South Australia Oyster Mortality Syndrome (SAMS) Workshop

Trudy McGowan

AUSTRALIAN SEAFOOD COOPERATIVE RESEARCH CENTRE

2013/721

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The Australian Seafood CRC is established and supported under the Australian Government's Cooperative Research Centres Program. Other investors in the CRC are the Fisheries Research and Development Corporation, Seafood CRC company members, and supporting participants.

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Australian Government

Fisheries Research and Development Corporation

An Australian Government Initiative

CRC AUSTRALIA

ISBN: 978-1-925982-06-0

NON-TECHNICAL SUMMARY

PROJECT NO: 2013/721 South Australian Oyster Mortality Syndrome (SAMS) Workshop

PRINCIPAL INVESTIGATOR: Dr Charles Caraguel

ADDRESS: Adelaide University, Roseworthy SA 5371

(PROJECT) OBJECTIVES OF RESEARCH TRAVEL GRANT:
To ensure the expertise of Ben Madden & Rachel Gordon from Ausvet was provided in the second workshop on South Australia Oyster Mortality Syndrome (SAMS)

NON TECHNICAL SUMMARY:

OUTCOMES ACHIEVED TO DATE
A report provided on South Australia Oyster Mortality Syndrome (SAMS) with recommendations for industry to implement

(PROJECT) OUTPUTS DEVELOPED AS RESULT OF TRAVEL GRANT:

A Strategic research plan for the SA oyster industry

A process of identifying the gaps and possible research to help overcome the deficits were identified for the development and appraisal of any future research. These themes were:
1. Better understanding of the *normal* oyster
2. The nutritional requirements of SA Oysters
3. Information management
4. Information extension

Addressing these themes should be a central part of the strategy for SA oyster research, and will enable the maximum return from any relevant research. The first two themes address the deficits in knowledge which will require targeted research by the SA oyster industry to overcome—no one else will be doing it. Although environmental information is vital, the issue for oyster producers is not how to research it, but how to access and interpret existing information, either industry specific or more general (such as climate and oceanographic data) and use this for analysis and decision making. Ensuring that producers are aware of these themes will help to develop understanding of the decisions that are made in funding research, and ensure the successful extension and integration of research findings into the industry.

ABOUT THE PROJECT/ACTIVITY

BACKGROUND

The South Australian Oyster Industry has been suffering from high mortalities (up to 50%) for a number of years that seem to be specific to South Australia. It was determined a number of workshops should be held with industry and scientific experts to further investigate this problem.

RESULTS

The attached report provides specific recommendations to guide further industry research to help address the issue of SAMS

INDUSTRY IMPACT

PROJECT OUTCOMES (THAT INITIATED CHANGE IN INDUSTRY)

Industry(SAORC/SAOGA) will use the recommendations to guide its future research programs

SUMMARY OF CHANGE IN INDUSTRY

(What immediate changes might be expected for business/industry?)

SAORC/SAOGA is using this report to guide its research requirements such as those requested as part of the CRC rebid.

WHAT FUTURE AND ONGOING CHANGES ARE EXPECTED?

(What will be the impact?)

This report will be used as a guide for future research requirements.

WHAT BARRIERS ARE THERE FOR CHANGES TO OCCUR?

None except for financial.

IF NOT ALREADY HAPPENING, WHEN WILL THE CHANGES OCCUR?

(e.g. 2 businesses will adopt project findings and two more are expected to adopt findings within 12 months)

WHAT IS THE LIKELIHOOD THAT THESE CHANGES WILL OCCUR?
(e.g. 50% chance that four businesses will adopt project findings)?

Changes already occurring.

WHAT BARRIERS ARE THERE TO ADOPTION OF THESE CHANGES AND WHAT ACTION COULD BE TAKEN TO OVERCOME THESE?

(e.g. to adopt project findings will require group training/sharing equipment/invest additional capital etc.)

None

COMMUNICATION OF PROJECT/EXTENSION ACTIVITIES

WHAT IS THE OUTPUT THAT NEEDS TO BE COMMUNICATED?

Report and intended actions have been communicated to SAOGA & SAORC executive and the wider industry as well as the relevant government bodies such as PIRSA & SARDI.

WHO IS/ARE THE TARGET AUDIENCE/S?

Growers, Researchers, Funding Bodies.

WHAT ARE THE KEY MESSAGES?

SA Oyster Industry has determined its key research priorities.

WHAT IS THE CALL TO ACTION?

(What is it you want people to do once you communicate the key message to them – i.e. what change of behaviour or action do you want them to take?)

Understand these are industries research priorities and assist in these areas as appropriate.

COMMUNICATION CHANNELS

(How can these messages be communicated and by who?):

Channel	*Who by*	*When*
Government ***Industry*** ***Researchers & Funding Bodies***	***SAOGA*** ***SAOGA*** ***SAOGA***	***Done & ongoing*** ***Done & Ongoing*** ***Done & ongoing***

LESSONS LEARNED AND RECOMMENDED IMPROVEMENTS

WHAT IS YOUR FEEDBACK?

(e.g. *What difficulties were experienced in undertaking this research and how did this affect the project*, *what improvements and/or considerations can be recommended for future projects in this area* and *what barriers are there to undertaking further research in this area and how could these be overcome?)*

Important to include a wide variety of experts from different backgrounds as well as industry.

FURTHER ACTION REQUIRED IN REGARDS TO COMMERCIALISATION?
(e.g. IP protection, licensing, sales, revenues etc)

ACKNOWLEDGEMENTS

FRDC, CRC, SAORC, AUSVET, University of Adelaide.

APPENDIX (IF APPLICABLE)

Refer attached report.

Workshop report

South Australia Oyster Mortality Workshop

Prepared for:
South Australian Oyster Research Council

Ben Madin[1]
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Charles Caraguel[2]

31 July 2013

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Contents

Acronyms

ASBTIA Australian Southern Bluefin Tuna Industry Association.

ASI Australian Seafood Industries Pty Ltd.

CRC Cooperative Research Centre.

DPIWE Department of Primary Industries, Water and Environment.

FRDC Fisheries Research and Development Corporation.

GAB Great Australian Bight.

GSP Gross State Product.

OEO Oyster Extension Officer.

PIRSA Department of Primary Industries and Resources South Australia.

POMS Pacific Oyster Mortality Syndrome.

SA South Australia.

SAMS South Australian Mortality Syndrome.

SAOGA South Australian Oyster Growers Association.

SAORC South Australian Oyster Research Council.

SARDI South Australian Research and Development Institute.

SASQAP South Australian Shellfish Quality Assurance Programme.

SBT southern bluefin tuna.

Chapter 1

Executive Summary

Over the last ten years the South Australia (SA) Oyster Industry has nearly doubled its output, and now contributes nearly one hundred million dollars annually to the Gross State Product (GSP). Coincident with this growth has been an increasing sense within the industry that the mortality rates of juvenile oysters during the late autumn/winter period has been increasing and has now become a significant impediment to increasing production. This increase in mortality has been labelled South Australian Mortality Syndrome (SAMS).

In September 2012 a workshop was held for producers in Port Lincoln, with the intention of describing and evaluating the mortality being experienced across the SA growing zones. The input from a large number of producers was assessed and a report of this meeting produced for the South Australian Oyster Research Council (SAORC) and distributed to the industry.

