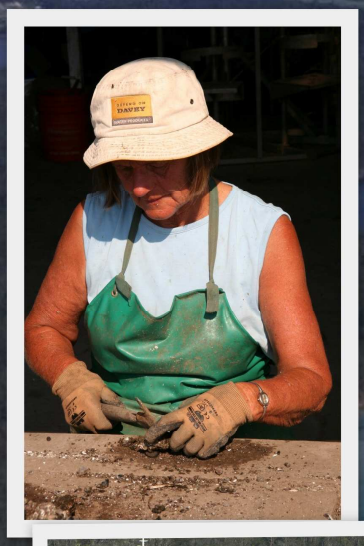
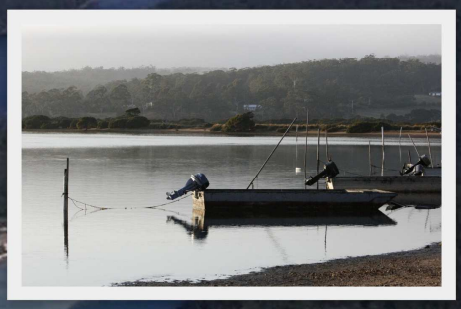
Pambula Lake Oyster Growers





Environmental Management System

NSW GOVERNMENT | Catchment Management Authority Southern Rivers

ENVIRONMENTAL MANAGEMENT SYSTEM
REVISION STATUS

OWNER	Pambula Lake Oyster Growers	REVIEW INTERVAL	Every AGM (~1yr)

REV No	Date	Description of Revision	APPROVALS	
			Originator	Checked by Owner
0	Aug-09	Draft sent to Southern Rivers CMA for review	Ana Rubio	Helen Davies
1	Feb-10	1st review by Pambula Lake Oyster Growers	Ana Rubio	Pambula Lake Oyster Growers
2	Jul-10	Review of Action Table by Pambula Lake Oyster Growers	Ana Rubio	Pambula Lake Oyster Growers
3	May-11	2nd review of document by Pambula Lake Oyster Growers	Helen Davies	Pambula Lake Oyster Growers
4	July -11	Review of Action Table by Pambula Lake Oyster Growers	Helen Davies	Pambula Lake Oyster Growers

Citation:
Pambula Lake Oyster Growers (2011) Pambula Lake Oyster Growers' Environmental Management System. A report prepared by Dr A. Rubio (Environmental Consultant) for Southern Rivers Catchment Management Authority on behalf of the Pambula Lake Oyster Growers. 61 pages.

Special note:
The term 'Pambula Lake Oyster Growers' refers to those growers who have agreed to be part of the Environmental Management System (EMS) process in Pambula Lake and who have committed to undertake best practices in the management of their local industry in order to maintain and improve the health of Pambula Lake (Appendix 1).

Pambula Lake Oyster Growers may be referred to in the document as PLOG.

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Vision: To continue to cultivate oysters for the benefit of seafood consumers in a manner that is environmentally sustainable, commercially viable and internationally respected.

Oyster farming is the largest aquaculture industry in NSW and plays an important role in maintaining our natural resources. It is therefore important to protect this resource for future generations including our children and grandchildren so they can enjoy the same foods and lifestyle that we are fortunate enough to enjoy today. For this reason, Pambula Lake Oyster Growers have committed to implement an Environmental Management System (EMS) to ensure the long term viability of the environment and their industry in Pambula Lake.

An EMS is a structured system designed to help the oyster industry reduce environmental impacts from its operations, ensuring best practices and no detrimental effects on the catchment. During the preparation of this EMS all aspects of the oyster culture industry were assessed including the type and level of effect that individual activities have on the environment at a local and regional level, both currently and potentially, and how they can best be managed.

One of the key reasons for the adoption of an EMS by the Pambula Lake oyster industry is the potential for ongoing environmental degradation in the catchment particularly in relation to water quality and pollution. This stems predominantly from increasing levels of human population in the area. The consequence is likely to be increased nutrient loads and sedimentation levels in the waterway with potentially detrimental impacts on oysters and the overall health of the lake.

