Eastern Australian Salmon *Arripis trutta* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021)

Stuart-Smith, J and Lynch, T and McEnnulty, F and Green, M and Devine, C and Trotter, AJ and Bessell, T and Wong, L and Hale, P and Martini, A and Stuart-Smith, R and Barrett, N, "Conservation of handfishes and their habitats - Final Report 2020", Project A10 – Conservation of handfishes and their habitats, Report to the National Environmental Science Program, Marine Biodiversity Hub, University of Tasmania, Hobart, Milestone 13, April (2021)

Tracey, S and Wolfe, B, Satellite tagging of swordfish *Xiphias gladius* caught by the recreational fishery in southeast Victoria, Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, July (2022)

Twiname, S and Lyle, JM and Pearn, R and Tracey, S and Hartmann, K and Krueck, N, Options to effectively monitor and regulate recreational catch in the Tasmanian rock lobster fishery, Fisheries Research and Development Corporation, Institute for Marine and Antarctic Studies, UTAS, FRDC 2019/183 (2022)

White, C, Hartog, M, Brasier, M, and Ross, J "Rapid visual assessment surveys on rocky reef assemblages in Port Arthur", Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, February (2022)

White, C and Brasier, M, "Rapid visual assessment surveys on rocky reefs in the Derwent Estuary", Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, May (2021)

White, C, McAllister, J, Johnson, O, Mundy, C and Ross, J, Assessment of reef condition in the southern D'Entrecasteaux Channel, Institute for Marine and Antarctic Studies, University of Tasmania, March (2021)

Woodhams, J and Krueck, N and Peddemors, V, "*Elephantfish Callorhinchus milii* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021)

Woodhams, J and Braccini, M and Krueck, N and Peddemors, V and Rogers, P, "Sawsharks *Pristiophorus spp.* (2020)", Status of Australian Fish Stocks Report 2020, Fisheries Research and Development Corporation, Canberra (2021) Ziegler, PE and Burch, P and Peron, C and Welsford, DC and Farmer, BM and Yates, PM and Potts, JM and Woodcock, EJ and Barnes, TC and Duhamel, G and Gardner, C, "Development of robust assessment methods and harvest strategies for spatially complex, multi-jurisdictional Toothfish fisheries in the Southern Ocean - Final Report", Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, Tasmania, February, FRDC No. 2013/013 (2021)

## Papers, books and book chapters

Abduh, MY and Koh, ICC and Abol-Munafi, A and Norazmi-Lokman, NH and Noordin, NM, "Effects of dietary fish oil and corn oil on gonadosomatic and hepatosomatic index, gonadal histology, 17 -oestradiol level and fatty acids profile of mahseer *Tor tambroides* broodstock in captivity", Aquaculture Nutrition, 27 (5) pp. 1448-1459. (2021)

Adams, LW and Morris, RL and Hull, RB and Dempster, T and Strain, EMA, "Making marinas bivalve friendly for enhanced biodiversity outcomes", Marine Pollution Bulletin, 169 Article 112464. (2021)

Alfaro, AC and Nguyen, TV and Venter, L and Ericson, JA and Sharma, S and Ragg, NLC and Mundy, C, The effects of live transport on metabolism and stress responses of abalone *Haliotis iris*, Metabolites, 11, (11) Article 748. (2021)

Ajani, PA and Sarowar, C and Turnbull, A and Farrell, H and Zammit, A and Helleren, S and Hallegraeff, G and Murray, SA, "A comparative analysis of methods (LC-MS/MS, LC-MS and rapid test kits) for the determination of diarrhetic shellfish toxins in oysters, mussels and pipis", Toxins, 13 (8) Article 563. (2021)

Alexander, KA and Fleming, A and Bax, N and Garcia, C and Jansen, J and Maxwell, KH and Melbourne-Thomas, J and Mustonen, T and Pecl, GT and Shaw, J and Syme, G and Ogier, E, "Equity of our future oceans: practices and outcomes in marine science research", Reviews in Fish Biology and Fisheries, 32 pp. 297-311. (2021)

Awruch, CA and Bell, JD and Semmens, JM and Lyle, JM, "Life history traits and conservation actions for the Maugean skate *Zearaja maugeana*, an endangered species occupying an anthropogenically impacted estuary", Aquatic Conservation, 31 (8) pp. 2178-2192. (2021)

Baker, KG and Geider, RJ, Phytoplankton mortality in a changing thermal seascape, Global Change Biology, 27, (20) pp. 5253-5261. (2021)

Basford, AJ and Makings, N and Mos, B and White, CA and Dworjanyn, S, Greenwater, but not live feed enrichment, promotes development, survival, and growth of larval *Portunus armatus*, Aquaculture, 534 Article 736331. (2021)