This workshop follows the earlier, producer-orientated workshop and was intended to gather together various experts in relevant fields to endeavour to find a way forward for the SA oyster industry. This workshop had three objectives, listed in section 2.1. A summary of these objectives form the majority of this report.

Key aspects of current information and knowledge

Two very clear messages emerged from the presentations given by subject experts, and are discussed here. The summary of the presentations given during the workshop and the key messages from the presentations in the SA oyster production context are fully described in chapter 3.

The importance of *normal*

Every single presenter referred to the need to better understand the *normal* aspects of their topic better. When the presentation was about the nutrition of the animal, the expert discussed the limited understanding of the normal nutrition requirements, dietary preferences and feed availability; when the topic was disease pathology it was the need to have a better understanding of the appearance of normal animal, which might require the sampling or analysis of normal animals. When the disease experience in a bay was being discussed, it became apparent that while most producers had a well developed concept of normal, there was little shared objective data that would allow a third party to come to a similar conclusion on what was normal production.

There is no doubt that normal information comes from a wide range of sources, however a particular benefit of this workshop was learning how much of the information is not discipline specific—that is, data that was important in one area often had crossover with another. For example, nutritional requirements require a better understanding of ocean currents (especially upwellings) and ecology.

The variation described between what was being experienced in the different bays was also instructional, with some reporting a well defined period of losses, while others had much greater variability in their experience. Under these conditions it is important to remember that the current working case definition is not fixed, and every effort should be made to try to make it more robust.

The availability of information

Most presenters were clear in their message that improved knowledge of the animal performance, disease and risk factors are vital to protect against disease and to manage performance in the absence of disease. Knowledge can only come from adequate access to information. There were two main aspects to this lack of information that are useful to consider:

- data that is not being collected or supplied to the right people to help in identifying the normal picture or problems,
- information that was available but not being adequately utilised—if at all.

There is no question that, insofar as it is possible in oyster-culture, most producers have an excellent knowledge of their production cycle and performance. What is less clear is how much of that information is objectively collected and stored in a manner that would allow others to contribute to improving production or managing disease, or making meaningful comparisons between different sites.

It is no surprise that two of the most important factors affecting oyster production are the impact of the climate and ocean. What is surprising is how much data is already available in these areas. In many cases valuable data is available for no charge—the reality is that it is not always in a format which is clear or 'user-friendly'. Some degree of processing is required to turn the data into information to be useful to producers. It is likely that with some help the data could be managed to provide useful information—this is already being done for the southern bluefin tuna (SBT) industry. It may be that the opportunity exists for improved collaboration between aquaculture industries.

Risk Factors

The original plan for the workshop had been to elucidate opinions of likely and unlikely risk factors of SAMS from the experts present. This information was then used for identifying priorities for further research or action during workshop sessions. There is little doubt that SAMS is going to be a multifactorial problem—not a problem that lends itself to a simple change to overcome it. In this context, discussion was undertaken in three groups and focussed on how to gather and analyse further information to reduce the knowledge gaps, rather than focussing just on risk factors. The three groups were tasked with looking at different aspects of the production, identifying the gaps and to suggest activities which might help to overcome deficits in knowledge. The areas evaluated were:

- Environment, feed, and carrying capacity
- Stock performance: genetics, growth, and mortality
- Stock performance: health, prevention and control

The issues raised during the workshop sessions showed common themes, and these are presented in chapter 5.

Strategic research plan for the SA oyster industry

It was not possible during the time available in the programme to provide costs and benefits of the research proposed during the workshop sessions. Nonetheless, the process of identifying the gaps and possible research to help overcome the deficits showed that even when groups were looking at different potential risk factors, there were common themes, as there were during the presentations. These themes provide an important context for the development and appraisal of any future research. These themes were:

1. Better understanding of the *normal* oyster
2. The nutritional requirements of SA Oysters
3. Information management
4. Information extension

Addressing these themes should be a central part of the strategy for SA oyster research, and will enable the maximum return from any relevant research. The first two themes address the deficits in knowledge which will require targeted research by the SA oyster industry to overcome—no one else will be doing it. Although environmental information is vital, the issue for oyster producers is not how to research it, but how to access and interpret existing information, either industry specific or more general (such as climate and oceanographic data) and use this for analysis and decision making. Ensuring that producers are aware of these themes will help to develop understanding of the decisions that are made in funding research, and ensure the successful extension and integration of research findings into the industry.

Chapter 2

Introduction

2.1 Objectives

This report presents the findings of a workshop held in Adelaide, South Australia, in April 2013 to further investigate mortalities occurring in South Australia (SA) oyster farms. The mortality syndrome has been referred to as South Australian Mortality Syndrome (SAMS) and this report will continue to use this name.

The workshop was organised and funded by the South Australian Oyster Research Council (SAORC) with assistance from Dr Charles Caraguel, an aquatic diseases expert from the School of Animal & Veterinary Sciences (SAVS) at the University of Adelaide (UofA). Funding from the Seafood Cooperative Research Centre (CRC) under their visiting experts programme allowed a larger number of people to contribute to the workshop.

The objectives of the workshop were to:

- present the current information and knowledge about these areas as they relate to SAMS
- to seek opinion from various experts on potential risk factors associated with SAMS
- to compare the cost and the benefit of investigating each of these risk factors to clearly define a strategic plan for future research

The Terms of Reference for the workshop are included at Appendix A.

Venue

The workshop was held in the Lower Napier Building, LG21 Tutorial Room, North Terrace Campus, The University of Adelaide. The workshop commenced at 1pm Thursday 18th April 2013 and concluded on Friday afternoon at 4pm.

Programme and participants

The programme for the workshop in included at Appendix B. A list of participants for the workshop is in Appendix C.

Format

The format of the workshop focused on structured presentations given by people in various areas that may assist with investigation SAMS, followed by discussions designed to gather as much information regarding the oyster mortalities experienced in SA. Following the presentations, participants were divided into three groups to work on specific topics in more detail. Results of the workshop were presented and further discussed.

Facilitators

The workshop was facilitated by Dr Charles Caraguel (The University of Adelaide), and Dr Ben Madin (AusVet Animal Health Services).

Chapter 3

Current information and knowledge

3.1 Reports from production areas

A summary of the current conditions and recent experience with SAMS (and other issues) was provided by the South Australian Oyster Growers Association (SAOGA) bay representatives present at the meetings. A map showing the locations of the bays is included in Appendix D.

Denial Bay (Gordon Gardner)

Denial Bay is approximately 780 kms from Adelaide, near Ceduna. Oyster farming began in 1985, with commercial production beginning in 1988. There are effectively two zones in this area—Denial Bay and St Peter's Bay. To date there haven't been any losses experienced in St Peter's Bay. Denial Bay has 14 leases which have experienced unexplained losses for a long time, appearing to peak in 2011-12. Every grower in the bay experienced high, unexplained mortalities at this time.

Smoky Bay (Gary Zippel)

Smoky Bay has two major growing areas—the south side and north side. The south side is the more productive, and it is this zone that has been most affected by SAMS. There is approximately 100ha in leases, and the bay supports 20 operations. Increased mortalities have been experienced irregularly since 1998, ten years after oyster farming began in the area. There were occurrences for two years before it appeared to stop. It recommenced in 2006 and has continued from this time.