Oyster farming has a positive impact on the lake and Pambula Lake Oyster Growers would like to promote this more actively among the local community and catchment users, for instance:

- Oyster cultivation is one of the most ecologically sustainable types of farming because, in contrast to fish farming, oysters do not require artificial food sources, feeding instead on particulate matter available in the water column. Oyster growers rely on the natural environment to supply these nutrients and food particles together with sunlight, to produce the optimum food mix on which oysters thrive.
- Oysters gather their food by filtering large volumes of water from the waterways. This filtration capacity helps to clean the water by removing particulate matter, enhancing water clarity and promoting seagrass, saltmarsh and mangrove health. Oysters are the 'canaries' of the waterways – if the oysters are healthy, it indicates that the waterways are healthy.
- Oysters are not only delicious but are also considered to be one of the most nutritionally balanced foods available, containing an extensive range of vitamins, minerals and omega-3.

The presence of a thriving oyster industry in Pambula Lake demonstrates that the lake is healthy. As part of the NSW Quality Assurance Program, oyster growers are constantly monitoring the

quality of the water and the oysters. Their diligence means that any unexpected pollution entering the lake is quickly identified and can therefore be managed, thus ensuring the water is clean and safe for fishers, swimmers and other users of the lake, as well as oyster consumers.

Oyster growers happily play an important role as stewards of the local environment but the community also needs to play its part to help maintain the health of the catchment and therefore the oyster industry. It is important to keep in mind that all activities in the catchment can have an impact on other users, in particular your local oyster growers.

As part of the EMS process, Pambula Lake oyster growers undertook a risk assessment in which industry-related and external risks were identified and prioritised. As a consequence, growers developed an action plan to address the high risk activities impacting on the sustainability and therefore long-term tenure of their industry. Pambula Lake Oyster Growers are now working to manage high risk activities through the following actions.

Industry-related activities

1. Upgrading oyster cultivation infrastructure to more environmentally-friendly materials.
2. Adopting best practice cultivation methods to ensure that the oysters are not overstocked so as to minimise potential impact on the sediment under farms.
3. Improving communication between growers in order to combine effort and strategies for improving product value, community education and marketing.
4. Improving communication with the local community and other stakeholders to increase awareness of the nature of the oyster industry and its role in environmental management.

External activities

1. Appropriately managing and maintaining unsealed roads in the catchment to reduce run-off into and sedimentation of the waterways.
2. Minimising occurrence of sewage pollution (septic tanks and private camping), increased nutrient loads (horticultural and agricultural products) and fine sediments in run-off (from forestry activities and/or land clearing) in order to maintain/improve water quality.
3. Monitoring hydrological changes including changes at the lake's entrance.
4. Minimising the mooring on oyster leases by recreational fishers and lake users, an activity that damages infrastructure.
5. Reducing boat wash from large boats which results in shore erosion thus impacting on fragile cultural heritage sites as well as oyster growing infrastructure.
6. Increasing awareness and monitoring of environmental changes due to climate change.

The NSW Oyster Industry is a significant and developing aquaculture industry that relies on the maintenance of good water quality and other environmental standards for its success. Pambula Lake oysters are award-winning oysters, testimony to the quality of farming and recognition of the great environment in which they grow. The Pambula Lake Oyster Growers are committed to protecting the health of Pambula Lake, however many of the risks cannot be tackled by the industry alone. Help us protect Pambula Lake!

For further information on the Pambula Lake Oyster Growers' EMS, please contact Greg Carton on 02 6495 6704

2 Acknowledgements

The EMS coordinator would like to acknowledge the outstanding effort that has been made by the Pambula Lake Oyster Growers (PLOG) in developing this EMS. Additional thanks to all who were approached by the EMS coordinator, and who gave their time and support as they became involved in various activities in the catchment to support this process.

The project was funded by the Australian Government's Natural Heritage Trust through the Southern Rivers Catchment Management Authority (CMA) as part of the Oyster Industry Partnership Program.

3 Pambula Lake growers commitment to an EMS

Vision: To continue to cultivate oysters for the benefit of seafood consumers in a manner that is environmentally sustainable, commercially viable and internationally respected.

For the purposes of this EMS, PLOG includes all growers listed in Appendix 1. The list has been compiled to document those members who agree to their responsibilities under the environmental policy and action plan described in this EMS.

