SAOGA
SOUTH AUSTRALIAN
OYSTER GROWERS ASSOCIATION

PO Box 757 Stirling
South Australia 5152
Ph: 08 83643831
Fax: 08 83643895
Email: saoga.saorc@bigpond.com
A.B.N. 083 574 001

Renee Preece
External Affairs Advisor – South Australia
BP Developments Australia Pty Ltd
147 Pirie Street
Adelaide SA 5000

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Dear Renee,

Regarding BP's draft Environmental Plan for Exploratory Drilling in the Great Australian Bight

Thank you for continuing to consult as the Environmental Plan is developed.

This submission outlines:

1) Our position
2) Our requests
3) Our concerns and the unique features of the SA oyster industry
4) Technical background including unique features of the SA oyster industry and references

Our position

The Oil and Gas Industry will potentially have a substantial benefit for Eyre Peninsula and South Australia – and we do not want to block it. However, development of this nature in the GAB does pose a significant risk to the currently pristine unpolluted environment and the image of this. These are the features that our reputation and credentials in the market place are based upon, and have taken decades to establish and promote.

Whilst we welcome BP's current focus on prevention of an oil spill, we believe it is equally important that all measures and equipment be in place and immediately available to address the situation of an accident.

Our requests are:

(1) Specific mitigation measures (a capping device) to address a loss of well control need to be located on-site *before* drilling commences. This is a realistic option that has been adopted by other companies undertaking

exploratory activities in remote and sensitive environments (e.g. Shell in the Arctic have a capping device stationed on a ship on-site to *stop any uncontrolled oil flow within 24hours*).

(2) Details and results for oil spill modelling and water current studies in the GAB are released in their entirety to potentially impacted stakeholders.

(3) That a real time drifter study be undertaken at the potential drill sites for a representative time period in each of the four seasons BEFORE drilling commences.

(4) NO drilling commences *before* the baseline scientific assessment of the region is completed (including the final report).

(5) That booms be stationed and maintained at every coastal community shellfish growing/harvesting area at risk of hydrocarbon pollution. These must be ready for immediate deployment to deflect contaminated waters away from these areas.

(6) The transit routes for the rig (and future FPSO's) wherever feasible be via the west coast of Australia and ballast exchange occur multiple times throughout the voyage. Water masses from the BP permit area do interact with the coastal bays where oysters are grown, and ballast water sourced from NSW increases the risk of introducing the ostreid herpesvirus-1 microvariant into SA growing areas. This virus causes Pacific Oyster Mortality Syndrome (POMS) - sudden acute mortalities in all age groups of Pacific oysters. (The virus does not pose a threat to humans, or human consumption of oysters.)

(7) Detailed study on the use and impact of dispersants and oil-dispersant mix including whether spilled oil becomes more available and accessible to filter feeding oysters.

(8) Measure and publish what are the natural background levels of hydrocarbon degrading bacteria in the Great Australian Bight, determine what is the natural capacity of the GAB environment to process hydrocarbons.

(9) Financial commitment to the state government regulated South Australian Shellfish Quality Assurance Program (SASQAP) to support what will inevitably be an increased demand for coastal water quality monitoring based on potential increased risk of both pollutants and harmful biotoxins.

Our concerns:

- Development of an oil industry in the Great Australian Bight will negatively impact the pristine environment that our industry and reputation in the market place is based upon.
- Non-predictable release of hydrocarbons will increase the scope and cost of the South Australian Shellfish Quality Assurance Program (SASQAP).
- Details of oil spill modelling and water currents in the GAB have not been disclosed.
- Drilling is scheduled to start *BEFORE* the baseline scientific assessment of the region is completed.