Bax, N and Novaglio, C and Maxwell, KH and Meyers, K and McCann, J and Jennings, S and Frusher, S and Fulton, EA and Nursey-Bray, M and Fischer, M and Anderson, K and Layton, C and Emad, GR and Alexander, KA and Rousseau, Y and Lunn, Z and Carter, CG, Ocean resource use: building the coastal blue economy, Reviews in Fish Biology and Fisheries, 32 pp. 189-207. (2021)

Britton, D and Mundy, CN and Noisette, F and McGraw, CM and Hurd, CL, "Crustose coralline algae display sensitivity to near future global ocean change scenarios", ICES Journal of Marine Science, 78 (10) Article fsab220. (2021)

Britton, D and Schmid, M and Revill, AT and Virtue, P and Nichols, PD and Hurd, CL and Mundy, CN, "Seasonal and site-specific variation in the nutritional quality of temperate seaweed assemblages: implications for grazing invertebrates and the commercial exploitation of seaweeds", Journal of Applied Phycology, 33 pp. 603-616. (2021)

Choi, HK and Jang, JE and Byeon, SY and Kim, YR and Maschette, D and Chung, S and Choi, SG and Kim, HW and Lee, HJ, Genetic diversity and population structure of the Antarctic toothfish, *Dissostichus mawsoni*, using mitochondrial and microsatellite DNA markers, Frontiers in Marine Science, 8 Article 666417. (2021)

Chuku, EO and Effah, E and Adotey, J and Abrokwah, S and Adade, R and Okyere, I and Aheto, DW and Kent, K and Osei, IK and Omogbemi, ED and Adite, A and Ahoedo, K and Sankoh, SK and Soro, Y and Wele, M and Saine, DF and Crawford, B, Spotlighting women-led fisheries livelihoods toward sustainable coastal governance: the estuarine and mangrove ecosystem shellfisheries of West Africa, Frontiers in Marine Science, 9 Article 884715. (2022) Coleman, MA and Reddy, M and Nimbs, MJ and Marshell, A and Al-Ghassani, SA and Bolton, JJ and Jupp, BP and De Clerck, O and Leliaert, F and Champion, C and Pearson, GA and Serrao, EA and Madeira, P and Wernberg, T, Loss of a globally unique kelp forest from Oman, Scientific Reports, 12 Article 5020. (2022)

Condie, CM and Vince, J and Alexander, KA, The long-term evolution of news media in defining socio-ecological conflict: a case study of expanding aquaculture, Marine Policy, 138 Article 104988. (2022)

Condie, CM and Vince, JZ and Alexander, KA, "Increasing polarisation in attitudes to aquaculture: Evidence from sequential government inquiries", Marine Policy, 136 pp. 1-8. (2021)

Cullen-Knox, C and Fleming, A and Lester, L and Ogier, E, "Perceiving environmental science, risk and industry regulation in the mediatised vicious cycles of the Tasmanian salmon aquaculture industry", Social Epistemology, 35 (5) pp. 441-460. (2021)

Dennis, JD and Grammer, G and Ward, T and Smart, J and Huveneers, C, Using otolith chronologies to identify extrinsic drivers of growth of 2 commercially targeted small pelagic fish species, Fishery Bulletin, 119, (2-3) pp. 135-148. (2021) DiBattista, JD and Berumen, ML and Priest, MA and De Brauwer, M and Coker, DJ and Sinclair-Taylor, TH and Hay, A and Bruss, G and Mansour, S and Bunce, M and Goatley, CHR and Power, M and Marshell, A, Environmental DNA reveals a multi-taxa biogeographic break across the Arabian Sea and Sea of Oman, Environmental DNA, 4, (1) pp. 206-221. (2022)

Dodds, KC and Schaefer, N and Bishop, MJ and Nakagawa, S and Brooks, PR and Knights, AM and Strain, EMA, Material type influences the abundance but not richness of colonising organisms on marine structures, Journal of Environmental Management, 307 Article 114549. (2022)

Farmery, AK and Alexander, K and Anderson, K and Blanchard, JL and Carter, CG and Evans, K and Fischer, M and Fleming, A and Frusher, S and Fulton, EA and Haas, B and MacLeod, CK and Murray, L and Nash, KL and Pecl, GT and Rousseau, Y and Trebilco, R and Van Putten, IE and Mauli, S and Dutra, L and Greeno, D and Kaltavara, J and Watson, R and Nowak, B, Food for all: designing sustainable and secure future seafood systems, Reviews in Fish Biology and Fisheries, 32 pp. 101-121. (2022)