During the height of the problem it was difficult to get 50% of oysters to full production. Ongrowers from the Yorke Peninsula appeared perform better. There has also been notable differences between batches of oysters, with some batches experiencing losses up to 95%.

Stocking densities in Smoky Bay increased in the late 1990s, however one of the responses to ongoing mortality events has been producers reducing the number of oysters in each basket.

Coffin Bay (Gary Olds)

Oysters have been grown in the Coffin Bay area[1] since the 1960s. There are approximately 150ha of leases spread between three bays over about 20kms. Coffin Bay itself is different from other bays in that isn't any crab in the area and it is generally cooler.

Coffin Bay makes a particularly good area for finishing oysters, and a lot of stock is introduced from other parts of the state to finish. Opinions regarding SAMS varied from it not being a problem to similar experiences of growers in other bays. No particular winter peak has been observed—oysters have appeared to be growing and then died over late summer to autumn. Most deaths were associated with grading, and seem to vary between batches. Triploid oysters appear to be affected the worst. Returning the oysters to the water as soon as possible after grading seems to lessen mortalities but it increases the cost of grading.

Oysters in Kellidie Bay appear more robust, and '...can be handled like we used to handle them...'. These oysters can be picked up in the morning, graded and returned to the water the next morning.

The Port Douglas oysters appear to react differently—the condition of the oysters appears irrelevant. It has been observed that the greater their condition, the more easily they appear to succumb to SAMS.

Differences in food availability were noted: food availability in Port Douglas is either in abundance or drought, whereas in Mt Dutton Bay there always seems to be food.

Franklin Harbour/Cowell (Terry Rehn)

Franklin Harbour is an area of approximately 10 000ha, with oyster leases amounting to 112.5ha, predominantly in the southern part of the bay. Oyster farming has been attempted in the northern parts with very poor results. The bay is shallow and surrounded by mangroves. The leases along western shore are marginal. There are three growers in Franklin Harbour, along the western bank that have not experienced SAMS to date.

The western bank is not suitable for finishing oysters but they appear to start there successfully.

Spat is grown along the Howard Spit where there is strong tide flow. The first signs of SAMS appeared in March 2011. Inclement weather during grading led to 20% of baskets lost, resulting in a large percentage of oysters lost in that event. The batch experienced high ongoing mortalities since that time. The main leases on southern side are where SAMS has been most noticed.

From a production perspective, the bay performed well in the 1990s. In 2000-01 farmers bought lease areas, starting oysters in Coffin Bay, then going to Cowell Bay, then back to Coffin Bay. It is difficult to determine if productivity in Cowell Bay is growing. The area was bought by a company in 2007 area bought up by a company which then became financially unviable. Some of the areas have been taken back by the original owners.

In the last decade the overall number of oysters in Cowell Bay have gone down.

[1] Coffin Bay is actually three different growing areas, Port Douglas, Mt Dutton Bay and Kellidie Bay.

Stansbury (Steve Bowley)

Oyster farming began in Stansbury in the 1970s with stick culture from Tasmania. The industry progressed in the 1990s. The area is 200kms from Adelaide (by car) or 70kms over water.

There are a lot of hobby growers, three main commercial growers, and two growers who farm near Kangaroo Island. Stansbury Bay has a substantial tidal movement. The main oyster growing areas are on a spit that goes out 6-7 kilometres.

Oyster leases encompass approximately 70ha. A nursery is on the shore lease, which is closest to land. The bigger growing areas are further out where the fast moving tide occurs. Leases have lower stocking densities. The main operation is ongrowing to supply the west coast.

Unexplained mortalities are not common—those mortalities that do occur are generally attributed to grading and are in the order of 0.5 - 1%.

3.2 Precis of previous workshop

Dr Ben Madin (AusVet)

Ben Madin is a veterinary epidemiologist who works on disease outbreaks and surveillance in marine and terrestrial animal species.

A summary of the initial workshop held in Port Lincoln in September 2012 was presented. The case definition for SAMS developed during the workshop and subsequent report development was of a disease that affected:

- animals from 20–60mm in size (<12 months old),
- experiencing their first winter (May–August),
- experience >10% unexplained mortality.

The workshop focussed on a disease that was likely to be multifactorial, with the expression of disease being a common reflection on a combination of pressures from a causative agent, the environment and the animal itself. The original workshop report provides further detail.

Key Points

- The condition being experienced in SA is not Pacific Oyster Mortality Syndrome (POMS)
- the condition is having a significant effect on production (and profitability) in South Australia
- six recommendations were made for future activities:

1. Improved Surveillance
2. Centralised information management
3. Increased laboratory analysis
4. Husbandry practices workshop
5. Analyse data from existing sources
6. Seek input from a wider range of experts

This workshop has evolved as one of these recommendations.

3.3 Pacific Oyster Mortality Syndrome update

Professor Richard Whittington (University of Sydney)

Professor Whittington is a veterinarian with special interests in microbiology, epidemiology and pathobiology of infectious diseases of farmed animals. He is an affiliate of the University of Sydney Institute of Marine Science and has been involved in research in a number of finfish species including the pilchard herpesvirus outbreak in 2005–2008, national marine disease surveys and is currently heavily involved in POMS research.

Presentation Summary

A massive POMS outbreak occurred in the Hawkesbury River, New South Wales, in January 2013. Increased mortalities (≈20–30%) in 3mm spat were noticed during routine monitoring in Mullet Creek at 10am, 21 January 2013. By 5pm it became obvious that a mass mortality event was occurring, and the next day POMS was confirmed. Within 48 hours of increased mortalities first being observed approximately ten million spat and adult oysters were dead. Voluntary quarantines were imposed to try and prevent the infection spreading upstream of the affected oyster beds. Oyster movements were mapped, and it was apparent that movement of infected oysters did not appear to be enough to cause a mass outbreak. There was an extreme heat event on 19 January but additional data are required to assist in determining the cause of POMS. More surveillance will be crucial in determining the factors associated with POMS, as well as further investigations including spatial analysis of the distributions of mortalities, possible vectors, and additional pathogens.

Key Points

- Virus was present in healthy stock for greater than three months without causing disease
- The speed of spread suggests a massive synchronous exposure to the necessary effect—this is inconsistent with a propagating epidemic common with spread of virus
- High quality data on animal numbers and movements was vital in determining a number of the findings
- there is no obvious link between POMS and SAMS

3.4 Infectious disease investigation

Dr Stephen Pyecroft (University of Adelaide)

Dr Pyecroft is a specialist veterinary pathologist with a long term interest in aquatic animal health management. He has recently joined the School of Animal and Veterinary Sciences of the University of Adelaide. Prior to this he was the Principal Veterinary Pathologist for the Department of Primary Industries, Water and Environment (DPIWE) in Tasmania, and was heavily involved in a range of aquaculture industries including oysters. He has worked closely with the Tasmanian Oyster Research Council and Oysters Tasmania organisation to develop and the annual Tasmanian Pacific Oyster Health Program and laboratory capacity for the detection of OsHV-1 by RT PCR to allow surveillance within a national framework of testing laboratories for this disease.

