

# Marine Innovation Southern Australia

The first seven years: a foundation for the future



# Key achievements

**Marine Innovation Southern Australia, an initiative of the Government of South Australia, was developed in September 2005 to boost South Australia's capability in aquatic research and educational opportunities and support the growth of the South Australian seafood industry. Funding of \$18.5 million over seven years was provided by the State Government to build South Australia's marine expertise and research infrastructure.**

MISA partners, the South Australian Research and Development Institute (SARDI), Flinders University, the University of Adelaide, the South Australian Museum (SA Museum), Primary Industries and Regions South Australia (PIRSA), the Department of Environment, Water and Natural Resources (DEWNR), and the seafood industry, have since worked collaboratively to achieve many milestones including:

- the appointment of more than 40 research positions across MISA partners. These researchers provide additional capabilities to South Australia in the areas of aquatic animal health, biosecurity, ecology of large marine vertebrates, ecosystem modelling, feed technology, food quality and safety, genetics, market access, nutrition, oceanography, product development and spatial risk analysis.
- 280 new or expanded projects spanning four industry and government research priority areas: Aquaculture Innovation; Biosecurity, Ecosystem Services, and Seafood Product Quality and Value Adding, with a total value exceeding \$75 million\*.
- a significant contribution to education through the co-supervision of 121 Honours, Masters and PhD students, as well as nine Postdoctoral scientists, by SARDI Aquatic Sciences and Flinders University and the University of Adelaide researchers. Fifteen MISA researchers also participated in seven Flinders University and the University of Adelaide undergraduate courses, providing students with a practical understanding of research and industry needs.

- the completion of the \$2.4 million South Australian Aquatic Biosecurity Centre at the University of Adelaide's Roseworthy Campus; and the \$4.5 million expansion to the Lincoln Marine Science Centre, owned and operated by Flinders University, boosted by an additional \$2.1 million from Flinders University through the Federal Government's Capital Development Pool Scheme.
- establishment of the \$9.1 million<sup>A</sup> Southern Australian Integrated Marine Observing System (SAIMOS) funded through the National Collaborative Research Infrastructure Scheme (NCRIS) with support from the Government of South Australia, to study ocean current systems and climate change impacts. SAIMOS is one of the largest nodes of the national Integrated Marine Observing System (IMOS), which is globally regarded as one of the best marine observing systems in the world.

Through the MISA initiative, South Australia's aquatic capability now forms a solid foundation on which to undertake diverse research, including major multi-disciplinary marine ecosystem programs. These programs will integrate and analyse a range of current and potential future human impacts on our coastal and off-shore regions.

\*Based on the value of all projects; includes direct and in-kind contributions from funders and participants.

<sup>A</sup>SAIMOS total value includes \$900,000 in-kind salary support from MISA.

Right: Oceanographic advances, through the Southern Australian Integrated Marine Observing System, are providing critical insights into ocean circulation and marine productivity.



*Optimising the use of South Australia's marine resources,  
safeguarding biodiversity and ecosystems, and  
establishing South Australia as an internationally  
recognised centre for southern temperate marine  
research, education and development.*





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Left: Australian sea lions are being utilised as 'ocean observers' collecting information to help scientists better understand ocean circulation and the ecology of South Australia's productive shelf waters. MISA pelagic ecologist, A/Prof Simon Goldsworthy is pictured removing a radio tracking aerial from an Australian sea lion on Dangerous Reef off Port Lincoln, South Australia (Photo: Roy Hunt, Australian Geographic).

# Foreword



**The Minister for Agriculture,  
Food and Fisheries,  
the Honourable Gail Gago**

I am pleased to present this summary of the work of Marine Innovation Southern Australia (MISA). MISA is an ambitious undertaking which unites all sectors involved in the development of South Australia's seafood industry and the protection of its marine environment.

The Government of South Australia has recognised the importance of continuing research to make the most of one of our State's most significant attributes, Premium Food from our Clean Environment. Our remarkable seafood, drawn from pristine seas is a great resource for all of us, and the work done by MISA underpins this bounty.

An initiative of the State Government, MISA has drawn together the State's top marine research and development institutions, Universities and the South Australian seafood industry, to pool our resources and knowledge and grow South Australia's seafood industry more efficiently.

MISA works to position South Australia as a pre-eminent centre for marine science, education and industry development by collaborating with South Australia's marine partners and focusing on innovative science.

MISA has invested \$18.5 million of State funding in the appointment of more than 40 high level researchers and significantly enhancing research facilities and equipment to support cutting edge marine research and education.

This strong capability has led to 280 new or expanded research projects in Aquaculture Innovation, Seafood Product Quality and Value-adding, Ecosystem Services and Biosecurity, firmly placing South Australia at the forefront of marine science both nationally and internationally.

Total research and development investment through MISA over the past seven years has been \$75 million. This investment is the value of all projects and includes direct and in-kind contributions from funders and participants. The majority of this investment has directly benefited South Australia, driving economic development and innovation in this State. An additional \$10.3 million of Federal Government funding has been leveraged for infrastructure, supporting South Australia's commitment to the Primary Industries Standing Committee Fishing and Aquaculture R, D & E framework for marine research.

MISA partners are now delivering innovative and practical solutions to South Australia's seafood producers and processors to help the industry grow in a healthy and environmentally sustainable manner.

MISA's achievements include enhancing the quality of our seafood, protecting our aquatic resources, providing solutions to help aquaculture diversify and grow and developing a deep understanding of our ocean marine systems, so that we can utilise the resources at the same time that we protect our assets.

The collaboration and capability developed through MISA has positioned South Australia as a leader in the new era of ecosystem-based marine science. I congratulate MISA on its important work and look forward to an exciting future from this innovative group.

**The Honourable Gail Gago, MLC.  
Minister for Agriculture, Food and Fisheries**







Chair of the MISA  
Steering Committee,  
Prof Rob Lewis

Marine Innovation Southern Australia's strong collaborative approach has been its strength, bringing together South Australia's key marine researchers and institutions with industry partners. The \$18.5 million funding provided by the Government of South Australia has supported more than 40 research positions and new infrastructure, expanding South Australia's capability as a leader in southern temperate marine research. This investment has attracted 280 research projects worth more than \$75 million\* and federal infrastructure support of \$10.3 million, to address priority issues facing our community, industry and government.

**Professor Rob Lewis, Chair, MISA Steering Committee**

*MISA is:*

*"Building regional science capability, South Australia's biodiversity and knowledge base and community awareness."*

**A/Prof Ian Menz, Flinders University**

*"Facilitating competitiveness and growth of South Australia's aquaculture industry."*

**Mr Brian Jeffriess,  
seafood industry**

*"Advancing science to inform policy and management."*

**Prof Mehdi Doroudi, PIRSA  
Fisheries & Aquaculture**

*"Securing the sustainability of South Australia's wild fisheries and advancing biosecurity technologies."*

**Mr Bob Pennington, seafood industry**

\*Based on the value of all projects; includes direct and in-kind contributions from funders and participants.





Marine Innovation Southern Australia's Steering Committee is chartered with overseeing the MISA initiative. The committee represents the commitment from MISA partners to collaborate and continue to build southern Australian's marine research capability. Back row (L to R): A/Prof Ian Menz (Flinders University), Prof Mehdi Doroudi (PIRSA Fisheries & Aquaculture), Mr Brian Jeffriess (seafood industry), Prof Gavin Begg (SARDI); Front row (L to R): Prof Pauline Mooney (SARDI), Prof Robert Hill (The University of Adelaide), Mr Martin Hernen (seafood industry), Prof Rob Lewis (Chair). Absent: Mr Bob Pennington (seafood industry).

Marine Innovation Southern Australia is a formal partnership of the Aquatic Sciences division of SARDI, Flinders University, the University of Adelaide, and the SA Museum. It also includes PIRSA, DEWNR and the seafood industry.

The objectives of the MISA initiative have been to:

- extend the knowledge base required to conserve and protect environments on which the fisheries, aquaculture and marine eco-tourism industries rely; and
- provide key infrastructure to support South Australia's aquatic resource-based industries and resource biosecurity.

To achieve this, the Government of South Australia provided \$18.5 million over seven years, comprising \$11.6 million for salaries and \$6.9 million for infrastructure. Additional to this, Flinders University, through the Federal Government's Capital Development Pool Scheme, provided \$2.1 million to boost the total amount available for an extension of the Lincoln Marine Science Centre, Port Lincoln.

Resources were allocated to four research areas: Aquaculture Innovation, Biosecurity, Ecosystem Services and Seafood Product Quality and Value Adding.

*"Advancing curricula and aligning academic and applied research."*

Prof Bob Hill, The University of Adelaide

*"Communicating with industry to develop and deliver research directed at their priorities."*

Mr Martin Hernen, seafood industry

*"Leading applied research which is driving sustainable economic growth for South Australia."*

Prof Pauline Mooney, SARDI

# The collaboration

Marine Innovation Southern Australia's governance structure includes a Steering Committee, Advisory Committee and ten Science Groups.

A Steering Committee was established to build on the MISA initiative on behalf of the joint investors and participating institutions and industries. It includes high level representation from each of the key MISA partner organisations and stakeholders.

Initially, three Advisory Committees reported to the Steering Committee addressing education, infrastructure and research. They focused on working with stakeholders to identify research capabilities and gaps, develop research projects and identify infrastructure requirements. These committees have since been integrated into a single Advisory Committee, with its primary function to identify and develop the scope and resources to initiate and deliver project outcomes. The present Advisory Committee includes representatives from key partner organisations and stakeholders, as well as four leaders with expertise in the research areas of Aquaculture Innovation, Biosecurity, Ecosystem Services, and Seafood Product Quality and Value Adding.

More recently, with a broadening of MISA's geographical area of interest and involvement of all marine sciences staff within partner organisations, ten science discipline-based Science Groups, covering the four MISA research areas, have been initiated. Science Group leaders are experts in their field with a willingness to facilitate communications between like minded researchers across MISA partner organisations.

## Benefits of the collaboration

The benefits of pooling South Australia's resources and knowledge have been demonstrated through MISA's achievements:

- Economic development: the MISA initiative leveraged \$10.3 million for novel infrastructure and supporting resources and more than \$75 million\* for 280 new or expanded projects, supporting the growth of South Australia's seafood industry.

- Environmental sustainability: MISA research supported South Australian government policy and environmental planning initiatives. In particular:

- > aquaculture planning and monitoring;
- > modelling of food webs to understand the reliance of wild fisheries species on other elements of their ecosystem; and
- > interactions of protected or endangered species with fisheries and aquaculture to enhance their conservation.

- Science research creativity: MISA has expanded South Australia's marine research capability in the areas of:

- > aquatic animal health;
- > aquafeed technology;
- > genetics;
- > invasive species risk identification, quantification, control and eradication;
- > nutrition and propagation;
- > oceanography, ecosystem modeling and ecology of large threatened and endangered species; and
- > product market access, quality, safety and value adding.

MISA is now recognised as a major provider within the national Primary Industries Standing Committee 'Fisheries and Aquaculture R,D&E Strategy'.

MISA researchers have contributed to educational opportunities for partner universities and facilitated the transfer of research outcomes to the seafood industry and policy managers.



Above: Chair MISA Steering Committee, Prof Rob Lewis, Former Vice Chancellor, the University of Adelaide, Prof James McWha, Director Science Partnerships, SARDI, Prof Simon Maddocks, Member for Light Mr Tony Piccolo, MP and Chief Executive, PIRSA, Mr Ian Nightingale, at the official launch of the South Australian Aquatic Biosecurity Centre (SAABC).

\*Based on the value of all projects; includes direct and in-kind contributions from funders and participants.

## Steering Committee

Prof Rob Lewis (Chair)
Prof Pauline Mooney SARDI
Prof Robert Hill The University of Adelaide
A/Prof Ian Menz Flinders University
Prof Mehdi Doroudi PIRSA Fisheries & Aquaculture
Mr Brian Jeffriess Seafood industry
Mr Bob Pennington Seafood industry
Mr Martin Hernan Seafood industry
Prof Gavin Begg SARDI
Mr Steven Clarke SARDI MISA Executive Officer

## Advisory Committee

Prof Gavin Begg (Chair)
Mr David Ellis Australian Southern Bluefin Tuna Industry Association
Mr Sean Sloan PIRSA Fisheries & Aquaculture - Government Policy (Seafood)
Prof Xiaoxu Li SARDI Aquaculture Innovation
Dr Marty Deveney SARDI Biosecurity
Prof Bronwyn Gillanders The University of Adelaide Ecosystems
A/Prof Tim Ward SARDI Ecosystems
Prof Peter Fairweather Flinders University Ecosystems
Dr Cath McLeod SARDI Seafood Product Quality & Value-adding
Mr Steven Clarke SARDI MISA Executive Officer

## Science Groups

Prof Xiaoxu Li SARDI Aquaculture, Biodiscovery & Biotechnology
Dr Marty Deveney SARDI Biosecurity
Prof Luciano Beheregaray Flinders University Molecular Ecology & Biodiversity Discovery
Prof Peter Fairweather Flinders University Ecosystem Modelling & Data Integration
Dr Jason Tanner SARDI Benthic Ecology
Prof Bronwyn Gillanders The University of Adelaide Catchment, Estuarine & Coastal Ecology
A/Prof John Middleton SARDI Oceanography
A/Prof Tim Ward SARDI Sustainable Fisheries
A/Prof Simon Goldsworthy SARDI Pelagic Ecology, Apex Predators & Species of Conservation Interest
Dr Cath McLeod SARDI Seafood Development, Safety, Quality & Market Access

Aquaculture Innovation

Biosecurity

Ecosystem Services

Seafood Product Quality



# Aquaculture innovation



## MISA: Developing new opportunities and supporting the aquaculture industry to diversify and expand seafood production.

The Aquaculture Innovation research area has established a multi-disciplinary team of researchers supported by specialised infrastructure to provide technical and scientific support to enhance South Australia's aquaculture industry. Science capabilities include; aquatic animal health, genetics, nutrition, propagation and systems design. Practical culture experience includes marine and freshwater algae, crustaceans, molluscs and finfish.

Specifically, Marine Innovation Southern Australia has benefited aquaculture research through the direct employment of three key senior researchers. Benefits have also flowed from the establishment of a fish health laboratory as part of the new extension to the Lincoln Marine Science Centre, Port Lincoln; a biosecure experimental tank system for fish health research at the South Australian Aquatic Biosecurity Centre, Roseworthy Campus; and an experimental tank facility for nutrition, propagation and therapeutic research at SARDI Aquatic Sciences. Indirect benefits have resulted from a number of new scientific appointments to each of the other three MISA research areas.

The expertise and facilities gained through MISA has enabled Aquaculture Innovation research to provide expert advice and research services to government and industry to develop novel aquaculture sites, species and technologies; enhance their competitiveness; minimise their risks; and support aquaculture education.



**Above: South Australia is the global centre of the southern bluefin tuna aquaculture industry and research and development (Photo: Adam Watkins). Opposite page: Premium oysters, produced on farms off South Australia.**

### Major achievements

- Established a range of new infrastructure that facilitates the sustainable development of aquaculture in South Australia, by improving the resources available for research and development, education and training.
- Supported entrepreneurs to develop new opportunities using novel aquaculture species and technologies. For example, mullocky, *Argyrosomus japonicus*, was demonstrated to be a suitable species for culture in tanks in the Riverland region of South Australia using salt interception scheme saline groundwater.
- Addressed key factors that inhibit the juvenile rearing of aquaculture species. Improved the larval growth and survival of southern bluefin tuna (SBT), *Thunnus maccoyii*, and yellowtail kingfish (YTK), *Seriola lalandi*, and provided advice on the negative impact of high salinities experienced in South Australia's upper gulf waters during summer on the performance of juvenile YTK.
- Produced hatchery-reared juveniles mussels, *Mytilus galloprovincialis*, and native oysters, *Ostrea angasi*, to overcome situations where South Australian aquaculturists were unable to secure farm stock from traditional sources. Mussel spat were supplied when natural spat settlement was poor and native oyster spat when imports were stopped from interstate due to increased aquatic animal health risks.
- Improved the understanding of the nutritional requirements of key South Australian aquaculture species such as abalone, SBT and YTK and developed, evaluated and enhanced their feeds. For example, the dietary protein requirements for the commercial culture of greenlip abalone, *Haliotis laevis*, were refined in relation to seasonal changes in water temperature and different life stages.
- Discovered and optimised the production of a microalgal species suitable for biofuel production. Extensive bioprospecting across southern Australia led to the identification of a strain of a specific species of green microalgae, *Nannochloropsis*. When grown under optimised environmental conditions in small-scale outdoor raceways, this alga has shown considerable promise not only for the production of biofuels but also for other higher value co-products.
- Advanced the management of aquaculture diseases and pests by identifying the host species of a number of parasites, making recommendations to improve hatchery biosecurity and assessing the efficacy of, and environmental residues associated with, selected therapeutics and sea-cage net antifoulants.
- Provided high level scientific and technical advice to industry and government, including the development of policy and regulations associated with:
  - > the management and expansion of existing aquaculture industries. Knowledge of the technical aspects and issues of commercial aquaculture provide an important input for the development of policy and regulation;
  - > the commercialisation of novel aquaculture species. Feasibility studies provide the ideal opportunity for proactively developing policies and regulations relating to potential aquaculture industries; and
  - > future aquaculture industry needs. A comprehensive knowledge of the scientific and technical literature and the most recent innovative research and development outcomes provide direction for the future.



## Future Pathways

- Establish full time hatchery capability at SARDI Aquatic Sciences to: enhance the practical scientific and technical expertise of staff to support the aquaculture industry in this specialised field; to foster a diverse aquaculture industry through an improved capacity to assess the feasibility of rearing novel aquaculture species; to undertake industry priority research and development on the early life stages of species; to provide farm stock to industry when traditional supplies fail; and to provide improved education and training opportunities.
- Continue research into the development of sustainable aquatic feeds to address five key issues facing the rapidly expanding global aquaculture sector: the increasing costs and reduced availability of fish meal and fish oil; the efficient use of fish meal and fish oil as key diet ingredients of aquafeeds; the incorporation of more affordable ingredients into aquafeeds; the impact of alternative more affordable ingredients on the health and welfare of cultured species; and reducing aquafeed related waste discharges to the environment.

## Environmental sustainability

- Research to assess and facilitate the establishment of Integrated Multi-trophic Aquaculture (IMTA) by the South Australian aquaculture industry to better utilise existing areas zoned for aquaculture; increase and diversify aquaculture production; and further reduce the environmental 'footprint' of aquaculture. For example, farming macroalgae and bivalve molluscs in the vicinity of finfish farms to assimilate waste nutrients and particulate matter.

Aquaculture Innovation research activities are consistent with those attributed to MISA in the national Primary Industries Standing Committee (PISC) Fisheries and Aquaculture R,D&E Strategy.

A full list of Aquaculture Innovation projects is available on page 67.

## Finding the ultimate fish diet



Fish farming is often seen as one solution to feeding the world's growing population. But what will the fish eat?

Marine Innovation Southern Australia nutrition and feed technologist Dr David Stone said marine resources used in the production of fish were virtually at breaking point.

"We are already on the verge of using the world's total supplies of fish oil and fish meal for aquaculture feed.

It is critical that we find alternative sustainable ingredients, both to increase production of fish and demonstrate to international markets that we are instituting sustainable practices. We also have to find ways to help reduce costs for farmers," he said.

Dr Stone said alternatives to replace fish oil and fish meal in fish feed included terrestrial plants and animal products and by-products from fish processing. Microalgae and macroalgae offered a future source, he added.

A major focus of Dr Stone's research, based at SARDI Aquatic Sciences, is to address the 'fish in, fish out' ratio being demanded by markets across Europe and America. In reducing the amount of marine resources used in the production of fish, the measure considered as efficient is a 'fish in, fish out' ratio of 1:1 or one kilogram of wild fish used in the production of one kilogram of cultured fish. Currently on average, two kilograms of wild fish are used to produce one kilogram of farmed fish.

Top right: Yellowtail kingfish fingerlings. Bottom: Experimental pool farm, SARDI Aquatic Sciences, Adelaide. Opposite page: Mulloway fingerlings.





“Fish farming in Australia is a relatively young industry, and there is much to learn,” said Dr Stone.

“There’s so much to consider — not only do diets have to be developed to suit individual species, they have to change with the seasons and different water temperatures, and cater for varying ages of the fish and transitional feed requirements. Other special feeds boost product attributes such as omega 3 fatty acids, frozen storage stability, flavour and immuno-stimulants, and there are medicated feeds for the fish themselves.”

One of the newest aquaculture industries is based on the farming of yellowtail kingfish (YTK), *Seriola lalandi*. Dr Stone and his colleagues discovered that canola oil and soy bean meal, used in feed for YTK for more than ten years and typical of many fish feeds, were causing the fish to feed less and lose weight. Their feed conversion rates were well below what they should have been and when fish were fed canola oil they were often afflicted with what is known as green liver, compromising their overall health. Mr Matt Bansemmer, an Honours student from the University of Adelaide, found that soy bean meal was eroding the mucous membrane in the fish intestine removing its first line of defence against disease.

Australian feed producers immediately removed the ingredients from the YTK fish feeds. Since then much of Dr Stone’s work has focussed on understanding nutrient utilisation and requirements in YTK and finding better alternative ingredients.

Following the canola oil and soy bean meal finding, Dr Stone along with Flinders University PhD candidate, Ms Jenna Bowyer identified poultry oil as a suitable substitute for a high proportion of the fish oil in YTK feeds — a solution that could also potentially save farmers up to \$480,000 every year.

The ongoing project, Sustainable Feeds and Feed Management for YTK, being funded by the Australian Seafood Cooperative Research Centre (Australian Seafood CRC) and Clean Seas Tuna Ltd (CST), found that in the short term, the use of poultry oil does not impact on fish health or growth.

Ms Bowyer also studied how fluctuating water temperatures over summer and winter in Spencer Gulf impacted on the digestive enzyme activity and growth of YTK being fed poultry oil, canola oil and soybean products, within their diet, and how seasonal diets can be adjusted for optimum growth rates.

“For example, the fish grow nearly twice as fast when water temperatures are around 22 degrees, compared to 18 degrees,” said Dr Stone.

“Our experiments looked at increasing indicative levels of test ingredients and checking the growth performance, feed efficiency and health of the animals at varying temperatures.”

“SARDI Aquatic Sciences provides facilities to run replicated studies testing multiple products at the same time with large numbers of tanks of differing sizes and fantastic water quality.

“However, at the end of the day, the good thing in fish is the fish oil which brings strong health attributes for human consumers in the form of Omega 3 fatty acids,” said Dr Stone.

“The challenge is to extend our fish oil resources by finding the optimum time to incorporate fish oil in fish feeds before the fish head to market.”

**The experimental pool farm at SARDI Aquatic Sciences, Adelaide, developed as a result of Marine Innovation Southern Australia, is a major research resource for South Australia.**

**In particular, it is helping develop the State’s aquaculture sector providing excellent facilities for research focussed on feed development, nutrition, product quality and husbandry, and for maintaining and conditioning broodstock.**

**The infrastructure is comparable to the best in Australia for tank-based research targeted at temperate marine and freshwater fish, crustaceans and molluscs. It comprises 80 tanks of varying sizes allowing well replicated experiments, thereby providing more conclusive results.**



**The tanks vary in size from one kilolitre capacity to 20 kilolitres. Each tank is piped with fresh**

**filtered seawater or filtered re-circulated seawater plus an additional optional pipe work system that allows freshwater to be provided. To maintain oxygenated water, compressed air is also provided via diffusers for every tank. A computer controlled system monitors water quality and experimental variables.**

**Experiments conducted in the pool farm range from examining the winter dietary requirements of yellowtail kingfish (YTK), *Seriola lalandi*, to looking at ways of increasing omega 3 fatty acids in fish, and how dietary oxidised products and antioxidants interact to influence the quality of fish flesh.**

**The experimental pool farm is available for use by marine and aquaculture industries, universities and MISA research partners.**



Above: MISA nutrition and feed technologist, Dr David Stone and EP Aquafeeds director, Dr Tom Coote with pellets developed at SARDI for abalone feed trials.

## Aquafeed masterchef

A breakthrough in the nutrition requirements of aquacultured abalone is expected to have major implications for this small but lucrative Australian export industry.

Marine Innovation Southern Australia nutrition and feed technologist, Dr David Stone, along with abalone growers and feed manufacturers, is now taking promising preliminary laboratory work to large scale commercial trials at four abalone farms in South Australia and Victoria.

If successful, the feed improvements will immediately result in large productivity gains adding up to 10 percent to the industry's overall value. This will be welcome news to an industry that is struggling to supply a rapidly rising demand for a delicacy in the strong markets of China and Japan.

Dr Stone says nutrition has been a major bottleneck in the development of cultured abalone. "Many within the industry have long suspected that farmed abalone were not reaching their potential growth rates with one formulation of feed being provided throughout the 2.5 year production cycle, regardless of the abalone life stage or seasonal climatic variations," he said. "We know that in the wild, abalone have at least two distinct feeding strategies as they develop, with young cryptic abalone grazing on epiphytes and older animals feeding on larger macroalgae," said Dr Stone.

"Our tank trials have clarified optimum protein requirements for greenlip abalone, *Haliotis laevis*, and hybrid abalone, *Haliotis rubra* x *Haliotis laevis*, which relate to the size of the animal and seasonal changes in water temperatures.

"Now the really exciting work has begun with full blown commercial trials underway and supported by the entire abalone industry."

The Australian Seafood CRC and Fisheries Research and Development Corporation (FRDC) have provided a \$300,000 grant through the Australian Abalone Growers Association (AAGA) for the project. Abalone farmers and all three Australian commercial abalone feed companies are providing a further \$1 million in kind, with four major abalone farms in South Australia and Victoria providing facilities and animals, and feed companies supplying feed at cost price.

The trials are being undertaken in South Australia at Kangaroo Island Abalone, and in Victoria at Coastal Sea Farms, Portland, Southern Ocean Mariculture, Port Fairy and Great Southern Waters, Port Philip Bay. The feed companies involved are EP Aquafeeds, Adam and Amos Abalone Foods and Skretting Australia. SAM Abalone at Port Lincoln in South Australia supplied the animals

for the initial tank trials undertaken by SARDI Aquatic Sciences. Each farm is committing eight raceways to the trials that are expected to produce a total of around 2.4 tonne of abalone per farm.

"The clincher is that we have the feed companies participating directly with the farmers, so any improvements to feed will become available to all abalone farmers in South Australia, Victoria, Tasmania and Western Australia virtually immediately," said Dr Stone.

Dr Stone said the formulated feed is sustainably produced using plant proteins including wheat products, soy bean products, lupins, minerals and a small amount of fish meal and fish oil.

"Currently these pellets use between 25 and 30 percent protein across the board. Based on our research we have suggested protein levels for younger greenlip abalone at a shell length of 20 to 30 millimetres is 35 percent during summer when water temperatures are around 22 degrees, and 27 percent in winter and 32 percent in spring when water temperatures are cooler.

"We have also found from our research that larger abalone with a shell length of 50 to 70 millimetres have lower protein requirements of between 24 and 27 percent in winter, and a bit higher in summer. These seemingly small variations will make a big difference to the growth rate of abalone and in optimising the cost of feed."

## Growing Australian seafood industries

EP Aquafeeds director, Dr Tom Coote, said Dr Stone's preliminary research has confirmed that young, fast growing greenlip abalone utilise dietary protein more efficiently than larger abalone.

"This new information will allow us to diversify our production to at least two diets that differ in their protein levels. This, in turn, will allow abalone farmers to feed abalone of different sizes different feeds, depending on water temperatures.

"Better feed conversion ratios will result in lower feed input costs. Better protein efficiency will result in lower effluent levels. At a time of rising costs and exports being hampered by a strong Australian dollar, this is welcome news for abalone growers."

Dr James Harris from Flinders University and Dr Louise Ward from the University of Tasmania are collaborating with Dr Stone.

## Reviving the oyster lover's oyster

Marine Innovation Southern Australia is helping South Australian oyster growers revive the culture of the native or flat oyster, *Ostrea angasi*. Known as the oyster lover's oyster, the native oyster can command twice the price of the introduced Pacific oyster, *Crassostrea gigas*, which is now commonly grown on oyster leases along the pristine South Australian coastline, mainly on Eyre Peninsula.

The native oyster was the first substantial fishery in South Australia, having been exploited from the 1860s. The industry collapsed around the 1880s primarily as a result of over fishing, and subsequent attempts to recover this valuable resource were hindered due to poor spat survival.

MISA geneticist, reproduction and biotechnologist specialist, Professor Xiaoxu Li, appointed by SARDI, is helping oyster growers develop an aquaculture industry by using local broodstock to refine hatchery techniques. This has had the added benefit of producing large quantities of spat for growers, who have been unable to source sufficient stock commercially.

Prof Li, who has extensive expertise in all areas of shellfish culture, initiated the research in 2011 when he recognised increasing interest in farming the native oyster in South Australia.

The one million spat produced by Prof Li in the hatchery at SARDI Aquatic Sciences were purchased by Coffin Bay oyster grower, Mr Brendan Guidera, who has been slowly incorporating native oysters within his Pacific oyster farming business for the past five years. Mr Guidera said the main stumbling block had been sourcing large enough quantities of spat to make its production feasible.

"I see a great future for this industry, but we can't get enough seed from commercial hatcheries because the demand is not yet there. And we can't build the demand until we have a reasonable supply. The only native oyster spat we could get from a commercial hatchery this year was 100,000" he said.

*"Prof Li has a wealth of knowledge in shellfish production, and it would be very difficult to secure the spat and get the native oyster industry going without the work he is doing."*

**Mr Brendan Guidera, Coffin Bay oyster grower.**



The technology required to grow oyster spat and the microalgae to feed it, is highly specialised. However, Prof Li was confident that he would be able to draw on his experience with other bivalve species including scallops, mussels and Pacific oysters.

Under natural conditions, the female native oysters look after their progenies inside their shells and release them as free swimming larvae into the water column when they are about a week old. The larvae further develop, and then metamorphose into spat and settle on the substrate.

In this project the progenies of different ages (from a few hours to about a week old) were collected from the females directly. They were then reared in 2000 litre round tanks and fed a mixture of four microalgae species.

Above: MISA genetics, reproduction and biotechnology specialist, Prof Xiaoxu Li, has expertise in shellfish culture. He is playing a major role in the development and improvement of abalone, cockle, mussel and native oyster farming. With over 25 years experience working as a researcher in Australia and China, Prof Li has primarily focused on selective breeding, chromosome set manipulation, spermatozoa and embryo cryopreservation, and molluscan reproduction, physiology, ecology and histology.

**SARDI's appointment of Marine Innovation Southern Australia nutrition and feed technologist Dr David Stone has addressed pressing needs within the aquaculture industry to improve nutrition and feeds used on fish farms, in particular greenlip abalone, *Haliotis laevis*, SBT, *Thunnus maccoyii*, and YTK, *Seriola lalandi*. He has worked on numerous nutrition programs, both nationally and internationally, investigating the effects of the substitution of fish meal and fish oil on the growth performance and product quality of a range of freshwater and marine aquaculture species. Recently Dr Stone worked with the University of Idaho, USA and with the Agriculture Research**

**Service, Department of Agriculture, USA; and other research groups in Alaska on a federally funded grant entitled "Converting Alaska Fish By-products into Value Added Products and Ingredients". Dr Stone's research has also concentrated in areas of nutrient digestibility and availability, amino acid nutrition, fatty acid metabolism and deposition, feed technology, health, and nutritional genomics (nutrigenomics) of fish. Dr Stone has been an active collaborator with South Australian university staff and supervisor of graduate and postgraduate students from Flinders University and the University of Adelaide.**



The microalgae were about five to ten micron (one-thousandth of a millimetre) in diameter, and so tiny that they had to be counted under a microscope. The microalgae were produced in SARDI's Algal Culture Room in plastic bags where they receive balanced light, nutrients and carbon dioxide to promote fast growth and good nutritional quality. The microalgae in the bags were maintained at a density of up to ten million cells per millilitre.

Prof Li said that by the completion of a number of hatchery trials, survival rates of at least 70 percent were being achieved from early stage larvae to metamorphosis.



## Growing Australian seafood industries

"The subsequent metamorphosis rate and early spat survival rate to three months of age have been similar to those typical for Pacific oysters, a species considered to be easier to culture," he said.