- In the advent of a ‘casing failure’ or ‘loss of well control’ the proposed response time of 35 days is an unacceptable target in this remote pristine ecosystem that is known to be very challenging operating environment due to weather and ocean conditions. Other companies working in remote and sensitive temperate/cool water ecosystems have the capping and containment equipment located on-site to enable oil flow to be stopped within 24 hours.
- Rig and support vessel transit routes potentially increase the risk of spreading POMS to South Australia.
- Dispersants will make spilled oil more available and accessible to filter feeding oysters.
- On a map it does appear that the drilling will occur a substantial distance from the coastal oyster production areas. However there is mixing of offshore and onshore waters. Evidence for this is that phytoplankton transported in the Leeuwin Current along the shelf edge appears seasonally in the coastal embayment’s every year.
- The logistics and capacity of relief well drilling as a feasible response measure given that a rig is being custom designed and built to operate in the Great Australian Bight.
- It is not clear how human error and compliance with documented well construction standards will be adhered to or independently regulated especially with use of subcontractors. Non-compliance to documented standards and human error are key factors of notable oil spills to date (Piper Alpha, West Atlas, Deep Water Horizon (Cullen 1990; Borthwick 2010; Hunter 2010; DRET 2011)).

BACKGROUND:

Oysters are bivalve filter feeders, which means they have 2 solid shells and this naturally limits spatial mobility. They extract their nutrition from the ambient environment by passing large volumes of water across their gills and retaining the phytoplankton and particulate matter carried by the water currents. A study in NSW showed that farmed oysters could remove over 1 million tonnes of suspended material, mostly phytoplankton in their lifetime.

Hydrocarbons and pollutants present in the water column will be accumulated by filter feeding oysters.

Evolution of the Oyster Industry

The presence of large middens of discarded oyster shells is evidence that aboriginal people had always eaten Australia’s native oysters, the Sydney Rock Oyster (*Saccostrea commercialis*) in the warmer waters along eastern Australia and the Flat Oyster (*Ostrea angasi*) in the cooler and temperate areas of southern Australia.

In the early days of European colonial settlement oyster harvesting was a key fishery. The native oyster beds (oyster reefs) were dredged; the shells were burnt and ground to produce lime for building and flesh used as food. The natural beds of NSW were effectively destroyed by the mid 1860’s. The South Australian industry continued to operate across 1,500km of coastline up until mid1940’s (Alleway and Connell 2015).

Oyster dredging was one of the first industries for the settlers of South Australia and underpinned the success of the colonies.

Attempts at commercial oyster farming in Australia began in the Sydney region in 1872 using the locally occurring Sydney Rock Oyster within their native distribution range. However, it was the introduction of a temperate water oyster species that is native to Japan (the Pacific oyster, *Crassostrea gigas*) in the 1960's that enabled oyster farming to occur in other locations. These early ventures were highly successful. The Pacific oyster is the most commonly farmed species in aquaculture in many regions of the world. South Australia is the highest producer of Pacific Oysters in Australia.

The Australian oyster industry includes in excess of 550 individuals and businesses across 3 states, SA, NSW, and Tasmania; and of which 386 licences are held in South Australia. Predominately these are family owned and owner operated. In 2007 Australian production exceeded 16 million dozen with a farm gate value of around $100 million (41% NSW, 37% SA, and 21% Tasmania).

In South Australia the oyster industry is the second most valuable aquaculture sector in terms of farm-gate sales value (PIRSA 2015). The most recent economic assessment (2012-2013) shows the South Australian oyster industry has a farm-gate value of $35.3 million that is directly contributed to the state's economy (ABARES 2014). Downstream activities directly associated with the oyster industry (i.e. processing, transport, retail) equated to $68.3 million and the flow-on to other sectors a further $145.6 million, contributed to the SA economy from the oyster industry (Econsearch 2013).

The South Australian oyster industry directly employs 254 FTE in regional areas, and a further 433 FTE in downstream activities. The flow-on business activity generates a further 553 FTE (Econsearch 2013).