Presentation Summary

In the investigation of diseases of unknown cause it is essential to have an objective understanding of the normal animal to be able to identify changes in affected animals. At present there is no evidence of a specific pathogen causing an outbreak of SAMS. Due to the poor understanding of the causes of SAMS it is not possible to have a single test, nor even recognise animals affected with this disease. A diagnostic laboratory can undertake a range of generic tests, including gross pathology, histopathology and microbiology. Greater numbers of samples submitted to laboratories for testing allows for a larger and more varied dataset. Without a comprehensive dataset it is difficult to determine relevant patterns and from where these patterns might originate.

The understanding of what constitutes a *normal* oyster in SA within a given growing area is essential for comparison purposes. An appropriately designed survey of oysters across the state would provide the opportunity to build a substantial database, as well as assist with showing evidence of freedom from particular pathogens, and monitoring endemic disease. Samples need to be representative, and ideally from each bay. This approach has potential to assist the industry to monitor the overall health of the oysters, and potentially allow the identification of trigger points that may influence an occurrence of SAMS and/or other diseases. The keys to this approach are an appropriately designed sampling strategy and a 'case management' approach to the submissions and data analysis.

It would appear that SA oysters are dying over time, and growers are not experiencing the sudden, mass-mortalities associated with an outbreak caused by POMS.

Key points

- Surveillance data collected during periods of normal activity assist with determining potential risk factors associate with abnormal activity—the POMS virus was present without clinical signs of disease several months prior to the outbreak
- We are entering the period where a peak of SAMS would be expected, so it is important to get on with organising larger numbers of samples to the laboratory to enable patterns to be observed.

- Representative sampling (systematic or randomised) is vital to ensure the findings reflect the population.
- Samples should be sent to a single laboratory and the data generated from informed testing be analysed appropriately.

3.5 Defence mechanisms of oysters

Professor David Raftos (Macquarie University)

Professor Raftos is heavily involved in research in a range of oyster species, including Sydney rock oysters *Saccostrea glomerata*, Silver-lipped pearl oysters *Pinctada maxima* and Pacific oysters *Crassostrea gigas*. He is especially interested in the defence mechanisms oysters use and the impact of the environment on the ability of these immune responses to function normally.

Presentation Summary

Contrary to prior beliefs, research has found that oysters do have a complex and effective immune response. The Pacific oyster genome has multiple immune response genes, as well as the necessary ancillary genes required to assist the immune response genes. The immune response of an oyster differs according to the infectious agent involved, although bacterial and protozoan infections are handled using similar pathways. We already know of about 50 genes or proteins involved in this process. Understanding of anti-viral responses is less well understood.

The immune response developed by oysters has been shown to be reduced by stress, which may lead to increase susceptibility to disease.

Key points

- It may be possible to immunise oysters against specific diseases
- Oysters have a universal stress response pathway that determines disease resistance
- Molecular markers can be developed to assist with selective breeding
- Tools can be developed to identify stressful management practices

3.6 Oceanographic trends

Kirsten Rough (Southern Bluefin Tuna Industry Association)

Ms Rough has been involved in various research areas (health, nutrition, environment, production and engineering) with the Australian Southern Bluefin Tuna Industry Association

(ASBTIA) over the past 19 years. During this time the research has guided changes to the operation of the industry. Through 2012 she has been investigating the relationships between climate variation and the southern bluefin tuna (SBT) fishery in the Great Australian Bight (GAB). Tuna ranching relies on the capture of wild fish to stock the farms in Spencers Gulf.

Presentation Summary

The SBT industry has invested substantial funding into research over the years and the benefits of this investment are reflected by the industry's ability to identify and react to changes as they occur. The value of data collection to the ASBTIA with respect to tuna farming and fishing was demonstrated. Knowing what is normal allows changes to be identified quickly, and an increase in mortality rate of just a few percent from 2008 was identified and rapidly brought under control[2] with a combination of medication and husbandry changes.

Since 2008 the catching area for SBT has expanded from an area spanning 160 km in length to 460 km in 2012. There was also a decrease in the number of large fish in the GAB through 2012. This has been attributed to the combined influence of climatic conditions, including the La Niña and El Niño phenomenons (their effect on the water currents and temperature) and a large-scale marine seismic survey adjacent to the fishing grounds through the 2012 fishing season. Using data collected and collated after the 2012 fishing season, the industry was able to estimate with a greater degree of accuracy where the tuna was likely to be during catching for the 2013 fishing season.

Key points

- The collection of objective data allows the understanding of what is *normal*—previous data collection allows the tuna industry to prepare for unusual fishing seasons, and changes of just a few percent in various metrics through the ranching cycle can trigger responses.
- Targeted research can help provide solutions
- Large amounts of 'risk factor' data have already been collected and many of the oceanographic data are freely available
- The last 2–3 years have experienced abnormal, marine heat waves
- The SBT industry is based on a batch farming system ('catch and ranch') compared to the continuous farming in the oyster industry
- The fish haven't changed—the environment is changing instead.

3.7 Feed availability

[2] The increased mortality was caused by a substantial increase in number of the ubiquitous *Cardicola forsteri* blood fluke.

Clinton Wilkinson (SASQAP/PIRSA)

Mr Wilkinson has been the Program Leader of the South Australian Shellfish Quality Assurance Programme (SASQAP) for nearly four years, and is responsible for managing the daily activities of the program. SASQAP assists in ensuring the ongoing food safety of shellfish harvested from SA waters.

Presentation Summary

The results of a recent analysis of ten years of data collected by the SASQAP were presented and discussed. Sampling sites are located in each growing area and are chosen to target high risk areas. Typically six different species are seen, and there is evidence of selective feeding by the oysters. There is enormous variation in phytoplankton availability both between the oyster growing bays between seasons. In summary:

- In Denial, Smoky and Streaky Bays there is an abundance of food over summer, with very little food availability through winter.
- Port Douglas (the outer harbour of the Coffin Bay group of sites) is unique, as the water funnels into the bay and provides a more persistent food supply: this bay experiences occasional winter loss.
- Franklin Harbour (Cowell) has an average food count throughout the year, and does experience some winter loss. The sites where the oyster beds have been placed are more likely to experience toxic algal blooms. Franklin Harbour appears to be a self-contained ecosystem, with less reliance on upwelling.
- Stansbury Bay (Yorke Peninsula) has a very low consistent food supply, and to date does not appear to suffer the losses of the other bays.
- Port Vincent (Yorke Peninsula) has a consistently low level of food availability, with occasional food spikes. The mortalities observed in the Port Vincent area have been in low numbers.

Food availability is generally associated with phytoplankton counts, however there are reports of oysters in very good condition in spite of low phytoplankton counts. Matching up the relative availability with mortality reports suggests that rapid changes in phytoplankton counts appear to be a more important risk factor for SAMS than total phytoplankton count. Consideration needs to be given to alternative food sources for oysters such as suspended solids.

Data relating to food can be compared with climatic data - for example an El Niño event influences the upwellings, strengthening them which brings colder, and more nutrient rich, water up from the ocean floor. Oyster farmers present noted that La Niña years appeared to correspond with poor years for oysters.

Key points

- There have been pronounced food dips in bays that have experienced oyster mortalities.
- Bays where median food levels are lower but more consistent appear less susceptible to SAMS than those where high counts can rapidly drop away to extremely low.
- Further understanding of the alternative nutrition sources available to oysters in South Australia is required.