The success of the project has increased industry's confidence to further develop native oyster aquaculture in South Australia, and SARDI Aquatic Sciences now has improved capability to provide support and advice on hatchery techniques.

The native oyster is a less hardy oyster to grow than the Pacific oyster and takes twice as long to grow to market size in the same farming environment; however they achieve a much higher market price.

It is thought that the longer growth cycle of the native oyster gives it a richer flavour than Pacific oysters, their texture is firmer and they have a longer after taste. These attributes have already attracted the attention of some top seafood chefs in Australia and overseas.

Below: South Australian Mussel Growers Association researcher, Mr Jonathan Bilton and MISA genetics, reproduction and biotechnology specialist, Prof Xiaoxu Li (SARDI) pictured with mussel broodstock (Photo: The Advertiser, Sarah Reed). Top right: Oyster farming in South Australia (Photo: BST Oyster Supplies).



## Mussel growers hatch new plans

Confidence in the future of South Australia's young mussel industry has been boosted with the successful growout of hatchery reared mussel spat, *Mytilus galloprovincialis*, at commercial farms in Boston Bay near Port Lincoln and offshore of Wallaroo.

The expertise of Marine Innovation Southern Australia researchers at SARDI Aquatic Sciences, led by Professor Xiaoxu Li, produced around six million spat spawned from 70 male and female broodstock that were transported to farms following a dramatic fall in the number of wild-caught spat collected due to fouling of the mussel spat settlement ropes. Fouling prevents the spat from settling, or outgrows them after settlement.

The hatchery grown spat were reared on ropes in tanks at SARDI Aquatic Sciences' laboratories. Boston Bay mussel grower Mark Andrews said the growth and quality of the hatchery reared spat to harvest "was equally as good as wild caught and raised spat."

"We achieved a high retention rate of the spat that settled onto the ropes for grow out, and our final harvest was up to expectations, equal to what we would have expected with wild caught spat."

Mr Andrews said that the Port Lincoln mussel industry generally enjoyed high natural spat settlements and good success when collecting larvae on ropes in selected locations over winter.

"But so many factors can impact the numbers we catch, from currents to climate variations, as well as fouling of the ropes. In addition, a lack of sunshine can reduce the abundance of microalgae in the sea, which in turn affects broodstock condition and larval and spat production," he said.

"Knowing that we can augment mussel spat numbers on a large scale when we need to boost production minimises the risk, giving us much greater confidence in investing in this industry."

South Australian Mussel Growers Association (SAMGA) researcher, Mr Jonathan Bilton, who looked after the spat which had been settled onto ropes held within tanks at SARDI Aquatic Sciences, said that based on the trials' success, industry should take the next step and that a commercial hatchery is "the way of the future."

"A hatchery will give growers much more security by reducing the risks inherent in sourcing mussel larvae from the wild, and provide greater opportunities to increase production levels by having spat available over a longer period of each year."

Mr Bilton said that building a commercial hatchery was a big investment for the mussel industry with establishment costs at around \$0.5 million. "Having access to SARDI's facilities and the expertise in these early stages is providing us with the information we need before we commit to further investment."

Mr Andrews wanted further research into the development of spawnless or triploid mussels from hatchery stock. He said this was because triploids maintained higher condition because they did not spawn, and therefore they could grow all year round, could be harvested all year round and provided year round market availability.

The mussel broodstock were supplied to SARDI Aquatic Sciences by a South Australian mussel farmer.

MISA researchers conditioned the mussels for the spawning in the hatchery at SARDI Aquatic Sciences. Initially, 200 mussels were spawned

individually to ensure that the best quality gametes and the right sperm and egg ratio were used in the fertilisation.

A similar procedure has been used previously at SARDI Aquatic Sciences for research associated with cryopreservation of a number of shellfish species, the breeding of Pacific oysters, *Crassostrea gigas* and more recently to assess the feasibility of culturing cockles, *Donax deltoides*, and *Katelysia* spp.

The mussel larvae and subsequent spat were fed a number of microalgal species, which are also being cultured by SARDI researchers.

Prof Li said that mussel larval production was very successful with close to 80 percent survival and excellent growth to the competent larval stage, and added that they grew rapidly.

“They ate vast amounts of microalgae every day — around 100 billion and two trillion microalgae cells per day at larval and spat stages respectively.”

The microalgae were cultivated in 500 litre bags by SARDI senior technician, Mr Mark Gluis, where they received balanced light, nutrients and carbon dioxide to promote fast growth and good nutritional quality. The microalgae in the bags were maintained at a density of about five million cells per millilitre.

The project was undertaken by Kinkawooka Mussels, South Australian Seafoods (SA Seafoods) and Flinders Seafoods in association with SARDI Aquatic Sciences.

### Microalgae ‘bulging with biofuel potential’

Marine Innovation Southern Australia researchers at SARDI have isolated and evaluated a strain of a native microalgae species that could form the basis of a local multi-million dollar biofuels industry. The breakthrough discovery comes after six years of ‘bioprospecting’ across thousands of kilometres of South Australia and into the waters of the Great Australian Bight (GAB) by MISA researchers, followed by trials in the laboratory and small-scale outdoor raceways.

The success in finding this particular strain of microalgae among the hundreds of microalgal species and strains evaluated has given South Australia a head start as research into third generation biofuels advances to the next level. MISA algal production researcher, Dr Sasi Nayar, who leads the SARDI Algal Production Group said the research isolated 14 native strains with potential.

It is carbon neutral because it absorbs or recycles carbon as it grows, rather than emitting new carbon into the atmosphere.

The mining industry is one of the largest users of diesel in Australia, and biofuel derived from microalgae provides one of the best alternatives to petroleum-derived fuel for the aviation and vehicle industries. For the aviation industry, algal biofuel is a sustainable alternative because it has the right environmental signature, as well as the correct energy and viscosity characteristics for jet engines. It is a ‘drop-in’ fuel that can replace current jet fuels without any modification to the engines. SARDI has undertaken research for the US Department of Defence in this area.

### Innovative technologies

“The flagship strain stands head and shoulders above the rest — it is a specific strain of the green alga, *Nannochloropsis*, with an unusually high lipid content of up to 58.1 percent and very high protein content.

“These attributes mean that this microalgae has tremendous commercial potential with application across the full range of oil uses from biofuels to high value co-products such as animal and human food supplements, medicines and cosmetics,” he said.

“This particular strain doubles in biomass every day, is highly tolerant to extreme conditions, and is native to southern Australia. The high oil content was achieved by optimising growing conditions without any genetic manipulation to the microalgae itself.”

“We are at a stage where we now know a lot about this species and its optimal growing conditions and we are ready to scale up to commercial level to refine the production systems to be used.”

The industry partner, Plentex Ltd, is raising capital to take the research to commercial pilot scale and then full commercial scale.

Microalgae are a non-food feedstock which does not compete with traditional agriculture for land and resources. It is a clean, renewable fuel that opens the door to significantly reducing greenhouse gas emissions.



Above: MISA algal production researcher, Dr Sasi Nayar, with biofuel extracted from a strain of microalgae species, *Nannochloropsis* (a green alga), which has high lipid and protein content.



The background of the slide is a photograph of a coral reef. The image is oriented vertically, with the reef structure running from top to bottom. The corals are primarily green and brown, with some white patches visible. A solid yellow horizontal banner is positioned in the upper right quadrant of the image. The word "Biosecurity" is written in white, sans-serif font on this banner. A dashed white line curves across the lower half of the image, starting from the left edge and ending on the right edge. In the bottom left corner, there is a small blue square containing the number "16".

# Biosecurity



## MISA: Providing technology to managers and users of the aquatic environment to decrease risks and impacts associated with pests and disease.

Pests and diseases pose threats to environments, the communities that they sustain, industries and infrastructure. The Marine Innovation Southern Australia Biosecurity research area provides expertise and infrastructure, and develops technology to assess and manage risks, undertake surveillance and control activities. It also addresses the threats associated with aquatic pests and diseases.

Since the initiation of MISA, a biosecure facility for aquatic disease and pest research, called the South Australian Aquatic Biosecurity Centre (SAABC) has been constructed. Four high level researchers have also been recruited to bring new capabilities and deliver research and development outcomes for a range of industries.

### Major achievements

- The establishment of the SAABC has provided biosecure conditions for research on aquatic pathogens and pests in a system large enough for meaningful applied research. SAABC's secure conditions support studies on pathogen transmission, pathology and epidemiology, pest reproduction and growth, invasion dynamics and control.
- Molecular assays for marine pest surveys are being developed to meet Government needs for tools to cost effectively undertake surveillance required under the National System for the Prevention and Management of Marine Pest Incursions (the National System). These tools can also be used by port operators and the shipping and energy industries to monitor ballast water and rapidly identify marine pests.
- Assessment of products for disease and pest management has been enhanced by development of three new and two renewal Minor Use Permit (MUP) applications to the Australian Pesticides and Veterinary Medicines Authority (APVMA). Permits facilitate industry management of health issues with regulatory oversight to ensure the safety and efficacy of treatments. Agencies include APVMA, Department of Agriculture, Fisheries and Forestry (DAFF), Department of Sustainability, Environment, Water, Population and Communities (DSEWPoC), Biosecurity SA - PIRSA and the aquaculture and shipping industries. New standards have also been developed for environmental management of products used to treat ballast water.
- A next-generation DNA sequencer offers advanced capacity to rapidly obtain data on environmental samples, pest and pathogen DNA, to better understand diversity in the environment and to aid in ensuring the specificity and sensitivity of other DNA technologies.
- High level scientific and technical advice to industry and government through MISA Biosecurity research supports industry sustainability and maintenance of Australia's environmental credentials. Highlights include:
  - > Marine pest surveys of the port of Adelaide to meet Biosecurity SA's National System obligations to monitor its priority ports for listed marine pests.
  - > Environmental risk assessment for the invasive green alga, *Caulerpa taxifolia*. This study resulted in the replacement of the anchoring ban in Port Adelaide with a designated containment area, improving this

important urban waterway's amenity for local recreational activities and assessment of risk under climate change scenarios.

- > Assessing risks and auditing practices to inform policy development, validate regulation and manage industry practices to meet World Organisation for Animal Health standards for aquatic animal health.
- > Assessing the marine pest status of western king prawn nursery areas and establishing the health status of those prawns to support pest management regulation, facilitate trade and support Australia's restrictions on imported prawns.
- > Review and collation of spatial data for all records of introduced marine species in South Australia.
- > Development of a system for assessing the pest risks associated with aquarium fish currently permitted to be held in Australia but identified as grey list species (i.e. species of unknown risk).

### Future Pathways



Above: *Perna canaliculus*, the New Zealand green-lipped mussel, has been found in South Australia after being introduced with biofouling. Opposite page: *Sabella spallanzanii*, the European fanworm has invaded much of southern Australia including Gulf St Vincent and Spencer Gulf. It competes with native species for space and food.

MISA is a national leader in aquatic biosecurity and through its partners has infrastructure and capacity to manage threats to industries, communities and infrastructure in an environment of shifting economic priorities, increased trade, tourism and a changing climate. Key areas include:

- Molecular assays for environmental samples – development of a complete system for sampling, processing, testing and reporting the outcomes of environmental testing using molecular tools.
- Novel technologies for management of pests and diseases – using molecular biology, environmental techniques and epidemiology to manage pests and diseases in aquatic environments.

These roles are consistent with those attributed to MISA in the national PISC Biosecurity R,D&E Strategy.

A full list of Biosecurity projects is available of page 70.

## Advancing aquatic biosecurity

Safe research involving marine organisms that threaten our marine ecosystems and fisheries has been boosted in South Australia with the opening of a significant new facility at Roseworthy Campus, the University of Adelaide.

The South Australian Aquatic Biosecurity Centre (SAABC) provides researchers with highly secure conditions for the study of aquatic pathogens and pests, offering capabilities previously unavailable in Australia because of its combination of scale and level of containment.

The \$2.4 million Physical Containment Level 2 (PC2) Facility, funded by the Government of South Australia through Marine Innovation Southern Australia and built by SARDI in collaboration with the University of Adelaide, positions South Australia as a key national provider of aquatic biosecurity research.

The SAABC is co-located with the University's new Veterinary Health Centre, School of Animal and Veterinary Sciences, and offers researchers access to the School's diagnostic laboratories and its veterinary specialists. The SAABC is jointly operated by SARDI and the University.

The need for a highly secure aquatic biosecurity facility was identified as critical to the continued growth of South Australia's \$800 million (gross food revenue) seafood industry, when MISA was first established.

The benefits of biosecurity research and development for marine industries are considerable, including increased certainty of production, improved sustainability and market access.

The SAABC enables rapid response to aquatic health threats, and on-going research to help safeguard our valuable aquatic resources.

## Safeguarding aquatic biosecurity

The SAABC's co-location with the Veterinary Health Centre also provides university students opportunities to study aquatic animal health within the veterinary curriculum which is unique in Australia.

Former University Vice-Chancellor, Professor James McWha said the development had delivered great benefits in collaborative research and training in one of the State's most important but developing industries.

"Our students now have the opportunity to learn in a state-of-the-art facility beside internationally recognised researchers. They are able to take

*"Australia's geographical isolation is not enough to protect us from the continuing major fish disease events in Asia and South America. The new South Australian Aquatic Biosecurity Centre was developed with these realities in mind and is an important step forward for the Australian seafood industry."*

**Mr Brian Jeffriess, Chief Executive Officer, Australian Southern Bluefin Tuna Industry Association (ASBTIA).**

this unique experience and knowledge and apply it as animal science and veterinary professionals in a range of settings."

Researchers also have access to the adjacent Veterinary Diagnostic Laboratory facilities for research projects and to the expertise of veterinary specialists, including MISA aquatic animal health researcher, Dr James Munro, appointed jointly by SARDI and the University, and Dr Charles Caraguel, a veterinary aquatic epidemiologist with the University.

The facility is available to outside collaborators for research involving pathogen transmission, pathology and epidemiology, pest growth, invasion dynamics and control.

One of the initial projects is looking at *Perkinsus olseni*, a protozoan parasite that can cause serious disease in abalone. It is a problem in the Central and Western Zone abalone fisheries in South Australia, with first outbreaks noted in the early 1980s. Prior to this new facility, there was nowhere to safely study the pathogen on a large scale. Environmental factors influence the expression of the disease and this facility enables experiments to be designed to explain these interactions.



**Left: *Perkinsus olseni*, a protozoan parasite first detected in South Australia in the early 1980s when it caused serious mortalities in abalone populations on Yorke Peninsula. It continues to occur in abalone around Eyre Peninsula and poses a threat to South Australia's \$38 million a year abalone industry.**

## Baseline study boosts marine pest management

In an environment of increased world trade, passenger-ship movement and with the threat of climate change, nations face new challenges from marine pests and diseases.

The management of marine pests is a relatively new area of marine research in South Australia. In 2007 Dr Marty Deveney was appointed to lead Marine Innovation Southern Australia's Biosecurity research area and develop South Australia's capability in monitoring, identifying and managing invasive marine species.

### Safeguarding aquatic biosecurity

One of the first tasks was to undertake a marine pest census – tracking the number of invasive species, the extent to which these were established and where they occurred in South Australian waters. Dr Deveney and SARDI



Aquatic Sciences research officer, Ms Kathryn Wiltshire, produced the first comprehensive listing of introduced marine species in South Australia collating all confirmed records of non-indigenous species. Ninety-nine introduced species – 62

animals and 37 algae – were pinpointed and geo-referenced from more than 1200 previous records.

"This baseline information provides us with the first really useful resource for future invasions," said Dr Deveney. "If an exotic organism is found and it is not on the list, we can assume it is a new invasion. If detected sufficiently quickly after introduction, we have a much better chance of eradicating it before it establishes. It also helps identify range extensions and greatly assists in the management of introduced species."

Recreational fishers were relieved when a five-year ban on anchoring in the Port River was lifted in 2009 following research by Marine Innovation Southern Australia into the invasive green alga, *Caulerpa taxifolia*.

One of the trigger species listed on the National System, *C. taxifolia* was first noted in South Australia in the semi-closed suburban West Lakes system and the upper regions of the Port River in 2002.

The fear that it might spread to the Gulf St Vincent led to a ban on recreational fishers anchoring in the Port River from 2003.

It is now accepted that the pest, which outcompetes natural seaweeds and eventually denudes the surrounding benthic community, cannot be eradicated from the region. But a study led by MISA Biosecurity research leader, Dr Marty Deveney, found that the risk of *C. taxifolia* spreading into the Gulf was extremely low because the environmental conditions were unlikely to be suitable for its establishment and growth.

The findings changed fisheries management policy for *C. taxifolia* in the upper Port River which has since been declared a control area, and no further

action will be taken unless the alga spreads outside that zone.

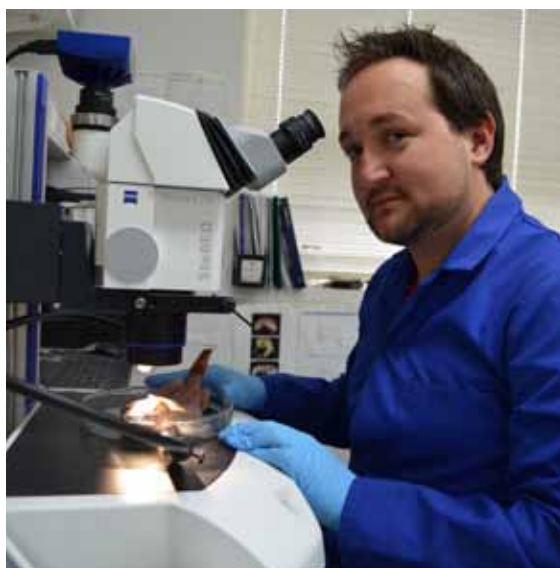
Dr Deveney said research for the Environmental Risk Assessment Report on *C. taxifolia* examined the physiological tolerances of the plant, factors associated with colonisation success and growth and compared the biological features of invaded and control sites.

"Environmental conditions within the Port River including increased temperatures and nutrients, coupled with a high level of human activity, are driving the establishment and growth of *C. taxifolia* in this region," said Dr Deveney.

Below: The invasive green alga, *Caulerpa taxifolia*, is native to tropical areas but has invaded the Mediterranean Sea, and areas in California, Japan, and southern Australia. Above: *Asterias amurensis*, northern Pacific seastar, is an invasive seastar found in Victorian and Tasmanian waters, known to cause damage to shellfish beds and farms.







Above: MISA biosecurity research leader, Dr Marty Deveney.

The research highlights 13 species that are on the trigger list for monitoring in the National System. The report also informs the surveys undertaken as part of the National System that is being implemented around Australia by State and Territory governments to manage the risks associated with the spread of marine pests.

When new incursions of trigger list species are discovered, they must be reported to Biosecurity SA, PIRSA. The national Consultative Committee on Marine Pest Emergencies (CCIMPE) is then convened to discuss and manage the response. Important trigger list marine pests such as the brown alga, *Undaria pinnatifida*, and the Pacific seastar, *Asterias amurensis*, do not occur in South Australia, although the European fanworm, *Sabella sapallanzanii*, and the green crab, *Carcinus maenas*, are among 13 trigger list species recorded in South Australia.

The report entitled *Introduced marine species in South Australia: a review of records and distribution mapping*, is available through SARDI Aquatic Sciences at [www.sardi.sa.gov.au](http://www.sardi.sa.gov.au).

South Australia's ability to protect the health of its aquatic resources has been advanced by Marine Innovation Southern Australia's determination to fill a critical gap in the State's expertise and infrastructure.

Dr Marty Deveney was appointed to lead MISA Biosecurity and SARDI's Marine Biosecurity program in 2007, providing the first dedicated aquatic biosecurity research and development program in South Australia.

MISA Biosecurity research now has five high level invasive species and fish disease researchers, and with the establishment of the South Australian Aquatic Biosecurity Centre (SAABC) in 2011, South Australia is now positioned to become a key national provider in aquatic biosecurity research.

Dr Deveney has a PhD in parasitology, and special interests in finding ways to prevent pests or pathogens invading biological systems including natural environments and farms. He has significant experience in working with monogenean (flatworm) parasites

of finfish and with macroalgal bio-invasions and management of these biosecurity issues.

He is also experienced in the use and registration of chemotherapeutants and disinfectants to manage diseases and pests, including designing and performing efficacy and safety studies, registration processes and ongoing monitoring of use.

Dr Deveney is involved in developing policy frameworks and supporting auditing and management capabilities for government. He is currently acting as technical executive to the Emergency Aquatic Animal Disease Response Agreement Working Group of the Aquatic Animal Health Committee. The intergovernmental and industry group is developing a framework within which formal agreements between aquatic industries and government could be developed for co-management and cost sharing in disease-related emergencies.

Dr Deveney is an expert on *Caulerpa taxifolia*, an invasive green alga that was first identified in South Australia in 2002.

## Biosecurity a sound investment

Clean Seas Tuna Ltd (CST) has been working with Marine Innovation Southern Australia researchers, through the Australian Seafood CRC, to safeguard its investment in southern bluefin tuna (SBT), *Thunnus maccoyii*, by improving biosecurity protocols.

CST, which is pioneering the propagation of SBT, deals with a production line that extends from holding broodstock offshore to onshore broodstock facilities, culture of live feeds, larval culture and the potential transfer of animals in and out of the facility.

MISA researchers have helped evaluate current hatchery protocols, and identified critical control points, allowing existing protocols to be modified to further reduce potential risks in the occurrence or spread of infectious diseases.

## Growing Australian seafood industries

An ongoing benefit of the collaboration has been the transfer of skills and methodologies to CST staff to sample SBT larvae for histology and archival storage as part of routine health checks. Collecting samples prior to unexpected mortalities can detect latent infectious agents that may be present in larvae, and can provide valuable information for future diagnostic testing.

## Heart warming DNA research

Marine Innovation Southern Australia molecular diagnostics researcher Dr Nathan Bott's interest in marine parasites has led to a major contribution to the Australian southern bluefin tuna (SBT), *Thunnus maccoyii*, industry.

Appointed by SARDI as part of its Molecular Diagnostics Unit, Dr Bott's research interests concentrate on the use of DNA to classify marine organisms, and the development of molecular assays for environmental monitoring.

Dr Bott was part of a research team that discovered the complete life-cycle of the pathogenic SBT blood fluke. The research team comprised participants from industry, SARDI (including MISA aquatic animal health researcher, Dr Craig Hayward), University of Tasmania, University of Queensland and Queensland Museum.

The bloodfluke parasite has a two-host life cycle and lives as an adult in the hearts of tuna but until recently the intermediate host was not known. The research team found a number of infections in a group of polychaetes (marine worms), and through the use of DNA sequencing Dr Bott was able to confirm the match to adults in SBT.

"This was an exciting discovery because it was like looking for a needle in a haystack, and even then we only had a vague idea of what we were actually looking for," said Dr Bott. "For the SBT industry, it's a great step forward. While this parasite does not affect humans, it can kill tuna. Knowing more about the problem will help SBT farmers better protect the fish."



Above: MISA aquatic animal health researcher, Dr Craig Hayward, describing parasites and diseases that can affect southern bluefin tuna.

SBT is the most valuable sector of South Australia's aquaculture industry, worth hundreds of millions of dollars to Australia annually. It is hoped that this finding can help lead to a more profitable industry.

Dr Bott has also developed expertise in understanding the transmission pathways of marine organisms, and is now developing a DNA-based detection system to identify a wide range of marine pests that can pose significant risks to fisheries, aquaculture and social amenity.

"With over 250 exotic marine species and 55 significant pests already identified in Australia, it is critical to monitor and adequately manage marine pests," said Dr Bott. "Elimination of an established pest from the marine environment is generally not feasible, so preventive methods and quick response times are the focus."

### Innovative technologies

The National System requires that each of Australia's 18 ports be surveyed for the presence of marine pests every two years.

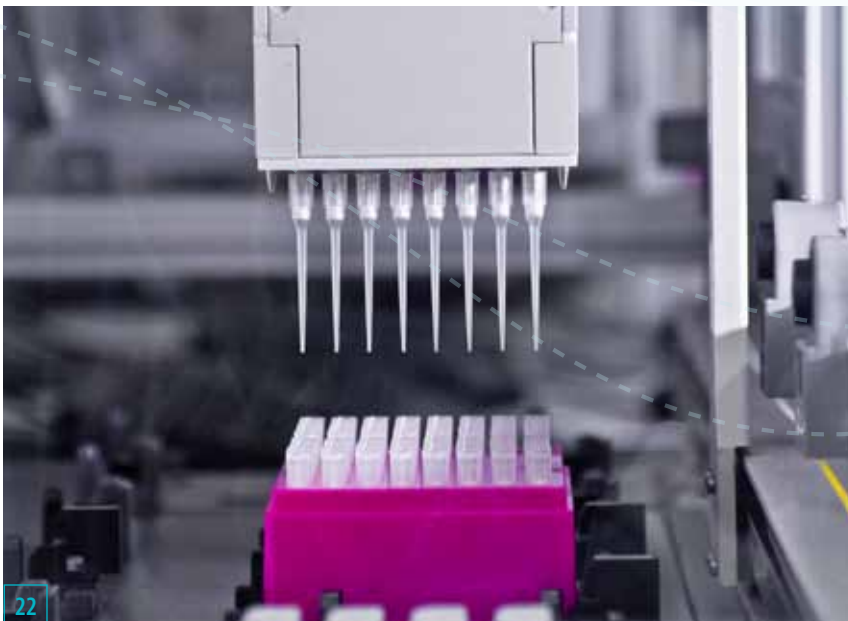
However, traditional techniques such as physical sampling and sorting for the identification of marine pests are expensive and slow.

"A robust molecular monitoring system will enable more rapid surveillance to be conducted," he said. "Quantitative polymerase chain reaction (qPCR) assays enable analysis of a high number of samples for numerous different species in under a week — even the detection of a few larvae can be made quickly and with confidence."

Dr Bott's team has already developed qPCR assays for ten of the 55 significant invasive marine species — northern Pacific seastar, *Asterias amurensis*, European clam, *Corbula gibba*, Asian bag mussel, *Musculista senhousia*, Pacific oyster, *Crassostrea gigas*, New Zealand green mussel, *Perna canaliculus*, European green shore crab, *Carcinus maenas*, vase tunicate, *Gona intestinalis*, Japanese seaweed, *Undaria pinnatifida*, European fanworm, *Sabella spallanzanii* and black-striped mussel, *Mytilopsis sallei*.

SARDI's recent acquisition of a GS Junior sequencing system will aid Dr Bott in the development and implementation of tests, and help in developing baseline species' information for individual ports.

Below: The DNA sequencer, enhancing molecular diagnostic capability. Opposite page: *Carcinus maenas* the European shore crab that has invaded marine and coastal waters in Tasmania, New South Wales, Victoria and South Australia. *Carcinus maenas* is a voracious predator with a broad diet and has been implicated in the decline of native shellfish populations, some of commercial importance (Photo: Anthony Fisher).



## DNA technology 'packs a punch'

"It's a small machine but it sure packs a punch!" laughed Marine Innovation Southern Australia molecular-diagnostic researcher, Dr Nathan Bott.

The next generation DNA sequencing technology of the '454 GS Junior' takes molecular diagnostic capability to new heights.

The powerful research tool based at SARDI Waite Campus equips researchers with the ability to rapidly evaluate long segments of DNA providing detailed information about the genetic composition of various organisms.

Dr Bott said the machine did not require a pure sample of the organism itself. It can evaluate environmental samples such as water or soil to determine 'species richness' and indicate whether a specific organism of interest is present and to what degree.

"From a sample of genomic DNA this machine can provide information totalling up to 50 million bases of sequence," said Dr Bott. "We can now do in one experiment what we could not previously do in one year. For example, trying to detect a low level genetic difference that would have previously taken months and months of laboratory work could be detected in a few days using this new machine."

Part of the 454's workload involves research to better understand the baseline species' assemblages from plankton and sediment samples from Australia's ports. It also enables researchers to identify pest species present for future monitoring and to better understand planktonic diversity and ecology.







# Ecosystem services



## MISA: Providing a better understanding of the key physical and biological processes that underpin production and biodiversity of our unique marine ecosystems has helped support the long-term sustainability of South Australia's seafood industry.

The Ecosystem Services research area has addressed major capability gaps to ascertain the nature of the marine ecosystems found in South Australia, and to what degree they are resilient to natural and anthropogenic influences including climate change, biological resource extraction, nutrient input, physico-chemical alteration, coastal development and pollution.

Over the past five years, 11 high level researchers have been recruited who are national and international experts in their fields. These encompass oceanography, numerical and biogeochemical modelling, ecosystem modelling, climate change biology, habitat assessment, high trophic level predator biology and ecology, phytoplankton, zooplankton and microbial ecology, benthic ecology and marine phycology.

These appointments have resulted in the establishment of major new capabilities, essential to manage our unique marine ecosystems and secure the long-term sustainability of our seafood industries.

### Major achievements

- The Southern Australian Integrated Marine Observing System (SAIMOS) as part of the Australia's Integrated Marine Observing System (IMOS) has built a state-of-the-art monitoring program based on measuring how physical, chemical and biological parameters underpin production and biodiversity of southern Australian marine waters. This includes the implementation of key observing infrastructure including moorings, High Frequency (HF) RADAR, ocean gliders and acoustic receivers. Apex predators including Australian sea lions are also being utilised. One of three new moorings has now been deployed to measure acidification and carbon dioxide fluxes into the ocean. The SAIMOS node represents a major new national capability that services not only the seafood industry, but also marine and coastal development, mining, and defence industries.
- Optimising the prawn and crab harvest: a biophysical management tool. The sustainable management of the prawn (and crab) harvest in Spencer Gulf has been significantly improved through biophysical modelling studies of larval dispersion. In particular, it has been demonstrated when and where adult prawns can be fished so as to minimise the loss of larvae to the mangrove settlement regions and maximise returns to the industry. A key to these results was the demonstration that Spencer Gulf prawn larvae behave in a similar manner to Gulf of Carpentaria prawn larvae in being able to "surf" the strong tides into the coastal regions.
- Protected species conservation and management is a core capability that has been enhanced through Marine Innovation Southern Australia. A major program to investigate the lack of recovery of threatened Australian sea lion populations identified by-catch in the shark gillnet fishery off South Australia, managed by the Federal Government, as the major factor. By combining data from an extensive sea lion satellite tracking program with data from a fishery by-catch observer program, Ecosystem Services researchers were able to estimate the extent of bycatch mortality occurring in the fishery. Results indicated that Australian sea lion mortality levels were unsustainable. Ecosystem Services researchers provided a range of mitigation options to the Australian Fisheries Management Authority (AFMA), resulting in a succession of adaptive management responses including fisheries' closures and bycatch trigger limits, which have since been introduced into the fishery. Researchers are now involved in monitoring signs of recovery in key Australian sea lion populations.
- Climate change is a major focus of many activities in the Ecosystem Services research area. It is important to understand the potential impacts on our marine industries and ecosystems if we are to continue to manage our marine environment sustainably. The Transect for Environmental Decision Making (TRENDS) project encompasses marine and terrestrial impacts of climate change, and involves using a space-for-time substitution to predict likely implications. This involves studying current responses of assemblages in northern areas of the State to predict what will happen further south as temperatures increase.
- High level scientific and technical advice to industry and government through the Ecosystem Services research area is supporting policy and management relating to the sustainable use of South Australia's marine natural resources. Highlights include:
  - > building an integrated marine observing system for southern Australia's marine waters;
  - > building a versatile, calibrated hydrodynamic/biogeochemical modelling facility;
  - > providing predictive tools for determining the carrying capacity of aquaculture zones in South Australia;
  - > developing trophodynamic models of southern Australian marine ecosystems; and
  - > providing research and advice to governments and industry on the mitigation of threatened, endangered and protected species interactions with fisheries, aquaculture and ecotourism industries.

### Future Pathways

To provide the scientific framework to underpin optimisation of ecological, economic and social outcomes to the South Australian community from utilisation, management and conservation of marine resources and ecosystems. This will be achieved based on two key platforms:

*Gulf Ecosystem Program* – this program will provide a scientific framework for ecosystem-based management of the two gulfs. In Spencer Gulf, this need is driven by the rapid increases in marine parks, mineral processing, shipping, aquaculture, recreation, desalination and other activities that are likely to occur in that ecosystem over the next decade. Gulf St Vincent also supports significant commercial and recreational fisheries and there is a need to address the impacts of terrestrial storm water run-off on marine habitats and assemblages adjacent to Adelaide.