These direct contributions are reduced from $44 million in the previous year's analysis, 2011/12 due to the large number of unexplained oyster mortalities in 2012, co-incidentally, after the first large-scale 3D marine seismic survey that occurred in the Great Australian Bight. Whilst direct cause and effect is difficult to assess, the timing and impact of these activities on the pelagic food base of the GAB's complex ecosystem is unknown. Dead oysters demonstrated nutritional deficiency with no sign of a pathogen being involved. Unexplained oyster mortality occurred again between February and June of 2014, with no infectious agents being found (PIRSA fish health pers.comm. 2014).

The Oyster industry significantly contributes to South Australia, particularly the economy and employment of regional centres. Pacific oysters are produced from 17 classified growing areas across SA, *ALL* of which are exposed directly or indirectly through ocean currents, to the BP permit areas in Great Australian Bight (Figure 1).

POMS was first detected in Australia in 2010 (Jenkins et al. 2013). By June 2014, it was known to occur in Australia in three estuaries: the Georges River–Botany Bay, Port Jackson–Sydney Harbour and Hawkesbury River–Brisbane Water estuaries. It has not been detected outside these areas. POMS has a substantial impact on the viability of businesses and regional productivity where it occurs. Maintaining freedom from infection in South Australia and Tasmania is a priority for Australian aquatic animal health authorities and the SA oyster industry. Pacific oysters (and the Portuguese cupped oyster, *C. angulata*) are the only species known to develop clinical disease due to infection with the virus (Department of Agriculture, 2015).

Figure 1: Map showing the proximity and exposure of the oyster growing regions of South Australia to the Great Australian Bight (SAOGA 2015).

The severe disease outbreaks in NSW in recent years mean that South Australia is now the largest producer of edible oysters in Australia. It is a <u>critical supplier</u> of disease free stock to the hatcheries for breeding purposes. Any impact on this state's oysters will impact on viability and production of oysters elsewhere around Australia.

Over 97% of oysters bought by Australians consumers are fresh in the half shell ➔ freshness, quality and food safety are paramount (further details in SASQAP section).

Production Systems of SA:

South Australian oysters are grown using two methods, either the traditional rack and rail system transferred from NSW, or using a locally developed adjustable long-line technology (the BST system). The BST system developed by growers in Spencer Gulf is now exported around Australia and the world (Figure 2). Both of these growing methods aim to increase the productivity of the oysters by holding them in baskets higher in the water column so they have access to phytoplankton which is more abundant in the well lit and mobile pelagic zone compared to the benthic/sea floor. What is important to note from both of these growing techniques is that growers can adjust (raise or lower) the oysters' position in the water column.

Increasing or decreasing the oysters distance from the sea floor allows growers to manage the time that oysters spend submerged. This accommodates seasonal differences in water and tide heights and enables growers to train oysters to hold their shells closed thereby improving survival throughout transport to market. More time underwater means more time for feeding and faster growth but can lead to weaker shells, weaker muscles (that hold shells shut once removed from water) and incursions of shell damaging mud worms. These can all have implications for decreasing the shelf life once oysters are removed from the water for harvest. Conversely positioning oysters higher on the racks/rails gives them greater exposure to air, encourages thicker shell growth, strengthens the muscle and enables them to hold their shells shut for longer periods of time, kills mud worms and other bio-fouling organisms, but decreases growth rates and can cause stress or death from temperature extremes.

Theoretically growers could respond to a surface oil slick for a limited period of time, by lowering or lifting baskets if the infrastructure for real-time monitoring of water currents is set-up before an accident. However the ability to respond in this manner would be negated if dispersants were used to spread the oil down through the water column. The main reason that dispersants are used is to reduce the size of the oil droplets; this potentially has an unintended consequence of increasing the likelihood of being ingested by the oysters.