Oyster farmers in Pambula Lake share aquatic and land resources with many other users through activities such as water sports, fishing, forestry, tourism, cultural and historical activities, swimming, agriculture, water extraction and residential development. All users of the environment have some effect on it. They can also impact on each other's activities which can result in positive or negative relationships. Consequently, it is important to be aware of the potential cascade effects that some activities might have on other activities within the same catchment. For instance, an activity in the upper catchment of a river could potentially have a significant impact on the lower sections of the river and in a downstream lake if no planning and precautions are taken.

Like many other sectors of the seafood industry, oyster farming in NSW is currently moving towards greater efficiency and optimal environmentally-friendly systems. PLOG agreed to implement an EMS in Pambula Lake to ensure professional and environmentally responsible management of their industry and to communicate this commitment to the wider community.

3.1 Need for an EMS

Coastal development and recreational use of waterways place significant pressures on coastal industries such as oyster farming. Through this EMS, the Pambula Lake oyster industry would like to strengthen its position to ensure the protection of the optimum environmental conditions required in estuaries and lakes for oyster growing. Many initiatives towards responsible business practices are already underway, and through its commitment to this EMS the oyster growing

industry will ensure its long term sustainability in Pambula Lake. The EMS also promotes the industry's role as a legitimate and responsible user and improver of this public waterway.

3.1.1 Oysters as indicators of healthy catchments

> If NSW coastal waterways are fit to support oysters which are healthy for consumers, they will pass muster on any more general water quality grounds. (ACIL, 1997)

Aquaculture plays a major role in meeting the growing world demand for fishery products as fishery captures fail to supply requirements, mainly due to stock collapses. Consequently, best practices and sustainable development in aquaculture, including oyster farming, needs to be ensured. Oyster farming has a number of positive outcomes and benefits that apply to Pambula Lake as much as other areas, including:

- It results in an ecological product (3.1.1.1);
- Oysters are the 'canaries' of the estuaries (3.1.1.2), ecosystem engineers (3.1.1.3) and a 'green' product (3.1.1.4); and
- Increased employment opportunities in rural/regional areas (3.1.1.5).

3.1.1.1 Ecological product

Oyster cultivation is potentially one of the most sustainable forms of aquaculture because, in comparison with fish cultivation, it uses species with a low trophic position in the aquatic food web. Oyster cultivation does not require artificial food input as the animals extract their nutrition principally by the filtration of microscopic particles available in the water column (e.g. phytoplankton – microscopic plants and organic detritus). That is, oysters only feed on what is available in the water column in the immediate area. These food components are produced in the lake from natural resources available in the catchment, waterways sediment and shore line vegetation, in addition to the local biological, physical and chemical characteristics of the oyster cultivation area.

3.1.1.2 Oysters - the 'canaries' of the estuaries

Oysters are very sensitive to changes in the physical and chemical characteristics of the water and as key indicators of the health of aquatic systems, have been referred to as the 'canaries' of the estuaries: if oysters are healthy it indicates that the waterways are also healthy, as canaries indicated the health of the air in underground mines in days gone by.

3.1.1.3 Oysters as ecosystem engineers

Oysters have been described as ecosystem engineers (Margalef, 1968) due to their massive filtration capacity. It has been estimated that on average, a cultivated Sydney Rock Oyster (SRO) can filter approximately 0.5 megalitres of estuarine river water and remove large quantities of suspended matter in their lifetime (White, 2001). As a result of their filtration capacity, oysters can clean the water, enhance water clarity, promote seagrass growth and accelerate nutrient recycling processes in the lake. Oysters are therefore important organisms in connecting processes in the

water column and the substrate/sediment by consuming suspended particles from the water column and depositing wastes and unwanted material in the sediment. As a result of oyster feeding mechanisms and metabolic processing of food particles, oysters excrete dissolved inorganic and organic waste back into the water column, and thus oysters become a major component in the recycling of essential elements in the oyster growing areas. The importance of oysters to the biological and chemical dynamics in coastal areas is widely recognised (Dame & Olenin, 2005).

3.1.1.4 Opportunity for 'green' tick

One of the benefits for oyster growers of implementing an EMS is that they will be able to maintain and improve market access through a form of 'eco' or environmental labelling of their product. The EMS confirms that oyster farming in Pambula Lake is low impact and that growers aim for environmentally sustainable practices. This reinforces the clean, green image of the industry which improves the oyster industry profile. PLOG will maintain close ties with the wider community, including their commercial partners such as other producers, processors, wholesalers and retailers, promoting their environmental system and providing updates on progress on the achievement of EMS outcomes.