Fowler, AM and Ochwada-Doyle, FA and Dowling, NA and Folpp, H and Hughes, JM and Lowry, MB and Lyle, JM and Lynch, TP and Miles, NG and Chick, RC, Integrating recreational fishing into harvest strategies: linking data with objectives, ICES Journal of Marine Science, 79, (2) pp. 285-307. (2022) Fu, F-X and Tschitschko, B and Hutchins, DA and Larsson, ME and Baker, KG and McInnes, A and Kahlke, T and Verma, A and Murray, SA and Doblin, MA, Temperature variability interacts with mean temperature to influence the predictability of microbial phenotypes, Global Change Biology, 28, (19) pp. 5741-5754. (2022)

Fudge, M and Alexander, K and Ogier, E and Leith, P and Haward, M, "A critique of the participation norm in marine governance: bringing legitimacy into the frame", Environmental Science and Policy, 126 pp. 31-38. (2021)

Gabriel, SM and Patterson, TA and Eveson, JP and Semmens, JM and Harasti, D and Butcher, PA and Spaet, JLY and Bradford, RW, Determining effective acoustic array design for monitoring presence of white sharks Carcharodon carcharias in nearshore habitats, Marine Biology, 168, (4) Article 49 (2021)

Graham, TDJ and Morris, RL and Strain, EMA and Swearer, SE, Identifying key factors for transplantation success in the restoration of kelp *Ecklonia radiata* beds, Restoration Ecology, 30, (4) Article e13536. (2021)

Green, ME and Appleyard, SA and White, WT and Tracey, SR and Heupel, MR and Ovenden, JR, Updated connectivity assessment for the scalloped hammerhead *Sphyrna lewini* in Pacific and Indian Oceans using a multi-marker genetic approach, Fisheries Research, 251 Article 106305. (2022) Haas, B and Mackay, M and Novaglio, C and Fullbrook, L and Murunga, M and Sbrocchi, C and McDonald, J and McCormack, PC and Alexander, K and Fudge, M and Goldsworthy, L and Boschetti, F and Dutton, I and Dutra, L and McGee, J and Rousseau, Y and Spain, E and Stephenson, R and Vince, J and Wilcox, C and Haward, M, The future of ocean governance, Reviews in Fish Biology and Fisheries, 32 pp. 253-270. (2021)

Harding, L and Jackson, A and Barnett, A and Donohue, I and Halsey, L and Huveneers, C and Meyer, C and Papastamatiou, Y and Semmens, JM and Spencer, E and Watanabe, Y and Payne, NL, Endothermy makes fishes faster but does not expand their thermal niche, Functional Ecology, 35, (9) pp. 1951-1959. (2021)

Harlock, M and Quinn, S and Turnbull, AR, Emergence of non-choleragenic Vibrio infections in Australia, Communicable Diseases Intelligence, 46 pp. 1-7. (2022)

Hazreen-Nita, MK and Abdul Kari, Z and Mat, K and Rusli, ND and Mohamad Sukri, SA and Che Harun, H and Lee, SW and Rahman, MM and Norazmi-Lokman, NH and Nur-Nazifah, M and Firdaus-Nawi, M and Dawood, MAO, Olive oil by-products in aquafeeds: opportunities and challenges, Aquaculture Reports, 22 Article 100998. (2022)

Hook, SE and White, C and Ross, DJ, A metatranscriptomic analysis of changing dynamics in the plankton communities adjacent to aquaculture leases in southern Tasmania, Australia, Marine Genomics, 59 Article 100858. (2021) Huveneers, C and Jaine, FRA and Barnett, A and Butcher, PA and Clarke, TM and Currey-Randall, LM and Dwyer, RG and Ferreira, LC and Gleiss, AC and Hoenner, X and lerodiaconou, D and Ledee, EJI and Meekan, MG and Pederson, H and Rizzari, JR and van Ruth, PD and Semmens, JM and Taylor, MD and Udyawer, V and Walsh, P and Heupel, MR and Harcourt, R, The power of national acoustic tracking networks to assess the impacts of human activity on marine organisms during the COVID-19 pandemic, Biological Conservation, 256 Article 108995. (2021)

Kelly, R and Evans, K and Alexander, K and Bettiol, S and Corney, S and Cullen-Knox, C and Cvitanovic, C and de Salas, K and Emad, GR and Fullbrook, L and Garcia, C and Ison, S and Ling, S and MacLeod, C and Meyer, A and Murray, L and Murunga, M and Nash, KL and Norris, K and Oellermann, M and Scott, J and Stark, JS and Wood, G and Pecl, GT, Connecting to the oceans: supporting ocean literacy and public engagement, Reviews in Fish Biology and Fisheries, 32 pp. 123-143. (2021)