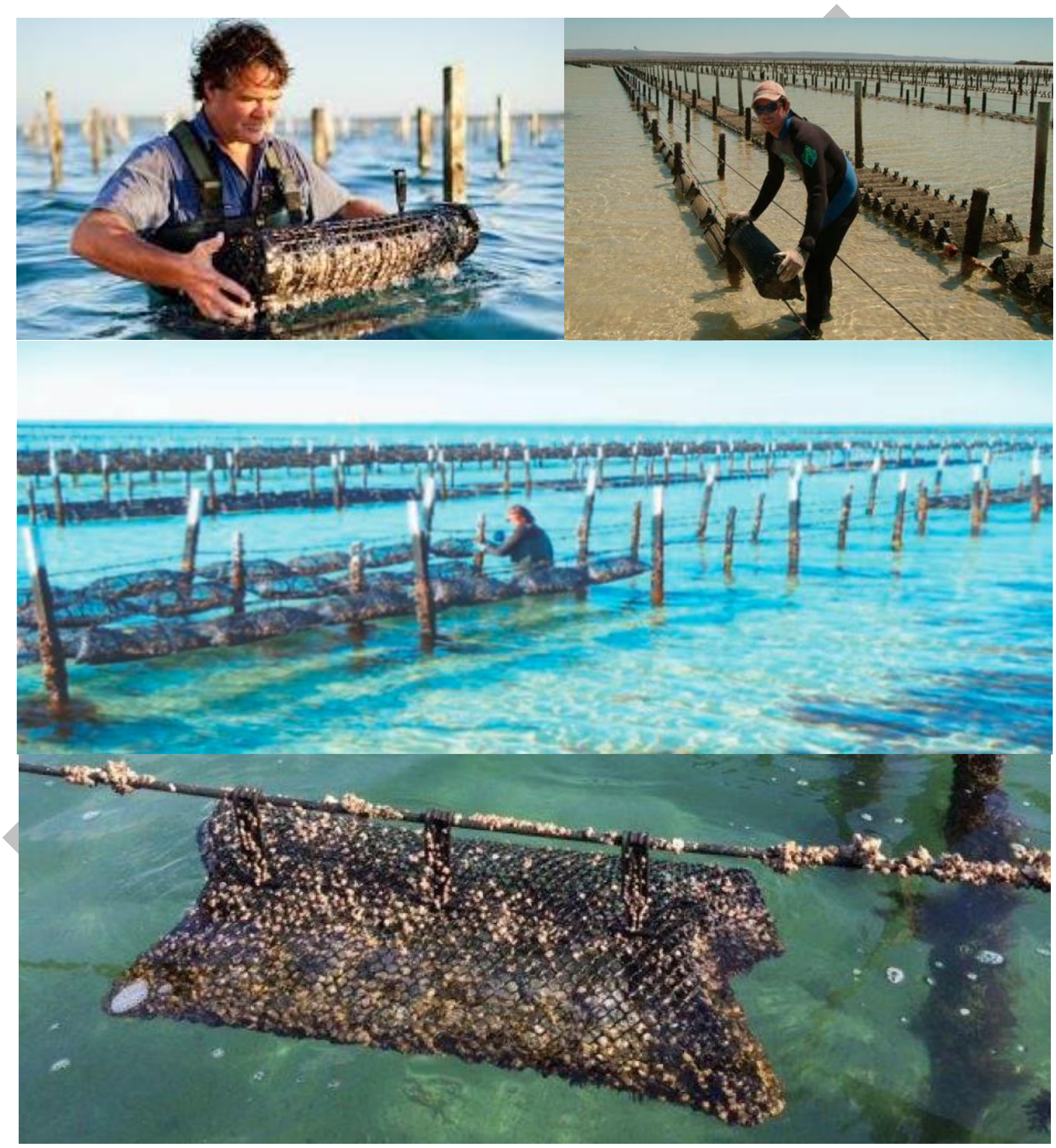

Figure 2: Operating oyster leases showing the diversity of water depths, tidal range and oyster basket suspension configurations on the BST long-line growing system (source Kerry Straight, ABC Landline 2014, SAOGA 2015).