3.8 Carrying capacity

Paul van Ruth (SARDI Oceanography)

Dr van Ruth is a biological oceanographer and a plankton ecologist. He has worked extensively in the shelf and coastal waters of southern Australia, investigating the environmental factors that influence marine plankton.

Presentation summary

Carrying capacity is the density at which oysters can be stocked before having a detrimental effect on their health or the surrounding environment. In order to estimate carrying capacity, we need to account for several factors.

1. The quantities of food (including microbes, phytoplankton, micro-zooplankton or detritus) and the amount consumed by zooplankton.
2. The physical and chemical environmental parameters, and ecosystem processes that drive production/consumption of this food, including circulation patterns, nutrient concentrations, irradiance, nutrient uptake rates, deposition rates, and primary/secondary productivity.
3. Potential shifts in food web structure from diatom driven classic food webs to the pico-phytoplankton driven microbial loop. Pico-phytoplankton are too small to be seen under the microscope but may be providing important food in times when microscope identifications suggest there is none.

There will be spatial and temporal variation (monthly, seasonal and annual cycles) in these parameters between growing regions—therefore each growing region will need to be considered separately.

The development of a database of environmental information relevant to each growing region will assist in defining what the *normal* conditions are for each region. With this information, it will be easier to be proactive and detect any anomalous or adverse conditions and respond accordingly.

There are more filter-feeders than just oysters in the bay which are also consuming available food, and an understanding of exactly what oysters consume will be beneficial.

This information can be used to develop mathematical models of carrying capacity of individual growing regions. These models, when calibrated and validated, could provide powerful predictive management tools for the industry.

Key points

- Carrying capacity is the density oysters can be safely stocked without detrimental effect.
- A variety of information is required in order to estimate the carrying capacity.
- Conditions in the growing regions can vary, and therefore each growing region needs to be considered separately.
- A dataset is needed to define normality, allowing events to be compared to a *normal* situation.
- The information gathered can be used to develop models of carrying capacity for each growing region.
- Large amounts of data are available already to better understand upwelling activity and food avaiablility of the SA coast.

3.9 Genetics

Matt Cunningham (Australian Seafood Industries Pty Ltd)

Matt Cunningham is the General Manager of Australian Seafood Industries Pty Ltd (ASI), which is the company that manages the selective breeding program for Pacific Oysters in Australia

Presentation summary

Oyster mortality is well know to be affected by genetics. ASI is using SA survival data in current selection decisions. Enormous benefit is gained by assembling a good dataset of family performance data, which improves the knowledge of genetics in relation to SAMS.

Data is collected for each year class:

- at multiple sites (Denial, Smoky, Coffin Bays and Cowell)
- at different stages of growth.

This allows good discrimination between the families—for comparison purposes average survival of 50% is ideal. Very low or high survival rates make comparison between groups difficult as there may be inadequate numbers in one of the groups for robust analysis.

Knowledge areas that ASI would like to improve are:

- the most efficient way of running a field trial or test
- mortality in different years, different seasons and at different stages of life under the same genetic control
- the causative factors of mortality on different sites and in different years
- the role of metabolic activity in SAMS in relation to genetics
- the role of immune activity in SAMS in relation to genetics

Key points

- Oyster mortality can be influenced by genetics (heritability is approximately 0.2–0.3).
- Selection for non-specific mortality could be improved by understanding causative effects
- Mortality data across the entire growing region requires further strengthening.

Chapter 4

Risk factors and potential risk factors

The second objective of the workshop was "to seek opinion from various experts on potential risk factors associated with SAMS". The initial intention had been to engage the speakers on their opinion of likely and unlikely causes of SAMS, and using this information rank those causes to identify priority areas for investigation. During and following the presentations from the experts at the workshop substantial discussion and questioning of the information being presented was held.

In contrast to the early theories of disease causation[1] which defined a single causative agent, more modern theories consider a range of factors which in combination cause effects on health[2]. In some cases a single agent may have strong enough effects to cause disease under almost any conditions, but most examples (such as POMS) the presence of the disease agent alone is not enough to cause disease, but often requires a combination of other factors (such as increased environmental temperature) before morbidity and mortality are seen. The ongoing discussion invariably identified the need to obtain (or have access to) more information about the ongoing conditions in the population, both at the animal level, farm level and broader environment. As a result discussion tended to trend towards questions of how to gather and analyse further information, rather than focussing just on risk factors. In considering all the information SAMS is likely to be a multifactorial problem, not a problem that is likely to come with a simple solution. A number of risk factors were elucidated from the presentations and discussions.

4.1 Factors considered potentially significant for SAMS

At the conclusion of the presentations, a number of factors were identified as core areas worthy of further investigation. These include:

- Variability in nutritional availability (Feast then famine food situations, such as those related to upwelling cycles)
- Preferred feed source at different stages of growth and location
- Presence of opportunistic or potential pathogenic agents in the population

[1] The classic example is Koch's Postulates, published in 1890.
[2] A modern set of principles consistent with Mill's principles of induction are described by Evans (1976)

- Impact of different management strategies on animal health
- Change in sea environment during larger scale climatic events (such as El Niño/ Southern Oscillation (ENSO) events)
- Impact of long term trends (climate change) on the ocean.

4.2 Factors unlikely to be important for SAMS

The lack of consistent findings of the disease presentation makes it inadvisable at this early stage to rule out potential causes, but it is clear at this point that it is unlikely the disease is being caused solely by a highly pathogenic infectious agent.

4.3 Developing priorities

There was little apparent benefit from trying to rank factors which might be significant given the large number of unknowns. The next part of the workshop thus focussed on starting discussion on the approaches to reducing some of the knowledge gaps identified in the earlier discussions. This was done by working in three groups, containing a mix of producers and experts, and focussing on planning for three areas:

- Environment, feed, and carrying capacity
- Stock performance: genetics, growth, and mortality
- Stock performance: health, prevention and control

The results from these three groups discussions are presented here.

4.4 Environment, feed, and carrying capacity

Knowledge needs

The lack of data and knowledge with respect to what is *normal* regarding oysters was identified as an area that needs improvement, and this should be given a high priority. Additionally, information is needed to understand:

- Food:
  - what do South Australian oysters actually eat
  - how much is available and when
  - effect on growth and vitality of oysters.
- Oceanographic data:

- salinity
- temperature
- pH and oxygen levels
- turbidity and suspended solids
- currents and tidal movements in each bay
- seasonal variation in each bay.

Current capacity

There is some water sampling data that has been collected by oyster farmers on a regular basis, over time. A substantial amount of oceanic and climatic data is already freely available but will need resources to analyse and process this data into a usable format that will enable it to be matched to relevant events in the oyster industry.

Information relating to what oysters have been feeding on over the past six years has been collected, and Clinton Wilkinson is in a position to access this data on behalf of the oyster industry.

Research and extension

Extension officer

An appropriate person, for example an Oyster Industry Extension Officer, is needed to adequately process the data already available and to effectively disseminate the information throughout the industry via email, newsletters and farm visits. Part of this process would include educating oyster growers on the importance of data collection, and how to collect suitable information effectively. This person will need experience in an extension role, and ideally qualifications in extension, aquaculture and /or marine biology. Port Lincoln is possibly the most suitable location for this person to be based, and there may be benefits gained by working in corporation with ASBTIA.