Both the NSW and Australian Quality Assurance Programs (QAPs) recognise the need for a proactive oyster industry working towards positive water quality outcomes. This is essential for the long term protection of public health. The EMS documents the Pambula oyster growers commitment to the state and national QAPs.

3.1.1.5 Increased employment opportunities in rural and regional areas

As an indicator of employment potential, the historical SRO industry directly employs about 800 people, more than any other form of aquaculture in Australia. While the oyster industry has experienced a decline in production since the mid 1970's, it has now stabilised and is set to achieve a sustainable annual production of around 120,000 bags of premium oyster products by 2013 (NSW Department of Primary Industries (DPI), 2006).

As an employer, the oyster industry in the Bega Valley Shire is of high economic and social importance. The industry is widely spread across six estuaries from the south to the north of the Bega Valley Shire, and therefore provides valuable employment and economic opportunities to a large area. This is in spite of environmental threats to the viability of the industry in some other areas of NSW. The long-term viability of the local industry can be improved, and this is occurring, through better farming practices, advances in technology, more capital input, expansion of the SRO market and protection of local water quality (Chen, 2006). Hence the importance of this EMS for Pambula Lake oyster growers.

3.2 EMS Development

Interest in development of an EMS was initiated by PLOG as a way of securing and pursuing a sustainable industry into the future, and a workshop organised by Southern Rivers CMA precipitated commencement of work on the initiative. PLOG received funding from the National Heritage Trust through the Southern Rivers CMA to engage a facilitator to assist with development

of the EMS. Specific information on the process followed during the first year, and future steps towards implementation are documented in Appendix 2.

3.2.1 Aims of the EMS

With increased environmental awareness in the industry and broader society today, there is more pressure to reduce impacts on the environment from everyday activities and this has encouraged industries like the Pambula Lake oyster industry to implement an EMS. In doing so, PLOG will aim to:

- Manage the identification and adoption of new techniques and technologies to continually improve operations in a sustainable and responsible manner;
- Document how they are meeting their responsibilities to operate sustainably;
- Provide a basis to communicate and cooperate with natural resource managers and the community on the environmental management of oyster cultivation, Pambula Lake and its catchment; and
- Provide this 'living' document that can be reviewed and updated at each Annual General Meeting to address and manage new risks and opportunities.

3.2.2 EMS Scope

The scope of this EMS is limited to the:

- Environmental aspects of the operations of PLOG; and
- Catchment activities in which PLOG are involved, particularly activities undertaken in collaboration with other stakeholders, which aim to improve the health of the catchment and enhance the environmental quality of the Pambula Lake and waterways.
-

Future revisions of the EMS may broaden this scope to cater for wider issues such as OH&S and management protocols if required, and/or become more detailed with regard to specific matters such as requirements towards international certification.

3.3 National ecologically sustainable development framework for aquaculture

As a result of the impacts of unrestrained economic growth and development on the environment, principles of sustainable development have been developed and described as: *today's needs which are met through current industry practices* (that*) should not compromise future needs* (Fletcher*, et al*, 2004). The NSW Oyster Industry Sustainable Aquaculture Strategy (OISAS) (NSW DPI, 2006) and the Pambula Lake Estuary Management Plan, currently in development, integrate the principles of ecologically sustainable development (ESD), community expectations and the needs of other user groups in the management and operation of the NSW oyster industry. Consequently, PLOG continue to adopt and benefit from the principles of ESD by incorporating both OISAS and the developing estuary management plan in this EMS.

3.4 EMS in relation to other management mechanisms

This EMS is designed to complement the existing policies and laws that control or guide oyster farming and natural resource management in NSW, as follows:

- *Fisheries and Oyster Farms Act 1935*
- *Fisheries Management Act 1994*
- Fisheries Management (General) Regulation 2002
- New South Wales Oyster Industry – Sustainable Aquaculture Strategy (by NSW DII Fisheries)
- State Environmental Planning Policy 62
- *Environmental Planning and Assessment Act 1979*
- *Environment Protection and Biodiversity Conservation Act 1999*
- Environment Protection and Biodiversity Conservation Regulations 2000
- *Threatened Species Conservation Act 1995*
- *Crown Lands Act 1989*
- *Protection of the Environment Administration Act 1991* (for Ecological Sustainable Development)
- *Food Act 2003*
- The Southern Rivers Catchment Action Plan (developed by the Southern Rivers CMA)
- *Coastal Protection and Other Legislation Amendment Act 2010*
- NSW Food Authority
- Australian Shellfish Quality Assurance Program
- Australian Quarantine Inspection Service
- Food Standards Australia New Zealand
- All other codes and policies adopted by Council relating to the development of land in the Bega Valley Shire