Threats to the Oyster Industry Globally

Globally oysters are in serious trouble, more than 90% of the world's oyster reefs having been lost in the last century (Alleway, pers.comm. 2015)

In the United States of America, 'Gulf Oysters' had been harvested for generations from the highly productive coastal fringe of Louisiana before the oil spill of 2010 in the Gulf of Mexico (GoM). Prior to the Deep Water Horizon event, Louisiana had accounted for about half of the Gulf Oyster harvest, typically producing between 3-7 million pounds of oyster meat per annum. This was approximately one third of the total production in the United States. Now dredging in this area only yields empty lifeless oyster shells. The gulf oyster harvest volume has declined dramatically in the 4 years since the Deep Horizon oil spill. Thousands of acres of oyster beds where the oil washed ashore are still only producing less than a third of the pre-spill harvest, "but more worrying is the lack of oyster larvae, these were once abundant on the shell of the older oysters" (oyster fishers GoM pers.comm. 2015).

Ocean acidification due to rising atmospheric carbon dioxide driven by anthropogenic emissions and burning of fossil fuels (Sabine et al 2011; Shaw et al 2013) is seriously threatening the viability of natural and hatchery larval production of oysters in the significant growing area of the US Pacific Northwest (NRC 2010; PGSA 2010) and elsewhere (Barton et al 2012; Kroeker et al 2013). Pollution (from freshwater flows and oil spills) are implicated in the deaths of "thousand of acres" of oyster reefs and lack of recruitment in the oyster industry of the Gulf of Mexico (Galtsoff et al., 1935; US Fish and Wildlife Service 1945; NOAA 2013; BP 2014).

Disease is another key threat that has decimated various stocks of oyster growing industries throughout the world. One that is of particular concern for the oyster industry of South Australia is a herpes virus that causes Pacific Oyster Mortality Syndrome (POMS). This disease has decimated the oyster growing industries throughout Europe, Asia and USA with rapid mortality of 80-100% (Friedman et al., 2005; Burge et al., 2006; Garcia et al., 2011; Lynch et al., 2012). Through 2010 the POMS virus was detected from mass mortalities in New Zealand and New South Wales, Australia (Paul-Pont et al., 2014).

From a marketing perspective, agricultural and industrial pollution, encroaching human habitation, and biotoxins are increasingly becoming a concern for growing areas outside of South Australia. Examples include Norovirus and Vibrio's that affect humans in USA; PSP biotoxin in Tasmania and New Zealand; various viruses that affect humans in Wallis lakes NSW (Walsh et al 2011; Farrell 2015; ISSC 2015).

SOUTH AUSTRALIA DOES NOT HAVE ANY OF THESE ISSUES AND THEREFORE CURRENTLY HAS A CLEAR ADVANTAGE IN THE MARKET PLACE → THE RISK OF OIL POLLUTION IN THE GREAT AUSTRALIAN BIGHT COMPROMISES THIS.

SA Shellfish Quality Assurance Program (SASQAP)

Australia has a Quality Assurance Program (QAP) that applies to all species of bivalve shellfish (2 shelled molluscs) that are consumed in Australia or exported for consumption. This program is to provide public health protection for consumers of shellfish and underpins sustainable development and consumer confidence in the industry.

It includes a variety of species ranging from clams, cockles/pipi's, mussels, oysters, razorfish and scallops. There are 3 basic forms of production defined in the operations manual (ASQAP 2009).

- harvesting directly from naturally occurring wild stocks (eg cockles, clams, scallops, flat oysters)

- grown in natural conditions with the application of cultural practices to increase catchment area or elevate stock in water column to promote productivity through greater access to natural pelagic food sources (eg mussels, scallops)

- stock produced in a hatchery, introduced to a containment system in the marine environment to grow under natural conditions (eg cupped and flat oysters).

Growing areas where the bivalve molluscs are commercially harvested from natural occurring stocks or are grown by means of aquaculture; are assessed for "pollution conditions". The South Australian Shellfish Quality Assurance Program (SASQAP) is a regulatory program managing food safety risks that are underpinned by legalisation, standards and guidelines.

The program sits within PIRSA Biosecurity SA and monitors water and shellfish where oysters, mussels, cockles and scallops are harvested to ensure that commercial shellfish product only originates from areas free of any harmful substances.