Nutrition

There appears to be very little knowledge with respect to what oysters eat, the effect of varying food supplies on the growth and vitality of the animal, and the availability of this food. Given this lack of knowledge, there is scope for a research project to investigate oysters and nutrition in SA.

Data collection

A timeline of at least 12 months is needed in order to collect sufficient, seasonal data detailing information about the oyster growing areas and any events experienced during this time. There is potential to use the growers or SASQAP to assist in collecting these samples. The focus needs to be on each individual growing area, as the experience of SAMS differs between bays. Data collection in individual bays will assist in building a greater picture of the environment in each bay, and also any SAMS events that occur during this time.

4.5 Stock performance: health, prevention and control

Knowledge needs

A lack of data, and the need to understand *normal* was again identified as a priority with respect to understanding SAMS. To be able to investigate health disorders (infectious or not) it is necessary to collect health information at two levels: the individual oyster level and the population level. The information collected by the above processes needs to be recorded and centralised for later consultation and case management.

At the oyster level, information can first be collected directly on field macroscopically with the appearance of gross signs (body condition score, shape, lesions, and death). More advanced techniques are needed to assess the health of an oyster microscopically (histopathology) and analytically (physiological function such as immune activity, and individual tests for specific agents).

At the population level, oyster health is assessed by monitoring mortality levels (cumulative or real-time), growth rate, and stock profiles (homogeneity of a group of oysters). To be useful, the information collected at the individual oyster level must be representative of the population. To do this requires a knowledge of the population structure and the use of correct oyster sampling techniques.

The continuing monitoring and recording of health information will help identify what is not normal from what is considered normal by the industry. This has numerous utilities including early detection of disease outbreak and quick response, investigate disease causation and its impact, facilitate certification procedure for export and/or translocation, ease mandatory reporting for government support and research funding, and develop evidence-based husbandry and health management practices using informed decisions.

Current capacity

Some farmers have developed their own monitoring and recording system for oyster growth, condition and mortality—however the implementation of this monitoring varies greatly among farms and there is a need to improve and standardise the process over the whole industry. More advanced techniques to assess oysters (microscopic and analytic) are not commercially available in SA. Although some aquatic health expertise has recently become available locally, capacity needs to be built to provide appropriate services. The delivery of proper case management by veterinarians or aquatic health professional to ensure optimal use and interpretation of the health information is also lacking. Finally, a centralised database to enable data collection and storage does not currently exist.

Research and extension

Farmer-based Health Monitoring

Valuable oyster health information is already collected and recorded by few individual farmers. This practice should be extended to the overall industry by offering education and training opportunities to other farmers. This will provide the opportunity to harmonise and standardise the scoring and health assessment criteria for individual oysters and the oyster population for the entire industry. This scope is important to carry comparisons across batch, season and populations, and allow for detection of early changes anywhere in the oyster production zones. However, the method and approaches to collection, record and report can be adapted to suit each individual farmer's capacity and commitment. To increase the power of this information, a centralised database could be built and managed by the industry.

Field Health Professional

Farmers generally do not consult veterinary or aquatic health experts or send oyster samples to laboratories for testing so data and support at this level is lacking. The overall oyster industry would benefit from having access to private aquatic health professional on a case per case basis. Understandably, consultation cost might not be reasonable for individual farmers but collective consultation at the bay or regional level might be achievable. It is recommended that industry looks towards identifying experienced aquatic animal health professionals (preferably local) prepared to provide sustainable services.

Laboratory-based Health Monitoring

Often the macroscopic information gained by gross examination of oysters is not sufficient to provide an appropriate assessment of the health status of an oyster population (e.g. subclinical or non-pathognomonic conditions). It is therefore necessary to access professional services to provide additional information about the presence or absence of pathogen or toxicant and assess the associated host reaction. The Department of Primary Industries and Resources South Australia (PIRSA) has a responsibility to detect and report the presence of any listed exotic disease, which requires laboratory confirmation, however, to date the industry has been unclear of what assistance they can request from PIRSA. The recently established Veterinary Diagnostic Laboratory (VDL) at the School of Animal & Veterinary Sciences (The University of Adelaide) is a commercial laboratory, and can assist in opening discussions between industry and PIRSA and optimise the surveillance effort for the SA oyster population.

Industry Central Database

As well as an individual farmers needs an informative decision support system to manage his/her oyster population, the industry would benefit from having a similar system to manage bay or regional populations. A centralised database that would collect data and provide aggregated health information across bays would be an excellent decision support system to direct and promote the interest of the industry. This health database would fit within the context of a more general industry database in combination with the production/transfer information and would be managed exclusively by the industry (see Oyster feedback and tracing in section 4.6).

4.6 Stock performance: genetics, growth, and mortality

Knowledge needs

There is a basic need to know what is happening to the animal during it's lifetime, and what is a *normal* South Australian oyster. The metabolism of an oyster, and exactly what they are eating in SA waters is still largely unknown. At present, although such data may exist in various forms, there is not a readily available source of this information. Details such as what normal nutrition sources exists indifferent locations and the impact of changes in the environment of the resilience of the oyster and subsequent susceptibility to disease and mortality. Currently much of the outcomes of development rely on feedback from trial sites. It is likely that these sites are not a reflection on the entire production system, and more data on other sites would be enormously valuable in determining the resilience of current breeding families. This may also provide the opportunity to link genetic trials back to industry outcomes to ensure that the improvements being made in family lines are being realised in the production environment—this may require some changes in the hatchery system to ensure the correct linkages of data. The question of the selection pressure on spat whilst in the hatchery was also raised. The understanding of the process was that on a regular basis the fastest growing animals were selected by filtering the cohort to remove dead and slow growing animals. This may inadvertently limit the selection to fast growing animals, at the expense of animals which may be slower growing but more robust in terms of disease resilience.

Current capacity

The following are potential sources of data that are already available:

- annual returns and stock books
- ASI trial data (limited number of leases)
- genetic variability
- nutrient (phytoplankton & other) levels
- climatic and oceanographic data.

Neither is there capacity to evaluate changes in the situation in 'real-time' as most of this information is stored in disparate forms in multiple locations. Some of the data is unavailable as it is collected under legislative authority. The capacity to link much of this environmental data back to oysters does not exist at this stage.

Research and Extension

The group working in this area identified four priority activities for research and extension

Oyster feedback and tracing

A industry database needs to be developed that will record information such as numbers, location, date, and batch numbers. This database will require a simple method of submitting data (such as sms) that is recorded in a central database. This database should be available to all industry members to use, with options restricting access to an oyster grower's own data, plus aggregated data. This sort of capacity is likely to exist in multiple forms, and would probably only require choosing a suitable system which would require some localisation/ customisation for the SA industry.

It was recommended that an interim approach could be to make use of new features being added to the SAOGA website to record details such as mortalities and oyster movements. It was acknowledged that many oyster farmers follow batches from purchase through to the point of sale.

An estimate of cost to develop, install and train users on such a system was in the order of $60–100 thousand. Ongoing costs are likely to be relatively low and based on the level of use.

Building resilience in the SA oyster

There is scope for a three-year research project to investigate the knowledge gaps identified above in SA oyster metabolism, nutrition and immune response. It is possible that a project of this size may require funding from multiple sources, including industry funds, state government R&D funding and potentially Fisheries Research and Development Corporation (FRDC) or Seafood CRC. Early discussions would suggest a multi-disciplinary team including expertise in physiology, ecology, genetics and immunology.