4 Overview of Pambula Lake and catchment

4.1 Pambula Lake catchment

Pambula Lake is situated on the NSW Far South Coast approximately 460km from Sydney (Lat. 36.947S, Long. 149.917E) and 5km south of Pambula (Figure 1). It is fed by the Pambula and Yowaka Rivers. Pambula catchment has an area of 275 km^2, of which 2.9km^2 is covered by waterways (NSW Dept. Environment, Climate Change and Water, 2010). The Pambula Lake estuary and its catchment fall within the Southern Rivers CMA region. Major land use around Pambula Lake estuary includes forestry, conservation and urban, agricultural and light industrial development areas (NGH Environmental, 2008). The township of Pambula and several other smaller urban/rural localities including South Pambula, Lochiel and Nethercote are located within the catchment.

Pambula Lake is surrounded by a large area of Ben Boyd National Park on the eastern side, and its catchment has large forest areas including Nullica, Broadwater, Gnupa and Yurammie State Forests. The Pambula catchment also has a series of sensitive areas including wetlands and Indigenous heritage areas.

The wetland areas (Panboola and other wetlands) are located to the north and west of the estuary. The Pambula estuarine wetland is listed on the Directory of Important Wetlands compiled

by the Commonwealth Department of Environment and Heritage, and is protected by the State Environmental Planning Policy 14 – Coastal Wetlands. Panboola is located on the flood plain at the upstream end of the estuary and is managed by the Pambula Wetlands and Heritage Project Inc. in conjunction with the Pambula Wetlands and Heritage Reserve Trust. With community assistance, Panboola is being rehabilitated for the purposes of nature conservation, protection and restoration of habitat for birds and indigenous flora and fauna, and for community education and passive enjoyment.