**Opposite page: Deploying plankton nets as part of a program sampling Australian sardine eggs to monitor population abundance.**



Great Australian Bight (GAB) and Bonney Coast Ecosystem Program — this program will provide a scientific framework for an ecosystem-based management system that supports valuable commercial fisheries, globally-significant populations of species with high conservation value, and diverse and highly endemic benthic ecosystems. The main drivers for the development of this program are the existing and proposed marine parks and oil and gas exploration programs that are about to be established in the region.



These two key initiatives underpin the next phase of MISA, and aim to enhance collaboration among the institutions and researchers that undertake marine science off southern Australia. MISA will take a major role in facilitating ongoing engagement with and among the stakeholders and policy makers that utilise, conserve and manage these marine resources and ecosystems.

These roles are consistent with those attributed to MISA in the national PISC Fisheries & Aquaculture R,D&E Strategy.

A full list of Ecosystem Services projects is available on page 71.

Below: Marine assemblages on jetty piles being surveyed at multiple sites as part of the TREND project. Top right: *Naxia aurita*, a native spider crab found in southern Australia.



## TREND

Marine Innovation Southern Australia researchers, Professor Corey Bradshaw (University of Adelaide) and Dr Jason Tanner (SARDI), are driving the marine component of the Transect for Environmental Decision Making (TREND) project. Using one of the world's most geographically concentrated natural oceanic gradients in temperature and salinity, the Marine Ecosystems researchers are evaluating how marine invertebrate assemblages are likely to change under different climate change scenarios. By combining field results with experimental manipulations and information on physiology, the projected susceptibility of different temperate marine environments to climate change are being modelled.

Marine invertebrate assemblages on jetty piles have been surveyed at each site along north and south marine gradients and temperature and salinity on the east and west coastline of Gulf St Vincent. These plots will be photographically monitored every three months for the duration of the study. In addition, settlement plates at the northern and southern-most sites were deployed to establish assemblages which have been translocated to other sites. This allows study into how these assemblages change when exposed to different conditions.

Researchers are predicting the geographical distribution of marine invertebrate taxa under realistic climate change scenarios, by constructing spatial models using data from settlement plates and clearance experiments, and climate model forecasts.

## Research goes deeper

Rising interest in oil and gas production as well as deep sea fishing in the GAB Marine Park Benthic Protection Zone (BPZ) has heightened the need to better understand the region's benthic biodiversity.

In 2010 Marine Innovation Southern Australia benthic ecologist, Dr David Currie, initiated and led a ten day exploratory expedition through the GAB Marine Park BPZ, aboard the Commonwealth Scientific and Industrial Research Organisation (CSIRO) marine national facility the RV Southern Surveyor, to sample sea floor biodiversity in Australian waters at depths of up to 4000 metres.



Dr Currie said it was important to understand the ecology of the region, in order to manage potential oil and gas production or deep water fishing in the area.

"When the BPZ, which covers a total area of 4000 square nautical miles, was initially declared in the late 1990s, it wasn't known exactly what it was that we were really protecting.

"This expedition helped provide data on the composition and distribution of the fauna inhabiting some of the deepest parts of the Marine Park that is to 4000 metres. By comparing it with other places in Australia and around the world we will know if the fauna is endemic to this area," said Dr Currie.

The \$450,000 expedition, funded by the Australian Government, swath mapped over 150 square nautical miles of seabed throughout the park, and sampled seafloor biodiversity as well as the water's conductivity, temperature and nutrient content.

Dr Currie said the composition of the benthic fauna in the GAB changes markedly with depth and sediment structure. On the relatively shallow seabed of the continental shelf (less than 200 metres depth), sponges and bryozoans were the dominant organisms. On the upper slope (around 500 metres) solitary corals and anemones flourished, but below 1000 metres depth brittle-stars and sea cucumbers were the most frequently encountered organisms.

Dr Currie said that because many of the benthic organisms were important sources of food for fish, marked changes in the types of fish represented at different depths in the GAB also occurred.

One of the most exciting finds was a cone-shaped 'volcano' 100 nautical miles offshore and at 2000 metres depth.

Dr Currie said that organisms living on the feature could be unique to the location and date back 'thousands of years.'

"While there are similar volcanic features outside the zone, this is significant because it is located in an area now protected from human disturbance, preserving its biological diversity into the future. The 800 metre diameter volcano rises 200 metres out of a generally flat and featureless seafloor.

"Previous work by Geoscience Australia mapping volcanic features on seismic data in the region suggests that it is likely to be an igneous build-up formed when molten magma pushed toward the surface thousands of years ago," he said.

Dr Currie said the extinct volcano was from the Eocene Epoch dating back 48 million years. It was likely to support a diverse community of long-lived, slow-growing, organisms such as stony corals, hydroids, gorgonians and glass sponges.

"We are now very keen to go back and sample around this volcanic feature and assess the biological community that it supports. There may be some unique aspects to this feature in the GAB that makes its immediate ecological environment extremely important."

Dr Currie added that a sustained commitment to data collection is required. "We still know so little about such a large area that it is difficult to comment on the conservation values of the many benthic fauna sampled in the BPZ, as their identities have yet to be confirmed, or because no data have been published on their distribution.

Almost 96 percent of infauna and 61 percent of epifauna collected during this expedition could not be confidently assigned to existing species and it appears that a large proportion of these organisms may be undescribed."

## Environmental sustainability

Voucher material for each taxon collected on the mission has been lodged with the South Australian Museum and will be a valuable reference for future bio-geographical assessments.

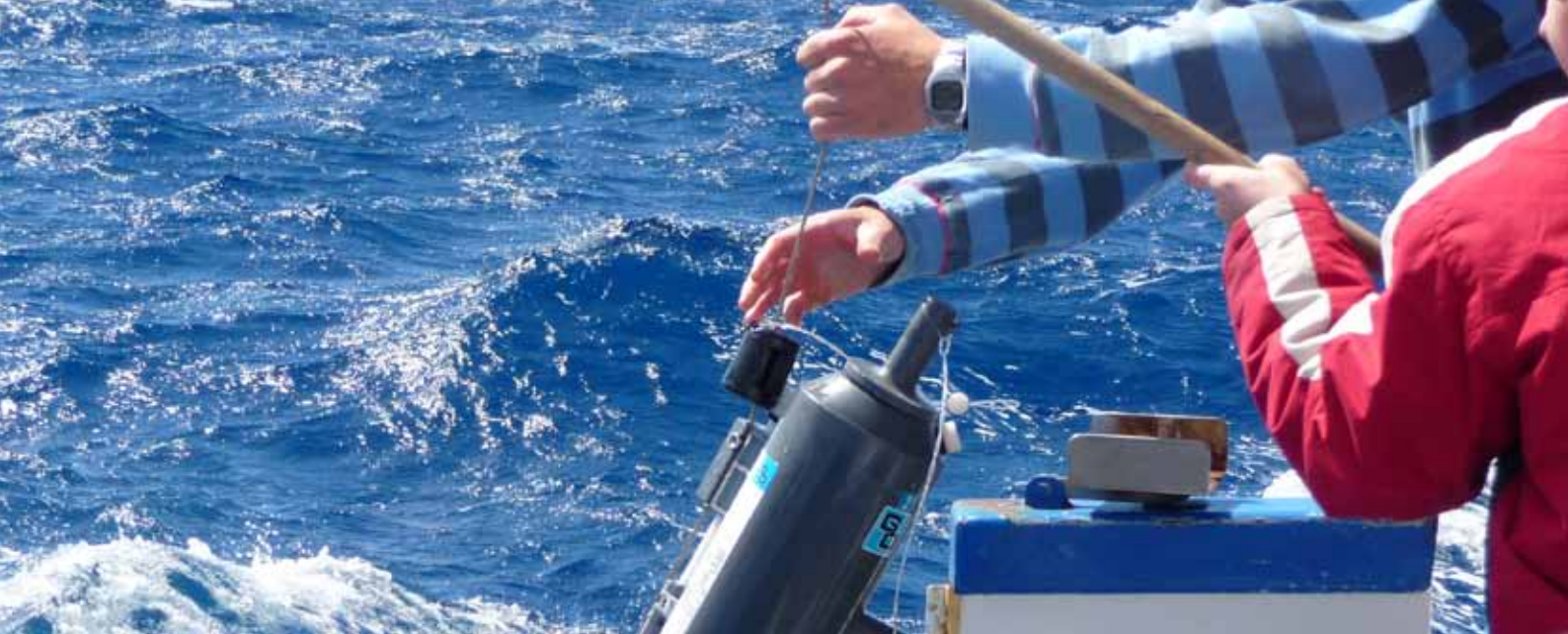
The expedition team named the volcanic seamount *Anna's Pimple* in honour of swath operator Ms Anna Hill, a post-graduate student from the University of Tasmania, who spotted the feature.

Dr Currie's survey followed several successful surveys of the GAB by Geoscience Australia. In 2000 Geoscience Australia (then Australian Geological Survey Organisation) undertook the first comprehensive bathymetric mapping and seafloor sampling of the BPZ. This was followed by the Bight Basin Geological Sampling Survey in 2007, which mapped a suite of volcanic build-ups across the region, including several larger volcanoes approximately 150 kilometres to the northwest of this feature.



Above: Jessica Nilsson (UTAS), Laura Richardson (SARDI) and Sue Reynolds (CSIRO) onboard the RV Southern Surveyor. Top left: MISA benthic ecologist, Dr David Currie, with deep sea snails sampled during a benthic survey in the GAB Benthic Protection Zone.





Above: MISA oceanography researchers deploying a CTD (conductivity, temperature and depth) instrument. Right: Dr Brad Page fitting an Australian sea lion with a GPS tracker (Photo courtesy of: Owen Daniel).

## Insights into the Southern Ocean on climate, ecosystems and seafood

Unlocking the knowledge beneath our seas will divulge critical information to help manage our valuable fisheries and shape our responses to climate change.

MISA physical oceanographer Associate Professor John Middleton was appointed by SARDI in 2006 to build South Australia's oceanographic capability with the aim of providing timely information to support and enhance the State's fisheries and aquaculture industries.

He established the Southern Australian Integrated Marine Observing System (SAIMOS), which today is one of the largest nodes of the Australian Integrated Marine Observing System (IMOS). It is supported by a team of 12 highly skilled researchers with expertise in hydrodynamic modelling, biological ecosystems, shelf and coastal ocean circulation systems, field data collection and tidal modelling and sediment transport. The \$9.1 million program is based at SARDI Aquatic Sciences and the School of Biological Sciences, Flinders University.

SAIMOS maintains an extensive network of state-of-the-art equipment deployed off the coasts of southern Australia including sub-ocean gliders, shelf moorings, acoustic observatories, autonomous underwater vehicles and over-the-horizon HF RADAR. It even uses Australian sea lions to collect critical data on the status of our marine environment.

With the completion of more than 25 research cruises and the collection of more than four years of continuous data since SAIMOS was established in 2008, the data

streams retrieved from the wide array of technology platforms are now benefiting the State's fisheries and aquaculture managers.

SAIMOS data streams are being interpreted using a hydrodynamic/ biogeochemical modelling capability, developed by SARDI oceanographers and funded by the Government of South Australia through MISA.

The research team, through its ocean circulation and ecosystem modelling capability, is providing answers to the critical links between ocean currents, planktonic responses and marine nutrient cycles. The research is helping guide fisheries management, the selection of aquaculture sites, the establishment of marine parks and to quantify the impacts of desalination plants, sewage outfalls and potential biosecurity risks.

A suite of advanced oceanographic models is now being used to determine sustainable stocking rates for existing and proposed aquaculture zones in Spencer Gulf, as well as to optimise the prawn harvest in Spencer Gulf by understanding wild prawn larval dispersal and recruitment to the fishery.

Recent additions to SAIMOS have included the deployment off Kangaroo Island of a buoy that monitors the carbon dioxide and pH levels associated with the seasonally upwelled waters that support the richest pelagic ecosystem in Australia.

Information from the buoy and water sampling undertaken on regular research cruises is used to assess the effect of ocean acidification in response to climate change on our marine ecosystems.

An HF Ocean RADAR system is processing data for surface winds providing near real-time information available on the web on incoming fronts for the Eyre Peninsula region. This benefits marine industries and ecotourism operators who can optimise cruise plans to 'surf' ocean currents to save time, money and greenhouse gas emissions. It also helps sea search and rescue operations, weather prediction during bushfire events and marine pollution management.



### *Innovative technologies*

**The Southern Australian Integrated Marine Observing System (SAIMOS) forms part of the national Integrated Marine Observing System (IMOS) funded by the Federal Government's National Collaborative Research Infrastructure Scheme (NCRIS) and Education Investment Funds (EIF). SAIMOS is one of the largest of the five coastal nodes in Australia with infrastructure covering South Australia and western Victoria. Investment in the project over seven years from 2006 to 2013 exceeds \$9.1 million with Federal and State Government funding, as well as in-kind support from SARDI Aquatic Sciences, Flinders University and the Marine and Freshwater Resources Institute (MAFRI).**



## The highs and lows of South Australia's gulfs

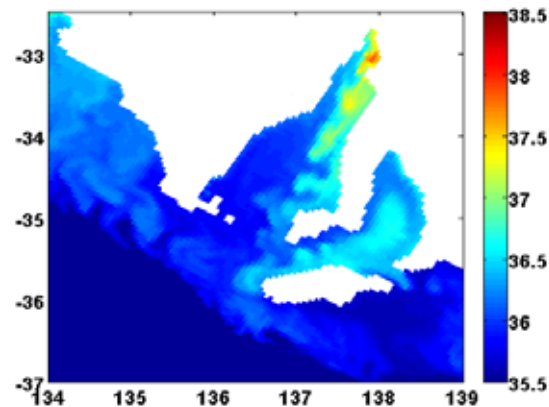
Marine Innovation Southern Australia researchers using SAIMOS data streams have discovered patterns within South Australia's gulf waters which are the equivalent to high and low pressure systems in the atmosphere.

The discovery of the gulf eddies by Associate Professor John Middleton and Dr Carlos Teixeira (SARDI and the University of New South Wales), has unlocked the mystery of the 'flushing' of Spencer Gulf and the Gulf St Vincent every winter.

The phenomena of the gulfs' 'flushing' has long been known, but not understood. These eddies are similar to the "Meddies" that form to depths of several hundred metres as salty water flows out of the Mediterranean. The eddies create the flushing effect, clearing the gulf of detritus and nutrient wastes which build up over the warmer months.

"Now that we know when and how these eddies occur, we can determine more accurately the cycling of nutrients, helping to provide management solutions for activities including the positioning of farmed SBT, *Thunnus maccoyii*, cages and desalination plants," said Dr Teixeira.

The project is providing PIRSA management with much improved estimates of the carrying capacity of existing and proposed aquaculture zones so that financial return to the industry is maximised and the industry is managed in a sustainable manner. It will also provide



information to set aquaculture feed and stocking rates that maximise the industry's growth potential while also ensuring that the natural environment remains healthy.

The three-year \$1.2 million project, 'Carrying Capacity of Spencer Gulf', is being funded by PIRSA Fisheries & Aquaculture, FRDC and MISA.



Above: Dr Carlos Teixeira with one of the shelf moorings deployed at depths of between 100 and 600 metres off the southern Australian coastline. The devices measure water temperature, salinity, current speed and direction, and phytoplankton concentrations. Top right: Model showing the salty then fresh eddies leaving Spencer Gulf and Gulf St Vincent.

## Landmark study supports ecosystem-based fisheries management

A major seven year study led by Marine Innovation Southern Australia pelagic ecologist, Associate Professor Simon Goldsworthy, has provided a landmark for assessing ecological sustainability in the eastern Great Australian Bight (GAB).

A model produced by the study is now assisting ecosystem-based management strategies in the highly productive region which supports Australia's largest fishery by weight, the sardine fishery, with around 30,000 tonnes harvested annually.

The study, the first of its kind in the world, was prompted by concerns about the potential ecological implications of the fishery's rapid development in the GAB. The \$2.5 million project, funded by FRDC and the South Australian Sardine Industry, looked at the role of sardines in the region's food web.

The sardine industry, South Australian fisheries managers and SARDI researchers supported by MISA initiated the study to address community concerns that taking large catches of sardines could change the balance of the ecosystem, and potentially impact on some of the region's valuable marine predators including SBT, *Thunnus maccoyii*, seabirds such as crested terns, *Sterna bergii* and short-tailed shearwaters, *Puffinus tenuirostris* and marine mammals including New Zealand fur seals, *Arctocephalus forsteri* and common dolphins, *Delphinus delphis*.

The project produced a trophodynamic model of the eastern GAB ecosystem which captured 18 years of change in the region, including development of the sardine fishery and fluctuations in 11 other fisheries, changes in apex predator populations and oceanographic variations especially those involving the region's nutrient-rich upwelling.

### Innovative technologies

The expertise of 22 researchers from SARDI Aquatic Sciences was used in completing the project, including Honours and PhD students from

Flinders University and the University of Adelaide who investigated the diets and habitats of 47 predator groups including pelagic fishes, squids, marine mammals and seabirds in the region.

"The ability to resolve and attribute potential impacts from multiple fishing fleets, other human impacts and ecological change will be critical to ensuring future ecological sustainable development within the region," said A/Prof Goldsworthy who also leads SARDI's Threatened, Endangered and Protected Species science program.

The research also revealed that South Australia's pelagic marine ecosystem is in good health. Associate Professor Tim Ward, who has led SARDI's sardine fishery research program since 1998, said that SARDI assessments had estimated the total sardine population in the eastern GAB at around 200,000 tonnes.

"With 30,000 tonnes harvested annually, this equates to a conservative exploitation rate of 15 percent of the spawning mass, which is well below the internationally accepted boundaries for small pelagic fishes, and well within the biological limits of the stock."

*"The findings in this report, 'Establishing ecosystem-based management for the South Australian Sardine Fishery,' will give industry immense leverage in the future should it wish to pursue accreditation as a sustainable fishery from global organisations such as the Marine Stewardship Council."*

**Mr Paul Watson, South Australian Sardine Industry Executive Officer.**

A/Prof Ward said the sardine fishery grew from nothing to eclipse all other Australian fisheries in just 18 years. "We have monitored the sardine population using a stock assessment technique known as the daily egg production method since the 1990s, so we knew that the stock was in a strong position," he said. "What we didn't understand before this study was the role of sardines in the ecosystem and how the ecosystem is structured," said A/Prof Ward. "This study shows that South Australia's pelagic marine ecosystem is in good health. The evidence suggests that the precautionary approach to management that the sardine fishery has taken, is achieving its goal of ensuring ecological sustainability."

South Australian Sardine Fishery Executive Officer, Mr Paul Watson, said the project demonstrated that the industry was leaving nothing to guesswork or speculation regarding the ecological sustainability of the fishery.

"Now more than ever, fisheries are being scrutinised over their potential environmental impacts, and a report that credibly quantifies the benign ecological footprint of the South Australian Sardine Fishery leaves us in a strong position."

A/Prof Simon Goldsworthy added that all Australian fisheries must be managed on the principle of ecological sustainable development. "But to achieve that, the tool is ecosystem-based management — an extremely expensive and challenging thing to do."

A/Prof Goldsworthy added the greater benefit from this project was that there was now a tool usable by multiple stakeholders from fisheries to aquaculture and conservation. "All future ecologically sustainable management will stem from the origins of this study," said A/Prof Goldsworthy. "The sardine fishery should be congratulated for supporting the study, because as well as demonstrating the sustainability of the fishery, this work will ultimately benefit many other fisheries and stakeholders in the region."



Below: SARDI wildfisheries Program Leader A/Prof Tim Ward (Photo: The Advertiser, Simon Cross). Right: Little penguins, *Eudyptula minor*, were part of the study to understand the food webs of the eastern GAB.





Above: MISA oceanographer, Dr Mark Doubell (SARDI) and wild fisheries researcher, Dr Cameron Dixon (SARDI) with western king prawns, *Melicertus latissulcatus*.

### ‘Virtual larvae’ point prawn fishers in the right direction

Spencer Gulf in South Australia supports the largest known population of western king prawns, *Melicertus latissulcatus*, in the world. Researchers using data from the MISA supported SAIMOS program have been working with the Spencer Gulf and West Coast Prawn Fishermen's Association to develop robust fishing strategies for the sustainable management of the fishery.

“Obviously trying to track the routes travelled by individual prawn larvae in the field is not achievable. These models allow us to research prawn dispersal for various scenarios including climate change. Our results clearly show larval behaviour plays a key role in maximising the number of prawns recruited to the fishery and identifies the major spawning and nursery sub-regions to protect”, said Dr Doubell.

#### Environmental sustainability

This is being achieved using models to develop harvest strategies which optimise both the catch and the recruitment of prawns for future fishing.

“Advances in computer modelling have allowed us to determine the complex routes travelled by prawn larvae to settlement grounds. These models mean we can simulate the development, behaviour and transport of prawns in relation to the circulation and hydrodynamic features of Spencer Gulf,” explained MISA oceanographer, Dr Mark Doubell.

Dr Doubell heads the biological modelling of SARDI's Oceanography Hydrodynamic and Biogeochemical Modelling research group. Data streams collected from SAIMOS have underpinned the development of detailed circulation models for the South Australia region, including Spencer Gulf.

With additional funding support from FRDC, modellers and biologists from SARDI are working together to further improve prawn fishing strategies.

**Oceanographic capability fostered by Marine Innovation Southern Australia is being used to help the sustainable development of aquaculture in Spencer Gulf and provide knowledge relating to the interactions between the ocean currents and planktonic ecosystems off southern Australia. Collectively, the effort of MISA researchers is providing world-class scientific support for the continued development of South Australia's fisheries and aquaculture industries.**



## Seeing eye to eye with sharks

A world-first project led by Marine Innovation Southern Australia shark ecologist Dr Charlie Huveneers has initiated improved management practices for South Australia's shark cage-dive industry. Scientists and South Australian cage-dive operators collaborated in the project with the common aim of ensuring the State's eco-tourism activities take good care of Australia's protected white sharks.

It resulted in reduced time in the water by the industry's three licence holders with the introduction by the Department of Environment, Water and Natural Resources (DEWNR) of 'operator free' days at Neptune Islands to prevent sharks being continually exposed to cage-dive operations.

DEWNR Chief Executive Allan Holmes said the decision followed a review of cage diving activity. "The decision will balance the need to protect sharks from activities which might adversely impact on their behavior, with the need to ensure the sustainability of our local tourism industry," he said.

The research provided important information to help the Government of South Australia manage the growing industry. Its outcomes are also

helping to inform similar cage diving operations around the world in places such as New Zealand, South Africa and Mexico.

### Environmental sustainability

Dr Huveneers' team and cage operators worked together throughout 2010 tagging 21 white sharks which inhabit the area around Australia's main cage-diving operations off the remote Neptune Islands, 75 kilometres from Port Lincoln.

Sharks were tagged with an acoustic tag as they swam past the boat, allowing researchers to record their positions in relation to the cage-diving boats for a period of up to 45 days.

"We used a radio-acoustic positioning system enabling fine-scale modelling of the swimming behavior of the tagged sharks through near-continuous recording of positions and depths with one metre accuracy," said Dr Huveneers.

Andrew Fox from the Fox Shark Research Foundation and operator of cage-diving tours off Neptune Island helped the scientists find and tag the sharks.

Key results showed that sharks spent a significant amount of time in close proximity to berleying vessels thus affecting their location and swimming depth. Sharks also spent more time in close proximity to berleying vessels than they would if randomly distributed within the site. They also spent more time on the surface interacting with the cages and bait than they would do when away from the berleying vessels. An interesting finding

*"This research provides a fantastic platform for the start of some serious research into the white shark, and it will help our industry move forward in a responsible way that does not impact on these magnificent sharks or the environment."*

**Mr Andrew Fox, Fox Shark Research Foundation.**

was that sharks also partitioned their time between berleying vessels, and spent time in close proximity to both vessels, suggesting that a shark can be 'shared' by two cage-diving operators.

The research team included researchers from SARDI, University of Tasmania (UTAS), Flinders University and CSIRO, with funding and support from the Nature Foundation of SA, MISA, DEWNR, Neiser Foundation, Fox Shark Research Foundation and Solar Online.

Below: MISA shark ecologist, Dr Charlie Huveneers uses acoustic tags to monitor the movement of white sharks across southern Australia (Photo: Patrice Heraud). Opposite page: HF RADAR installed along South Australia's coast form part of a national network monitoring Australia's oceans that provides data supporting research on critical issues such as climate change and sustainability of ecosystems.



**MISA shark ecologist, Dr Charlie Huveneers, has played a major role in expanding the knowledge base of the biology and ecology of sharks and rays in Australia. He coordinates a number of significant research programs that describe the life history parameters (age and growth, diet, reproduction) of demersal and pelagic shark species and their associated vulnerability to commercial fisheries. He has published over 20 scientific papers and reports, and has supervised five PhD and seven Honours students. Dr Huveneers is the South Australian representative for the acoustic telemetry component of the Australian Animal Tagging and Monitoring System (AATAMS). He leads SARDI Aquatic Sciences' Southern Shark Ecology Group and has a full academic position with the School of Biological Sciences, Flinders University and affiliate status at the Sydney Institute of Marine Science. In 2010 Dr Huveneers was awarded the South Australian Young Tall Poppy Science Award and Flinders University Vice-Chancellor Early Career Research Award.**







## Seafood product quality and value adding



## MISA: Helping the seafood industry become more responsive to consumer demands is a critical element in increasing the overall value of the South Australian seafood industry.

Marine Innovation Southern Australia has provided the resources to fill numerous capability gaps in the areas of food technology, processing, cold-chain management, packaging, branding, sensory analysis, market requirements, economics and new products in the effort to drive a 'market pull' seafood industry and deliver products that consumers want.

Over the past seven years, six high level researchers have been recruited to support research and commercial capability in new product development, seafood processing, seafood safety risk assessment and trade and market access. MISA has also provided a range of new facilities, including those at the Lincoln Marine Science Centre, Port Lincoln; at Regency TAFE; and SARDI Plant Research Centre, Waite Campus, Urrbrae.

These appointments and facilities have resulted in major new national capabilities helping industry develop new and existing products and expand its markets.

### Major achievements

New product development has been significantly expanded with the appointment of an experienced seafood technologist, packaging technologist and processing engineer, as well as the purchase of advanced packaging equipment. Post-graduate students recruited alongside these researchers are also helping to develop new products and apply new food processing technologies to seafood. This platform now represents a major new national capability in seafood innovation.

Food safety research capacity at SARDI has evolved into a leading national program to access new markets, maintain existing markets and support premium quality labelling claims in high value markets. A specialist seafood safety risk assessment researcher appointed to lead the program has built the area's capability to world-leading standards dealing with seafood hazards including Norovirus, Hepatitis A and marine *Vibrios*. These seafood-borne hazards are the subject of increasingly stringent market access standards that can result in increased regulatory costs or limit market access.

*SafeFish*, a national program hosted by SARDI in collaboration with the Australian Seafood CRC, grew out of the success of the food safety program. *SafeFish* identifies and prioritises seafood safety trade and market access issues and the resulting technical requirements to uphold the changing standards expected of regulators and industry.

Other major achievements include:

- expanding the potential for the sardine fishery to include supply of high quality sardine products for human consumption;
- establishing the compositional profile of seafood products to support labeling and marketing;
- introducing Modified Atmosphere Packaging (MAP) technology to extend the retail shelf life of mussels and shucked oysters;
- supporting the reopening of the European Union (EU) market for Australian abalone resulting from a risk assessment of marine biotoxins that showed negligible risk under current minimal regulation arrangements;

### Increasing the value of South Australian seafood by improving:

- Processing efficiency
- Post harvest value
- Sales to high value markets

- facilitating cost effective chemical residue testing (under a deed of agreement with DAFF (formerly Australian Quarantine and Inspection Service, AQIS) required by seafood exporters to meet EU market access standards;
- established, primarily through Flinders University, a comprehensive product quality and value adding capability at the Lincoln Marine Science Centre, Port Lincoln. The new facility includes a variety of specialised infrastructure and equipment for this purpose; and
- developed a novel technological solution for adding various ingredients to baitfish feeds for SBT.

High level scientific and technical advice to industry and government through MISA research is supporting rising food safety standards to ensure that markets remain open to our seafood producers. Highlights include:

- developing diagnostic tests and providing scientific advice on their interpretation to support policy and regulation development and inform the risk management of food safety issues;
- conducting risk assessments to inform policy development and validate the industry's ability to meet export trade standards;
- providing industry with cost effective interventions to minimise food safety risks; and
- hosting packaging workshops and providing manufacturing advice and sensory training.



Above: South Australian yellowtail kingfish is a favoured dish on menus at top end restaurants. Opposite page: South Australian blue mussels (Photo: Kinkawooka Shellfish).

## Future Pathways

The provision of a national seafood science leadership and coordination role by the MISA Seafood Product Quality and Value Adding program, pursued by the SARDI Food Safety and Innovation Research Program, is seen as an opportunity for industry to build sustained technical capacity and research impact. Key platforms include:

*SafeFish* - The priority setting, implementation and delivery process for technical trade and market access is well developed and supported by SARDI through *SafeFish* with its industry, trade and regulatory stakeholders.

*Seafood Innovation Hub* - The development of an industry-led *Seafood Innovation Hub* has been proposed to define priorities, drive technology uptake, facilitate collaboration and direct research for product and processing innovation.

These roles are consistent with those attributed to SARDI in the national PISC Fisheries and Aquaculture, R,D&E Strategy.

The proposed program will conduct risk assessments on technical trade barriers as prioritised by *SafeFish*. Development of shellfish (foodborne) virus and marine *Vibrio* diagnostic tests is a key capability to underpin risk assessments that meet emerging international trade access requirements.

The *Seafood Innovation Hub* initiative will provide new product development, sensory, shelf life, packaging, processing and administrative skills that support the process to identify industry research priorities and underpin a range of technology delivery activities.

A full list of Seafood Product Quality and Value Adding projects is available on page 79.



## Dining out on sardines

Australian sardines, *Sardinops neopilchardus* or pilchards as they were formerly known, have been the preferred choice for tuna farmed in pens off Port Lincoln since the early 1990s.

Now sardine fishers at Port Lincoln want people to dine out on sardines which are rich in omega-3 fatty acids for lowering cholesterol levels, vitamin B12 for cardiovascular well-being and vitamin D for bone health.

Plans to direct about 10 percent of the annual 30,000 tonne catch to human consumption would add significant value to the industry. The current return on sardines for tuna feed is 60 to 70 cents a kilogram. Sardines sold for human consumption could be worth up to several times more.

Below: The SARDI sensory tasting laboratory, Waite campus, Urrbrae. Top right: MISA researchers are identifying opportunities to develop the sardines for human market.



## SEAFOOD PRODUCT QUALITY AND VALUE ADDING



MISA seafood technologist Ms Karen McNaughton's appointment to SARDI has filled an important capability gap within the South Australian seafood industry. With over 20 years product development experience gained in the United Kingdom and New Zealand, Ms McNaughton has a strong track record in delivering new products to market that are innovative, safe and commercially viable for both retail and food service customers. Since joining SARDI she has collaborated with Clean Seas Tuna Ltd and the oyster and abalone industries in South Australia to provide advice on optimising current processes and practices and develop new value-added product concepts.

Supplying tasty, nutritious and high quality sardines for the human consumption market is a very different proposition to supplying fish feed for tuna farms. Sardines are a very delicate fish to catch and maintain at a high quality. The skin is easily damaged and temperature control along the cold chain has to be precise.

SARDI has been working closely with three sardine processors; Australian Southern Exporters, Port Lincoln Sardines and Sardine Temptations to help them add value to their product, identify market niches for sardines, and develop techniques to deliver the best product to market.

The catch, storage and handling logistics of sardines for human consumption are challenging. Leading the Australian Seafood CRC funded project is MISA seafood technologist, Ms Karen McNaughton (SARDI), who has been working with industry to improve the flesh quality and shelf life of sardines as well as developing a range of value added products to meet consumer expectations, for both domestic and export markets.

### *Growing Australian seafood industries*

Ms McNaughton has also led new handling and packaging techniques for fresh sardines, initiated development of a new frozen product to allow for year-round supply, undertaken microbiological testing and overseen consumer panels to clarify product preferences.