An estimate of cost to undertake a three year research project of this scale with supervision, salaries, travel and consumables was in the order of $400 thousand.

Linking trials to production outcomes

It is highly likely that adoption of an industry-level tracing system could allow the outcome of batches to be recorded and analysed regularly. By allowing family information to be associated with the batches, it would be possible to evaluate the outcome of particular breeding decisions. The Damoclean threat of POMS and the potential for genetic breeding programmes to reduce the impact of disease make now a good time to build such a rapid feedback system.

Better understanding of the hatchery process

The final suggestion of this group was to organise a study tour for growers to visit hatcheries in Tasmania to gain a better understanding of the process and hopefully eliminate concerns about the selection pressures on the animal. It is a reality that concerns about movements of people and equipment between growing areas are a risk for disease spread however it is likely that normal biosecurity precautions should be adequate to reduce this risk to an acceptable level.

Chapter 5

Defining a strategic plan for future research

The final objective of the workshop was "to compare the cost and the benefit of investigating each of these risk factors to clearly define a strategic plan for future research". As it was infeasible to undertake any detailed costing of possible research during the workshop, the groups focused on developing potential solutions for the risk factors identified, as reported in Chapter 4.

5.1 Recurrent themes to guide a research plan

During the discussions in this workshop a number of recurrent themes became evident. In the development of a research plan these themes are likely to cross a number of areas, and careful planning may allow cost-effective delivery of a number of concurrent research goals With these themes in mind the development of the strategic plan for industry research and subsequent final decisions on the research priorities can then be debated by SAORC in consultation with levy-payers.

Better understanding of the *normal* oyster

Nearly every project raised during the workshop discussed looking at risk factors for disease. In order to be able to identify the significance of putative risk factors, it is vital to understand the change in the health of the oyster population in the presence or absence, or at varying levels, of the risk factor. A recurrent theme in the presentations was the importance of understanding the *normal* oyster at an animal and population level.

The ability to measure the health of oysters in a production setting is limited due to their basic characteristics. As raised by speakers during the workshop, the need to develop a good baseline understanding of normal oyster populations in South Australia is important, and this (initially at least) may be achieved by increased familiarity of pathologists with normal animals. In contrast to individuals, the health of the oyster population is able to be measured much more easily on the average lease. Simply monitoring and recording the death rate of animals on a lease can provide rapid feedback on the health of the batches of oysters and provide early warning of problems. The relatively rapid change in state from a healthy animal to an empty, opened shell allows a simple count to quantify changes in the health status of the animals. This provides an enormous contribution to diagnostics in the event of a disease—and likely also the farm manager as they plan for sales and introductions. A weakness in this approach is the difficulty in quantifying the losses in an efficient but acceptably accurate manner. During sorting it may be difficult to count the number of animals sorted, and the number of shell removed. A number of alternatives have been previously discussed[1] for on-farm counting, but it may be possible to trial and evaluate these for their suitability and validity. It may be even more difficult to ensure that it is properly recorded. Overcoming these obstacles is a priority for understanding the health of the industry.

Some of the suggestions for monitoring discussed during the workshop included:

1. Implement a performance monitoring system
2. Food availability monitoring
3. Oyster care plan—baseline testing etc. to determine what is normal
4. Ongoing monitoring to complement research—breeding for resilience etc.
5. Animal movement for real-time tracing in the event of a disease outbreak.

An outline of a workshop to discuss and develop on-farm sampling and reporting is presented in Appendix E.

Nutritional requirements of SA oysters

Enormous variation in the levels of phytoplankton were clearly demonstrated by the ten years worth of SASQAP data presented during the workshop. This data however presented a further question—how much of the dietary needs of a Pacific oyster in SA waters is met by phytoplankton, and how does it vary between production location? Currently the role of upwellings in ensuring phytoplankton availability appears to have an important place in the understanding of management of oysters. While this may be critical for some production zones, in other zones the importance of this relationship is not clear. For example, the Franklin Harbour growing area has limited regular circulation of water compared to other areas, and due to its position in the Spencer Gulf is unlikely to benefit from upwellings in the same way as other areas. However, it continues to be a suitable production zone for early production, but not as suitable for finishing, the reasons for which may also be related to the types of nutrition available.

Information management

Turning data into knowledge requires the capacity to collect, store, process and analyse it in a timely fashion. This is best done using computerised systems so that it can be updated as soon as new information is available—for example trends in mortality can be seen early enough to guide interventions and sampling for laboratory testing.

[1] See the prior workshop report.

Although information management on many farms could and should be improved, there is merit in the development of an industry owned system for data storage and analysis. As well as providing a simple and secure solution for individual producers to securely store their own data, it could also provide a multitude of outputs including annual returns, information on transfers between leases and allow disease tracing to be undertaken centrally. Furthermore, understanding the outcomes by hatchery cohort was identified as an enormous opportunity to further refine the breeding/genetic selection programmes, which currently follow some parts of the cohort to a number of sites. There are also regulatory requirements that need to be met by industry—rather than wait for the relevant authority to force this upon producers, the opportunity exists for the industry to develop systems of their own choosing.

Information extension—the case for an Oyster Extension Officer

There is plenty of information available for producers to help in their decision making, but it is not all easily accessible or digestible. The relates not only to the availability of freely available information on climatic and oceanographic conditions, but also the collation and redistribution of industry information specifically related to the animal husbandry requirements.

There appears to be a potential role for an industry based extension officer, at least on a part time basis initially, to help ensure that information customised to suit the needs of the industry is routinely available. There is merit in this role being a direct employee of the industry, however there are precedents in many industries of extension officers being supported partly or fully by the relevant government authority (in this case maybe the South Australian Research and Development Institute (SARDI) or PIRSA).

An Oyster Extension Officer (OEO) could have a number of responsibilities which were undertaken on a regular basis. These roles might be extremely specific to the oyster industry (such as facilitating trials and oyster research) or may involve more generic information (such as analysis of climatic and oceanographic data), which could be done working with other associated groups (i.e. in the climate data case, the ASBTIA). An OEO would also have a role as an information source for producers, part of which would include assimilating industry relevant information into a regular 'newsletter' (or similar type of media) so that all producers have access, and being responsible for other information dissemination, such as organising field days or trips to view the hatchery process.

The coordination of information sessions and workshops, assistance with monitoring disease and support for sample submission could also become a responsibility of the OEO.

5.2 Conclusion

There are rarely adequate funds for the research that needs to be done, and so the industry needs to ensure it understands the priorities for research before committing to funding. Although this report details in chapter 4 a number of activities which were developed during the workshop, it is unlikely that some of these would get support if presented to industry without a good understanding of the context in which they were developed. This chapter summarises the four key themes that recurred during the expert presentations and the workshop sessions and subsequent presentations. These themes should be kept 'front and centre' in all discussions of a strategic nature and when developing or assessing future research priorities.

Appendices

Appendix A

Workshop Terms of Reference

In association with University of Adelaide (Dr Charles Caraguel), AusVet will assist to conduct a two day workshop with predominantly experts to investigate concerns over the increased levels of mortality experienced by oyster farmers on the Eyre Peninsula of South Australia. The workshop will be held in Adelaide, South Australia.