Whilst oysters grown in areas subjected to higher pollution from human activities have built systems onshore to depurate (purge or clean) oysters; SA is the only state where this is not necessary. SA has pristine oceanic waters, with both little estuarine influence and agricultural run-off from rain events, and growing sites or zones are located in regional areas with low industrial activity and low population bases.

SASQAP is based at the Lincoln Marine Science Centre, Port Lincoln, SA and operates a NATA accredited laboratory for the screening and enumeration of microbiological and harmful micro-algae samples. Biotoxin and chemical (residues) testing is provided by other NATA accredited laboratories on a fee for service basis.

There are currently 17 growing areas and 29 classified harvesting areas spread across South Australia with the majority on the West Coast.

<u>SASQAP is based on a risk assessed approach.</u>

A shoreline and sanitary survey is regularly performed on growing areas to ensure the growing areas are not subject to contamination from human or animal faecal matter, pathogenic organisms, poisonous or deleterious substances or marine biotoxins exceeding the standards as described in the SASQAP and ASQAP Operations Manuals.

The internationally accepted frequency for phytoplankton monitoring suggests weekly to be the most effective, and to be increased in frequency in the event of a bloom. However, in SA, biotoxin risk assessments which have been undertaken in all growing areas suggest fortnightly monitoring between October and April and monthly at other times to be sufficient.

<u>This reduced level of monitoring due to low assessed risk keeps costs down for the shellfish industries.</u>

Monitoring is increased when triggers are initiated. BP's activity in the GAB would be a trigger for increased monitoring, and increased cost.

Microbiological monitoring for approved areas occurs a minimum of six times per year. Additional monitoring occurs following adverse environment conditions such as rainfall exceeding 20mm in an hour resulting in a deluge of water and contaminants entering the marine environment.

Over the past few years there has been increased financial pressures placed on the shellfish industry. These pressures include the implementation of marine parks, PIRSA cost recovery processes, increased operational costs, new labour awards and unusual growing conditions resulting in unexplained mortalities in 2012, poor growth and condition of oysters.

A further economic challenge has been poor market demand for oysters as a direct result of shellfish contamination from *Alexandrium tamarense* experienced in Tasmania in October 2012.

The Ellis Review of SASQAP suggests proposed increase in shipping to and from South Australian ports requires urgent attention. From a biosecurity perspective, safe guarding marine industries and the environment must be one of the main priorities for the South Australian government.

In recent times we have seen biosecurity failures - Abalone Viral Ganglioneuritis (AVG) sweep across the south west Victoria coastline like a fire front in 2007 resulting in widespread abalone mortalities, the Pacific Oyster Mortality Syndrome wreak havoc on the Eastern Seaboard of Australia since 2010, not to mention isolated shellfish and marine-life mortality events in South Australian waters.

Food safety must be of paramount importance if the South Australian government is to achieve one of its priorities of the State Strategic Plan in producing premium food and wine from our clean environment. Currently South Australia is very fortunate in that it doesn't have large industrial areas close to shellfish growing areas and the industry has been shellfish poisoning event free. <u>SA shellfish industries wish to maintain this positive record and image.</u>

The 2012 Tasmanian shellfish poisoning event had an estimated financial impact of $23.279m. Furthermore, the event had a very significant impact on accessing markets with extra barriers and processes introduced thereby adding further costs, not to mention the ongoing impact on the Tasmanian seafood brand and possible market price.

As there are no natural seeps in the GAB, once drilling commences, hydrocarbons or PAH will need to be added to SASQAP list of parameters for which to routinely test. This would add a significant additional cost to industry. Any further cost to SASQAP would be financially unsustainable for industry.

Credentialing – Premium, Food and Wine Strategy

Alongside of the *Premium Food and Wine* Strategy, the State Government has promoted credentialing for all seafood sectors.