"This is a new area for sardines which traditionally are sold as lower value canned products," she said.

"A major aim has been to lay the foundations for a new market by developing fresh sardine products that will attract consumers, including those who may not even have thought to include sardines in their diet before, by ensuring

the taste and texture is maintained on the shelf and by creating value added sardine products that are delicious, convenient and ready to go," she said.

MISA seafood technologists now have eight new product concepts that are ready for industry evaluation. These include breaded sardines with a lemon and pepper coating, a range of chilled, marinated and ready to eat products presented in modified atmosphere trays, and sardines packed in cans and pouches.

"We've also tested existing products of sardines presented in modified atmosphere packs and indicated the potential these products have in further extending their shelf life and the quality of the sardines."

Ms McNaughton said the ultimate goal of the project was to enable a constant supply of good size sardines to the human consumption market.



"You can't build a human consumption market unless you can sustain it with year round supply. The next stage of the project will concentrate on freezing, packaging and storage methods to ensure there is always raw material available."

Ms McNaughton added that plans to use the sardines for the human consumption market had been inhibited by the small size of the sardines caught on occasion but hopefully this can be overcome in the future.

Above: MISA seafood technologist, Ms Karen McNaughton (left) and MISA packaging technologist, Ms Emma Langlois (right and below), are helping to develop the sardines for human consumption market.



## Making the most of delicious yellowtail kingfish

When yellowtail kingfish (YTK), *Seriola lalandi* are filleted, the resulting products are two fillets to sell and a left over fish frame that is usually treated as a waste product. MISA seafood technologist, Ms Karen McNaughton has been working with Clean Seas Tuna Ltd (CST) on an Australian Seafood CRC funded project to ensure this remaining fish flesh is put to good use. CST purchased a meat extraction machine that can be used to extract the fish flesh from the frame and produce a 'fish mince'. This product can then be sold to manufacturers of value-added products as an ingredient for fishcakes, fish-balls, spring rolls and the like. SARDI food technologists have already completed trials on the extraction of fish flesh from the frames and produced a promising fish mince. Trial results have included the production of frozen blocks of extracted fish flesh as a finished product and collection of data to enable a product costing to be completed. The resulting fish mince has been evaluated for shelf life stability in a number of ways: microbiological testing, biochemical testing and informal sensory evaluation of the raw and cooked product.

Below: MISA researchers are working with Clean Seas Tuna Ltd to produce fish mince that can be sold as an ingredient in value added products such as spring rolls. Top right: Southern bluefin tuna, Port Lincoln (Photo: Adam Watkins).



## Collaborative effort for innovative solution

Expertise and cooperation from all sectors of the tuna industry in Port Lincoln has resulted in a technology which is saving the industry about \$20m a year in southern bluefin tuna (SBT) mortalities as well as improving tuna health and productivity.

In 2008, the discovery that high tuna mortalities were possibly related to a bloodfluke parasite, led to a novel extension of an Aquafin CRC project that was assessing whether tuna product quality and shelf life could be improved by injecting baitfish feed with soluble vitamins.

The extension looked at using, under veterinary supervision, the injection technology for disease prevention and treatment, and in particular to target the bloodfluke parasite.

Chief Executive of the Australian Southern Bluefin Tuna Industry Association (ASBTIA), Brian Jeffriess said the ability to be able to extend the technology in such a timely manner for something that was suddenly a pressing need reflected the industry and researchers' unique capacity to work well together.



"Almost every challenge in aquaculture can be resolved by a combination of research expertise and engineering. Fortunately South Australia is very well served in these areas," he said.

The technology is now available for use with the appropriate regulatory authority approvals throughout the South Australian SBT industry. Mr Jeffriess said that researchers from MISA covering university and government, fishers, processors, veterinary professionals and industry representatives pooled their skills to transform the project.

In 2008, MISA and Flinders University product quality and post harvest researcher, Dr Trent D'Antignana, was involved in an ongoing project investigating the feasibility of supplying a vitamin premix to farmed SBT to enhance health and growth.

The project had its beginnings in 2006 when Dr Philip Thomas from Flinders University and Dr Jeff Buchanan from SARDI first looked at the potential of supplying SBT with natural antioxidants to extend the shelf life of tuna products for the lucrative Japanese market. Dr D'Antignana, working closely with tuna processor Tony's Tuna International at Port Lincoln, had been adapting a marinating machine from Holland to bulk inject sardines, one type of baitfish used to feed the tuna, with selected vitamins.

"The vitamin trials morphed into disease treatment trials when the cause of SBT mortalities was determined, and it hit us that the machine – already on our doorstep – was a fitting approach to treating this particular disease," said Dr D'Antignana.

ASBTIA research manager, David Ellis, added that to develop a treatment to reduce blood fluke infections in SBT required a team effort.

"It involved the skills and knowledge of Dr Paul Hardy-Smith, a private veterinarian; Dr Trent D'Antignana from Flinders University and MISA;

## SEAFOOD PRODUCT QUALITY AND VALUE ADDING



a team of researchers led by Professor Barbara Nowak, University of Tasmania; and SBT industry researchers and companies. It was supported collaboratively by PIRSA Fisheries and Aquaculture and other government regulatory departments," said Mr Ellis.

"It wasn't an easy undertaking but through a team effort the final step in the manufacturing of medicated baitfish was realised," he said.

"This technology has provided us with a treatment that can be included in a readily accepted tuna feed, thereby allowing SBT to be treated by a prescribing veterinarian".

SBT industry researchers, ranching companies, and Tony's Tuna International and Blaslov Fishing supplied the expertise and staff to run the trial machine and support the significant costs in developing the technology. The technology was trialled across the industry in 2011, and commercially adopted in the same year.

### *Innovative technologies*

There are now three baitfish injection units in action in Port Lincoln servicing the region's 12 tuna ranching companies. The machines can inject up to four tonne of sardines per hour.

The technology is the only method currently available for delivering therapeutics to control bloodfluke. Feeding injected baitfish revolves around the life cycle of the parasite. The timing of feeding medicated baitfish matches with a certain life stage of the parasite, killing the flukes before they mature and release their eggs. The treatment is a one-off medication. The bloodfluke can kill tuna, but is harmless to humans.

This research was underpinned by the research partnership between ASBTIA and FRDC.

*"Using this technology industry can now treat bloodfluke infections and others that may arise in the future. It has massive financial benefit and provides a strategy that engenders confidence in the future of the industry."*

**Mr Ellis, Research Manager, Australian Southern Bluefin Tuna Industry Association.**



**Above: MISA seafood quality specialist, Dr Trent D'Antignana (Flinders University - SARDI), with a bait injection machine (also pictured below) that is helping the southern bluefin tuna industry improve the health of farmed tuna.**

## Expanding regional marine science capability

New projects and greater industry collaboration have resulted from a major expansion of one of Australia's premier marine research and education facilities, the Lincoln Marine Science Centre.

Based at Port Lincoln on the Eyre Peninsula, the Lincoln Marine Science Centre is located at the heart of Australia's premier fishing and aquaculture region. Its global reputation in aquaculture has grown for its work in abalone, southern bluefin tuna and black mussel research, and its wild fisheries research is widely recognised for its ground breaking ecosystem-based fisheries management research.

Keen to work closely with industry, MISA researchers have used the Centre's enhanced capabilities to contribute to the growth of the aquaculture and fisheries industries, enabling development of technological solutions as needs arise.

Industry meetings are also often held at the Lincoln Marine Science Centre with scientists and government representatives. In addition, the Research and Development Officer with Clean Seas Tuna Ltd was permanently based at the MISA building for two years to foster research directions and collaboration.

Port Lincoln is one of the few places in the world where aquaculture leaders have the opportunity to collaborate closely with high level researchers at the 'coalface'.

With large ecosystem research programs proposed by MISA in the Great Australian Bight and Spencer Gulf, there will be more opportunities to increase use of the Centre in the future.

### *Building skills and capability*

Since the expanded centre was officially opened by the then Deputy Premier of South Australia, Kevin Foley, in March 2009, the new laboratories and facilities have helped ensure the South Australian seafood industry remains internationally competitive. The expansion was funded through Marine Innovation Southern Australia by the South Australian Government (\$4.5 million) and Flinders University (\$2.1 million through the Federal Government's Capital Development Pool Scheme).

Owned and operated by Flinders University since its establishment in 1995, the Centre has been primarily a centre for Flinders University, SARDI, PIRSA Shellfish Quality Assurance Program and TAFE Port Lincoln campus. It also offers excellent facilities for visiting students and researchers including a large lecture theatre, teaching laboratory and extensive aquarium areas.

The \$6.6 million expansion nearly doubled the size of the original centre providing the highest quality laboratories including constant temperature rooms and facilities for additional permanent and visiting scientists and educational staff.

Research at the centre ranges from understanding the key farmed marine species life cycles, their growing requirements, breeding and genetics. Further research is advancing fish health and pathology, pre and post harvest product quality and safety, cool chain management, product quality, waste minimisation and seafood market access.



Below: The Lincoln Marine Science Centre (LMSC), Boston Bay, Port Lincoln. Right: International, interstate and local researchers have benefited from the use of the expanded LMSC facilities.





## SEAFOOD PRODUCT QUALITY AND VALUE ADDING

### Keeping export doors open for Australian seafood



Export doors can slam shut in an instant with a slight change to regulations in overseas countries.

*SafeFish*, established by the Australian Seafood CRC, is keeping those doors open for Australian seafood producers by providing rapid technical response to varying global standards.

The national program is chaired by MISA seafood safety and market access researcher, Dr Catherine McLeod (SARDI).

Dr McLeod, was previously with the New Zealand Food Safety Authority and appointed by SARDI to support the development of seafood safety capability in South Australia. Significant investment has also been contributed by the Australian Seafood CRC to assist Dr McLeod in elevating South Australia's expertise in seafood safety to lead the national arena.

With a sound knowledge of food safety issues and seafood technical market access issues, Dr McLeod leads researchers, regulators and technical experts from around Australia who deal quickly with new regulations to help maintain free and fair access for Australian seafood producers to key international markets.

*SafeFish* also helps seafood producers stay up to date with regulatory issues and assists in their interpretation.

Advice extends to supporting trade negotiations, the development of international standards and the provision of technical assistance to Codex Australia on high priority seafood issues to ensure the safety and hygiene of seafood and fair food safety trading rules.

Dr McLeod said *SafeFish* was constantly on the look-out for emerging market access issues, in an effort to deal with them before they affected Australian producers.

### *Building skills and capability*

"A *SafeFish* project now underway is the provision of more accurate guidance to oyster producers and public health regulators as to when harvesting can resume following a pollution event such as an overflow from a waste water treatment plant," said Dr McLeod.

The project, co-funded through the New Zealand Seafood Industry Council, will provide an improved risk assessment approach to re-opening closed growing areas.

The outcomes from the project may mean that periods of closure are shorter and that there are less economic impacts on industry and greater reassurance to the community that the product is safe from potential pollution related to viruses.



Other *SafeFish* projects include the development of a risk profile on the distribution of parasites in Australian seafood to help improve market access and a review of international regulations on marine biotoxins.

**The appointment of Marine Innovation Southern Australia seafood safety and market access researcher, Dr Catherine McLeod, to chair SafeFish followed her success in a project to reopen market access for Australian abalone to the European Union (EU). The strategically important market had been closed to Australian abalone since March 2007 due to an EU regulation that logistically could not be applied to the vast fishing zones of the Australian abalone industry. Dr McLeod's research with the SARDI Food Safety and Innovation Program was pivotal in supporting the removal of**

**the EU regulation by demonstrating the product's high integrity and negligible marine biotoxin risk. The subsequent implementation of minimal entry requirements for abalone to the EU resulted in several companies re-commencing export to this important niche market.**



Above: MISA seafood safety and market access researcher, Dr Catherine McLeod (SARDI) is supporting the export of Australian seafood. Top left and right: Australian greenlip abalone, *Haliotis laevis*.

## Key to export success

The Australian Seafood Trade and Market Access Database, which aims to demystify the many complex trade access requirements for export markets, is boosting international opportunities and market confidence for Australian seafood producers.

The database, funded by the Australian Seafood CRC, with support from Marine Innovation Southern Australia, is the result of a long standing collaboration between SARDI researchers, Seafood Services Australia and DAFF Biosecurity. It is a simple, easy to use tool for Australia's \$2 billion seafood industry which is trying to grapple with the myriad of rules and regulations of more than 20 key international markets. This service can be accessed through a subscription to Seafood Services Australia ([www.seafood.net.au](http://www.seafood.net.au)).

Information collated in the database includes residue and contaminant standards, microbiological standards, preservatives standards (specifically relating to food additives), tariff and import duties, export certification

requirements, rejection and detention notification reports and trade volume statistics.

Exporters have to identify and meet importing countries food safety and trade requirements to gain access to their desired markets. This can be a difficult task, with port of entry requirements not always available in English and varying between countries. In addition, the numerous technical requirements for microbiological hazards, chemical residues and preservatives are commonly located across different agencies and websites.

This on-line database provides an access point that draws this information together, simplifying the process and making it easier for the Australian seafood industry to understand the requirements of exporting seafood.

Critically, the database underpins two other Australian Seafood CRC initiatives, the Seafood Access Forum, which is a forum for the seafood industry to identify and discuss trade issues and SafeFish, which has been developed to resolve technical trade issues facing Australia's seafood industry.

The partnership between these two initiatives, as well as the information contained on the Australian Seafood Trade and Market Access database, has contributed to increased industry and government efficiencies primarily through enhanced compliance of Australian seafood with port of entry requirements and reduced overall export compliance costs to industry and government.

Below: Southern bluefin tuna, Tsukiji market, Tokyo, Japan.





Above: Southern bluefin tuna (above) and Australian abalone (below) are premium seafood products on both domestic and international markets.

## Super seafood - what's in Australian seafood?

Industry now has a much clearer understanding of what's in Australian wild and farmed seafood following the release of a report that has studied the nutritional composition of 21 species of Australian seafood.

The report released by Marine Innovation Southern Australia partners – the Australian Seafood CRC, SARDI and FRDC – is the most comprehensive nutritional analysis of Australian wild and farmed seafood yet produced.

The study was prompted by a scarcity of robust nutritional data for key Australian seafood species. Now industry can gain easy access to information on the nutrient composition (key proximates, fatty acids, water and fat-soluble vitamins and minerals) of the 21 species studied.

The Australian Seafood CRC research has been embraced by industry. While some nutritional information is held by Food Standards Australia New Zealand (FSANZ), the National Residue Survey (NRS) and private companies, this new dataset focuses provides valuable information on

local species, such as prawns and oysters. Significantly it also tested for a wide range of nutrients.

The results have also confirmed that Australian seafood is healthy and safe to eat with all species tested compliant with Australian regulatory standards for cadmium, lead and mercury, and several species were discovered to contain nutritionally relevant quantities of important vitamins and minerals and omega 3 fatty acids.

This study can now fulfil baseline nutritional information to enable

industry to meet customer-based and regulatory needs, assist with risk-benefit assessments, promote the public health benefits of seafood consumption, and support response to market access threats. The study has also resulted in a significant consolidated resource that can be used by a wide range of stakeholders, including medical professionals, food regulatory agencies, researchers and consumers, not just industry associations and individual industry enterprises.

MISA researchers, through the Australian Seafood CRC, are now undertaking the development of an industry kit which will show industry how to make 'source' and 'good source' health claims for their products and develop key nutrient messages relevant to consumers. These industry kits will help guide industry on how the data can be used to its full potential, including offering some new marketing opportunities for industry.

The Australian Seafood CRC is working hard to make sure the information is understandable, usable and clear and that it can immediately be applied to business.

### *Growing Australian seafood industries*





# Education

Students are benefiting enormously from Marine Innovation Southern Australia's resources that are enhancing their educational opportunities. MISA's shared positions between SARDI and South Australian universities provide an ideal environment for building a practical understanding of research and industry needs, broadening the curriculum and expanding horizons for students.

As both lecturers and coordinators, MISA researchers contribute to the following undergraduate degrees at Flinders University and the University of Adelaide.

## Flinders University

- Bachelor of Science (Animal Behaviour)
- Bachelor of Science (Aquaculture)
- Bachelor of Science (Biotechnology)
- Bachelor of Science (Marine Biology)

## The University of Adelaide

- Bachelor of Science (Animal Science)
- Bachelor of Science (Marine Biology)
- Bachelor of Science (Veterinary Bioscience)

The expertise, knowledge, practical experience and industry awareness of MISA researchers has added a new dimension to science education. Students have responded enthusiastically to this collaborative approach.

MISA students (students supervised by a MISA researcher), have also made significant contributions to achieving applied outcomes for the seafood industry of South Australia. Many PhD students have obtained employment in government and industry after completing their studies.

## The number of students (current and completed) by qualification



## The number of students (current and completed) by MISA research area



A full list of teaching contributions by MISA researchers to the University of Adelaide and Flinders University is available on page 57.

MISA students are those supervised by MISA researchers. A full list of students is available on page 59.

## University students leap in

A rare opportunity for aquaculture students to be part of a project with commercial outcomes was established by MISA nutrition and feed technologist, Dr David Stone.

In 2008, Flinders University aquaculture and marine biology students, Phillipa Dean and Sam Kowald were the first to take part in the project to understand mulloway, *Argyrosomus japonicus*, feeding behaviours.

Around 5000 mulloway were involved in two experiments at the high-technology pool farm at SARDI Aquatic Sciences providing different feeding regimes to determine the best time of day to feed for optimum growth for this notoriously slow growing species.



Identifying morning and afternoon feeding as the optimum regime, this project provided students with invaluable hands on experience, exposing them to critical problems facing the industry and ultimately providing them with the fundamental skills to help solve issues. Many student projects have been co-supervised by SARDI and university researchers and a number of these students have gone on to work in industry.



Above: Examining yellowtail kingfish. Below: MISA aquatic animal health researcher Dr James Munro. Opposite page: Mulloway.

## MISA appointments create aquaculture opportunities for students

Aquaculture students are being exposed to a wider curriculum and the latest aquaculture research and facilities as a direct result of efforts by MISA aquatic animal health researcher, Dr James Munro.

Dr Munro's joint appointment with SARDI and the University of Adelaide has led to the development of a new intensive aquaculture course for the University's Veterinary School based at Roseworthy Campus.

The course provides students with a broad introduction to aquaculture equipping them with the necessary skills to take up a position within the aquaculture industry. The link between SARDI and the University of Adelaide through Dr Munro's appointment has promoted the involvement of SARDI researchers, exposing students to the latest aquaculture research and facilities.

Five MISA researchers presented a series of specialised lectures: Introduction to aquaculture; Aquatic biology - anatomy; Aquatic engineering; Biotechnology in aquaculture; Disease emergence; Intensive crustacean production; Intensive finfish production; Live feeds production; Macroalgal production; Nutrition in aquaculture; Viral diseases; and Water quality management, with many lectures and a practical component held at SARDI Aquatic Sciences, Adelaide.

The hands on three week elective 'Introduction to aquaculture and disease management,' is run during the mid year holidays.

The course is a critical step in achieving the veterinary school's vision to develop aquaculture production within their curriculum.

Feedback from students demonstrated the benefit of the University of Adelaide and SARDI collaboration, with all students commenting that they enjoyed the practical focus of the course and the direct involvement of researchers.





Above: MISA PhD student, Ms Jenna Bowyer, pictured at the experimental pool farm at SARDI Aquatic Sciences, studied the nutritional requirements of marine finfish species, specifically the replacement of fish meal in yellowtail kingfish feeds. Right: Formulating feeds. Bottom right: Yellowtail kingfish.

## MISA student profile

**Name:** Jenna Bowyer, PhD student.

**Research topic:** Nutritional factors influencing the performance of cultured yellowtail kingfish (YTK), *Seriola lalandi*, specifically at low water temperatures.

**Base location:** SARDI Aquatic Sciences, Adelaide and Flinders University, South Australia.

**Associated institutes:** Flinders University and SARDI.

**Research brief:** Research on the nutritional requirements for an Australian marine finfish species that are commercially important in Australia. My particular focus has been on the development of more sustainable aquafeeds in an effort to replace the traditional protein and lipid ingredients sourced from fish meal and fish oil with more sustainable terrestrial plant and animal based ingredients.

**Research benefits:** The direct benefit will go to the local YTK industry in South Australia. However, from a global-perspective, the human population will reach nine billion people by 2050 and an increasing 'seafood gap' has been predicted between what is desired for consumption and what can be produced by the ocean. I believe that aquaculture will provide the best hope for addressing this 'gap' and any research in this area will contribute towards this goal.

### Collaboration opportunities:

My PhD project was closely aligned to the YTK industry in South Australia to provide information that was directly applicable to their requirements. I believe that by having a link to industry through a SARDI supervisor as well as a university supervisor has provided me with a stronger background in my field of research and has made me more employable.

**Research extension:** Due to the project's close collaboration with its industry partner, Clean Seas Tuna Ltd (CST), the nutritional

research derived from my PhD has been directly implemented by the company into improving the feed management strategies of YTK culture in South Australia.

**Personal growth:** This PhD project has provided me with many opportunities, one of which was to present my research to an international audience at the World Aquaculture Society Conference in Brazil. By doing this research it has allowed me to meet and work with leading Australian and international researchers in the field of nutrition.



## Growing Australian seafood industries

**Current employment:** I have recently completed my thesis and accepted the position of "Sustainability and Communications Officer" with Skretting Australia. I am looking forward to continuing to work in the field of nutrition.

**Research funders:** Australian Seafood CRC, along with industry partner CST.

**Supervisors:** Associate Professor Jian Qin, Flinders University and Dr David Stone, SARDI.







conservationists will benefit from this work. Understanding where and how these species are spreading will allow management agencies to develop control, monitoring and management plans to prevent new invasions and limit spread of existing invasive populations. Better management will facilitate development of marine industries, enhance sustainability of fishing and aquaculture and minimise interruptions to recreational and social activities which require marine access.

**Collaborative opportunities:** Having supervisors with strong backgrounds in the collection and handling of *Caulerpa* spp. and others specialising in molecular techniques relating to *Caulerpa* spp. has allowed me to experience the different aspects of algal research. It has also provided an opportunity to collaborate with a range of specialists in this field.

### *Safeguarding aquatic biosecurity*

**Research extension:** Results are preliminary at this stage but will be shared with relevant management agencies and industries to help manage existing invasions of *Caulerpa* spp. and prevent current invasions from spreading.

**Personal growth:** My PhD has provided me with the opportunities to learn new skills including the use of cutting edge molecular biology methods. I have also presented at the Australian Society of Phycology and Aquatic Botany conference in 2011, and am currently assisting in the organisation for the 2012 meeting. I will be presenting at the international phycology congress in Bali, 2013. These opportunities have allowed me to present my findings and engage with international researchers in this field.

**Current employment:** I am working on next generation sequencing methodologies which I will use to genotype the ~500 specimens that I have collected to date.

**Research funders:** Australian Research Council (ARC) and Biosecurity SA.

**Supervisors:** Dr Marty Deveney (SARDI), Dr Fred Gurgel (The University of Adelaide – State Herbarium of SA – DEWNR – SARDI), Dr Peter Grewe (CSIRO) and Dr Jason Tanner (SARDI).

## MISA student profile

**Name:** Will Grant, PhD student.

**Research topic:** Phylogeography of the invasive marine macro-algae *Caulerpa taxifolia* and *Caulerpa racemosa* var. *cylindracea* in Australian waters.



**Base location:** SARDI Aquatic Sciences, Adelaide and The University of Adelaide, South Australia.

**Associated institutes:** SARDI and the University of Adelaide.

**Research brief:** *Caulerpa* spp. form large monospecific stands in invaded environments, excluding native species of flora and fauna, changing the physical

environment and affecting the species composition in the invaded habitat. My PhD aims to identify how native and invasive populations of these two species are related to understand where the invasive populations came from. Understanding these relationships will allow us to infer if the invasive populations have been introduced from populations outside Australia or within Australia. These data will inform hypotheses about how these species spread, and the relative risks posed by translocations of native and exotic *Caulerpa* spp.

**Research benefits:** Biosecurity and fisheries agencies, industries that use the marine environment, recreational anglers and boaters and



Above: MISA PhD student, Mr Will Grant (left) is studying native and invasive *Caulerpa* spp. to better understand the invasive marine macroalgae, *Caulerpa taxifolia* (above and top left).



## MISA student profile

**Name:** Andrew Lowther, postdoctoral scientist - marine mammal ecologist, previously MISA PhD student.

**Research topic:** Population structure and foraging ecology of Australian sea lions.

**Base location:** SARDI Aquatic Sciences, Adelaide.

**Associated institutes:** SARDI and the University of Adelaide.

**Research brief:** Determining fine-scale population structure amongst Australian sea lion breeding colonies in South Australia. This information was critical in determining the migratory movements of adult females

and was a key aspect in the creation of the AFMA Australian sea lion management plan, designed to mitigate bycatch mortality.

**Research benefits:** Ultimately the species will benefit in the long term by a sustained decrease in bycatch mortality rates that should help in the recovery of breeding colonies. It has prompted the commercial fishing industry to examine its demersal gillnet fishing practices with respect to bycatch mortality.

### Collaboration opportunities:

Working on a species with such unique life history traits has provided me with analytical and logistical challenges that are likely to set me in good stead for the future. My research and its outcomes have been recognised at international conferences for which I have been awarded best

presenter. It has also been refreshing to see scientific research being used in such an applied manner.

**Research extension:** Research investigating the population structure of over 80 percent of an entire species has had direct and immediate impacts on the way AFMA manages its demersal gillnet fishery. Changes to fishing gear (gillnet to longline) and having a more realistic set of trigger limits for zone closures have all occurred as a result of my work.

**Personal growth:** My PhD studies provided me with the opportunity to learn analytical and field skills that led to my postdoctorate appointment at SARDI. This research has also enabled me to create an international network of peers with whom I can collaborate and exchange research ideas.

**Current employment:** I am continuing my work as a Marine Mammal Ecologist with SARDI and hope to undertake many more collaborative marine mammal projects.

**Research funders:** Australian Geographic, Holsworth Wildlife Research Endowment, Sea World Research and Rescue Foundation, the Australian Marine Mammal Research Centre (DSEWPaC), the Wildlife Conservation Fund and the Department of Environment, Water and Natural Resources (DEWNR).

**PhD supervisors:** A/Prof Simon Goldsworthy (SARDI); Prof Rob Harcourt (Macquarie University).



**Dr Andrew Lowther's work with Australian sea lions was a key aspect in the creation of the Australian Fisheries Management Authority Australian sea lion management plan.**







## MISA student profile

**Name:** Tom Madigan, PhD student.

**Research topic:** Quality, shelf-life and value adding of Australian oysters.

The impact of my research will be in underpinning the development of new seafood products. Further, the capability developed during this research will assist the seafood industry in assessing and maximising shelf-life and exploring new product opportunities.

**Personal growth:** MISA supported me with a student scholarship that contributed towards the cost of attending

a PhD training course in Denmark led by recognised world experts in seafood quality analysis. This workshop allowed me to develop an understanding of the variety of techniques that can be used to assess the freshness and quality of seafood and understand the level required for my work to be acceptable internationally.

## Growing Australian seafood industries



**Current employment:** I am currently employed by SARDI and work on a variety of food safety and product innovation projects. I am located at the Waite Institute, where we have a variety of facilities such as a product development kitchen, processing equipment, access to a dedicated sensory laboratory and laboratories equipped for chemical and microbiological analysis.

**Research funders:** Australian Seafood CRC.

**Supervisors:** Dr John Carragher (Logifish consulting), Dr Miguel de Barros Lopes (University of South Australia), and Dr Andreas Kiermeier (SARDI).

**Above:** Bacterial colonies growing on selective agar; a key part of Mr Tom Madigan's PhD work. **Top left:** MISA PhD student, Mr Madigan. **Left:** Oyster trays loaded to a modified atmosphere packaging machine ready for gas flushing and sealing.

**Base location:** SARDI Plant Research Centre, Waite Campus, Urrbrae.

**Associated institutes:** SARDI and the University of South Australia.

**Research brief:** Much of my PhD research has centred on defining spoilage of Australian oysters. My work has included various ways of assessing spoilage including microbiology (traditional and molecular), biochemical analysis and sensory and near-infrared reflectance spectroscopy. Other aspects of my work have been in evaluating processing techniques that are aimed at increasing shelf-life such as modified atmosphere packaging and high pressure processing that may provide new market opportunities.

**Research benefit:** The direct benefit will go to the Australian oyster industry, particularly to producers in South Australia who have been involved in the project. However, the capacity developed to assess the freshness of product is applicable to all seafood and will help to increase profitability through the development of new product types and minimising wastage in the seafood industry.

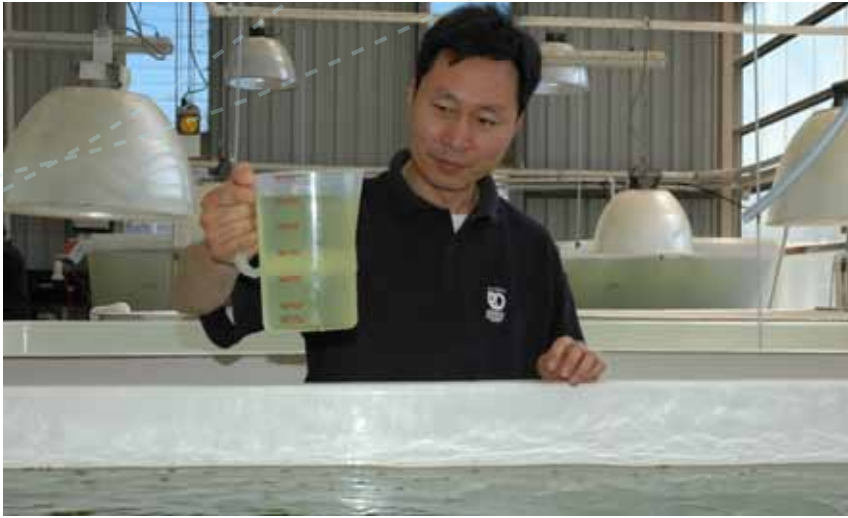
**Collaborative opportunities:** MISA has supported me as a junior researcher in working with projects on shellfish prior to undertaking my PhD work. These contacts were pivotal in identifying the potential for my PhD work and in developing a focus that was useful for industry. These contacts have also been indispensable in undertaking complex experimental work. My work in this area has allowed me to return to SARDI on a full-time basis with ability to assist industry in a wide variety of food safety and product quality related areas.

**Research extension:** My research on modified atmosphere packaging has been presented at industry forums. Importantly, I identified a potential packaging/product combination issue with oysters where gas mixtures high in carbon dioxide can impart detrimental flavours and was able to advise industry regarding this. I have also been able to share my knowledge with individual growers and processors who are looking at undertaking product development.

Skills developed during my research have allowed me to contribute to a range of projects during my candidature and since returning to SARDI on a full-time basis, I have taken on a more active role in project development and delivery.







Left: MISA postdoctoral scientist, Dr Bannan Chen studied yellowtail kingfish and southern bluefin tuna larvae and juveniles contributing to the farming of these species (bottom left: yellowtail kingfish; bottom right: southern bluefin tuna).

## MISA student profile

**Name:** Bannan Chen, postdoctoral scientist larval and early juvenile marine finfish rearing.

**Research topic:** Improvements in YTK, *Seriola lalandi*, larval and juvenile survival and quality; and SBT, *Thunnus maccoyii*, larval and juvenile rearing.

**Base location:** SARDI Aquatic Sciences, Adelaide.

**Associated institutes:** Flinders University and SARDI Aquatic Sciences.

**Research brief:** To gain a better understanding of YTK and SBT larval fish environmental and physiological requirements in their early life stage under experimental and hatchery conditions. My experiments were conducted in a small scale larval rearing system at SARDI Aquatic Sciences and in the pilot



research and development tank system in the commercial hatchery at Clean Seas Tuna Ltd (CST). Larval fish performances including survival, growth, swimbladder inflation and jaw malformation, were monitored and evaluated. The information is critical to improve the hatchery production protocols to produce high quality YTK and SBT fingerlings.

**Research benefits:** The Australian marine fish farming industry, specifically the hatcheries that produce marine fish. The YTK and SBT farming industries are the major aquaculture sectors in South Australia.