Kregting, L and Britton, D and Mundy, CN and Hurd, CL, "Safe in my garden: reduction of mainstream flow and turbulence by macroalgal assemblages and implications for refugia of calcifying organisms from ocean acidification", Frontiers in Marine Science, 8 Article 693695. (2021) Krisanski, S and Taskhiri, MS and Aracil, SG and Herries, D and Turner, P, Sensor agnostic semantic segmentation of structurally diverse and complex forest point clouds using deep learning, Remote Sensing, 13, (8) Article 1413. (2021)

Krueck, NC, "Marine conservation across protected area boundaries", Nature Ecology and Evolution, 5 pp. 1203–1204. (2021)

Kropielnicka-Kruk, K and Fitzgibbon, QP and Codabaccus, BM and Trotter, AJ and Giosio, DR and Carter, CG and Smith, GG, The effect of feed frequency on growth, survival and behaviour of juvenile spiny lobster *Panulirus ornatus*, Animals, 12, (17) Article 2241. (2022)

Landman, MJ and Codabaccus, BM and Carter, CG and Fitzgibbon, QP and Smith, GG, "Is dietary phosphatidylcholine essential for juvenile slipper lobster *Thenus australiensis*?", Aquaculture, 542 Article 736889. (2021)

Landman, MJ and Codabaccus, BM and Fitzgibbon, QP and Smith, GG and Carter, CG, Fresh or formulated: a preliminary evaluation of fresh blue mussel *Mytilus galloprovincialis* and formulated experimental feeds with inclusion of fresh blue mussel on the growth performance of hatcheryreared juvenile slipper lobster *Thenus australiensis*, Aquaculture, 531 Article 735924. (2021) Lawson, CL and Taylor, MD and Smith, JA and Payne, NL and Semmens, JM and Suthers, IM and Brodie, S, Bioenergetic model sensitivity to diet diversity across space, time and ontogeny, Frontiers in Marine Science, 8 Article 625855. (2021)

Lewis, CL and Fitzgibbon, QP and Smith, GG and Elizur, A and Ventura, T, Transcriptomic analysis and time to hatch visual prediction of embryo development in the ornate spiny lobster *Panulirus ornatus*, Frontiers in Marine Science, 9 Article 889317. (2022)

Lo, HP and Lim, Y-W and Xiong, Z and Martel, N and Ferguson, C and Ariotti, N and Giacomotto, J and Rae, J and Floetenmeyer, M and Moradi, SV and Gao, Y and Tillu, VA and Xia, D and Wang, H and Rahnama, S and Nixon, SJ and Bastiani, M and Day, RD and Smith, KA and Palpant, NJ and Johnston, WA and Alexandrov, K and Collins, BM and Hall, TE and Parton, RG, Cavin4 interacts with Bin1 to promote T-tubule formation and stability in developing skeletal muscle, Journal of Cell Biology, 220, (12) Article e201905065. (2021)

Lynch, TP and Green, M and Wong, LSC and Bessell, TJ and Cooper, A and Valentine, J and Barrett, N and Ross, DJ and McEnnulty, FR and Foster, SD, Assessment of conservations actions for the critically endangered spotted handfish *Brachionichthyidae*, following curation of data collected by multiple investigators into a long-term time-series, Journal for Nature Conservation, 69 Article 126237. (2022) Mahu, E and Sanko, S and Kamara, A and Chuku, EO and Effah, E and Sohou, Z and Zounon, Y and Akinjogunla, V and Akinnigbagbe, RO and Diadhiou, HD and Marchant, R, Climate resilience and adaptation in West African oyster fisheries: an expertbased assessment of the vulnerability of the oyster *Crassostrea tulipa* to climate change, Fishes, 7, (4) Article 205. (2022)

Meekan, MG and Speed, CW and McCauley, RD and Fisher, R and Birt, MJ and Currey-Randall, LM and Semmens, JM and Newman, SJ and Cure, K and Stowar, M and Vaughan, B and Parsons, MJG, A large-scale experiment finds no evidence that a seismic survey impacts a demersal fish fauna, Proceedings of the National Academy of Sciences of the United States of America, 118, (30) pp. 1-9. (2021)

Melbourne-Thomas, J and Audzijonyte, A and Brasier, MJ and Cresswell, KA and Fogarty, HE and Haward, M and Hobday, AJ and Hunt, HL and Ling, SD and McCormack, PC and Mustonen, T and Mustonen, K and Nye, JA and Oellermann, M and Trebilco, R and van Putten, I and Villanueva, C and Watson, RA and Pecl, GT, Poleward bound: adapting to climate-driven species redistribution, Reviews in Fish Biology and Fisheries, 32 pp. 231-251. (2021)