The oyster industry received a State Government matching grant to develop the TQCSI SA Oyster Growers Association QHSE Code which will embrace quality and food safety of oysters, environmental sustainability and workplace safety. The Code will meet all requirements of the current TQCSI QHSE Code:2013 which is a more practical, less bureaucratic version of the ISO Standards but requires the most important issues of each Standard to be addressed. The Code will also include a 'Code of Practice', to be accepted by all SAOGA members, agreeing to comply with industry accepted food safety, quality and environmental requirements and it will complement the South Australian Shellfish Quality Assurance Program (SASQAP).

Some individual businesses have also met the requirements for Friends of the Sea, and/or Organic Certification.

Businesses entering the export markets in China and Asean countries will be able to apply for a State Government *Statement of Recognition* signed by the Minister for Agriculture, Food and Fisheries to highlight to their customers the key regulatory requirements they meet. This could be used to support marketing by a producer in particular markets to demonstrate attributes such as sustainability, biosecurity, food safety to name a few.

Activities in the GAB must not pose any threat to these kinds of credentialing programs and certifications which have been achieved through considerable energy, effort and cost.

Oysters – the accumulators

In stark contrast to the Gulf of Mexico, the Great Australian Bight has no known documented oil seeps, and therefore it is likely that the GAB does not have natural ability to microbially digest/process oil from a spill.

Oysters being the "kidneys' of the sea are highly likely to accumulate any pollutants which may result from GAB activity.

The oyster industry trusts you will favourably consider our requests in view of our position and concerns and after reviewing the unique features of the SA oyster industry and the technical background in support of them.

REFERENCES

Alleway, H.K., Connell, S.D., (2015). Loss of an ecological baseline through the eradication of oyster reefs from coastal ecosystems and human memory. Conservation Biology 29(3): 795-804

ASQAP (2009). Australian Shellfish Quality Assurance Program Operations Manual 147pp http://www.pir.sa.gov.au/foodsafety/sasqap

Barton A, Hales B, Waldbusser GG, Langdon C, Feely RA, (2012). The Pacific Oyster, *Crassostrea gigas*, shows negative correlation to naturally elevated carbon dioxide levels: implications for near-term ocean acidification effects. Limnology and Oceanography 57(3): 698-710

Borthwick, D., (2010). Report of the Montara Commission of Inquiry. Commonwealth of Australia. 391pp

BP 2014. Oyster white paper. http://www.stateofthegulf.com/media/1363/oyster-background-white-paper

Burge, C.A., Griffin, F.J., Friedman, C.S., (2006). Mortality and herpes virus infections of the Pacific Oyster *Crassostrea gigas* in Tomales Bay, California, USA. Diseases of Aquatic Organisms 72: 31-43

Cullen, W.D., 1990. The Public Inquiry into the Piper Alpha disaster. London Stationary Office. 488pp

Department of Agriculture (2004) Australian Shellfish Quality Assurance Program. http://www.agriculture.gov.au (last reviewed 25th Feb 2015)

Department of Agriculture (2015) Australian Aquatic Veterinary Emergency Plan, Aquavetplan, Disease Strategy Infection with ostreid herpesvirus-1 microvariant, Version 1, 2015 http://www.daff.gov.au/SiteCollectionDocuments/animal-plant-health/aquatic/aquavetplan/aquavetplan-dsm-ostreid-herpes.pdf

DRET 2011. Final Government Response to the Report of the Montara Commission of Enquiry. Department of Resources, Energy and Tourism. 120pp

Ellis, D. and Associates (2014). Review of the South Australian Shellfish Quality Assurance Program.