This research will underpin the sustainable development of the healthy marine finfish based aquaculture in South Australia.

**Collaboration opportunities:** MISA has allowed me to collaborate with industry and other researchers. I had the opportunity to receive

feedback from industry while working at SARDI which has improved the outcomes from my research. The close relationship with industry benefited my research and made it easier for industry to adopt the findings rapidly. The interaction with industry during my post-doc research at SARDI also strengthened the path of my career, and I am now the Research and Development Hatchery Manager with CST.

**Research extension:** The upwelling system developed in my research in SBT larval rearing to improve survival has been extended to industry. Based on this model and concept, larger scale upwelling systems have been established in both the pilot and commercial SBT hatchery in Clean Seas Tuna Ltd. This has provided a foundation in SBT larval rearing research and development.

**Personal growth:** This research through MISA allowed me to work at the world's only SBT larval rearing research facility and collaborate with national researchers. I have also expanded my experience and skills in the commercial arena.

**Current employment:** Research and Development Manager, CST.

**Research funders:** Australian Seafood CRC.

**Supervisors:** Wayne Hutchinson (SARDI) and A/Prof Jian Qin (Flinders University).



## Growing Australian seafood industries



## MISA student profile

**Name:** Paul Rogers, PhD student.

**Research topic:** Critical habitats, migration and foraging dynamics of pelagic sharks.

**Base location:** SARDI Aquatic Sciences, Adelaide.

**Associated institutes:** Flinders University and SARDI Aquatic Sciences.

**Research brief:** Habitat use, movement and dietary dynamics of pelagic sharks in coastal and shelf ecosystems off southern Australia.

Prior to my PhD there were significant gaps in the information available to develop conservation and management measures for (Bronze whaler, *Carcharhinus brachyurus*, common thresher, *Alopias vulpinus*, dusky shark, *Carcharhinus obscurus*, shortfin mako, *Isurus oxyrinchus* and smooth hammerhead, *Sphyrna zygaena*).

Cutting edge satellite tags were used as part of this work to investigate the critical habitats and migration paths of key species. I also worked with fishing industries to investigate the dietary dynamics of the species in order to enhance trophodynamic models for the Great Australian Bight.

## Environmental sustainability

**Research benefits:** State and federal agencies, chartered with developing management policies will use my research findings to support management policies. The findings will also inform the International Union for Conservation of Nature assessment process for threatened, protected and endangered species and to address objectives in the Conservation of Migratory Species Memorandum of Understanding of which the Australian government is a signatory.

Improving our understanding and management of apex predators enhances our understanding of the structure and functioning of the marine ecosystem, which is a key goal in ecosystem based fisheries management.

My PhD was also central to the development of the shark research capability at SARDI Aquatic Sciences.

**Collaboration opportunities:** During my PhD I collaborated with commercial, recreational and game fishers to deploy satellite tags on pelagic sharks. This was critical to my project because of the isolated nature of the habitats of these animals. My project led to the formation of collaborations with international researchers. I was also able to participate in national workshops to set priorities for pelagic shark research and management in Australasia.

**Research extension:** Knowledge of shark fisheries has primarily been extended to management agencies. The development of a laboratory website for the Southern Shark Ecology Group and the availability of tracking data on several websites, have also led to the global extension of my project outcomes.

**Personal growth:** The opportunity to develop a range of new skills that are transferable to the research and management of other top predators and iconic species.

**Current employment:** Research Scientist in the Threatened, Endangered and Protected Species group at SARDI Aquatic Sciences, working on ecosystem modelling in a range of research projects on seals, sharks and seabirds.

**Research funders:** Wildlife Conservation Fund, Nature Foundation Inc., Australian Geographic Society, the Department of Environment, Water and Natural Resources (DEWNR), Mohamid Binzayed Conservation Fund and MISA.

**Supervisors:** A/Prof Simon Goldsworthy (SARDI), A/Prof Jim Mitchell (Flinders University) and Prof Laurent Seuront (Flinders University - SARDI).

**Below: Shortfin makos (top) were a key focus of MISA PhD student, Mr Paul Rogers, research.**



# Funding

## The \$18.5 million investment by the Government of South Australia in Marine Innovation Southern Australia, 2005-2012, has expanded marine research capability and infrastructure to support the South Australian seafood industry.

The State's investment of \$18.5 million in MISA over seven years, \$11.6 million in salaries and \$6.9 million in infrastructure, has enabled the appointment of more than 40 researchers across four research areas: Aquaculture Innovation, Biosecurity, Ecosystem Services and Seafood Product Quality and Value Adding, and made possible the:

- \$2.4 million development of the South Australian Aquatic Biosecurity Centre (SAABC) at the University of Adelaide's Roseworthy Campus. The SAABC is a facility unique in its level of biosecurity, tank size and proximity to a centre of veterinary tertiary education and research.
- \$4.5 million towards the expansion of the Lincoln Marine Science Centre, Port Lincoln.

This investment has leveraged 280 research projects with a total value of more than \$75 million, comprising direct and in-kind contributions from funders and participants. It also leveraged \$10.3 million in Federal Government funding for infrastructure:

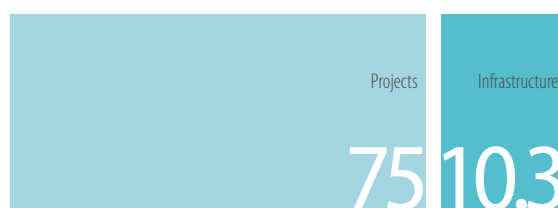
- \$2.1 million provided by Flinders University through the Federal Government's Capital Development Pool Scheme providing additional funds for the extension of the Lincoln Marine Science Centre.
- \$8.2 million towards the Southern Australian Integrated Marine Observing System (SAIMOS), funded through the National Collaborative Research Infrastructure Strategy (NCRIS) with support from the Government of South Australia, to study ocean current systems and climate change impacts. Combined with MISA in-kind support of \$0.9 million, the \$9.1 million SAIMOS forms one of the largest nodes of the national Integrated Marine Observing System (IMOS), which is globally regarded as one of the best marine observing systems in the world.

Overall, this funding has enabled MISA to provide a strong supportive role to the South Australian seafood industry during a very challenging period, when such factors as the high value of the Australian dollar compared to most other currencies, increasing seafood imports and the global financial crisis all affected industry growth. During this period MISA has worked closely with industry to develop solutions to a wide range of technical issues, provide critical data to address changing consumer and market requirements, and demonstrate potential development opportunities for the future.

Funds from the Government of South Australia invested in MISA, 2005-2012, for salaries and infrastructure (\$ million).



Additional funds leveraged by MISA for research projects (includes direct and in-kind contributions from funders and participants) and from the Federal Government for infrastructure (\$ million).



Research projects with a total value of \$75 million (includes direct and in-kind contributions from funders and participants), by MISA research area (rounded, \$ million).





# Future pathways



**Marine Innovation Southern Australia is strategically aligned to regional marine research and development to achieve a greater collaborative capability to enhance service delivery to traditional seafood industry stakeholders. While this proved successful by many performance measures, MISA has and continues to evolve in response to change.**

Key drivers that MISA has recently responded to include:

- the development of the “Primary Industries Standing Committee Fisheries and Aquaculture R,D&E Strategy”, which identifies major research partners while rationalising national investment;
- the provision of effective strategic regional input into submissions that will guide future investment in Australia’s marine industries through the “Strategic Roadmap for Australian Research Infrastructure”;
- the facilitation of ecologically sustainable development and equitable resource sharing, with the increasing presence and influence of the mining and defence industries on the southern Australian coastal, gulfs and offshore ecosystems; and
- the need for South Australia’s marine science community to establish processes that will ensure that it effectively identifies and responds to other opportunities for major marine research funding that will arise over the next five to ten years to benefit South Australia.

To adapt to the changing environment, MISA has recently:

- expanded its research membership to include all marine researchers associated with its partner organisations, leading to the creation of ten Science Groups to broaden its science discipline base in preparation for future research pathways;

- broadened its geographic interests from South Australia to southern temperate Australia, recognising that the marine ecosystems between south-west Western Australia and south-west Tasmania, including Bass Strait are closely interconnected;
- broadened its collaboration to include alliances with other southern temperate Australian regional research organisations to further enhance research capabilities; and
- driven the development of programs that will provide a scientific framework for marine ecosystem-based management in response to advances in mining, coastal industrial developments, shipping and marine parks. Programs are currently focused on four regions across southern Australia:
  - > Great Australian Bight
  - > Spencer Gulf
  - > Gulf St Vincent
  - > The Bonney Coast

These changes position MISA for the future to capture and deliver larger multi-disciplinary projects, as a leader in southern temperate marine science benefiting the sustainability of our seafood industry and marine environment.

# Appendix

## Committee members

The following people have contributed to the MISA objectives since its establishment in 2005.

### Steering Committee members

#### Current:

Prof Gavin Begg, SARDI

Mr Steven Clarke, SARDI

Prof Mehdi Doroudi, PIRSA  
— Fisheries & Aquaculture

Mr Martin Hernen,  
seafood industry

Prof Bob Hill, the  
University of Adelaide

Mr Brian Jeffriess, seafood industry

Prof Rob Lewis, Chair

A/Prof Ian Menz,  
Flinders University

Prof Pauline Mooney, SARDI

Mr Bob Pennington,  
seafood industry

#### Former:

Prof Michael Barber,  
Flinders University

Mr Nick Bolkus, seafood industry

Dr John Carragher, SARDI

Prof Anthony Cheshire,  
SARDI, former Chair

Prof David Day, Flinders University

Prof Peter Fairweather,  
Flinders University

Prof Bob Gibson, the  
University of Adelaide

Prof Bronwyn Gillanders, the  
University of Adelaide

Mr John Jefferson, SARDI

Prof Chris Marlin,  
Flinders University

Prof Jim Mitchell,  
Flinders University

Mr Ian Nightingale, PIRSA –  
Fisheries & Aquaculture

Dr Simon Stone, seafood industry

A/Prof Rob Thomas, SARDI

Prof John Wheldrake,  
Flinders University

Dr Qifeng Ye, SARDI

### Research Advisory Committee members

#### Current:

Prof Gavin Begg, SARDI (Chair)

Mr Steven Clarke, SARDI

Dr Marty Deveney, SARDI

Mr David Ellis, seafood industry

Prof Peter Fairweather,  
Flinders University

Prof Bronwyn Gillanders, the  
University of Adelaide

Prof Xiaoxu Li, SARDI

Dr Catherine McLeod, SARDI

Mr Sean Sloan, PIRSA —  
Fisheries & Aquaculture

A/Prof Tim Ward, SARDI

### Advisory Committee members

#### Former:

Ms Catherine Barnett, Seafood  
Training Centre of Excellence

Prof Corey Bradshaw, the  
University of Adelaide – SARDI

Dr John Carragher, SARDI

A/Prof Sue Carthew, the University  
of Adelaide, former Chair

Mr Steven Clarke, SARDI

A/Prof Sabine Dittmann,  
Flinders University

Prof Mehdi Doroudi,  
SARDI, former Chair

Mr Martin Hernen,  
seafood industry

A/Prof Simon Goldsworthy, SARDI

Mr Glen Ingham, PIRSA

Dr Stephen Madigan, SARDI

A/Prof Ian Menz,  
Flinders University

A/Prof John Middleton, SARDI

Dr Sue Murray-Jones, DEWNR

Mr Dennis O'Malley, SARDI

Dr Andrew Pointon, SARDI

Dr Laurent Seuront, Flinders  
University – SARDI

Dr David Stone, SARDI

Dr Jason Tanner, SARDI

A/Prof Rob Thomas, SARDI

Mr Lee Warneke, SARDI

A/Prof Ian Whittington,  
SA Museum – the  
University of Adelaide

Dr Qifeng Ye, SARDI

### Education Committee

#### Former:

Ms Catherine Barnett, Seafood  
Training Centre of Excellence

Mr Grant Carnie, Australian  
Fisheries Academy

Mr Mark Cody, Seafood Training SA

A/Prof Sean Connell, the  
University of Adelaide

A/Prof Sabine Dittmann,  
Flinders University

Prof Mehdi Doroudi, SARDI

Prof Peter Fairweather,  
Flinders University (Chair)

Mr Lyndon Giles, seafood industry

A/Prof Simon Goldsworthy, SARDI

Mr Martin Hernen,  
seafood industry

Prof Bob Hill, the  
University of Adelaide

Dr Stephen Madigan, SARDI

A/Prof Jim Mitchell,  
Flinders University

Ms Louise Renfry, Flinders  
University – SARDI

Mr Mike Stockdale,  
Spencer Gulf TAFE

## Research positions

The Government of South Australia has provided salary funding of \$11.6 million over the past seven years to more than 40 researchers\*, significantly enhancing South Australia's marine capability.

### Aquaculture Innovation

**Algal production researcher** - Expert advice on microalgal and macroalgal physiology, cultivation and biofuels, Dr Sasi Nayar (SARDI).

**Aquaculture science leader and MISA research leader** - Scientific and technical advice to support sustainable aquaculture development, Mr Steven Clarke (SARDI).

**Aquatic animal health researcher** - Expert advice on management of disease and fish health, current: Dr James Munro (SARDI – the University of Adelaide), formerly: Dr Shane Roberts (SARDI), A/Prof Craig Hayward (SARDI).

**Extruder technician** - Application of feed technology to assist in new feed development, current: Mr Raymond Cultura (SARDI), formerly: Mr Geoff Wyatt (SARDI).

**Genetics, reproduction and biotechnology specialist and MISA research leader** - Application of genetic, reproductive and biotechnological knowledge to improve competitive advantages of aquaculture products, Prof Xiaoxu Li (SARDI).

**Larval rearing researcher** - Application of developmental and nutritional knowledge to improve fish larval performances, Dr Bennan Chen (SARDI – Flinders University).

**Molecular geneticist** - Application of molecular genetic knowledge to improve economically important traits, Dr Nick Robertson (contracted through Nofima).

**Nutrition and feed technologist** - Application of nutritional knowledge and feed technology to improve performances of farmed fish and/or to reduce feed costs, Dr David Stone (SARDI).

**Propagation and systems specialist** - Application of reproductive and farming system engineering knowledge to assist industry development, Mr Wayne Hutchinson (SARDI).

**Quantitative geneticist** - Application of quantitative genetic knowledge to improve economically important traits, Dr Alex Safari (Flinders University – SARDI).

### Biosecurity

**Marine biosecurity researcher and MISA research leader** - Environmental effects of pests and diseases, invasion processes, risk analysis and mitigation methods, Dr Marty Deveney (SARDI).

**Marine botanist** - Seagrass health, surveillance and environmental impacts, Dr Andrew Irving (SARDI).

**Marine ecologist and MISA research leader** - Anthropogenic impacts on marine systems, Dr Jason Tanner (SARDI).

**Marine ecologist** - Introduced marine species surveillance, macroalgal biology, climate change, Ms Kathryn Wiltshire (SARDI).

**Marine pest researcher** - Design and conduct surveys for introduced marine species, formerly: Mr Keith Rowling (SARDI), Dr Ib Svane (SARDI), Dr Greg Collins (SARDI).

**Microalgal researcher** - Marine system productivity, biological oceanography, biogeochemical modelling, plankton biology and ecology, Dr Paul van Ruth (SARDI).

**Molecular diagnostics researcher** - Development of molecular tools for detection of pests and diseases, parasite biology, marine taxonomy, Dr Nathan Bott (SARDI).

**Spatial modeller** - Modelling habitat change in the Coorong, Dr Sunil Sharma (SARDI).

\* MISA researchers are those that have received salary funding for MISA related research.



## Ecosystem Services

**Benthic ecologist** – Evaluating the ecological consequences of human-induced impacts on the seafloor, Dr David Currie (SARDI).

**Biological oceanographer** – Biological oceanography, phytoplankton ecology, marine observing systems, desalination, biofouling, data analysis, Dr Sophie Leterme (Flinders University – SARDI).

**Biological oceanographer** – Development of conceptual and numerical bio-geophysical models of phyto/zooplankton/nutrients to be calibrated and implemented for the South Australian shelf and Spencer Gulf region using SAIMOS and other data sets, Prof Laurent Seuront (Flinders University – SARDI).

**Cetacean ecologist** – Behavioural ecologist interested in the evolutionary, ecological and genetic basis of marine mammal behaviour and in the application of ecological research to inform conservation and management decisions. Dr Guido Parra (Flinders University – SARDI).

**Ecosystem modeller** – Ecological modeller, specialist in population dynamics and climate change impacts on biodiversity, Prof Corey Bradshaw (The University of Adelaide – SARDI).

**Marine botanist** – Molecular systematics (taxonomy, phylogenetics, phylogeography), biogeography and ecophysiology of marine macroalgae, Dr Fred Gurgel (The University of Adelaide – State Herbarium of SA – DEWNR – SARDI).

**Oceanographer** – Biological and physical oceanography bio-physical couplings, plankton ecology, turbulence, numerical modelling, oceanographic instruments, data and statistical analysis, Dr Mark Doubell (SARDI).

**Pelagic ecologist and MISA research leader** – Specialist in the ecology of marine mammals and seabirds, mitigation of interactions between fisheries and protected marine species and food web modelling, A/Prof Simon Goldsworthy (SARDI).

**Physical oceanographer** – Ocean dynamic and processes, data analysis, modelling and prediction, particularly in relation to the physical processes of Australia's southern shelves including upwelling, dispersion and diffusion, A/Prof John Middleton (SARDI).

**Physical oceanographer** – Physical oceanography, analysis and modelling of ocean circulation, waves and tides, Dr John Luick (SARDI).

**Physical oceanographer** – Oceanography marine field services, numerical modelling, research mooring design, oceanographic instruments, computer programming, and data analysis, Dr Charles James (SARDI).

**Shark ecologist** – Investigate the ecology and biology of elasmobranchs in relation to anthropogenic impacts, Dr Charlie Huveneers (SARDI – Flinders University).

## Seafood Product Quality and Value Adding

**Chemical engineer** – Development of new seafood products and improvement in supply chain efficiency, Dr Stephen Pahl (SARDI).

**Chemical residue specialist** – Chemical residue advice to support industry market access, Dr David Padula (SARDI).

**Market access advisor** – Chemical residue advice to support industry market access as well as the coordination of European Union market access and SafeFish programs, Ms Natalie Dowsett (SARDI).

**Packaging technologist** – Investigation and evaluation of new packaging technologies to optimise product quality and shelf life, Ms Emma Langlois (SARDI).

**Seafood physiologist** – Application of physiology knowledge through the supply chain to improve quality of seafood, current: Dr Richard Musgrove (SARDI), formerly: Dr John Carragher (SARDI).

**Seafood processing engineer** – Providing support to industry to improve processing efficiency and reduce costs, Mr Mohan Raj (SARDI).

**Seafood safety and market access researcher and MISA node leader** – Seafood safety advice to support industry market access, Dr Catherine McLeod (SARDI).

**Seafood safety and quality researcher** – Application of biochemical and physical techniques to assist in extending shelf life and improve product safety, Mr Tom Madigan (SARDI).

**Seafood technologist** – Develop new products and enhance product quality to maximise the post harvest value of Australian seafood, Ms Karen McNaughton (SARDI).

**Sensory technologist** – Sensory services to undertake organoleptic assessments and comparisons for new and existing products, Ms Briony Liebich (SARDI).

**Seafood quality specialist** – Application of biochemical and physical techniques to assist in extending shelf life, Dr Trent D'Antignana (Flinders University – SARDI).

**Supply chain specialist** – Investigate the impacts of post harvest handling, transportation and processing on time-temperature control of product and shelf life, Dr Michael Rettke (SARDI).

**Toxicologist** – Expert advice on natural toxins (marine biotoxins, cyanotoxins) and chemical residues to improve safety and support market access, Dr Ian Stewart (SARDI).

## Education

**MISA researchers make significant contributions to marine science education in South Australia through specialised lectures within a number of undergraduate degrees at Flinders University and the University of Adelaide.**

### Flinders University

#### Bachelor of Science (Animal Behaviour)

- Animal biodiversity, Dr Charlie Huveneers (SARDI - Flinders University)
- Introduction to animal behaviour, Dr Charlie Huveneers (SARDI - Flinders University) and Dr Guido Parra (Flinders University - SARDI)
- Introduction to marine biology, Dr Charlie Huveneers (SARDI - Flinders University)
- Research methods in animal behaviour, Dr Charlie Huveneers (SARDI - Flinders University) and Dr Guido Parra (Flinders University - SARDI)

#### Bachelor of Science (Aquaculture)

- Animal animal health, Dr Marty Deveney (SARDI)
- Aquaculture technology and production systems, Dr Richard Musgrove (SARDI)
- Aquafeed technology, Dr David Stone (SARDI)
- Aquaculture reproduction, Prof Xiaoxu Li (SARDI) and Mr Wayne Hutchinson (SARDI)
- Biosecurity, Dr Marty Deveney (SARDI)
- Aquaculture genetics, Prof Xiaoxu Li (SARDI) and Dr Alex Safari (Flinders University - SARDI)
- Fish feeds: industry demand and supply, Dr David Stone (SARDI)
- Introduction to aquaculture, Dr Richard Musgrove (SARDI)
- Nutrition in aquaculture, Dr David Stone (SARDI)

#### Bachelor of Science (Biotechnology)

- Biotechnological applications of microalgae, Dr Sasi Nayar (SARDI)
- Algal biofuels and down stream products, Dr Sasi Nayar (SARDI)

#### Bachelor of Science (Marine Biology)

- Advanced microbiology, Dr Sophie Leterme (Flinders University - SARDI)
- Cetaceans: ecology of coastal dolphins, Dr Guido Parra (Flinders University - SARDI)
- Cetaceans: foraging behaviour and ecology, Dr Guido Parra (Flinders University - SARDI)
- Cetaceans: movement, migration and habitat use, Dr Guido Parra (Flinders University - SARDI)
- Demersal fisheries, Dr Shane Roberts (SARDI)
- Ecosystem management of fisheries, A/Prof Simon Goldsworthy (SARDI)
- Experimental design and statistics for biology and topic coordinator, Dr Charlie Huveneers (SARDI - Flinders University) and Dr Sophie Leterme (Flinders University - SARDI)
- Fisheries Management Committee role play and debate, Dr Charlie Huveneers (SARDI - Flinders University), along with others.
- Fisheries biology, science and management topic coordinator, Dr Charlie Huveneers (SARDI - Flinders University)
- Interactive session, questions for issues in South Australia, Dr Charlie Huveneers (SARDI - Flinders University) along with others.
- Introduction to marine biology, Dr Charlie Huveneers (SARDI - Flinders University)
- Marine ecological processes, Dr Sophie Leterme (Flinders University - SARDI)
- Marine mammals: biogeography, Dr Guido Parra (Flinders University - SARDI)
- Marine mammals, birds and reptiles topic coordinator, Dr Guido Parra (Flinders University - SARDI)

- Marine mammals: taxonomy and diversity, Dr Guido Parra (Flinders University – SARDI)
- Marine mammal evolution: cetaceans, Dr Guido Parra (Flinders University – SARDI)
- Pinnipeds: introduction, habitats, diversity and zoogeography, A/Prof Simon Goldsworthy (SARDI)
- Pinnipeds: systematic, evolution, biology and ecology, A/Prof Simon Goldsworthy (SARDI)
- Professional skills, Dr Charlie Huveneers (SARDI – Flinders University)
- Research projects in biology, Dr Sophie Leterme (Flinders University – SARDI)
- Sustainability of shark fisheries, Dr Charlie Huveneers (SARDI – Flinders University)
- Intensive crustacean production, Dr James Munro (SARDI – the University of Adelaide)
- Intensive finfish production, Mr Wayne Hutchinson (SARDI)
- Intensive molluscan production, Prof Xiaoxu Li (SARDI)
- Introduction to aquaculture lecturer and course coordinator, Dr James Munro (SARDI – The University of Adelaide)
- Live feeds production, Mr Wayne Hutchinson (SARDI)
- Macroalgae production, Dr Sasi Nayar (SARDI)
- Nutrition in aquaculture, Dr David Stone (SARDI)
- Viral disease, Dr James Munro (SARDI – the University of Adelaide)
- Water quality management in aquaculture, Dr Sasi Nayar (SARDI)

## The University of Adelaide

### Bachelor of Science (Animal Science)

- Nutrition in aquaculture, Dr David Stone (SARDI)

### Bachelor of Science (Marine Biology)

- Frontiers in marine biology, Dr Fred Gurgel (The University of Adelaide – State Herbarium of SA – DEWNR – SARDI)
- Large scale and long term studies in marine ecology, Dr Jason Tanner (SARDI)
- Research methods for seagrass biology, Dr Jason Tanner (SARDI) and Dr Fred Gurgel (The University of Adelaide – State Herbarium of SA – DEWNR – SARDI)
- Botany II, Dr Fred Gurgel (The University of Adelaide – State Herbarium of SA – DEWNR – SARDI)
- Life history, ecology and management of seals and sea lions – A/Prof Simon Goldsworthy (SARDI)

### Bachelor of Science (Veterinary Bioscience)

- Aquatic biology – anatomy, Dr James Munro (SARDI – the University of Adelaide)
- Aquatic engineering – systems, Mr Wayne Hutchinson (SARDI) along with others.
- Biotechnology in aquaculture, Prof Xiaoxu Li (SARDI)
- Disease emergence, Dr James Munro (SARDI – the University of Adelaide)



# Students

MISA postgraduate students\*, supervised by MISA researchers, have enhanced research outcomes while obtaining their degrees and benefiting from direct interaction with the seafood industry.

## Honours students

Student name	Thesis title	Institution	Supervisors	Current/completed
Nayssa Balcazar	Behavioural budget, respiratory patterns and proximity of southern right whales mother-calf pairs. Setting up a baseline for measuring human impacts	Flinders University, SARDI	Dr Guido Parra (Flinders University – SARDI), Dr Luciana Moller (Flinders University)	Completed
Matthew Bansemer	The effects of feeding alternative protein sources on the intestinal mucus layer and mucosal architecture in yellowtail kingfish, <i>Seriola lalandi</i>	SARDI, the University of Adelaide	Dr Rebecca Forder (The University of Adelaide), Prof Gordon Howarth (The University of Adelaide), Dr David Stone (SARDI)	Completed
Alice Barchi	Requirement of dietary protein in freshwater crayfish, <i>Cherax tenuimanus</i>	Flinders University, SARDI	Dr David Stone (SARDI), A/Prof Jian Qin (Flinders University): Industry participants: Mr Joel Adam Scanlon (Adam & Amos Abalone Feeds), Mr John Lucken	Current
Crystal Beckman	Using photographic identification to determine the behavioural ecology of the Great White sharks, <i>Carcharodon carcharias</i>	Flinders University	Prof Laurent Seunont (Flinders University – SARDI)	Completed
Emma Belgrove	Grape seed extract: A potential new treatment for “soybean meal induced enteritis” in yellowtail kingfish, <i>Seriola lalandi</i>	SARDI, the University of Adelaide	Dr Rebecca Forder (The University of Adelaide), Prof Gordon Howarth (The University of Adelaide), Dr David Stone (SARDI)	Completed
Robin Caines	Diets of large pelagic fish in the Great Australian Bight	SARDI, the University of South Australia	A/Prof Simon Goldsworthy (SARDI), Dr Topa Petite (University of South Australia)	Current
Kerryn Daly	Diets and trophic guilds among South Australian small pelagic fisheries	SARDI, the University of Adelaide	A/Prof Simon Goldsworthy (SARDI), Prof Sean O’Connell (The University of Adelaide)	Completed
Michael Drew	Age and growth of the scalloped hammerhead, <i>Sphyrna lewini</i> , and the pelagic thresher, <i>Alopias pelagicus</i> , in the eastern Indian Ocean	Flinders University, SARDI	Dr Charlie Huveneers (SARDI – Flinders University), Dr William White (CSIRO)	Completed
James Forwood	Treatments for the monogenean <i>Lepidodermis bidyana</i> infecting silver perch, <i>Bidyanus bidyanus</i>	Flinders University, SARDI	Dr Marty Deveney (SARDI), Dr James Harris (Flinders University)	Current
Holly Frazer	Maternal-embryo nutritional relationship in Port Jackson sharks, <i>Heterodontus portusjacksoni</i>	Flinders University, SARDI	Dr Charlie Huveneers (SARDI – Flinders University), Dr Megan Ellis (Flinders University)	Current
John Hayes	The effects of changing salinity and silica levels to the growth, silica content and nanostructure of the diatoms, <i>Phaeodactylum tricornutum</i>	Flinders University	Dr Sophie Leterme (Flinders University – SARDI)	Completed
Matthew Heard	Post-release stress physiology and mortality associated with trawl capture of stingarees (Family: Urolophidae)	Flinders University, SARDI	Dr Charlie Huveneers (SARDI – Flinders University), Dr Richard Reina (Monash University)	Completed
Carlisle Heaven	Osmoregulation of the Port Jackson shark, <i>Heterodontus portusjacksoni</i> , embryo: Response to changes in external salinity	Flinders University, SARDI	Dr Charlie Huveneers (SARDI – Flinders University), Dr James Harris (Flinders University),	Completed
Devesh Hemraj	Impact of salinity fluctuations on plankton communities	Flinders University	Dr Sophie Leterme (Flinders University – SARDI), A/Prof Jian Qin (Flinders University)	Current

Student name	Thesis title	Institution	Supervisors	Current/completed
Dirk Holman	Investigations into approach behaviour of white sharks, <i>Carcharodon carcharias</i> , to cage diving industry baiting operations	Flinders University, SARDI	Dr Charlie Huveneers (SARDI – Flinders University), Dr Alex Taylor (University of Auckland), Dr Rachel Robbins (Fox Research Shark Foundation)	Completed
Lauren Holmes	Relative abundance of bottlenose dolphins, <i>Tursiops</i> spp., within South Australian Gulfs	Flinders University, SARDI	Dr Luciana Moller (Flinders University), Dr Guido Para (Flinders University – SARDI)	Current
Tim Hunt	A preliminary examination of spinner dolphin, <i>Stenella longirostris</i> , diurnal behaviour and site fidelity at a reef complex in Fijian waters	Flinders University	Prof Laurent Seuront (Flinders University – SARDI), Dr C Miller (Whale and Dolphin Conservation Society – WDCS)	Current
Kristal Jay	Behavioural complexity and anthropogenically-driven stress in the common dolphin, <i>Tursiops aduncus</i> , and the Southern Right Whale, <i>Eubalaena australis</i>	Flinders University	Prof Laurent Seuront (Flinders University – SARDI)	Current
Jan-Georg Jendyk	Diatoms as environmental indicators after the implementation of a desalination plant	Flinders University	Dr Sophie Leterme (Flinders University – SARDI)	Completed
Darren Kennedy	Habitat modelling of southern Australian bottlenose dolphin, <i>Tursiops</i> spp., in Port Pirie, Spencer Gulf, South Australia	Flinders University	Dr Luciana Moller (Flinders University), Dr Guido Para (Flinders University – SARDI)	Completed
Lydia Kho	The effect of anthropogenic noise on the acoustic behaviour of bottlenose dolphins, <i>Tursiops aduncus</i> , in the Port River, Adelaide	Flinders University	Prof Laurent Seuront (Flinders University – SARDI), A/Prof Jim Mitchell (Flinders University)	Completed
Soxi Lee	Microbial communities associated with corals	Flinders University	Prof Laurent Seuront (Flinders University – SARDI), A/Prof Jim Mitchell (Flinders University)	Completed
Clayton McCloud	Swimming behavior and energetics of South Australian ostracods	Flinders University	Prof Laurent Seuront (Flinders University – SARDI)	Completed
Chloe McKimming	Edge effects on faunal abundance and predation rates in fragmented seagrass meadows	SARDI, the University of Adelaide	Dr Jason Tanner (SARDI), Dr Andrew Irving (The University of Adelaide)	Completed
Nathavong Navong	Impact of upwelling events on the phytoplankton communities off the South Australian continental shelf	Flinders University	Dr Sophie Leterme (Flinders University – SARDI)	Completed
Stephanie Papantoniou	Response of selected SA calcified macroalgal species to ocean warming and acidification	SARDI, the University of Adelaide	Dr Fred Guegel (The University of Adelaide – State Herbarium of SA – DEWNR – SARDI), Dr Marty Deveney (SARDI), Dr Jason Tanner (SARDI)	Current
James Paterson	Microscale interface gradient in microbial population	Flinders University	Prof Laurent Seuront (Flinders University – SARDI), A/Prof Jim Mitchell (Flinders University)	Completed
Thomas Pollet	Microscale gradient in evo- and ecotoenzymatic bacterial activity	Université des Sciences et Technologies de Lille (France)	Prof Laurent Seuront (Flinders University – SARDI)	Completed
Eloise Prime	Phytoplankton communities and diatom nanostructure along a natural salinity gradient	Flinders University	Dr Sophie Leterme (Flinders University – SARDI), A/Prof Jim Mitchell (Flinders University)	Completed
Shavojn Read	Site fidelity and association patterns of South Australian bottlenose dolphins, <i>Tursiops australis</i> , in Adelaide's metropolitan coastal waters	Flinders University	Dr Guido Para (Flinders University – SARDI), Dr Luciana Moller (Flinders University)	Current
Giverny Roberts	Dietary analysis of bycatch species from a commercial rock lobster, <i>Jasus edwardsii</i> , fishery	Flinders University, SARDI	Dr Charlie Huveneers (SARDI – Flinders University), Dr Adrian Linnane (SARDI)	Completed
Michelle Roberts	Diets of arrow squid	SARDI, the University of Adelaide	Dr Jeremy Austin (The University of Adelaide), A/Prof Simon Goldsworthy (SARDI), Dr Mike Steer (SARDI)	Completed
Ben Roudnew	Microbial abundance in water, pore water, and sediment along a salinity gradient and across the hyporheic zone	Flinders University	Prof Laurent Seuront (Flinders University – SARDI), A/Prof Jim Mitchell (Flinders University)	Completed