Meng, H and Hayashida, H and Norazmi-Lokman, NH and Strutton, PG, Benefits and detrimental effects of ocean warming for Tasmanian salmon aquaculture, Continental Shelf Research, 246 Article 104829. (2022) McIntosh, P and Barrett, LT and Warren-Myers, F and Coates, A and Macaulay, G and Szetey, A and Robinson, N and White, C and Samsing, F and Oppedal, F and Folkedal, O and Klebert, P and Dempster, T, Supersizing salmon farms in the coastal zone: a global analysis of changes in farm technology and location from 2005 to 2020, Aquaculture, 553 Article 738046. (2022)

McMillan, MN and Semmens, JM and Huveneers, C and Sims, DW and Stehfest, KM and Gillanders, BM, Grow or go? Energetic constraints on shark pup dispersal from pupping areas, Conservation Physiology, 9, (1) Article coab017. (2021)

Misiuk, B and Lacharite, M and Brown, CJ, Assessing the use of harmonized multisource backscatter data for thematic benthic habitat mapping, Science of Remote Sensing, 3 Article 100015. (2021)

Morris, RL and Bilkovic, DM and Walles, B and Strain, EMA, Nature-based coastal defence: developing the knowledge needed for wider implementation of living shorelines, Ecological Engineering, 185 Article 106798. (2022)

Murunga, M and Pecl, GT and Ogier, EM and Leith, P and Macleod, C and Kelly, R and Corney, S and Van Putten, IE and Mossop, D and Cullen-Knox, C and Bettiol, S and Fox-Hughes, P and Sharples, C and Nettlefold, J, More than just information: what does the public want to know about climate change?, Ecology and Society, 27, (2) Article 14. (2022) Nash, KL and Alexander, K and Melbourne-Thomas, J and Novaglio, C and Sbrocchi, C and Villanueva, C and Pecl, GT, Developing achievable alternate futures for key challenges during the UN Decade of Ocean Science for Sustainable Development, Reviews in Fish Biology & Fisheries, 32 pp. 19-36 (2021)

Nash, KL and Van Putten, I and Alexander, KA and Bettiol, S and Cvitanovic, C and Farmery, AK and Flies, EJ and Ison, S and Kelly, R and Mackay, M and Murray, L and Norris, K and Robinson, LM and Scott, J and Ward, D and Vince, J, "Oceans and society: feedbacks between ocean and human health", Reviews in Fish Biology and Fisheries pp. 1-27. (2021)

Nguyen, TV and Alfaro, A and Frost, E and Chen, D and Beale, DJ and Mundy, C, Investigating the biochemical effects of heat stress and sample quenching approach on the metabolic profiling of abalone *Haliotis iris*, Metabolomics, 18, (1) Article 7. (2022)

Nguyen, TV and Alfaro, AC and Mundy, C and Petersen, J and Ragg, NLC, Omics research on abalone (Haliotis spp.): current state and perspectives, Aquaculture, 547 Article 737438. (2022)

Nitschke, J and Knuckey, I and Koopman, M and Hudson, R and Huveneers, C and Grammer, G and Ward, TM, Spatio-temporal variability in the demersal fish assemblage on the outer continental shelf of the Great Australian Bight, Estuarine, Coastal and Shelf Science, 271 Article 107852. (2022) Ochwada-Doyle, F and Miles, N and Stark, K and Hughes, J and Murphy, J and Lowry, M and West, L, Spatial variation in species-specific catch and size structures across a large-scale and diffuse freshwater recreational-only fishery, Fisheries Management and Ecology, 29, (1) pp. 1-15. (2022)

Ochwada-Doyle, F and Stark, K and Hughes, J and Murphy, J and Lowry, M and West, L, "Temporal and regional variation in catch across an extensive coastal recreational fishery: exploring the utility of survey methods to guide and assess spatio-temporal management initiatives", PLoS ONE, 16 (7) Article e0254388. (2021)

Oellermann, M and Fitzgibbon, QP and Twiname, S and Pecl, GT, Metabolic plasticity improves lobster's resilience to ocean warming but not to climate-driven novel species interactions, Scientific Reports, 12, (1) Article 4412. (2022)

Ooi, CK and Haddy, J and Nowak, B and Lyle, J and Mai, Y and McLean, H and Lewis, T, Links between elevated zinc levels, diet and muscle melanisation in sand flathead *Platycephalus bassensis* from polluted estuaries, Environmental Advances, 7 Article 100177. (2022)

Ooi, CK and Lewis, T and Nowak, B and Lyle, J and Haddy, J, The use of image analysis techniques for the study of muscle melanisation in sand flathead *Platycephalus bassensis*, Environmental Pollution, 292 Article 118360. (2022)