This workshop objectives are to:

- To present the current information and knowledge about these areas as they related to SAMS;
- To seek for opinion from various experts on potential factors associated with SAMS;
- To compare the cost and the benefit of investigating each of these areas to clearly define a strategic plan for future research.

This workshop will also provide an opportunity to discuss enhanced surveillance and directions for future research.

At the conclusion of the workshop AusVet will produce a report containing information gained from the workshop and outline options for further research.

Appendix B

Programme

South Australia Mortality Syndrome Consultation Workshop

Organised by the South Australian Oyster Research Council

Lower Napier Building, LG21 Tutorial Room, North Terrace Campus, The University of Adelaide
North Terrace, Adelaide SA 5005

DAY 1 - Thursday April 18th, 2013 Afternoon (starts at 1pm)

Objective: *To present the current information and knowledge about these areas as they related to SAMS*

- Introduction
- Summary of the initial SAMS industry workshop
- Short area specific presentations

DAY 2 - Friday April 19th, 2013 (starts at 9am and finishes at 4pm)

Morning

Objective: *To seek for opinion from various experts on potential factors associated with SAMS*

- Ranking of likely and unlikely causes of SAMS
- Prioritization of the top areas of investigation

Objective: *To compare the cost and the benefit of investigating each of these areas to clearly define a strategic plan for future research*

- Working group to estimate workload and budget to investigation priority areas

Afternoon

- Group presentations on morning work
- Group discussion on future research plan
- Wrap-up

This is not a definitive agenda but more an anticipated programme with some flexibility in the order and the nature of the activities.

Appendix C

Workshop contributors

Attendance record for SAMS Consultation Workshop

18–19 April, 2013, University of Adelaide

Organisation	Name	Area	Email
Industry	Steve Bowley	Stansbury	sbowley@pacificestateoysters.com.au
Industry	Gordon Gardner	Denial/Port Douglas	gordon@marineculture.com.au
Industry	Gary Olds	Coffin Bay	westpointshellfish@bigpond.com
Industry	Terry Rehn	Franklin Harbour	terry.cowelloysters@gmail.com
Industry	Gary Zippel	Smoky Bay	gzippel@bigpond.com
Industry	Jill Coates	Coffin Bay	jill@naturaloysters.com.au
Adelaide Uni	Corey Bradshaw	Ecology	corey.bradshaw@adelaide.edu.au
Adelaide Uni	Stephen Pyecroft	Aquatic pathology	stephen.pyecroft@adelaide.edu.au
Adelaide Uni	Charles Caraguel	Epidemiology	charles.caraguel@adelaide.edu.au
ASI	Matt Cunningham	Genetic selection	mattasi@bigpond.com
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AusVet	Rachel Gordon	Epidemiology	rachel@ausvet.com.au
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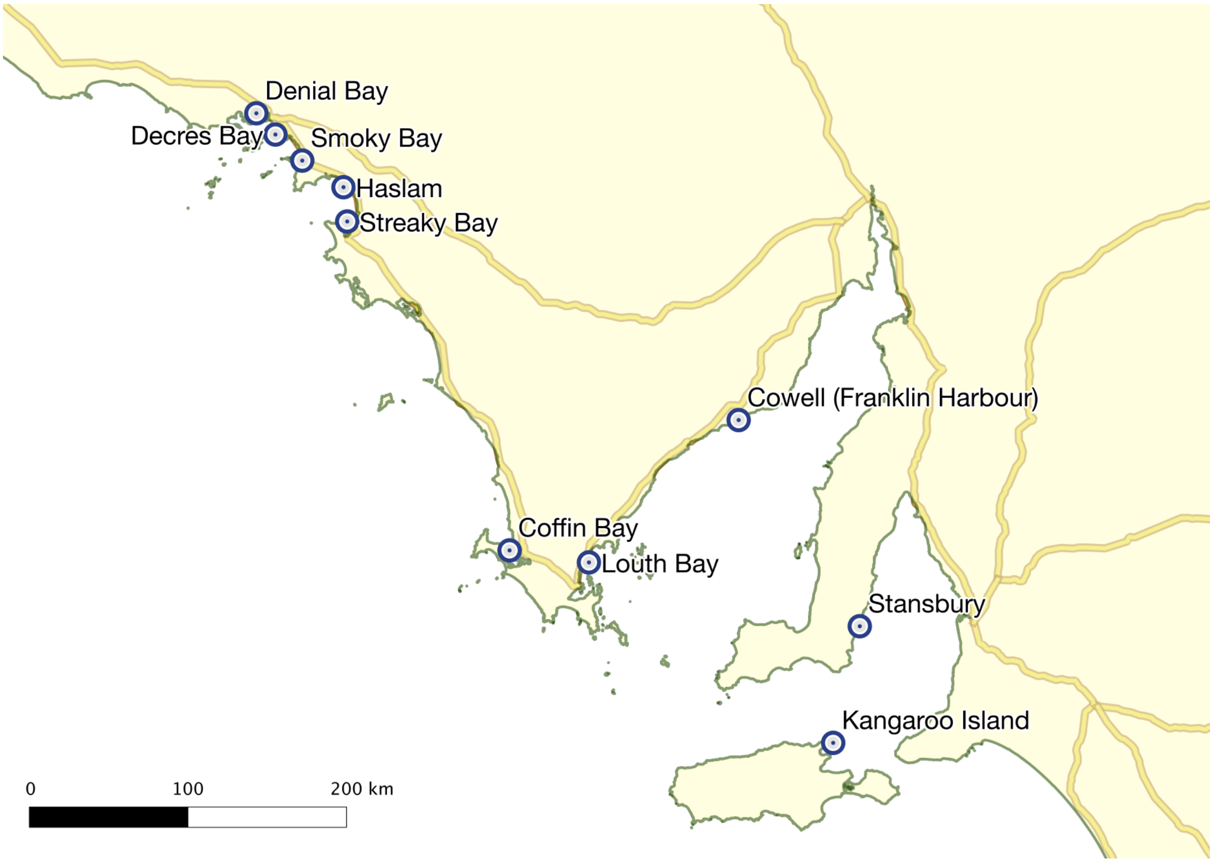
SARDI	Paul Van Ruth	Oceanography	paul.vanruth@sa.gov.au
SBTIA	Kirsten Rough	Aquaculture	kirstenrough@bigpond.com
Sydney Uni	Richard Whittington	Aquatic path.	richard.whittington@sydney.edu.au

Appendix D

Oyster Growing Areas in South Australia

Map developed with the co-operation of workshop participants.



Appendix E

Outline of possible future activity

Information and surveillance workshop

One of the questions asked during the workshop was for increased understanding of the details of some of the information presented to the workshop; and the potential for delivering this to producers in their bays. This approach would provide a valuable opportunity to discuss and demonstrate practical surveillance methods, recording of health status and appropriate selection of samples for submitting for further laboratory examination.

A possible workshop outline is presented below.

Information and surveillance workshop

- Information sessions on how to collect data
- One workshop per day held in each of the major growing areas

- Morning presentation
  - Systematic vs. random sampling
  - How & where to submit samples
  - denominators and numerators
  - ENSO, SOI and other climatic predictors
  - Longer term oceanographic trends
  - Nutrient sources for oysters
- Afternoon workshop
  - Practical field sampling
  - Counters and recorders
  - Sample packaging and consignment
  - Counting plankton