## APPENDIX - MISA HONOURS & MASTERS STUDENTS

Student name	Thesis title	Institution	Supervisors	Current/completed
Matthew Russell	Planktonic metabolism: the regulation of community production and respiration in aquatic ecosystems	Flinders University	Prof Laurent Seuront (Flinders University – SARDI)	Current
Tomo Segawa	Temporal dynamics of marine mammal sightings and strandings in South Australia waters: links to hydroclimatic forcing	Flinders University	Prof Laurent Seuront (Flinders University – SARDI), A/Prof Jim Mitchell (Flinders University)	Current
Elise Schaefer	The effects of water temperature and protein content of the histomorphology of the digestive tract of greenlip and hybrid abalone	Flinders University, SARDI	Dr James Harris (Flinders University), Dr David Stone (SARDI)	Completed
Shaun Schroeder	Age and growth estimation of three species of wobbegong sharks off the East Coast of Australia	Flinders University, SARDI	Dr Charlie Huveneers (SARDI – Flinders University)	Completed
Karl Shelly	Evolution of agar quality and yield in the red macroalgal family Gracilaraceae ( <i>Gracilariales, Rhodophyta</i> ), the biggest producer of agar in the world	The University of Adelaide	Dr Fred Guegel (The University of Adelaide – State Herbarium of SA – DEWNR – SARDI), Dr Jason Tanner (SARDI)	Current
Tamsyne Smith-Harding	Impact of frustules morphology on the absorption of nutrients by the diatoms	Flinders University	Dr Sophie Leterme (Flinders University – SARDI)	Completed
Flynn Taylor	A preliminary examination of bottlenose dolphin, <i>Tursiops</i> spp., abundance, behaviour, and site fidelity in Coffin Bay, South Australia	Flinders University, SARDI	Dr Guido Parra (Flinders University – SARDI), Dr Luciana Moller (Flinders University)	Completed
Chelsea Tothill	Molecular systematics of the marine red macroalgae, <i>Hypnea pannosa</i> , complex (Rhodophyta) in Australia	The University of Adelaide	Dr Fred Guegel (The University of Adelaide – State Herbarium of SA – DEWNR – SARDI)	Completed
Shareena White	Differential temporal haul-out dynamics of harbour seals, <i>Phoca vitulina</i> and grey seals, <i>Halichoerus grypus</i> , in the Strait of Dover: impacts of anthropogenic disturbance	Flinders University	Prof Laurent Seuront (Flinders University – SARDI)	Current
Emily Wilson	Human-wild dolphin feeding interactions in Whyalla, South Australia	Flinders University	Dr Luciana Moller (Flinders University), Dr Guido Parra (Flinders University – SARDI)	Current
Karina Winn	Heavy metals implications on bone loss and renal pathology in the Australian sea lion, <i>Neophoca cinerea</i> , and the Australian fur seal, <i>Arctocephalus forsteri</i>	Flinders University	Prof Laurent Seuront (Flinders University – SARDI), A/Prof Jim Mitchell (Flinders University)	Completed

### Masters students

Student name	Thesis title	Institutions	Supervisors	Current/Completed
Anika Van der Beek	Isolation and experimentation on diatoms sustainability in the Coorong	University of Amsterdam (The Netherlands), Flinders University	Dr Sophie Leterme (Flinders University – SARDI)	Completed
Julie Bracq	Impact of environmental changes and water circulation on phytoplankton species dynamics	AGROCAMPUS-RENNES (France), Flinders University	Dr Sophie Leterme (Flinders University – SARDI)	Completed
Cedric Le Bris	Aggregation and thermoregulation in the intertidal gastropod, <i>Merita atramentosa</i> : mechanistic links and inter-habitat variability	University of Brest (France)	Prof Laurent Seuront (Flinders University – SARDI)	Current
Huanhuan Cai	Gamete cryopreservation in shellfish	Dalian Ocean University (China), SARDI	Prof Yuenian Gao (Dalian Ocean University), Prof Xiaoxu Li (SARDI)	Current
Roxanne Crossley	Public perception of the need and efficiency of the main two types of shark attack mitigation measures used in Australia	Imperial College (UK)	Dr Charlie Huveneers (SARDI – Flinders University)	
Felix Froese	An economic model for large-scale macroalgae production in South Australia	SARDI, University of Freiburg (Germany)	Dr Sasi Nayar (SARDI), Prof Gerhard Oester (University of Freiburg)	Completed



Student name	Thesis title	Institutions	Supervisors	Current/Completed
Agnes Le Fur	Impact of a salinity gradient (25–150 PSU) on the community composition and dynamics of phytoplankton	UPMC-Paris VI (France), Flinders University	Dr Sophie Leterme (Flinders University – SARDI)	Completed
Meijian Liu	Cryopreservation of strip spawned sperm in blue mussels, <i>Mytilus galloprovincialis</i>	Dalian Ocean University (China), SARDI	Prof Yaqing Chang (Dalian Ocean University), Prof Xiaoxu Li (SARDI)	Complete
Yibing Liu	Oocyte cryopreservation in blue mussels, <i>Mytilus galloprovincialis</i>	Dalian Ocean University, SARDI	Prof Xiaoxu Li (SARDI), Prof Wei Zhou (Dalian Ocean University)	Complete
Karine Nedoncelle	Composition and dynamics of phytoplankton communities along the continental shelf of South Australia	UPMC-Paris VI (France), Flinders University	Dr Sophie Leterme (Flinders University – SARDI)	Completed
Louis Oulton	Assessing the impact of anthropogenic climate change in the aquaculture industry in South Australia: abalone as a case study	SARDI, the University of Adelaide, the University of London	Mr Steven Clarke (SARDI), Prof Corey Bradshaw (The University of Adelaide – SARDI)	Completed
Virginie Perlo	Harvesting marine microalgae <i>Nannochloropsis</i> sp. using magnetite and different polyelectrolyte flocculants	SARDI, the University of Montpellier (France)	Dr Sasi Nayar (SARDI), Mr Claude Amiel (University of Montpellier)	Completed
Capucine Rios	Isolation and experimentation on diatoms sustainability in the Coorong	AGROCAMPUS-RENNES (France), Flinders University	Dr Sophie Leterme (Flinders University – SARDI)	Completed
Rasha Abou Saada	Fresh prawns: maintenance of optimum quality for western king prawns, <i>Melicertus latiscutatus</i>	SARDI, the University of South Australia	Dr Andrew Barber (SARDI), Dr Miquel De Barros Lopes (University of South Australia), Dr Richard Musgrove (SARDI)	Current
Adrien Tableau	Variability in phytoplankton biomass and suspended matter along a salinity gradient	AGROCAMPUS-RENNES (France), Flinders University	Dr Sophie Leterme (Flinders University – SARDI)	Completed
Daqian Zhao	Water flow rates on cockle performances	Dalian Ocean University, SARDI	Prof Yuenian Gao (Dalian Ocean University), Prof Xiaoxu Li (SARDI)	Current

## PhD students

Student name	Thesis title	Institution	Supervisors	Funder	Current/completed
Wan Abdul Rahim Won Ahmad	Impact of alternative dietary oils on shelf life and antioxidant status of barramundi, <i>Lates calanifer</i>	Flinders University, SARDI	A/Prof Kathy Schuller (Flinders University), Dr David Stone (SARDI)	Flinders University, SARDI	Current
Yousef Alkhamis	Optimisation of growth and nutritious quality of microalgae used for aquaculture	Flinders University	A/Prof Ian Qin (Flinders University), Dr Sophie Leterme (Flinders University – SARDI)	Australian Development Scholarship	Current
Ina Ansmann	Taxonomy, population structure and foraging ecology of bottlenose dolphins, <i>Tursiops</i> spp., in Moreton Bay, Queensland, Australia	University of Queensland, SARDI	Dr Janet Lanyon (University of Queensland), Dr Guido Parra (Flinders University – SARDI)	University of Queensland, Winifred Violet Scott Charitable Trust	Completed
Matthew Bonsemer	Improvement of abalone nutrition with macroalgae addition	Flinders University, SARDI	Dr James Harris (Flinders University), Prof Gordon Howarth (The University of Adelaide), Dr David Stone (SARDI), A/Prof Ian Qin (Flinders University)	AACA, Australian Seafood CRC, Premier's Science Research Fund (PSRF)	Current
Alistair Bayliss	Oceanographic influence on the foraging ecology of New Zealand fur seals	SARDI, the University of Adelaide	A/Prof Simon Goldsworthy (SARDI), Dr David Paton (The University of Adelaide)	FRDC	Completed

## APPENDIX - MISA PhD STUDENTS

Student name	Thesis title	Institution	Supervisors	Funder	Current/completed
Crystal Beckmann	Validation of the use of fatty acid signatures to assess diet in sharks	Flinders University, SARDI	Dr Charlie Huveneers (SARDI – Flinders University), Dr David Stone (SARDI), Prof Laurent Seuront (Flinders University – SARDI)	ANZ Holsworth Foundation	Current
Gareth Belton	Molecular systematics of the green macroalgal genus <i>Caulerpa</i> in Australia	The University of Adelaide	Dr Fred Gurgel (The University of Adelaide – State Herbarium of SA – DEWNR – SARDI), Dr Andrew Lowe (The University of Adelaide)	Australian Postgraduate Awards (APA – Australian Federal Government)	Current
Alvaro Berg	The acoustic and surface behaviour of coastal dolphins in Queensland: implications for management	James Cook University, SARDI	Dr Helene Marsh (James Cook University), Dr Guido Parra (Flinders University – SARDI)	James Cook University, Marine and Tropical Sciences Research Facility	Current
Paul Bieman	Remote sensing to monitor interactions between aquaculture and the environment of Spencer Gulf, South Australia	SARDI, the University of Adelaide	Dr Jason Tanner (SARDI), A/Prof Megan Lewis (The University of Adelaide), Dr Bertam Ostendorf (The University of Adelaide)	AquaFin CRC	Completed
Jenna Bowyer	Nutritional factors influencing the performance of yellowtail kingfish, <i>Scorpaenopsis diabolus</i> cultured at low temperatures	Flinders University, SARDI	Dr David Stone (SARDI), A/Prof Ian Qin (Flinders University)	Australian Seafood CRC, Flinders University, SARDI	Completed
Felicity Brake	Enteric viruses in shellfish	SARDI, University of Tasmania	Dr Cath McLeod (SARDI), Dr Tom Ross (University of Tasmania)	Australian Seafood CRC	Current
Max Canepi	Effect of temperature and plant protein inclusion on the growth factor gene expression in yellowtail kingfish	Flinders University, SARDI	Dr David Stone (SARDI), A/Prof Ian Qin (Flinders University)	Flinders University, SARDI	Completed
Vineela Challaigulla	Optimising growth conditions of selected microalgae for biodiesel production	Central Queensland University, SARDI	Dr Larelle Fabbro (Central Queensland University), Prof Kerry Walsh (Central Queensland University), Dr Sasi Nayyar (SARDI)	Central Queensland University	Current
Coraline Chapperton	On the importance of behavioural adaptations in thermal challenged intertidal ectotherms: implications in climate change studies	Flinders University	Prof Laurent Seuront (Flinders University – SARDI), A/Prof Jim Mitchell (Flinders University)	Endeavour International Postgraduate Research Scholarships	Current
Nardi Cribb	Habitat site fidelity and behavior of bottlenose dolphins, <i>Tursiops aduncus</i> in the Adelaide dolphin sanctuary and spinner dolphin, <i>Stenella longirostris</i> in Fijian waters: application to management and conservation	Flinders University	Prof Laurent Seuront (Flinders University – SARDI), A/Prof Jim Mitchell (Flinders University)	Flinders University postgraduate Fellowship	Current
Rainbo Dixon	Molecular systematics of <i>Sargassum</i> (Phaeophyceae) in Australia	Murdoch University, the University of Adelaide	Dr John Huisman (Murdoch University), Dr Fred Gurgel (The University of Adelaide – State Herbarium of SA – DEWNR – SARDI)	APA – Australian Federal Government	Current
Michael Drew	The impacts of the South Australian fisheries on bronze and dusky whaler sharks, <i>Carcharias brachyurus</i> and <i>C. obscurus</i>	Flinders University, SARDI	Dr Charlie Huveneers (SARDI – Flinders University), Mr Paul Rogers (SARDI), Dr Mark Weekan (AIMS)	Adelaide & Mt Lofty Ranges Natural Resource Management (AMLR NMR) Board, Neiser Foundation	Current
Luke Einoder	Foraging and reproductive ecology of short-tailed shearwaters	SARDI, the University of Adelaide	A/Prof Simon Goldsworthy (SARDI), Dr David Paton (The University of Adelaide)	FRDC	Completed
Adrian Gutteridge	Biology, diversity and conservation of elasmobranchs from Hervey Bay, Queensland, Australia	University of Queensland	Dr Charlie Huveneers (SARDI – Flinders University), A/Prof Mike Bennett (University of Queensland)	Winifred Violet Scott Charitable Trust	Completed
Kate Lee	Habitat use and residence times of large predators within marine protected areas	Macquarie University	Dr Charlie Huveneers (SARDI – Flinders University), Prof Rob Harcourt (Macquarie University)	Caring for Our Country, Sydney Aquarium Conservation Fund	Current
Georgia Mercer	Development and optimization for anaesthetics for use in the abalone aquaculture industry	Flinders University, SARDI	Dr Marty Deveney (SARDI), Dr James Harris (Flinders University)	Australian Seafood CRC	Current
James Forwood	Integrated Pest Management (IPM) strategy for the monogenean infection, <i>Lepidodermis bidyana</i> , infecting silver perch, <i>Bidyanus bidyanus</i> .	Flinders University, SARDI	Dr Marty Deveney (SARDI), Dr James Harris (Flinders University)	FRDC	Current

Student name	Thesis title	Institution	Supervisors	Funder	Current/completed
William Grant	Phylogeography of the invasive marine green macroalgae <i>Caulerpa taxifolia</i> in Australia	SARDI, the University of Adelaide	Dr Marty Deveney (SARDI), Dr Fred Gurgel (The University of Adelaide - State Herbarium of SA - DEWNR - SARDI), Dr Jason Tanner (SARDI)	ARC, Biosecurity SA	Current
Derek Hamer	Interactions between protected species and some commercial fisheries in South Australia	SARDI, the University of Adelaide	A/Prof Simon Goldsworthy (SARDI), Prof Peter Shaughnessy (South Australian Museum), A/Prof Tim Ward (SARDI)	FRDC, Department of Environment and Heritage	Current
John Hayles	Biofouling in desalination systems: assessment and management of microbial communities	Flinders University	Dr Sophie Leterme (Flinders University - SARDI), Prof Melissa Brown (Flinders University), A/Prof Amanda Ellis (Flinders University)	APA - Australian Federal Government, National Centre of Excellence in Desalination (NCED) PhD Scholarship	Current
Matthew Heard	Assessment of the vulnerability of fresher sharks, <i>Apogias</i> spp., in Australian commercial and recreational fisheries	Flinders University, SARDI	Dr Charlie Huveneers (SARDI - Flinders University), Mr Barry Bruce (CSIRO), Mr Paul Rogers (SARDI)	Nature Foundation of SA, Paddy Pallin Scientific Grant, Save Our Seas Foundation	Current
Hasnun Nita Ismail	Effect of temperature, salinity, food quality and quantity on life history and behaviour of the euryhaline cladoceran, <i>Daphniopsis australis</i>	Flinders University	A/Prof JQin (Flinders University), Prof Laurent Seuront (Flinders University - SARDI)	Malaysian Government	Completed
Jan-Georg Jendyk	Phytoplankton communities of the Coorong wetlands: variability, adaptation and plasticity	Flinders University	Dr Sophie Leterme (Flinders University - SARDI), Prof Melissa Brown (Flinders University)	Flinders University Research Scholarship, NCED PhD Scholarship	Current
Emlyn Jones	The interaction between physical and sedimentary biogeochemical processes in south-west Spencer Gulf, South Australia	Flinders University, SARDI	A/Prof Iochen Kaempf (Flinders University), Dr Milena Fernandes (SARDI)	Aquaflin CRC	Completed
Peter Lauer	Benthic metabolism adjacent to southern bluefin tuna, <i>Thunnus macoyii</i> , pontoons in South Australia	Flinders University, SARDI	Prof Anthony Creshie (SARDI), Prof Peter Fairweather (Flinders University), Dr Jason Tanner (SARDI)	Aquaflin CRC	Completed
Patricia Lavery	The importance of marine mammal induced turbulence in fine-scale transport of nutrients	Flinders University	A/Prof Jim Mitchell (Flinders University), Prof Laurent Seuront (Flinders University - SARDI)	Flinders University postgraduate Fellowship	Completed
Yan Li	Spawning mediated responses of Pacific oyster, <i>Crassostrea gigas</i> , to environmental stress: toward an explanation of oyster summer mortality	Flinders University, SARDI	Dr Kirsten Benkendorff (Flinders University), Prof Xiaoxu Li (SARDI), A/Prof Jim Mitchell (Flinders University), A/Prof Jian Qin (Flinders University)	Endeavour International Postgraduate Research Scholarships	Completed
Yibing Liu	AS CRC abalone sperm cryopreservation project	Flinders University, SARDI	Prof Xiaoxu Li (SARDI), Dr Nick Robinson (Flinders University)	Australian Seafood CRC	Current
Andrew Lowther	Social and genetic factors shaping Australian sea lion foraging strategies	SARDI, the University of Adelaide	Prof Steve Dornellen (South Australian Museum, the University of Adelaide), A/Prof Simon Goldsworthy (SARDI), Prof Rob Harcourt (Macquarie University)	APA - Australian Federal Government	Current
Zhenhua Ma	Improvement of yellowtail kingfish, <i>Seriola lalandi</i> , fingerling production efficiency through food and feeding management	Flinders University, SARDI	Dr Berman Chen (CST), Mr Wayne Hutchinson (SARDI), A/Prof Jian Qin (Flinders University)	Australian Seafood CRC	Current
Tom Madigan	Quality, shelf-life and value adding of Australian oysters	SARDI, the University of South Australia	Dr Miguel De Barros Lopes (University of South Australia), Dr Andreas Kiermeier (SARDI)	Australian Seafood CRC	Current
Bryan McDonald	The influence of seagrass habitat architecture and integrity on associated faunal assemblages	Flinders University, SARDI	Dr Jason Tanner (SARDI), Prof Peter Fairweather (Flinders University)	Natural Heritage Trust (NHT)	Completed
Rebecca McIntosh	Life history and populations demographics of the Australian sea lion	La Trobe University	A/Prof Simon Goldsworthy (SARDI), Prof Peter Shaughnessy (La Trobe University)	SA Wildlife Conservation Fund, Sea World RRF	Completed



## APPENDIX - MISA PhD STUDENTS

Student name	Thesis title	Institution	Supervisors	Funder	Current/completed
Lachie Mcleay	Foraging and reproductive ecology of crested terns	SARDI, the University of Adelaide	A/Prof Simon Goldsworthy (SARDI), Dr David Paton (The University of Adelaide), A/Prof Tim Ward (SARDI)	FRDC	Completed
Chloe McKimming	Forecasting the future of coastal ecosystems under global and local impacts	SARDI, the University of Adelaide	A/Prof Sean Connell (The University of Adelaide), Dr Bayden Russell (The University of Adelaide), Dr Jason Tanner (SARDI)	APA - Australian Federal Government	Current
Kelly Newton	Microbial processes, structure and diversity along the natural salinity gradient present in the Coorong lagoon, South Australia — a model for anthropogenic impact	Flinders University	Prof Laurent Seuront (Flinders University – SARDI), A/Prof Jim Mitchell (Flinders University)	Flinders University Postgraduate Fellowship	Completed
Carol Palmer	Ecology of Indo-Pacific Humpback, <i>Stousoa chinensis</i> , and Australian Snubfin Orcaella, <i>heirisoni dolphins</i> in Northern Territory waters	Charles Darwin University (CDU), Flinders University, SARDI	Dr Chris Austin (Flinders University), Dr Guido Parra (Flinders University – SARDI), Dr Deborah Thiele (Flinders University)	Charles Darwin University, World Wildlife Fund	Current
James Patterson	Population-specific spatiotemporal dynamics of viral and microbial communities in South Australian continental shelf waters: impact of coastal upwelling and hydroclimatic forcing	Flinders University, SARDI	Prof Laurent Seuront (Flinders University – SARDI), A/Prof Jim Mitchell (Flinders University)	Flinders University Postgraduate Fellowship	Completed
Kristian Peters	Molecular and morphological analyses of Australian sea lion diet	SARDI, the University of Adelaide	A/Prof Simon Goldsworthy (SARDI), A/Prof Kathy Ophelkeller (SARDI)	NHT	Current
Eloise Prime	Impact of climate variability on phytoplankton communities	Flinders University	A/Prof Jim Mitchell (Flinders University), Dr Sophie Leterme (Flinders University – SARDI)	Flinders University Research Scholarship	Current
Nadiah Rasdi	Establishing a sustainable growth and reproduction of <i>Daphnia galeata mendotae</i> with emphasis on dietary factors manipulation	Flinders University, Australia	A/Prof Ian Qin (Flinders University), Dr Sophie Leterme (Flinders University – SARDI)	Malaysian Government Scholarship	Current
Flavio Ribeiro	Cannibalism control in marine fish larval rearing	Flinders University, SARDI	Dr Beniamin Chen (CST), Mr Wayne Hutchinson (SARDI), A/Prof Ian Qin (Flinders University)	Brazilian Government	Current
Laura Richardson	Water mass connectivity and mixing using hydrographic and stable isotope analyses	Australian National University, SARDI	A/Prof John Middleton (SARDI), Dr Brad Opdyke (Australian National University)	APA - Australian Federal Government	Current
Paul Rogers	Ecology of pelagic sharks in South Australia	Flinders University, SARDI	Prof Laurent Seuront (Flinders University), A/Prof Simon Goldsworthy (SARDI), A/Prof Jim Mitchell (Flinders University)	Flinders University, MISA	Completed
Nuttanun Soisup	Molecular systematics of <i>Gyrodactylus</i> , <i>Acrocarpia</i> and <i>Caulocystis</i> (Phaeophyceae)	SARDI, the University of Adelaide	Dr Fred Gurgel (The University of Adelaide - State Herbarium of SA – DEWNR – SARDI), Dr Julian Caley (AIMS), Prof Corey Bradshaw (The University of Adelaide - SARDI)	Royal Thailand Government Scholarship	Current
Tracey Spokes	Phylogeography of Australian marine macroalgae	The University of Adelaide	Dr Fred Gurgel (The University of Adelaide - State Herbarium of SA – DEWNR – SARDI), Dr Julian Caley (AIMS), Prof Corey Bradshaw (The University of Adelaide - SARDI)	Self funded	Current
Liu Fei Tan	Microalgal strain optimization for lipids and bioactives	Flinders University, SARDI	Prof Chris Franco (Flinders University), Dr Sasi Nayar (SARDI)	Flinders University	Current
Carlos Teixeira	Ocean dynamics of Spencer Gulf: a numerical study	SARDI, University of New South Wales	A/Prof John Middleton (SARDI), Dr Moniya Roughan (University of New South Wales)	Brazilian Government (CNPq)	Completed
Wei-Chun Tu	Optimising vegetable oil blends in aquaculture feeds to increase omega-3 fats in fish filets	SARDI, the University of Adelaide	Prof Robert Gibson (The University of Adelaide), Dr David Stone (SARDI)	RAH, SARDI, the University of Adelaide	Completed

Student name	Thesis title	Institution	Supervisors	Funder	Current/completed
Virginie van Dongen-Vogels	On the role of local and global physical forcing to space-time dynamics of microbes: a case study from the Southern Seas	Flinders University, SARDI	Prof Laurent Seuront (Flinders University), A/Prof Jim Mitchell (Flinders University)	Endeavour International Postgraduate Research Scholarships	Completed
Annelise Wirebkin	Foraging and reproductive ecology of little penguins	SARDI, the University of Adelaide	A/Prof Simon Goldsworthy (SARDI), Dr David Paton (The University of Adelaide)	FRDC	Current
Rissa Williams	Oral treatments for monogenean parasites of farmed yellowtail kingfish, <i>Seriola</i> spp. (Carangidae)	SARDI, the University of Adelaide	Dr Marty Deveney (SARDI), A/Prof Ian Whittington (The University of Adelaide)	ARC	Completed
Kathryn Wilshire	Investigation of macroalgal species with potential for Integrated Multi-Trophic Aquaculture (IMTA) in South Australia	SARDI, the University of Adelaide	Dr Fred Gurgel (The University of Adelaide – State Herbarium of SA – DEWNR – SARDI), Dr Jason Tanner (SARDI), Dr Marty Deveney (SARDI)	FRDC	Current
Lindsey Woolley	Body buoyancy and distribution of fish larvae: exploring the mechanism of mass mortality in post-larvae	Flinders University, SARDI	Dr Berman Chen (CST), Mr Wayne Hutchinson (SARDI), A/Prof Jian Qin (Flinders University)	Australian Seafood CRC	Current
Nikki Zanardo	Socio-genetic structure of common dolphins, <i>Delphinus delphis</i> , in South Australian waters	Flinders University, SARDI	Dr Luciana Moller (Flinders University), Dr Guido Parra (Flinders University – SARDI)	Current	Current

## Postdoctoral scientists

Scientist	Topic	Institution	Supervisors	Funder	Current/completed
Dr Berman Chen	Larval rearing	Flinders University, SARDI	A/Prof Jian Qin (Flinders University), Mr Wayne Hutchinson (SARDI)	Australian Seafood CRC, Flinders University, MISA	Completed
Dr Craig Hayward	Aquatic animal health	SARDI	Mr Steven Clarke (SARDI)	Australian Seafood CRC, MISA	Completed
Dr Andrew Lowther	Marine mammal ecology	SARDI	A/Prof Simon Goldsworthy (SARDI)	AMMC, IMOS, SARDI	Current
Dr Catherine McLeod	Seafood safety and market access	SARDI	Dr Andreas Kiermeier (SARDI)	Australian Seafood CRC, MISA	Current
Dr Stephen Pahl	Chemical engineering	SARDI	Ms Karen McLaughton (SARDI)	Australian Seafood CRC, MISA	Current
Dr Mohan Raj	Seafood processing	SARDI	Dr Andrew Barber (SARDI)	Australian Seafood CRC, MISA	Completed
Dr Shane Roberts	Aquatic animal health	SARDI	Mr Steven Clarke (SARDI)	Australian Seafood CRC, MISA	Completed
Dr Alex Safari	Quantitative genetics	Flinders University, SARDI	Prof Xiaoxu Li (SARDI)	Australian Seafood CRC, Flinders University, MISA	Completed
Dr Ian Stewart	Toxicology	SARDI	Dr Catherine McLeod (SARDI)	Australian Seafood CRC, MISA	Current

## Projects

MISA projects\* are primarily targeted at South Australian industry and government priorities, and focus on the research areas of Aquaculture Innovation, Biosecurity, Ecosystem Services and Seafood Product Quality and Value Adding.