Ooi, MC and Goulden, EF and Smith, GG and Bridle, AR, "Predatory bacteria in the haemolymph of the cultured spiny lobster *Panulirus ornatus*", Microbiology, 167 (11) Article 001113. (2021)

O'Shaughnessy, KA and Perkol-Finkel, S and Strain, EMA and Bishop, MJ and Hawkins, SJ and Hanley, ME and Lunt, P and Thompson, RC and Hadary, T and Shirazi, R and Yunnie, ALE and Amstutz, A and Milliet, L and Yong, CLX and Firth, LB, "Spatially variable effects of artificially created physical complexity on subtidal benthos", Frontiers in Ecology and Evolution, 9 Article 690413. (2021)

Pecl, GT and Alexander, KA and Melbourne-Thomas, J and Novaglio, C and Villanueva, C and Nash, KL, Future Seas 2030: pathways to sustainability for the UN Ocean Decade and beyond, Reviews in Fish Biology and Fisheries, 32 pp. 1-7. (2022)

Price, CA and Emery, TJ and Hartmann, K and Woehler, EJ and Monash, R and Hindell, MA, Inter-annual and inter-colony variability in breeding performance of four colonies of short-tailed shearwaters, Journal of Experimental Marine Biology and Ecology, 537 Article 151498. (2021)

Qiu, X and Carter, CG and Hilder, PE and Hadley, S, A dynamic nutrient mass balance model for optimizing waste treatment in RAS and associated IMTA system, Aquaculture, 555 Article 738216. (2022) Rani, NF and Abduh, MY and Norazmi-Lokman, NH and Aripin, SA, Data on growth performance, glucose concentration and testosterone level of Asian seabass, Lates calcarifer juveniles fed with exogenous melatonin at different concentration, Data in Brief, 44 Article 108495. (2022)

Rocha Pavan Da Silva, R and White, CA and Bowman, JP and Raes, E and Bisset, A and Chapman, C and Bodrossy, L and Ross, DJ, "Environmental influences shaping microbial communities in a low oxygen, highly stratified marine embayment", Aquatic Microbial Ecology, 87 pp. 185-203. (2021)

Rocha Pavan Da Silva, R and White, CA and Bowman, JP and Ross, DJ, Composition and functionality of bacterioplankton communities in marine coastal zones adjacent to finfish aquaculture, Marine Pollution Bulletin, 182 Article 113957. (2022)

Ryan, KL and Shaw, J and Tracey, SR and Lyle, JM, Recreational fishers' perceptions of climate change, ICES Journal of Marine Science, 79, (2) pp. 540-551. (2021)

Seger, A and Hallegraeff, G, Application of clay minerals to remove extracellular ichthyotoxins produced by the dinoflagellates *Karlodinium veneficum* and *Karenia mikimotoi*, Harmful Algae, 111 Article 102151. (2022) Schrobback, P and Rolfe, J and Rust, S and Ugalde, S, Challenges and opportunities of aquaculture supply chains: case study of oysters in Australia, Ocean and Coastal Management, 215 Article 105966. (2021)

Sharma, R and Swearer, SE and Morris, RL and Strain, EMA, "Testing the efficacy of sea urchin exclusion methods for restoring kelp", Marine Environmental Research, 170 Article 105439. (2021)

Silva, CNS and Young, EF and Murphy, NP and Bell, JJ and Green, BS and Morley, SA and Duhamel, G and Cockcroft, AC and Strugnell, JM, Climatic change drives dynamic source-sink relationships in marine species with high dispersal potential, Ecology and Evolution, 11, (6) pp. 2535-2550. (2021)

Smith, DC and Haddon, M and Punt, AE and Gardner, C and Little, LR and Mayfield, S and O'Neill, MF and Saunders, T and Stewart, J and Wise, B and Fulton, EA and Conron, S, "Evaluating the potential for an increased and sustainable commercial fisheries production across multiple jurisdictions and diverse fisheries", Marine Policy, 124 Article 104353. (2021)

Smith, JE and Keane, J and Mundy, C and Gardner, C and Oellermann, M, Spiny lobsters prefer native prey over range-extending invasive urchins, ICES Journal of Marine Science, 79, (4) pp. 1353-1362. (2022)

Stacy, B and Burch, P and Ziegler, PE and Cresswell, KA and Hartmann, K and Hillary, RM, "Are tag-based integrated stock assessments robust to IUU fishing?", Fisheries Research, 243 Article 106098. (2021) Strain, E and Lai, RWS and White, CA and Piarulli, S and Leung, KMY and Airoldi, L and O'Brien, A, Marine pollution: emerging issues and challenges, Frontiers in Marine Science, 9 Article 918984. (2022)