Farrell H (2015). Shellfish toxin study a first. http://www.uts.edu.au/research-and-teaching/our-research/climate-change-cluster/news/shellfish-toxin-study-first

Friedman, C.S., Estes, R.M., Stokes, N.A., Burge, C.A., Hargrove, J.S., Barber, B.J., Elston, R.A., Burreson E.M., Reece, K.S., 2005. Herpes virus in juvenile Pacific Oysters *Crassostrea gigas* from Tomales Bay, California, coincides with summer mortality episodes. Diseases of Aquatic Organisms 63: 33-41

Galtsoff, P.S., Prytherch, H.F., Smith, R.O., Koehring, V., 1935. Effects of crude oil pollution on oysters in Louisiana waters. Bulletin of the Bureau of Fisheries 18: 144-208

Garcia, C., Thébault, A., Dégremont, L., Arzul, I., Miossec, L., Robert, M., Chollet, B., François, C., Joly, J.P., Ferramd, S., Kerdudou, N., Renault, T., 2011. Ostreid herpesvirus 1 detection and relationship with *Crassostrea gigas* spat mortality in France between 1998 and 2006. Veterinary Research 42

Hunter, T., 2010. The BP oil spill and Australia….Is there a connection. The National Legal Eagle 16(2/3): 6-9

IOS6. http://oystersymposium.org/about-ios6/platform/

Kroeker KJ, Kordas RL, Crim R, Hendriks IE, Ramajo L, Singh GS, Duarte CM, Gattuso JP, (2013). Impacts of ocean acidification on marine organisms: quantifying sensitivities and interactions with warming. Global Change Biology19: 1884-1896, doi: 10.1111/gcb.12179

Lynch, S.A., Carlsson, J., Reilly, A.O., Cotter, E., Culloty, S.C., 2012. A previously undescribed ostreid herpes virus 1 (OsHV-1) genotype detected in the pacific oyster, *Crassostrea gigas*, in Ireland. Parasitology 139: 1526-1532

NOAA 2013. Commerce Secretary declares fisheries disaster for Florida oyster fishery. http://www.noaanews.noaa.gov/stories20130812

NRC (2010). Ocean acidification: A national strategy to meet the challenges of a changing ocean. National Research Council. National Academies Press.

Paul-Pont, I., Evans, O., Dhand, N.K., Rubio, A., Coad, P., Whittington, R.J., 2014. Descriptive epidemiology of mass mortality due to *Ostreid herpesvirus-1* (OsHV-1) in commercially farmed Pacific Oysters (*Crassostrea gigas*) in the Hawkesbury River estuary, Australia. Aquaculture 422-423: 146-159

PGSA (2010) PACIFIC COAST SHELLFISH GROWERS ASSOCIATION, Shellfish production on the west coast. http://www.pcsga.org/pub/farming/production

PIRSA (2015). http://www.pir.sa.gov.au/biosecuritysa/foodsafety/sasqap

Sabine CL, Feely RA, Wanninkhof R, Takahashi T, Khatiwala S, Park GH (2011). The global ocean carbon cycle. p. S100–S108. In State of the Climate in 2010, 3. Glob. Oceans. Bull. Am. Meteorol. Soc. 92: S100–S108, doi:10.1175/ 1520-0477-92.6.S1

SAOGA (2015). www.oysterssa.com.au

Shaw EC, McNeil BI, Tilbrook B, Matear R, Bates ML, (2013). Anthropogenic changes to seawater buffer capacity combined with natural reef metabolism induce extreme future coral reef CO_2 conditions. Global Change Biology 19: 1632-1641, doi: 10.1111/gcb.12154

http://www.issc.org/closuresreopenings.aspx

US Fish and Wildlife Service 1945. An investigation of oyster producing areas in Louisiana and Mississippi damaged by flood waters in 1945. Special Scientific report: Fisheries No. 8: 48pp

Walsh PJ, Smith S, Fleming L, Solo-Gabriele H, Gerwick WH, (2011). Oceans and Human Health: risks and remedies from the seas. Academic Press 672pp

Authors:

Kirsten Rough

<u>EXTENSION RESEARCH OFFICER</u>

<u>SOUTH AUSTRALIAN OYSTER RESEARCH COUNCIL</u>

Jill Coates

<u>IMMEDIATE PAST PRESIDENT</u>

<u>SOUTH AUSTRALIAN OYSTER GROWERS ASSOCIATION</u>