### MISA Aquaculture Innovation projects

Project Name	Principal Investigator	Total Project Funds (\$)	Funders	Project Participants
A pre-feasibility study of the use of a macroalgal phytoremediation system for the treatment of Penrice effluent water	Prof Anthony Cheshire (Science to Manage Uncertainty Pty Ltd), Dr Sasi Nayar (SARDI)	37,915	Penrice Soda Products Ltd	Science to Manage Uncertainty Pty Ltd, SARDI
ACIAR – Achieving consistent spawning of captive yellowfin tuna, <i>Thunnus albacares</i> , broodstock at Gondal Research Institute for Mariculture, Bali, Indonesia	Mr Wayne Hutchison (SARDI)	408,100	Australian Centre for International Agricultural Research (ACIAR)	ACIAR, Research Institute for Mariculture (Gondal Bali), SARDI
Australian Seafood CRC – AAGA: Development of formulated diets for cultured abalone	Dr David Stone (SARDI)	701,126	Australian Seafood CRC	Flinders University, SARDI, the University of Tasmania (UTAS)
Australian Seafood CRC – Cleans Seas Tuna Ltd: Improvements in yellowtail kingfish, <i>Seriola lalandi</i> , larval and juvenile survival and quality	Mr Mike Thompson (CST)	802,092	Australian Seafood CRC	CST, Flinders University, SARDI
Australian Seafood CRC – Cleans Seas Tuna Ltd: Southern bluefin tuna, <i>Thunnus maccoyii</i> , larval rearing project	Mr Mike Thompson (CST)	1,035,786	Australian Seafood CRC	CST, Flinders University, SARDI
Australian Seafood CRC – CST: Addressing causes of early mortality in southern bluefin tuna, <i>Thunnus maccoyii</i> , larvae	Dr Berman Chen (CST)	2,532,016	Australian Seafood CRC	CST, NSW Industry & Investment (NSW I&I), SARDI, IMAS – UTAS
Australian Seafood CRC – CST: Addressing key aquatic animal health issues limiting production of Australian yellowtail kingfish, <i>Seriola lalandi</i> , and hatchery-reared southern bluefin tuna, <i>Thunnus maccoyii</i> industries	Dr Craig Hayward (SARDI), Dr Shane Roberts (SARDI)	628,066	Australian Seafood CRC	SARDI
Australian Seafood CRC: Post doctoral research scientist – larval and early juvenile marine finfish rearing scientist	A/Prof Jian Qin (Flinders University)	375,000	Australian Seafood CRC	CST, Flinders University, SARDI
Australian Seafood CRC: Post doctoral research scientist – SARDI Aquatic animal health scientist	Mr Steven Clarke (SARDI)	187,500	Australian Seafood CRC	SARDI
Australian Seafood CRC: Post doctoral research scientist – SARDI Quantitative geneticist	Prof Xiaoxu Li (SARDI)	430,250	Australian Seafood CRC	SARDI
CST: Southern bluefin tuna (SBT), <i>Thunnus maccoyii</i> , experimental commercial feed trial – Second generation SBT feeds project	Dr David Stone (SARDI)	15,000	Australian Seafood CRC	SARDI
Developing a proof-of-concept facility for microalgal biodiesel feedstock and value-added products to pioneer a sustainable South Australian biofuels industry	Prof Wei Zhang (Flinders University), Dr Sasi Nayar, SARDI	4,031,871	PSRF, Department of Further Education, Employment, Science and Technology (DFEEST)	Flinders University, SARDI, United Water International and Plenex Ltd
Developing clam aquaculture in Australia: a feasibility study on culturing <i>Donax deltoides</i> and <i>Kateleyia</i> spp. on intertidal and subtidal leases in South Australia	Mr Mark Gluis (SARDI)	592,145	FRDC	SARDI
Developing research and development microalgal systems at Ocean University China	Prof Xiaoxu Li (SARDI)	18,180	Ocean University China	SARDI
Developing tools for the management of nutrient and sediment interactions with seagrass ecosystems in Port Phillip Bay	A/Prof Greg Jenkins (DPI -Victoria)	700,000	Victoria Department of Sustainability and Environment	DPI - Victoria, Monash University, SARDI, Victorian Environmental Protection Agency (EPA)



Project Name	Principal Investigator	Total Project Funds (\$)	Funders	Project Participants
Development of sperm refrigeration and cryopreservation techniques in greenlip and blacklip abalone	Prof Xiaoxu Li (SARDI)	71,491	Australian Seafood CRC	Flinders University, SARDI
Development of spermatozoa cryopreservation techniques in farmed abalone	Prof Xiaoxu Li (SARDI)	116,576	FRDC	SARDI, the University of Sydney
Development of techniques for production of homozygous Pacific oysters, <i>Crassostrea gigas</i>	Prof Xiaoxu Li (SARDI)	601,575	FRDC	Flinders University, SARDI
Development of techniques for quantification of stress-induced catecholamine changes in the hemolymph of the Pacific oyster, <i>Crassostrea gigas</i>	Prof Xiaoxu Li (SARDI)	36,596	FRDC	SARDI
Effect of diet processing and protein type on growth performance of marron, <i>Cherax tenuimanus</i>	A/Prof Jian Qin (Flinders University), Dr David Stone (SARDI)	1,000	Flinders University	Flinders University, SARDI
Effect of temperature and plant protein inclusion on the growth factor gene expression in yellowtail kingfish, <i>Seriola lalandi</i>	Prof Andy Ball (Flinders University), A/Prof Jian Qin (Flinders University), Dr David Stone (SARDI)	10,000	Australian Seafood CRC	Flinders University, SARDI
Effects of temperature and plant protein inclusion on the growth factor gene expression in yellowtail kingfish, <i>Seriola lalandi</i>	Prof Andy Ball (Flinders University), A/Prof Jian Qin (Flinders University), Dr David Stone (SARDI)	10,000	The National Scientific and Technical Research Council, Argentina (CONICET)	Flinders University, SARDI
Effects of temperature and protein inclusion on the digestive tract structure of the greenlip abalone, <i>Haliotis laevis</i>	Dr James Harris (Flinders University), Dr David Stone (SARDI)	3,000	AGAA, Australian Seafood CRC, Flinders University	Flinders University, SARDI
Evaluation of fatty acid metabolism in juvenile barramundi, <i>Lates calcarifer</i>	Prof Robert Gibson (The University of Adelaide), Dr David James (RAH), Dr David Stone (SARDI)	15,000	Royal Adelaide Hospital (RAH)	SARDI, The University of Adelaide
Experimental production of tetraploid oysters for use as broodstock for commercial hatchery production of triploids	Prof Xiaoxu Li (SARDI)	16,479	FRDC	Flinders University, SARDI
Exposure of tissue homogenate from diseased yellowtail kingfish (YTK), <i>Seriola lalandi</i> , with suspected viral infection to juvenile YTK by intraperitoneal injection	Dr James Munro (SARDI) – The University of Adelaide	13,499	CST	SARDI, The University of Adelaide
Feasibility study of culturing unique fish in South Australia	Prof Xiaoxu Li (SARDI)	32,058	Private Company	PIBSA, SARDI
Grape seed extract: a potential new treatment for "soybean meal induced enteritis" in yellowtail kingfish, <i>Seriola lalandi</i>	Dr Rebecca Forder (The University of Adelaide), Prof Gordon Howarth (The University of Adelaide), Dr David Stone (SARDI)	3,000	The University of Adelaide	SARDI, The University of Adelaide
Impact of alternative dietary oils on shelf life and antioxidant status of Barramundi, <i>Lates calcarifer</i>	Prof Kathryn Sculler (Flinders University), Dr David Stone (SARDI)	500	Flinders University	Flinders University, SARDI
Impact of commercial hatchery practices on the family structure and effective population size in yellowtail kingfish, <i>Seriola lalandi</i>	Dr Alex Safari (Flinders University – SARDI)	25,000	Australian Seafood CRC	Flinders University, SARDI
Impact of fish oil replacement on the expression of anti-oxidant genes and genes involved in the synthesis of highly unsaturated omega-3 fatty acids in yellowtail kingfish, <i>Seriola lalandi</i> , liver and muscle tissue	A/Prof Kathryn Sculler (Flinders University), Dr David Stone (SARDI)	10,000	Australian Seafood CRC	Flinders University, SARDI
Improving hatchery production of southern bluefin tuna, <i>Thunnus maccoyii</i> larvae and fingerlings	Dr Jenny Cobcroft (University of Tasmania)	1,626,934	Australian Seafood CRC	Flinders University, SARDI, UTAS
Improving hatchery production of yellowtail kingfish, <i>Seriola lalandi</i> larvae and fingerlings	Dr Jenny Cobcroft (University of Tasmania)	373,389	Australian Seafood CRC	SARDI, UTAS
Investigating the potential for eel propagation for aquaculture in southern Australia	Mr Wayne Hutchison (SARDI)	18,000	DPI - Victoria	DPI - Victoria, SARDI
Investigations to address key policy gaps associated with the development of clam, <i>Kateleyia</i> spp., farming in South Australia: genetic and health issues aligned to translocation and stock identification	Prof Xiaoxu Li (SARDI)	92,052	FRDC	PIBSA, SARDI

## APPENDIX - MISA PROJECTS

Project Name	Principal Investigator	Total Project Funds (\$)	Funders	Project Participants
Kangaroo Island – abalone health project	Dr Craig Hayward (SARDI)	15,664	KI Abalone	SARDI
Large-scale microalgal biodiesel feedstock and value added biochemical products for a sustainable South Australian biofuels industry	Dr Stephen Clarke (Flinders University), Dr Sasi Nayar (SARDI)	259,893	DFEEST	Flinders University, SARDI
Maintaining southern bluefin tuna, <i>Thunnus maccoyii</i> , high health status - understanding SBT parasites and investigating ways to mitigate their influence on SBT production	Prof Barbara Nowak (the University of Tasmania)	2,201,771	FRDC	ASBTA, Flinders University, SARDI, UTAS
Metabolic and genetic optimisation of microalgae for biofuels production	Dr Sasi Nayar (SARDI)	54,967	DFEEST	Australian National University, SARDI, the University of Manitoba
Nutritional factors influencing the performance of yellowtail kingfish, <i>Seriola lalandi</i> cultured at low temperatures	A/Prof Jian Qin (Flinders University), Dr David Stone (SARDI)	260,000	Australian Seafood CRC	Flinders University, NSW I&I, SARDI
Phase 1 & 2 DARPA JP8 jet fuels from microalgae	Dr Sasi Nayar (SARDI)	239,828	General Atomics	SARDI
Population genetic structure of sea cucumbers, <i>Holothuria scabra</i> , in Northern Australia	Dr Michael Gardiner (Flinders University)	472,533	Australian Seafood CRC	DPI – Northern Territory, Flinders University, SARDI
Provision of larval and spat for feasibility study of establishment of mussel hatchery in South Australia	Mr Mark Gluis (SARDI)	6,600	SAMGA	SARDI
Provision of microalgae for feasibility study of establishing a bivalve hatchery at SAM Abalone	Prof Xiaoxu Li (SARDI)	9,394	SAM Abalone	SARDI
Reduction of Pacific oyster, <i>Crassostrea gigas</i> , mortality by improving farming and processing techniques in South Australia	Prof Xiaoxu Li (SARDI)	1,144,176	FRDC	SARDI
Research to foster investment in aquaculture using groundwater from salinity interception schemes	Mr Wayne Hutchison (SARDI)	2,653,578	National Action Plan	Loxton and Waikerie District Council, SARDI
Review of available software tools that can be used to support selective breeding programs in the Australian Seafood CRC	Dr Nick Robinson (contracted by MISA from Nofima)	14,850	Australian Seafood CRC	Flinders University, SARDI
Scope and economic analysis of options for a national unified breeding program that provides significant economic benefit to the Australian abalone aquaculture industry	Dr Nick Hobertson (contracted by MISA from Nofima)	90,306	Australian Seafood CRC	CSIRO, Flinders University, SARDI
Scope of options to establish gamete cryobanking services to genetic improvement programs in Australian aquaculture industry	Prof Xiaoxu Li (SARDI)	21,796	Australian Seafood CRC	Flinders University, SARDI
Selective breeding of farmed abalone to enhance growth rates	Prof Xiaoxu Li (SARDI)	521,664	FRDC	Deakin University, SARDI, UTAS, Fisheries WA
Selective breeding of farmed abalone to enhance growth rates II	Prof Xiaoxu Li (SARDI)	771,794	FRDC	Deakin University, SARDI, UTAS, the Department of Fisheries Western Australian (Fisheries WA)
Smoky Bay oyster mortality report	Prof Xiaoxu Li (SARDI)	3,500	South Australian Oyster Growers Association (SAOGA)	Flinders University, SARDI
Southern bluefin tuna, <i>Thunnus maccoyii</i> , maturation and sexing: develop and apply new technologies	Dr Craig Foster (CST)	2,214,318	Australian Seafood CRC, FRDC	CST, Flinders University, SARDI, University Sunshine Coast
Sustainable feeds and feed management for yellowtail kingfish, <i>Seriola lalandi</i> ; understanding YTK	Dr David Stone (SARDI)	1,500,000	Australian Seafood CRC	Flinders University, NSW I&I, SARDI, UTAS
Sustainable feeds and feed management for yellowtail kingfish, <i>Seriola lalandi</i>	Dr David Stone (SARDI)	1,005,553	Australian Seafood CRC	Flinders University, New South Wales Industry and Investment (NSW I&I), SARDI, the University of South Australia, UTAS

Project Name	Principal Investigator	Total Project Funds (\$)	Funders	Project Participants
Sustainable production of biodiesel from microalgae utilising saline waters from the salt interception schemes and saline aquifers in the Lower Murray	Dr Sasi Nayar (SARDI)	1,509,361	Centre for Natural Resource Management	SARDI
The effects of feeding alternative protein sources on the intestinal mucus layer and mucosal architecture in yellowtail kingfish, <i>Seriola lalandi</i>	Dr Rebecca Forder (The University of Adelaide), Dr David Stone (SARDI), Prof Gordon Howarth (The University of Adelaide)	10,000	Australian Seafood CRC	SARDI, The University of Adelaide
The provision of South Australian Research and Development Institute Australasian Experimental Stockfeed Extrusion Centre R & D services to Department of Primary Industries Victoria – Aquaculture	Dr David Stone (SARDI)	67,258	Private companies	SARDI
Utilisation of nutrients in wastewater at Melbourne water sewage treatment plants for algae to energy production	Mr John Poon (CH2M Hill), Mr David Austin (CH2M Hill), Dr Jay Mackie (CH2M Hill), Mr Jim Bays (CH2M Hill), Dr Sasi Nayar (SARDI)	200,000	Melbourne Water	CH2M Hill, SARDI
Yellowtail kingfish, <i>Seriola lalandi</i> ; sex specific AFLP markers	Prof Xiaoxu Li (SARDI)	5,000	SARDI	SARDI
Yellowtail kingfish, <i>Seriola lalandi</i> ; growth response, flesh quality and polyunsaturated fatty acids (PUFA) content through microalgae formulated aqua-feeds	Prof Wei Zhang (Flinders University), Dr David Stone (SARDI)	10,000	Australian Seafood CRC	Flinders University, SARDI

## MISA Biosecurity projects

Project Name	Principal Investigator	Total Project Funds (\$)	Funder	Project Participants
Assessing risks associated with the Australian Trade in ornamental non-native fish species	Dr Marty Deveney (SARDI)	43,359	Biosecurity SA	SARDI
Ecology, physiology and phylogeography: an integrated approach to the study of the invasive marine green macroalgae, <i>Caulerpa taxifolia</i> in Australia	Dr Fred Guegel (The University of Adelaide – State Herbarium of SA – DEWNR – SARDI)	318,000	ARC, Biosecurity SA	CSIRO, DEWNR, the State Herbarium of SA, the University of Adelaide
Molecular tools for detection of marine pests: development of quantitative polymerase chain reaction (PCR) assay for the black striped mussel, <i>Mytilopsis sallei</i>	Dr Nathan Bott (SARDI)	166,932	Biosecurity SA	SARDI
Optimisation of treatment of <i>Ichthyophthirius multifiliis</i> in farmed trout	Dr Marty Deveney (SARDI)	\$61,000	DPI – Vic, FRDC	SARDI, Flinders University, Future Fisheries Veterinary Services
PIRSA Innovative Solutions 3: Biosecurity risk assessment and development of standardised mitigation for tuna, <i>Thunnus maccoyii</i> and finfish aquaculture	Dr Marty Deveney (SARDI)	169,205	PIRSA	Fisheries WA, SARDI, UTS
Adelaide desalination plant – phytoplankton characterisation study	Dr Paul van Ruth (SARDI)	119,663	Private company	SARDI
<i>Caulerpa taxifolia</i> – 2009 survey of current distribution and high risk areas	Dr Marty Deveney (SARDI)	67,146	Biosecurity SA	SARDI
<i>Caulerpa taxifolia</i> – plant and sediment chemistry	Dr Marty Deveney (SARDI)	29,904	Biosecurity SA	SARDI
<i>Caulerpa taxifolia</i> – 2006 survey of current distribution and high-risk areas	Dr Grant Westphalen (SARDI)	51,000	Biosecurity SA	SARDI
<i>Caulerpa taxifolia</i> – 2008 survey of the upper Port River	Mr Keith Rowling (SARDI)	20,837	Biosecurity SA	SARDI
<i>Caulerpa taxifolia</i> – 2010 survey of current distribution and high risk areas	Ms Kathryn Wiltshire (SARDI)	82,621	Biosecurity SA	PIRSA – Biosecurity, SARDI



## APPENDIX - MISA PROJECTS

Project Name	Principal Investigator	Total Project Funds (\$)	Funder	Project Participants
<i>Galearpa taxifolia</i> : 2008 survey of current distribution and high risk areas	Mr Keith Rowling (SARDI)	65,811	Biosecurity SA	SARDI
<i>Galearpa taxifolia</i> : Ecological and economic risk assessment	Dr Marty Deveney (SARDI)	400,000	Biosecurity SA	SARDI
Collation and mapping of marine pest records in South Australia	Dr Marty Deveney (SARDI)	45,202	Biosecurity SA	PIRSA – Biosecurity, SARDI
Development of chemical discharge standards to ensure environmental protection following ballast water or biofouling treatment processes	Dr Marty Deveney (SARDI)	71,501	DAFF	SARDI
Development of gene probes for introduced marine pest species	Dr Grant Westphalen (SARDI)	227,273	NHT	SARDI
Investigation of risk and identification of treatment options and guidelines in relation to marine pest translocation associated with the aquaculture industry	Dr Grant Westphalen (SARDI)	155,633	DAFF	SARDI
Mangrove surveys: Part of the national system for the preventions and management of marine pest incursions	Mr Keith Rowling (SARDI)	44,897	Biosecurity SA	SARDI
Molecular tools for detection of marine pests - Development of putative diagnostic PCR assays for the detection of significant marine pests: <i>Asterius amurensis</i> , <i>Carcinus maenas</i> , <i>Undaria pinnatifida</i> and <i>Ciona intestinalis</i>	Dr Nathan Bott (SARDI)	65,092	AMLR NRM Board	SARDI
Molecular tools for detection of marine pests: Refinement of <i>Musculista senhousia</i> specific real-time PCR assay, further investigations into the specificity of the <i>Corbula gibba</i> real-time PCR assay and preliminary development of a specific real-time PCR assay for the detection of <i>Perna canaliculus</i>	Dr Nathan Bott (SARDI)	162,080	Biosecurity SA	SARDI
Molecular tools for detection of marine pests: Validation and optimisation of sampling and analysis procedures to provide quality assurance and quality control for routine monitoring	Dr Nathan Bott (SARDI)	124,714	Biosecurity SA	SARDI
Port Adelaide marine pest survey 2008	Dr Marty Deveney (SARDI)	52,876	Biosecurity SA	SARDI
Port Adelaide Marine Pest Survey 2010	Dr Marty Deveney (SARDI)	221,184	Biosecurity SA	SARDI
Port River marine pest survey: Implementation of the pest surveys guidelines developed for ports and harbours as part of the National System for the Preventions and Management of Marine Pest Incursions- phase 1	Mr Keith Rowling (SARDI)	129,374	Biosecurity SA	SARDI
Provision of an executive officer for the Aquatic Animal Health Committee	Dr Marty Deveney (SARDI)	35,000	Subcommittee for Aquatic Animal Health	SARDI
Review of buffdine fish report	Dr Marty Deveney (SARDI)	3,000	PIRSA	SARDI
Temperature and salinity tolerances of priority marine pests	Dr Grant Westphalen (SARDI)	16,664	Biosecurity SA	SARDI

### MISA ecosystem services projects

Project Name	Principal Investigator	Total Project Funds	Funders	Project Participants
Using fatty acid signature analysis to assess feeding ecology in elasmobranchs	Prof Laurent Seuront (Flinders University - SARDI), Dr Charlie Huveneers (SARDI - Flinders University), Dr David Stone (SARDI)	7,500	Flinders University, ANZ Trustees Foundation - Holsworth Wildlife Research Endowment	Flinders University, SARDI
A review of the distribution of seals in South Australia	A/Prof Simon Goldsworthy (SARDI)	5,175	Department of the Environment, Water, Heritage and the Arts (DEWHR)	SARDI

Project Name	Principal Investigator	Total Project Funds	Funders	Project Participants
A stable isotope method to rapidly screen the foraging ecology profile of Australian sea lion subpopulations: improving foraging distribution models to assist bycatch mitigation in gillnet fisheries.	A/Prof Simon Goldsworthy (SARDI)	150,907	AMMC	SA Museum, SARDI
Acoustic telemetry in Northern Gulf St Vincent, South Australia: contributions to understanding the movement and behaviour of snapper, <i>Chrysophrys auratus</i> and whaler and white sharks, <i>Carcharodon carcharias</i>	Dr Tony Fowler (SARDI)	In kind funding in the form of acoustic receivers	Australian Acoustic Tagging and Monitoring System	CSIRO, Flinders University, SARDI
Acoustic telemetry in Northern Spencer Gulf, South Australia: understanding the spawning aggregative behaviour of snapper, <i>Chrysophrys auratus</i> and their interactions with white sharks, <i>Carcharodon carcharias</i>	Dr Charlie Huveneers (SARDI – Flinders University)	In kind funding in the form of acoustic receivers	Australian Acoustic Tagging and Monitoring System	CSIRO, Flinders University, SARDI
Addressing direct interactions between the Australian sea lion and shark fishing vessels in the GAB Marine Park: a management focus	A/Prof Simon Goldsworthy (SARDI)	23,000	DEWNR, DEWNR	SA Museum, SARDI
AFMA – provision of data and analyses to ABARES to support Australian sea lion adaptive management strategy	A/Prof Simon Goldsworthy (SARDI)	6,839	AFMA	AFMA, DAFF, SARDI
Alinta Energy impacts of fly ash discharge	Dr Jason Tanner (SARDI)	108,787	Private company	SARDI
An assessment of climate change impacts on settlements on the Yorke Peninsula and the implications for government planning and approval processes – marine biological & ecological	Dr Jason Tanner (SARDI)	18,000	Private company	SARDI
An ocean observing system for the Adelaide desalination plant	A/Prof John Middleton (SARDI)	208,000	McDonnell Dowell Constructors (MIV)	SARDI
Analysis of information gaps and coordinated research strategy to collect information required to assess the national conservation status of Australian tropical inshore dolphins	Dr Guido Para (Flinders University–SARDI), Dr Isabel Beasley (James Cook University), Mr Simon Allen (Murdoch University)	59,000	DSEWPac	Flinders University, James Cook University, Murdoch University, SARDI
Anthropogenic contaminants in Queensland's coastal dolphins: levels and toxicological effects	Dr Daniele Cagnazzi (Southern Cross University), A/Prof Maria Fossi (Siena University), Dr Guido Para (Flinders University–SARDI)	170,010	DEWHA, AMMC	Flinders University, SARDI, Siena University, Southern Cross University
Assessing the biofouling role of microbes in the desalination system; from the intake pipe to the reverse osmosis membranes	Dr Sophie Letenne (Flinders University – SARDI)	536,408	NCEDA	Flinders University, SARDI
Assessing the impacts of berleying from shark cage-diving operators on the swimming behaviour of the white shark, <i>Carcharodon carcharias</i>	Dr Charlie Huveneers (SARDI – Flinders University)	19,200	Department for Environment and Heritage Wildlife Conservation Fund	CSIRO, Flinders University, Institute of Marine and Atmospheric Sciences in Tasmania (IMAS), SARDI
Assessing the impacts of berleying through four-dimensional modeling of the swimming behaviour of white sharks, <i>Carcharodon carcharias</i>	Dr Charlie Huveneers (SARDI – Flinders University)	9,000	Nature Foundation SA	CSIRO, Flinders University, IMAS, SARDI
Assessment of the status of the flesh-foot shearwater in South Australia: population status, subspecies status and foraging ecology	A/Prof Simon Goldsworthy (SARDI)	5,000	Nature Foundation SA	SA Museum, SARDI
Assessment of thresher shark, <i>Alopias</i> spp. vulnerability to the Australian commercial and recreational fisheries	Dr Charlie Huveneers (SARDI – Flinders University)	3,000	Nature Foundation SA	Flinders University, SARDI
Australian Bight Abalone stock surveys	Dr Jason Tanner (SARDI)	90,000	Private company	SARDI
Australian sea lion population monitoring at Seal Bay, Kangaroo Island, 2010–2012	A/Prof Simon Goldsworthy (SARDI)	213,570	DEWNR	DEWNR, SARDI
Australian sea lion populations at Seal Bay and Seal Slide (Kangaroo Island): continuation of the monitoring program	A/Prof Simon Goldsworthy (SARDI)	11,000	South Australian Wildlife Conservation Fund	DEWNR, SA Museum, SARDI
Australian sea lion populations at Seal Bay and the Seal Slide (Kangaroo Island): continuation of the monitoring program	A/Prof Simon Goldsworthy (SARDI)	12,973	Nature Foundation SA	DEWNR, SARDI

## APPENDIX - MISA PROJECTS

Project Name	Principal Investigator	Total Project Funds	Funders	Project Participants
Australian sea lion populations at Seal Bay and the Seal Slide: continuation of the monitoring program.	A/Prof Simon Goldsworthy (SARDI)	11,000	South Australian Wildlife Conservation Fund	DEWNR, SA Museum, SARDI
Baseline surveys of the marine environment adjacent to the proposed high salinity water discharge from the south lagoon of the Coorong	Dr Jason Tanner (SARDI)	51,143	Murray Darling Basin Natural Resource Management (MDB NRM) Board	SARDI
Benthic surveys for the Ceduna swimming enclosure	Dr Jason Tanner (SARDI)	7,000	Private company	SARDI
Beyond oceanography: behaviour as a tool to uncover ocean complexity	Dr Laurent Seuront (Flinders University - SARDI)	1,067,955	ARC	Flinders University
Biodiversity studies: South-East, Northern and Yorke natural resource management regions	Mr Keith Rowling (SARDI)	332,385	South-East, Northern and Yorke NRM Boards	SARDI
Biology and distribution of syngnathids of the Spencer Gulf	Dr David Currie (SARDI)	29,700	Nature Foundation SA, Spencer Gulf and West Coast Prawn Fishermen's Association	SARDI
Caring for our Country: assessing the adequacy and effectiveness of eastern blue rooper protection within Bronte-Coogee Aquatic Reserve utilising habitat mapping and acoustic monitoring techniques	T MacDonald	122,260	Caring for our Country	Flinders University, Macquarie University, NSW Department of Environment, Climate Change (NSW DECC), SARDI, Sydney Institute of Marine Science
CLAMM ecology	A/Prof Mike Geddes (The University of Adelaide)	2,195,861	CSIRO Collaboration Fund	Flinders University, SARDI, the University of Adelaide
Combining genetics and morphology to resolve a longstanding taxonomic and conservation management issue: how many bottlenose dolphin species are there in Australian waters?	Dr Catherine Kemper (SA Museum), Dr Michael Kuitzen (University of Zurich), Ms Maria Jedensjo (University of Zurich), Mr Simon Allen (Murdoch University), Dr Lars Bejder (Murdoch University), Dr Guido Parra (Flinders University-SARDI), Ms Kate Charlton-Robb (Monash University)	48,217	DEWHA, AMMC	Flinders University, Monash University, Murdoch University, SA Museum, SARDI, University of Zurich
Conservation management priorities for little penguin populations in Gulf St Vincent	Ms Annalese Wiebkin (SARDI)	16,609	AMLR NRM Board	SARDI
Deepwater biodiversity of the GAB marine park - Southern Surveyor Voyage SS2010_02	Dr David Currie (SARDI)	492,073	CSIRO, DEWNR, DEWHA	CSIRO, DEWHA, DEWNR, SARDI
DENR environmental impact assessment for Seal Bay upgrades	A/Prof Simon Goldsworthy (SARDI)	26,950	DEWNR	SARDI
Determination of the critical habitats and movement dynamics of the bronze whaler, <i>Carathrinus brachyurus</i> , off southern Australia	Mr Paul Rogers (SARDI)	20,000	The Mohamed bin Zayed Species Conservation Fund	SARDI
Determining precise estimates of modern biodiversity extinction rates	Prof Corey Bradshaw (The University of Adelaide - SARDI)	50,000	Australian Centre for Ecological Analysis and Synthesis	SARDI, the University of Adelaide
Developing a decision process based on expert knowledge to inform the management of dugongs and coastal dolphins in northern Australia: the Yanyuwa sea country in the Northern Territory as a case study - Phase 2	Prof Helene Marsh (James Cook University), Dr Guido Parra (Flinders University-SARDI)	39,563	DEWHA, AMMC	Flinders University, James Cook University, SARDI
Developing population monitoring protocols for Australia sea lions	A/Prof Simon Goldsworthy (SARDI)	44,000	NHT, Marine species Recovery Protection	SA Museum, SARDI
Developing population monitoring protocols for Australian sea lions	A/Prof Simon Goldsworthy (SARDI)	142,208	AMMC, DEWNR	DEWNR, SA Museum, SARDI



Project Name	Principal Investigator	Total Project Funds	Funders	Project Participants
Developing population monitoring protocols to determine the abundance of Australian sea lions at key subpopulations in South Australia	A/Prof Simon Goldsworthy (SARDI)	97,161	AMMC, DEWNR	DEWNR, SA Museum, SARDI
Development of a hydrodynamical/biogeochemical modelling facility	A/Prof John Middleton (SARDI)	648,000	MISA	SARDI
DNA tags & satellite tracks: shortfin mako shark	A/Prof Simon Goldsworthy (SARDI)	13,500	Seaworld Research and Rescue Foundation (Seaworld R&R Foundation)	SARDI
DNA tags and satellite tracks: a multi-disciplinary approach to resolving dispersal and connectivity among populations of the vulnerable shortfin mako shark, <i>Isurus paucus</i>	A/Prof Simon Goldsworthy (SARDI)	13,500	Seaworld R&R Foundation	Macquarie University, SARDI
Effects of environmental variability on recruitment to South Australian fisheries	A/Prof John Middleton (SARDI)	49,709	FRDC	SARDI
Environmental audit of marine aquaculture developments in South Australia	Dr Jason Tanner (SARDI)	527,514	FRDC	SARDI
Epifaunal biodiversity around deep sea canyons off the Bonney Coast and Kangaroo Island	Dr David Currie (SARDI)	218,126	South Australian Wildlife Conservation Fund, DEWNR, The Marine National Facility	SARDI
Establishing ecosystem-based management for the SA pilchard fishery: developing ecological performance indicators and reference points to assess the need for ecological allocations	A/Prof Simon Goldsworthy (SARDI)	799,999	FRDC	SARDI, the University of Adelaide
Estimating historical catches from proposed South Australian marine park sanctuary zones	Dr David Currie (SARDI)	122,934	PRSA	DEWNR, SARDI
Expert report on seal mortalities	A/Prof Simon Goldsworthy (SARDI)	2,750	DEWHA	SARDI
Feasibility study for integrated multitrophic aquaculture in southern Australia	Dr Jason Tanner (SARDI)	448,868	FRDC	DEWNR, SARDI, the University of Adelaide
Field surveys for capital project C0456 (Adelaide coastal waters studies outcomes)	Dr Jason Tanner (SARDI)	130,000	SA Water	SARDI
Fine-scale movements of white sharks to assess the impacts of burleying within a marine park	Dr Charlie Huveneers (SARDI - Flinders University)	20,000	Neiser Foundation	CSIRO, Flinders University, IMAS, SARDI
Foraging ecology and diet analysis of Australian sea lions	A/Prof Simon Goldsworthy (SARDI)	61,869	NHT, Marine species Recovery Protection	SA Museum, SARDI
Four-dimensional modelling of the swimming behaviour of white sharks, <i>Carcharodon carcharias</i> , with inferences to the impacts of burleying and electric repellents	Dr Charlie Huveneers (SARDI - Flinders University)	44,000	The WV Scott Charitable Trust	CSIRO, Flinders University, IMAS, SARDI
Genetic diversity of calcareous macroalgae and their vulnerability to global climate changes	Dr Fred Gurgel (The University of Adelaide - State Herbarium of SA - DEWNR - SARDI)	77,000	Department of Innovation, Industry, Science and Research (DISR)	SARDI
Identification of the behavioural ecology of bottlenose dolphins in relation to habitat type, and environmental water properties and assessment of the role of temporal variability	Prof Laurent Seuront (Flinders University - SARDI)	8,000	DEH	Flinders University
Informing the conservation status of the Australian snubfin dolphins, <i>Orcaella heinsdoni</i> by assessing its distribution and abundance in adjacent waters	Dr Isabel Beasley (James Cook University), Dr Guido Parra (Flinders University-SARDI), Prof Helene Marsh (James Cook University)	43,996	DEWHA, AMMC	Flinders University, James Cook University, SARDI
Innovative ways to ensure the future sustainability of the recreational fishery for shortfin makos, <i>Isurus paucus</i> in Victoria	Mr Paul Rogers (SARDI)	144,002	DPI - Victoria	Flinders University, Game Fishing Association of Victoria (GFAV), SARDI