Strain, EMA and Kompas, T and Boxshall, A and Kelvin, J and Swearer, S and Morris, RL, Assessing the coastal protection services of natural mangrove forests and artificial rock revetments, Ecosystem Services, 55 Article 101429. (2022)

Subramaniam, RC and Corney, SP and Melbourne-Thomas, J and Peron, C and Ziegler, P and Swadling, KM, Spatially explicit food web modelling to consider fisheries impacts and ecosystem representation within Marine Protected Areas on the Kerguelen Plateau, ICES Journal of Marine Science, 79, (4) pp. 1327-1339. (2022)

Suebsanguan, S and Strain, EMA and Morris, RL and Swearer, SE, "Optimizing the initial cultivation stages of kelp *Ecklonia radiata* for restoration", Restoration Ecology, 29 (5) Article e13388. (2021)

Sumaila, UR and Chuku, EO, (+295 additional authors), WTO must ban harmful fisheries subsidies, Science, 374, (6567) pp. 544. (2021)

Terraneo, TI and Benzoni, F and Arrigoni, R and Baird, AH and Mariappan, KG and Forsman, ZH and Wooster, MK and Bouwmeester, J and Marshell, A and Berumen, ML, Phylogenomics of Porites from the Arabian Peninsula, Molecular Phylogenetics and Evolution, 161 Article 107173. (2021) Tong, C and Hock, K and Krueck, NC and Tyazhelnikov, V and Mumby, PJ, "An MPA design approach to benefit fisheries: maximising larval export and minimising redundancy", Diversity, 13 (11) Article 586. (2021)

Torquato, F and Bouwmeester, J and Range, P and Marshell, A and Priest, MA and Burt, JA and Moller, PR and Ben-Hamadou, R, Population genetic structure of a major reef-building coral species Acropora downingi in northeastern Arabian Peninsula, Coral Reefs pp. 1-10. (2021)

Torok, VA and Hodgson, KR and Jolley, J and Turnbull, A, "Investigation of F-RNA bacteriophage as a tool in re-opening Australian oyster growing areas following sewage spills", Food and Environmental Virology, 13 pp. 201-217. (2021)

Tracey, SR and Lyle, JM and Stark, KE and Gray, S and Moore, A and Twiname, S and Wotherspoon, S, "Estimating the national fishing mortality of southern bluefin tuna *Thunnus maccoyii* from Australia's recreational fishing sector", Fisheries Management and Ecology, 29 (3) pp. 241-253. (2021)

Trotter, AJ and Vignier, J and Wilson, TK and Douglas, M and Adams, SL and King, N and Cunningham, MP and Carter, CG and Boudry, P and Petton, B and Degremont, L and Smith, GG and Pernet, F, "Case study of vertical transmission of ostreid herpesvirus-1 in Pacific oysters and biosecurity management based on epidemiological data from French, New Zealand and Australian hatchery-propagated seed", Aquaculture Research, 52 (8) pp. 4012-4017. (2021) Turnbull, A and Dorantes-Aranda, JJ and Madigan, T and Jolley, J and Revill, H and Harwood, T and Hallegraeff, G, "Field validation of the southern rock lobster paralytic shellfish toxin monitoring program in Tasmania, Australia", Marine Drugs, 19 (9) (2021)

Turnbull, A and Seger, A and Jolley, J and Hallegraeff, G and Knowles, G and Fitzgibbon, Q, "Lobster supply chains are not at risk from paralytic shellfish toxin accumulation during wet storage", Toxins, 13 (2) Article 129. (2021)

Turschwell, MP and Hayes, MA and Lacharite, M and Abundo, M and Adams, J and Blanchard, J and Brain, E and Buelow, CA and Bulman, C and Condie, SA and Connolly, RM and Dutton, I and Fulton, EA and Gallagher, S and Maynard, D and Pethybridge, H and Plaganyi, E and Porobic, J and Taelman, SE and Trebilco, R and Woods, G and Brown, CJ, A review of support tools to assess multi-sector interactions in the emerging offshore Blue Economy, Environmental Science and Policy, 133 pp. 203-214. (2022)

Twiname, S and Fitzgibbon, QP and Hobday, AJ and Carter, CG and Oellermann, M and Pecl, GT, Resident lobsters dominate food competition with range-shifting lobsters in an ocean warming hotspot, Marine Ecology Progress Series, 685 pp. 171-181. (2022)

Vo, TTM and Nguyen, TV and Amoroso, G and Ventura, T and Elizur, A, Deploying new generation sequencing for the study of flesh color depletion in Atlantic Salmon (Salmo salar), BMC Genomics, 22 Article 545. (2021)

Voyer, M and Allison, EH and Farmery, A and Fabinyi, M and Steenbergen, D and van Putten, I and Song, AM and Ogier, E and Benzaken, D and Andrew, N, The role of voluntary commitments in realizing the promise of the Blue Economy, Global Environmental Change. Part A, 71 Article 102372. (2021)