## APPENDIX - MISA PROJECTS

Project Name	Principal Investigator	Total Project Funds	Funders	Project Participants
Recommendations for inshore dolphin survey, Darwin Harbour (middle and west arm) surveys	Dr Guido Parra (Flinders University – SARDI)	3,000	GHD, INPEX	Flinders University, SARDI
Interactions of the South Australian southern rock lobster and Commonwealth southern shark fisheries with fur seals and sea lions	A/Prof Simon Goldsworthy (SARDI)	67,089	FRDC	SA Museum, SARDI
Inter-seasonal variation in cohort survival to recruitment in the threatened Australian sea lion: demographic modelling of the Seal Bay population to assist management and recovery of the species	A/Prof Simon Goldsworthy (SARDI)	38,444	AMMC, DEWHA, SARDI	AMMC, DEWHA, SARDI
Investigation of the durability of coated hessian bags for seagrass restoration	A/Prof Jamie Quinton (Flinders University)	55,000	Department of Environment and Heritage, Flinders University	Department of Environment and Heritage, Flinders University, SARDI
IS-2 Carrying capacity of Spencer Gulf	A/Prof John Middleton (SARDI)	1,169,000	FRDC, PIRSA	SARDI
Live telemetry ocean observing system for the Adelaide desalination plant	A/Prof John Middleton (SARDI)	426,669	McDonnell Dowell Constructors	SARDI
Maintaining the monitoring of pup production at key Australian sea lions at colonies in South Australia	A/Prof Simon Goldsworthy (SARDI)	220,492	AMMC, DSEWPac	SA Museum, SARDI
Maintaining the monitoring of pup production at key Australian sea lions at colonies in South Australia	A/Prof Simon Goldsworthy (SARDI)	111,005	AMMC	SA Museum, SARDI
Maintaining the monitoring of pup production at key Australian sea lions at colonies in South Australia	A/Prof Simon Goldsworthy (SARDI)	213,335	AMMC, DSEWPac	SARDI
Management of flows to the Southern Ocean to provide diatoms for off-shore cockle community-winter conditions	Prof Laurent Seurent (Flinders University – SARDI)	15,000	MDB NRM Board	Flinders University
Marine flora of the Alinytjara Wilurara NRM Region and the relict species concept	Dr Fred Gurgel (The University of Adelaide – State Herbarium of SA – DEWNR – SARDI)	91,000	Alinytjara Wilurara Natural Resource Management (AW NRM) Board	The University of Adelaide
Marine investigations for Stansbury Marina EIS	Dr Jason Tanner (SARDI)	27,000	Private company	SARDI
Marine investigations for the Adelaide desalination plant	Dr Jason Tanner (SARDI)	350,000	SA Water	SARDI
Marine survey - Stony Point bulk storage and ship-loading facility	Dr Jason Tanner (SARDI)	99,544	Private company	SARDI
Marine surveys – ABB loading facilities	Dr Jason Tanner (SARDI)	35,934	Private company	SARDI
Marine surveys for EIS of destroyer berth at Outer Harbour	Dr Jason Tanner (SARDI)	40,000	Private company	SARDI
Methods for distinguishing foraging ecotypes within and among Australian sea lion subpopulations: their importance to defining genetic population structure and assisting spatial management of fisheries	A/Prof Simon Goldsworthy (SARDI)	131,960	AMMC	SA Museum, SARDI, the University of Adelaide
Mitigating seal interactions in the SRL E and gillnet sector SESSE in South Australia	A/Prof Simon Goldsworthy (SARDI)	907,556	FRDC	SA Museum, SARDI
Modelling the habitat preferences and abundance of coastal dolphins in the Gold Coast region	Dr Lyndon Brooks (Southern Cross University), Dr Elizabeth Hawkins (Southern Cross University), Prof Peter Harrison (Southern Cross University), Dr Guido Parra (Flinders University-SARDI)	70,000	DEWHA, AMMC	Flinders University, Southern Cross University
Monitoring threatened, endangered and protected shark species and species of conservation concern within the Adelaide metropolitan region	Dr Charlie Huveneers (SARDI – Flinders University)	67,500	Neiser Foundation	Flinders University, SARDI

Project Name	Principal Investigator	Total Project Funds	Funders	Project Participants
Movement patterns of threatened pelagic sharks in southern Australia: determining critical habitats, hot-spots and migration corridors to enhance policy development and conservation management	A/Prof Simon Goldsworthy (SARDI)	8,000	Nature Foundation SA	Flinders University, SARDI
Performance assessment of the Benthic Protection Zone of the Great Australian Bight Marine Park	Dr David Currie (SARDI)	253,638	DEWHA, DEWNR	SARDI
PIRSA Aquaculture — FRDC innovative solutions for aquaculture: seal interaction with finfish aquaculture	A/Prof Simon Goldsworthy (SARDI)	629,479	PIRSA, FRDC	SARDI
Population demography of the threatened Australian sea lion: understanding the causes of decline in the Seal Bay population	A/Prof Simon Goldsworthy (SARDI)	13,998	Nature Foundation SA	SA Museum, SARDI
Population genetics and phylogeography of Australian snubfin and humpback dolphins: defining appropriate management units for conservation-Stage 1	Dr Guido Parra (Flinders University-SARDI), Dr Celine Frere (University of Queensland), Dr Michael Krützen (University of Zurich), Dr Jennifer Seddon (University of Queensland)	120,805	DEWHA, AMMC	Flinders University, SARDI, the University of Queensland
Population management and monitoring program for the seal bay Australian sea lion	A/Prof Simon Goldsworthy (SARDI)	11,330	Nature Foundation SA	DEWNR, SA Museum, SARDI
Population size, structure and habitat preferences of common dolphins, <i>Delphinus</i> spp. in South Australia: enhancing the assessment, reduction and mitigation of fisheries operational interactions	Dr Luciana Moller ( Flinders University), Dr Guido Parra (Flinders University-SARDI), Dr Kerstin Bilgmann (Flinders University)	387,545	DEWHA, AMMC	Flinders University, SARDI
Prawn and crab harvest optimisation: a biophysical management tool	Dr Cameron Dixon (SARDI)	783,862	FRDC	SARDI
Primary producers: morphological flexibility under environmental constraints	Dr Sophie Leterme (Flinders University – SARDI)	300,000	ARC	Flinders University
Primary producers: morphological flexibility under environmental constraints	Dr Sophie Leterme (Flinders University – SARDI)	241,000	NCEDA	Flinders University, SARDI
Project host a workshop: spatial modelling of cetacean habitat use and abundance	Dr Lars Bejder (Murdoch University), Dr Guido Parra (Flinders University-SARDI)	50,000	DEWHA, AMMC	Flinders University, SARDI, St Andrews University, Murdoch University
Protected species interactions in the South Australian sardine fishery	A/Prof Simon Goldsworthy (SARDI)	23,594	PIRSA	SARDI
Providing a safe working environment for marine activities: risk assessment of the efficiency of the shark shield	Dr Charlie Huveneers (SARDI – Flinders University)	176,586	SafeWork SA Occupational Health, Safety and Welfare Small Grants Programme	Flinders University, IMAS, SARDI, University of Cape Town
Provision of professional services for the assessment of southern and eastern scalefish and shark fishery compliance	A/Prof Simon Goldsworthy (SARDI)	3,400	DEWHR	SARDI
Pup production assessment and maternal investment strategies of the Australian sea lion <i>Neophoca cinerea</i> at Dangerous reef	A/Prof Simon Goldsworthy (SARDI)	8,500	South Australian Wildlife Conservation Fund	SA Museum, SARDI
Pup production assessment of the Australian sea lion at Dangerous Reef and English Island, SA	A/Prof Simon Goldsworthy (SARDI)	19,712	South Australian Wildlife Conservation Fund	SA Museum, SARDI
Pup production assessment of the Australian sea lion at Dangerous Reef and English Island, SA	A/Prof Simon Goldsworthy (SARDI)	25,418	Nature Foundation SA	SARDI
Review Mackerel Ictfish MSC application	A/Prof Simon Goldsworthy (SARDI)	3,000	Scientific Certification Systems, USA	SARDI



## APPENDIX - MISA PROJECTS

Project Name	Principal Investigator	Total Project Funds	Funders	Project Participants
Running the gauntlet: international and domestic protection of the vulnerable common thresher, <i>Alopias vulpinus</i>	Dr Charlie Huveneers (SARDI – Flinders University)	20,000	Neiser Foundation	Flinders University, SARDI
SAIMOS/HERADAR and moorings: NCRIS funding	A/Prof John Middleton (SARDI)	4,670,000	EIF, NCRIS, UTAS	SARDI
Salinity tolerance of Goolwa cockles – cockle propagation and larval aspects	Dr Jason Tanner (SARDI)	46,194	MDB NRM Board	SARDI
Seagrass rehabilitation	Dr Jason Tanner (SARDI)	450,000	DEH	DEH, SARDI
Seagrass rehabilitation investigations	Dr Jason Tanner (SARDI)	68,922	AMLR NRM Board	SARDI
Seagrass restoration : improving hessian durability in marine environments	A/Prof Jamie Quinton (Flinders University)	650,000	AMLR NRM Board, ARC, SA Water	DEWNR, Flinders University, SARDI
SEAP work area 1.1: understanding the biophysical implications of climate change	Dr Alistair Hobday (CSIRO), A/Prof John Middleton (SARDI)	102,269	FRDC	CSIRO, SARDI
Seascape genetics for shark management: an innovation in sustainable fisheries modelling	Prof Bronwyn Gillanders (The University of Adelaide)	380,000	ARC Linkage	Flinders University, Marine Fishers Association, Nature Foundation SA, PIRSA, SA Museum, SARDI, the University of Adelaide, FisheriesWA
SIMSA/IMOS - seals as oceanographic samplers. Deployment of CTD tags on marine mammals	Mr Tim Moltmann (University of Tasmania)	400,000	DIISR	SARDI, Sydney Institute of Marine Science (SIMS), UTAS
Slocum gliders collaboration agreement	A/Prof John Middleton (SARDI)	7,688	Defence Science and Technology Organisation (DSTO)	DSTO, SARDI
Spatial impacts and carrying capacity: further developing, refining and validating existing models of environmental effects of finfish farming	Dr Jason Tanner (SARDI)	253,376	FRDC	SARDI, the University of Adelaide
Spatial modelling of the distribution of Australian sealion foraging effort in South Australian waters	A/Prof Simon Goldsworthy (SARDI)	9,091	DEWNR	SARDI
Spencer Gulf research initiative: development of an ecosystem model for fisheries and aquaculture	Prof Bronwyn Gillanders (The University of Adelaide)	240,000	FRDC	PIRSA, SARDI, the University of Adelaide
Sponges of the investigator islands	Dr David Currie (SARDI)	5,032	Nature Foundation SA	SARDI
Status and trends in abundance of the threatened sub-Antarctic fur seal at Macquarie Island	A/Prof Simon Goldsworthy (SARDI)	77,166	DEWHA	SARDI
Structure and subdivision of the Australian sea lion - defining species-wide management units using ecological and genetic information	A/Prof Simon Goldsworthy (SARDI)	131,708	AMMC, DEWHA, SARDI	AMMC, DEWHA, SARDI
Survey of recreational and game fishers attitudes towards large pelagic sharks	Mr Matt Heard (Flinders University)	6,000	Ecological Society of Australia	Flinders University, SARDI
Survey of SONAR test sites, Phase 1, literature review	A/Prof John Middleton (SARDI)	48,339	DSTO	SARDI
Sustainability of the rock lobster resource in south-eastern Australia in a changing environment: implications for assessment and management	Dr Adrienne Linnae (SARDI)	651,085	FRDC	DPI Vic, IMAS, SARDI

Project Name	Principal Investigator	Total Project Funds	Funders	Project Participants
Sydney Aquarium Conservation Fund: assessing the adequacy and effectiveness of eastern blue groper, <i>Acrocerodus viridis</i> protection within Bronte-Coogee Aquatic Reserve utilising habitat mapping and acoustic monitoring techniques	Dr Charlie Huveneers (SARDI – Flinders University)	5,000	Sydney Aquarium Conservation Fund	Flinders University, SARDI
Temperate trophic cascades: impacts of seal foraging on benthic community dynamics	Prof Bronwyn Gillanders (The University of Adelaide)	314,500	ARC Linkage Projects	DEWNR, Nature Foundation SA, NSW National Parks and Wildlife Service, NSW Department of Environment and Heritage, SARDI, the University of Adelaide, the University of Sydney
The conservation of fur seals in the Antarctic marine ecosystem	A/Prof Simon Goldsworthy (SARDI)	30,000	Australian Antarctic Division, DSEWPac	SARDI
The conservation of fur seals in the Antarctic marine ecosystem	A/Prof Simon Goldsworthy (SARDI)	29,700	Australian Antarctic Division	Monash University, SARDI, the University of Adelaide
The conservation of fur seals in the Antarctic marine ecosystem	A/Prof Simon Goldsworthy (SARDI)	95,546	Australian Antarctic Division	Monash University, SARDI, the University of Adelaide
The conservation of fur seals in the Antarctic marine ecosystem	A/Prof Simon Goldsworthy (SARDI)	409,452	DSEWPac, Australian Antarctic Division	Australian Antarctic Division, DSEWPac, SARDI
The impact of drain discharges on seagrass beds in the south east of SA	Dr Jason Tanner (SARDI)	75,000	South East Natural Resource Consultative Committee	SARDI
The role of genetic and social factors in shaping alternate foraging strategies within and among Australian sea lion subpopulations	A/Prof Simon Goldsworthy (SARDI)	2,000	AMMC	SA Museum, SARDI, the University of Adelaide
The role of genetic and social factors in shaping alternate foraging strategies within and among Australian sea lion subpopulations	A/Prof Simon Goldsworthy (SARDI)	68,066	Seaworld R&R Foundation	SA Museum, SARDI, the University of Adelaide
The role of genetic and social factors in shaping alternate foraging strategies within and among Australian sea lion subpopulations	A/Prof Simon Goldsworthy (SARDI)	25,000	Seaworld R&R Foundation	SARDI
The role of submarine canyons in upwelling, sediment transport, and productivity hotspots off the Boney Coast and Kangaroo Island, South Australia	Dr David Currie (SARDI)	920,000	DEWHA, The Marine National Facility, the Government of South Australia	SARDI
Transect for Ecological Decision Making (TREND)	Prof Andy Lowe (The University of Adelaide – DEWNR)	4,143,000	PSRF	DEWNR, SARDI, the University of Adelaide
Transforming South Australian marine biodiversity into an emerging marine biotechnology industry	A/Prof Jim Mitchell (Flinders University)	60,000	PSRF	SARDI
Trends in abundance of New Zealand fur seals pups on Kangaroo Island	A/Prof Simon Goldsworthy (SARDI)	5,223	Nature Foundation SA	SA Museum, SARDI
Trophodynamics of demersal fish from the Spencer Gulf	Dr David Currie (SARDI)	58,082	Wildlife Conservation Fund	DEWNR, PIRSA, SARDI
Trophodynamics of small pelagic fishes in southern Australian ecosystems	A/Prof Simon Goldsworthy (SARDI)	5,500	FRDC	CSIRO, SARDI
Understanding the residence time and movement patterns of whaler sharks, <i>Carcharhinus</i> spp., along the Adelaide metropolitan beaches	Dr Charlie Huveneers (SARDI – Flinders University)	9,000	Nature Foundation SA	Flinders University, PIRSA, SARDI
Updating the report "Understanding the impediments to growth of Australian sealion populations"	A/Prof Simon Goldsworthy (SARDI)	28,931	DEWNR	SA Museum, SARDI

## APPENDIX - MISA PROJECTS

Project Name	Principal Investigator	Total Project Funds	Funders	Project Participants
Using fatty acid signature analysis to assess feeding ecology in elasmobranchs	Prof Laurent Seuront (Flinders University - SARDI)	7,500	ANZ Trustees Foundation - Holsworth Wildlife Research Endowment, Flinders University	Flinders University, SARDI
Using the foraging behaviour of the threatened Australian sea lion to assess habitat quality and inform the zoning of marine parks in South Australia	A/Prof Simon Goldsworthy (SARDI)	594,966	AMMC, DSEWPac	DEWNR, SARDI, the University of Adelaide
What is causing the decline in the number of little penguins breeding in the colony visited by tourists on Granite Island	A/Prof Simon Goldsworthy (SARDI)	4,700	Nature Foundation SA	DEWNR, SARDI
Wildlife Conservation Fund: determination of western blue groper, <i>Achoerodus gouldii</i> , and harlequin fish, <i>Orthos dentex</i> , home ranges and residence times in relation to sanctuary boundaries	Dr Simon Byrnes	52,000	Wildlife Conservation Fund	Flinders University, SARDI
Yankallia Bay seagrass condition index	Dr Jason Tanner (SARDI)	38,000	AMLR NRM Board	SARDI
You are what you eat: using fatty acid signatures to investigate diets in sharks – 2009–2010	Dr Charlie Huveneers (SARDI - Flinders University)	15,000	ANZ Trustees Foundation - Holsworth Wildlife Research Endowment	Flinders University, SARDI

## MISA seafood product quality and value adding

Project Name	Principal Investigator	Total Project Funds (\$)	Funder	Project Participants
A critical evaluation of supply-chain temperature profiles to optimise food safety and quality of Australian oysters	Tom Madigan (SARDI)	99,478	Australian Seafood CRC, MISA	South Australian Oyster Research Council (SAORC), SARDI, Select Oyster Company Ptd Ltd (SOCO), NSW Aquaculture Research Advisory Committee (ARAC), Tasmania Oyster Research Council (las ORC), UTAS
Australian seafood compositional profiles portal	Mr David Padula (SARDI), Ms Natalie Dowsett (SARDI)	239,860	Australian Seafood CRC	SARDI, Seafood Services Australia (SSA)
Australian Seafood CRC masterclass workshop series	Dr Andrew Barber (SARDI)	5,500	Australian Seafood CRC	SARDI, Mohan Raj
Barramundi taint	Richard Musgrove (SARDI)	100,000	Australian Seafood CRC, DEEDI (PI), SARDI	SARDI
Barriers and drivers of the South Australian food service sector's purchase of seafood	Dr Andrew Barber (SARDI)	45,000	MISA	Ehrenberg-Bass Institute (University of South Australia), SARDI
Chilled pre-packaged seafood category development	Ms Karen McNaughton (SARDI)	1,548,094	Australian Seafood CRC	SARDI
Codex Alimentarius working group on pathogenic marine <i>vibrio</i> spp.	Tom Madigan (SARDI)	5,000	Australian Seafood CRC	SARDI
Consultancy agreement for extension of seafood trade and market access database	Ms Natalie Dowsett (SARDI), Dr Damian May (SARDI), Mr David Padula (SARDI)	70,909	DAFF (AQIS)	SARDI, SSA
CSI: Harvest stress and maturation	Dr John Carragher (SARDI)	30,274	Australian Seafood CRC	CST, SARDI



Project Name	Principal Investigator	Total Project Funds (\$)	Funder	Project Participants
Development and evaluation of yellowtail kingfish consumer products	Ms Karen McNaughton (SARDI)	350,000	Seafood CRC, CST	SARDI
Export study tour to China	Mr David Padula (SARDI)	11,484	Australian Seafood CRC	SARDI
Fresh fresh prawns: maintenance of optimum quality for western king prawns, <i>Melicertus latissulcatus</i>	Dr Richard Musgrove (SARDI)	35,514	Australian Seafood CRC	SARDI
Gastronomic terms in menus and their influence on customer's choice of seafood	Andrew Barber (SARDI)	20,000	MISA	Ehrenberg-Bass Institute (University of South Australia), SARDI
Guideline for quality and safety assessment of novel seafood products	Ms Sutaseenee Anantanawat (SARDI)	97,633	Australian Seafood CRC	SARDI
High pressure processing of vac-packed abalone for extended shelf life	Mr Mohan Raj (SARDI)	6,500	Australian Seafood CRC	Bob Flemming, SARDI
Human enteric viruses in Australian bivalve molluscan shellfish	Dr Cath McLeod (SARDI), Ms Felicity Brake (SARDI)	177,046	Australian Seafood CRC, NSW Food Authority (NSWFA), DPI – NSW, Tasmanian Shellfish Quality Assurance Program (TSQAP), PIRSA, UTAS	SARDI
Improving post-harvest quality of sardines through utilisation of flow ice technology	Dr Richard Musgrove (SARDI), Dr John Carragher (SARDI)	84,793	SA Marine Scale Sardine Industry Association, Flinders University	SARDI
Maintaining postharvest quality of key species from the Great Australian Bight trawl sector	Dr Richard Musgrove (SARDI)	74,872	FRDC	SARDI
Market access for abalone	Dr Cath McLeod (SARDI), Ms Natalie Dowsett (SARDI)	131,752	Australian Seafood CRC	UTAS
Norovirus in retail oysters in NSW – development of a project plan	Dr Cath McLeod (SARDI)	15,000	NSWFA	SARDI
Norovirus oyster resistance	Dr Cath McLeod (SARDI)	188,600	DIISR	DPI – NSW, Queen Elizabeth Hospital, Rushan Rudong Aquatic Food Co. Ltd, Shandong, China, SARDI, SOCo, Yellow Sea Fisheries Research Institute, Qingdao, China
Novel treatments without sulphites for the prevention of blueing during the canning of abalone	Dr Richard Musgrove (SARDI)	29,516	Abalone Association of Australasia (AAA), Abalone Council of Australia (ACA), FRDC	SARDI
Nutritional profiles of baitfish 3: Effects of harvest and post harvest processes on quality of local baitfish for feeding southern bluefin tuna, <i>Thunnus maccoyii</i>	Dr John Carragher (SARDI)	305,109	FRDC	SARDI
Nutritional profiles of baitfish 3: Effects of harvest and post harvest processes on quality of local baitfish for feeding southern bluefin tuna, <i>Thunnus maccoyii</i>	Dr John Carragher (SARDI)	4,226	UTAS	SARDI
Overseas market access for shellfish	Dr Cath McLeod (SARDI)	9,500	Australian Seafood CRC	SARDI
Oyster product development innovation	Ms Karen McNaughton (SARDI)	73,000	Australian Seafood CRC	SARDI
Paralytic shellfish toxin (PST) testing in abalone	Dr Cath McLeod (SARDI), Ms Natalie Dowsett (SARDI)	50,000	Tasmanian Abalone Council	SARDI
Postdoctoral seafood scientist – quality (Dr Stephen Pahl)	Dr Stephen Pahl (SARDI)	250,000	Australian Seafood CRC	SARDI

## APPENDIX - MISA PROJECTS

Project Name	Principal Investigator	Total Project Funds (\$)	Funder	Project Participants
Postdoctoral research fellow (SARDI) – toxicology (Drian Stewart)	Drian Stewart (SARDI), Dr Cath McLeod (SARDI)	250,000	Australian Seafood CRC	SARDI
Prawn market access defenders	Dr Cath McLeod (SARDI), Ms Natalie Dowsett (SARDI), Dr Damian May (SARDI), Dr Andreas Kiermeier (SARDI), Mr David Padula (SARDI)	386,594	Australian Seafood CRC	SARDI
PSP testing of abalone	Dr Cath McLeod (SARDI)	12,826	Tasmanian Abalone Council	SARDI
Research, develop and trial new Australian wild caught abalone products into China – Stage 1	Ms Karen McNaughton (SARDI)	75,000	Australian Seafood CRC, ACA	SARDI
Research, develop and trial new Australian wild caught abalone products into China – Stage 2	Ms Karen McNaughton (SARDI)	75,000	ACA, Australian Seafood CRC	SARDI
Residue testing contracts conducted for private enterprises	Mr David Padula (SARDI), Ms Natalie Dowsett (SARDI), Mr Tom Madigan (SARDI), Dr John Carragher (SARDI), Dr Mohan Raj (SARDI), Dr Richard Musgrove (SARDI)	38,313	Private Enterprises	SARDI
Review of seafood market access issues	Dr Andrew Pointon (SARDI), Mr David Padula (SARDI)	13,000	Australian Seafood CRC	SARDI
Seafood CRC postdoctoral research scientist: SARDI seafood processing scientist (Dr Mohan Raj)	Dr Mohan Raj (SARDI)	375,000	Australian Seafood CRC	SARDI
Seafood CRC postdoctoral research scientist: SARDI shellfish safety (Dr Cath McLeod)	Dr Cath McLeod (SARDI)	375,000	Australian Seafood CRC	SARDI
Seafood CRC: quality, shelf-life and value-adding of Australian oysters (operating expenses)	Mr Tom Madigan (SARDI)	98,010	Australian Seafood CRC	SARDI, University of South Australia
Seafood CRC: quality, shelf-life and value-adding of Australian oysters (PhD stipend)	Mr Tom Madigan (SARDI)	100,600	Australian Seafood CRC	SARDI, University of South Australia
Seafood CRC research travel grant: PhD workshop on physical and biochemical methods of analysis for fish as food and subsidiary activities	Mr Tom Madigan (SARDI)	8,540	Australian Seafood CRC	SARDI
Seafood CRC travel research grant	Dr Cath McLeod (SARDI)	14,700	Australian Seafood CRC	SARDI
Seafood safety and abalone market access	Dr Cath McLeod (SARDI), Ms Natalie Dowsett (SARDI), Ms Suresinee Anantanawat (SARDI)	410,902	Australian Seafood CRC, DFEEST	Aquabio consultants, Cawthron Institute, NZ Pawa Industry Council SARDI, University of Tasmania
Seafood trade and market access portal	Mr David Padula (SARDI)	231,707	Australian Seafood CRC	SARDI, SSA
Seafood trade expert panel	Dr Cath McLeod (SARDI)	493,000	Australian Seafood CRC	SARDI
Successful sardines: post harvest optimisation and development of new products	Ms Karen McNaughton (SARDI)	174,072	Australian Seafood CRC, SAMSHIA	SARDI

Project Name	Principal Investigator	Total Project Funds (\$)	Funder	Project Participants
The whole prawn project	Mr John Sinclair	62,000	Australian Seafood CRC, Australian Council of Prawn Farmers	SARDI
Understanding yellowtail kingfish sub project 2 – precocious maturation component	Dr John Canagher (SARDI), Dr Trent D'Antignana (Flinders University - SARDI)	115,117	Australian Seafood CRC	SARDI, UTAS
Understanding yellowtail kingfish, <i>Seriola lalandi</i> , subproject 2: precocious maturation component	Dr Trent D'Antignana (Flinders University - SARDI)	293,000	Australian Seafood CRC	CST, DPI – NSW, SARDI, UTAS
Understanding yellowtail kingfish, <i>Seriola lalandi</i> , subproject 3: flesh quality component	Dr Trent D'Antignana (Flinders University - SARDI)	353,762	Australian Seafood CRC	CST, DPI – NSW, SARDI, UTAS
Understanding yellowtail kingfish, <i>Seriola lalandi</i> : project management component	Dr Trent D'Antignana (Flinders University - SARDI)	157,000	Australian Seafood CRC	CST, DPI – NSW, SARDI, UTAS
Vibrio testing of Australian oysters	Mr Tom Madigan (SARDI), Dr Cath McLeod (SARDI)	19,965	UTAS	SARDI
Victorian bivalve shellfish quality assurance	Dr Andreas Kiermeier (SARDI), Mr Tom Madigan (SARDI)	56,000	Fisheries Victoria	SARDI, John Sumner
Wanted dead or alive: novel technologies for measuring infectious <i>Noravirus</i> particles	Dr Cath McLeod (SARDI), Dr Klaus Oldach (SARDI), Ms Rose Flint (SARDI)	836,150	Australian Seafood CRC	SA Pathology, SARDI, the University of Adelaide

## Extension

Project Name	Principal Investigator	Total Project Funds (\$)	Funder	Project Participants
Can they hear me? Modern and innovative strategies to communicate with the seafood industry	Ms Jane Ham (SARDI)	85,276	Australian Seafood CRC	Australian Seafood CRC Oyster Consortium, SARDI



## Publications

**MISA has extended its research through reports, scientific journal articles and contributions to technical books.**  
**MISA publications\* total 431.**

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## APPENDIX - PUBLICATIONS

- Currie, D.R. and Kendrick, G.A. (2007). Ecological integration – biodiversity. In: S. McClatchie, J.F. Middleton, C. Pattiaratchi, D.R. Currie and G.A. Kendrick (eds) *The Southwest Marine Region: ecosystems and key species groups*. Department of the Environment and Water Resources, Hobart.
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## Acronyms

<b>AAA</b> – Abalone Association of Australasia	<b>DEWHA</b> – Department of Environment, Water, Heritage and the Arts	<b>NHT</b> – Natural Heritage Trust
<b>AAGA</b> – Australian Abalone Growers Association	<b>DEWNR</b> – Department of Environment, Water and Natural Resources	<b>NRS</b> – National Residue Survey
<b>ABF</b> – Algae and Biofuels Facility	<b>DFEEST</b> – Department of Further Education, Employment, Science and Technology	<b>NSW DECC</b> – Department of Environment & Climate Change
<b>ACA</b> – Abalone Council of Australia	<b>DIISR</b> – Department of Innovation, Industry, Science and Research	<b>NSWFA</b> – New South Wales Food Authority
<b>ACAAR</b> – Australian Centre for Applied Aquaculture Research	<b>DPI</b> – Department of Primary Industries	<b>NSW I&amp;I</b> – New South Wales Industry and Investment
<b>ACIAR</b> – Australian Centre for International Agricultural Research	<b>DSEWPac</b> – Department of Sustainability, Environment, Water, Population and Communities	<b>PC2</b> – Physical containment level 2
<b>AFMA</b> – Australian Fisheries Management Authority	<b>DSTO</b> – Defence Science and Technology Organisation	<b>PIRSA</b> – Primary Industries and Regions South Australia
<b>AIMS</b> – Australian Institute of Marine Science	<b>EIF</b> – Education Investment Fund	<b>PISC</b> – Primary Industries Standing Committee
<b>AMLR NRM Board</b> – Adelaide & Mt Lofty Ranges Natural Resource Management Board	<b>EPA</b> – Environmental Protection Agency	<b>PRSF</b> – Premier's Science Research Fund
<b>AMMC</b> – Australian Marine Mammal Centre	<b>EU</b> – European Union	<b>qPCR</b> – quantitative polymerase chain reaction
<b>APA</b> – Australian Postgraduate Awards	<b>Fisheries WA</b> – Department of Fisheries Western Australia	<b>RAH</b> – Royal Adelaide Hospital
<b>APVMA</b> – Australian Pesticides and Veterinary Medicines Authority	<b>FRDC</b> – Fisheries Research and Development Corporation	<b>SA Museum</b> – South Australian Museum
<b>AQIS</b> – Australian Quarantine and Inspection Service	<b>FSANZ</b> – Food Standards Australia New Zealand	<b>SAABC</b> – South Australian Aquatic Biosecurity Centre
<b>Aquafin CRC</b> – Aquafin Cooperative Research Centre	<b>GAB</b> – Great Australian Bight	<b>SAF</b> – Seafood Access Forum
<b>ARAC</b> – Aquaculture Research Advisory Council	<b>GABIA</b> – Great Australian Bight Industry Association	<b>SAIMOS</b> – Southern Australian Integrated Marine Observing System
<b>ARC</b> – Australian Research Council	<b>GFAV</b> – Game Fishing Association of Victoria	<b>SAMGA</b> – South Australian Mussel Growers Association
<b>ASBTIA</b> – Australian Southern Bluefin Tuna Industry Association	<b>GPS</b> – Global positioning system	<b>SAOGA</b> – South Australian Oyster Growers Association
<b>Australian Seafood CRC</b> – Australian Seafood Cooperative Research Centre	<b>HF</b> – High frequency	<b>SAORC</b> – South Australian Oyster Research Council
<b>AW NRM Board</b> – Alinytjara Wilurara Natural Resource Management Board	<b>IMAS</b> – Institute of Marine and Atmospheric Sciences in Tasmania	<b>SARDI</b> – South Australian Research and Development Institute
<b>BPZ</b> – Benthic Protection Zone	<b>IMOS</b> – Integrated Marine Observing System	<b>SASQAP</b> – South Australian Shellfish Quality Assurance Program
<b>CCIMPE</b> – the national Consultative Committee on Marine Pest Emergencies	<b>IMTA</b> – Integrated Multi-trophic Aquaculture	<b>SBT</b> – southern bluefin tuna
<b>CDU</b> – Charles Darwin University	<b>IPM</b> – Integrated Pest Management	<b>Seaworld R&amp;R Foundation</b> – Seaworld Research & Rescue Foundation
<b>CEBEL</b> – Cetacean Ecology, Behaviour and Evolution Lab	<b>MAFRI</b> – Marine and Freshwater Resources Institute	<b>SIMS</b> – Sydney Institute of Marine Sciences
<b>CONICET</b> – Consejo Nacional de Investigaciones Científicas y Técnicas, The National Scientific and Technical Research Council, Argentina	<b>MAP</b> – Modified Atmosphere Packaging	<b>SOC</b> – Select Oyster Company Pty Ltd
<b>CSIRO</b> – Commonwealth Scientific and Industrial Research Organisation	<b>MDB NRM Board</b> – Murray Darling Basin Natural Resource Management Board	<b>SSA</b> – Seafood Services Australia
<b>CST</b> – Clean Seas Tuna Ltd	<b>MISA</b> – Marine Innovation Southern Australia	<b>TAC</b> – Tasmanian Abalone Council
<b>CQU</b> – Central Queensland University	<b>MUP</b> – Minor use permit	<b>TAS ORC</b> – Tasmanian Oyster Research Council
<b>DAFF</b> – Department of Agriculture, Fisheries and Forestry	<b>National System</b> – the National System for the Prevention and Management of Marine Pest Incursions	<b>TREND</b> – Transect for Environmental Decision making
<b>DEEDI</b> – Queensland Department of Employment, Economic Development and Innovation	<b>NCEDA</b> – National Centre of Excellence in Desalination Australia	<b>TSQAP</b> – Tasmania Shellfish Quality Assurance Program
	<b>NCRIS</b> – National Collaborative Research Infrastructure Scheme	<b>UTAS</b> – the University of Tasmania
		<b>WDCS</b> – Whale and Dolphin Conservation Society
		<b>YTK</b> – yellowtail kingfish

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