Wang, S and Carter, CG and Fitzgibbon, QP and Smith, GG, "The use of stoichiometric bioenergetics to elucidate metabolic energy substrate use and specific dynamic action in cultured juvenile spiny lobsters Sagmariasus verreauxi of different nutritional status", Aquaculture, 532 Article 736021. (2021)

Wang, S and Carter, CG and Fitzgibbon, QP and Codabaccus, BM and Smith, GG, "Effect of dietary protein on energy metabolism including protein synthesis in the spiny lobster *Sagmariasus verreauxi*", Scientific Reports, 11 Article 11814. (2021)

Ward, TM and Grammer, GL and Ivey, AR and Smart, JJ and McGarvey, R, Increasing the precision of the daily egg production method; 2020's remix of a 1980's classic, ICES Journal of Marine Science, 78, (4) pp. 1177-1195. (2021)

Willis, KA and Serra-Goncalves, C and Richardson, K and Schuyler, QA and Pederson, H and Anderson, K and Stark, JS and Vince, J and Hardesty, BD and Wilcox, C and Nowak, BF and Lavers, JL and Semmens, JM and Greeno, D and MacLeod, C and Frederiksen, NPO and Puskic, PS, Cleaner seas: reducing marine pollution, Reviews in Fish Biology and Fisheries, 32 pp. 145-160. (2022)

Wilson, BR and Brown, CJ and Sameoto, JA and Lacharite, M and Redden, AM and Gazzola, V, Mapping seafloor habitats in the Bay of Fundy to assess megafaunal assemblages associated with *Modiolus modiolus* beds, Estuarine, Coastal and Shelf Science, 252 Article 107294. (2021)

Wirtz, A and Carter, CG and Codabaccus, MB and Fitzgibbon, QP and Townsend, AT and Smith, GG, Protein sources influence both apparent digestibility and gastrointestinal evacuation rate in juvenile slipper lobster *Thenus australiensis*, Comparative Biochemistry and Physiology. Part A, 265 Article 111121. (2022)

Wirtz, A and Mazumder, D and Carter, CG and Codabaccus, MB and Fitzgibbon, QP and Smith, GG, Application of stable isotope analysis to evaluate the assimilation of protein sources in juvenile slipper lobsters *Thenus australiensis*, Aquaculture, 560 Article 738570. (2022)

Wolfe, K and Deaker, DJ and Graba-Landry, A and Champion, C and Dove, S and Lee, R and Byrne, M, Current and future trophic interactions in tropical shallow-reef lagoon habitats, Coral Reefs, 40 pp. 83-96. (2021)

Wootton, N and Reis-Santos, P and Dowsett, N and Turnbull, A and Gillanders, BM, "Low abundance of microplastics in commercially caught fish across southern Australia", Environmental Pollution, 290 Article 118030. (2021)

Yoshida, K and Seger, A and Corkill, M and Heil, P and Karsh, K and McMinn, A and Suzuki, K, Low Fe availability for photosynthesis of sea-ice algae: ex situ incubation of the ice diatom *Fragilariopsis cylindrus* in low-Fe sea ice using an ice tank, Frontiers in Marine Science, 8 Article 632087. (2021)

### GLOSSARY

| AAD                    | Australian Antarctic Division  |
|------------------------|--|
| ACIAR                  | Australian Centre for International Agricultural Research              |
| AIRF                   | Abalone Industry Reinvestment Fund                                     |
| ARC                    | Australian Research Council  |
| Blue Economy CRC/BECRC | Blue Economy Cooperative Research Centre                               |
| CoSE                   | UTAS College of Sciences and Engineering                               |
| CRC                    | Cooperative Research Centre  |
| CSIRO                  | Commonwealth Scientific & Industrial Research Organisation             |
| CWUR                   | Centre for World University Rankings                                   |
| FRDC                   | Fisheries Research and Development Corporation – Australian Government |
| Holsworth WRE          | Holsworth Wildlife Research Endowment                                  |
| IMAS                   | Institute for Marine and Antarctic Studies – University of Tasmania    |
| NRE Tas/Tasmania       | Department of Natural Resources and Environment Tasmania               |
| NSW DPI                | New South Wales Department of Primary Industries                       |
| POMS                   | Pacific Oyster Mortality Syndrome                                      |
| RAG                    | Research Advisory Group  |
| SAFS                   | Status of Australian Fish Stocks                                       |
| SARDI                  | South Australian Research and Development Institute                    |

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IMAS Taroona Nubeena Crescent Taroona TAS 7053 T +61 3 6226 6379 www.imas.utas.edu.au