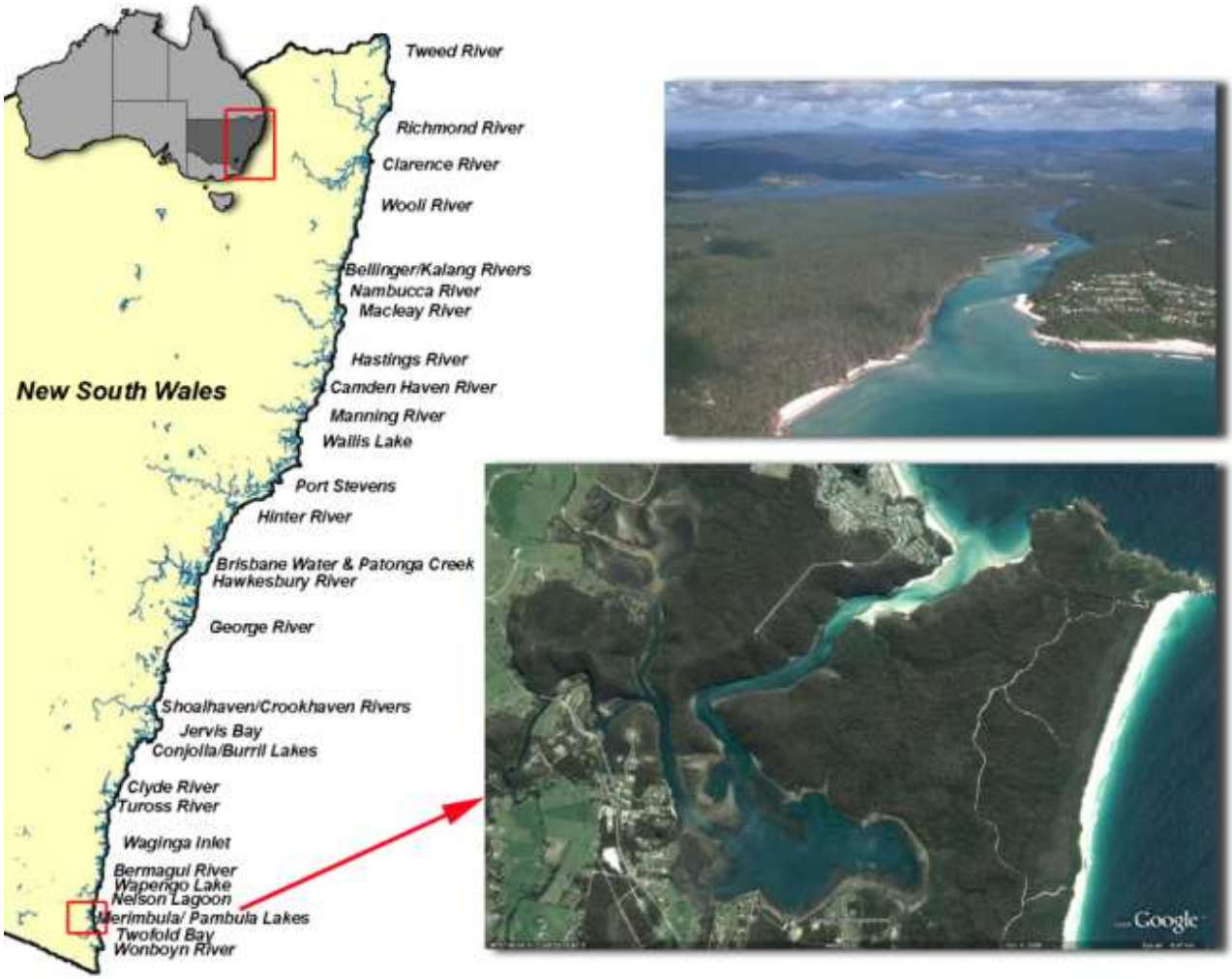

Figure 1: NSW map with location of Pambula Lake, aerial vegetation map of the lake and part of the catchment (source: Google Earth) and aerial photograph of the mouth of the lake (Source: NSW Government Natural Resources)

Wetlands and riparian vegetation, along with the mangrove community, play an important role in the health of aquatic ecosystems by filtering stormwater and associated nutrient runoff, and stabilising banks, thereby reducing erosion and any subsequent sedimentation.

In Pambula Lake a similar role is played by the seagrasses, important components of the ecosystem as they provide shelter, habitat, feeding grounds for fish and other aquatic fauna, improve water quality and aid in sediment control. Seagrasses improve water quality by decreasing water speed, allowing suspended particles to fall to the lake bed thereby reducing sediments within the water column. NSW DPI (2006) reported an estimated total area of 0.7 km^2

of *Posidonia australis* and *Zostera muelleri* seagrass within the Pambula estuary. Comparisons made with data from West *et al* (1985) showed a decrease in seagrass beds from 0.9 km^2 since 1985 (NGH Environmental, 2008).

A large number of Aboriginal cultural sites have been recorded along the Pambula Lake foreshore (Appendix 3), in particular in areas within Ben Boyd National Park and Reserve. The sites are predominantly shell middens but also include campsites, rock shelters and scarred trees. Mounded shell middens along the shoreline from the mouth to the main lake were first recorded in a survey in 1890 (Anderson, 1890) when it was estimated that there was approximately 57,000m^3 of shell midden area of which 95% has survived today. The majority of the shells forming the mounds are of estuarine species although rock platform and open coast beach species are also present (Appendix 3).

Further surveys by Sullivan and co-workers (Sullivan, 1981; Sullivan 1982; Sullivan & Hughes, 2006) identified additional sites (Appendix 3)). Most of the sites on the southern side of the estuary are within Ben Boyd National Park and these warrant special protection. Currently, intensive monitoring and investigations are being undertaken by the National Parks and Wildlife Service (NPWS), in collaboration with Eden Local Aboriginal Land Council, in order to protect these sites as a 'representative sample' of an important cultural heritage resource.

The Pambula Lake estuary has been classified as a wave-dominated estuary with an open lake entrance. The mouth is wide (290m) with good tidal flow allowing for replenishment of oceanic water twice daily. The lake has active sediment transport through waves and tidal action shifting particles between different areas in the lake. The maximum depth in the lake is approximately 12.5m with an average depth of just below 2m (NGH Environmental, 2008). There are several deeper channels that recreational and commercial fishers and other users, including a tourist vessel operator, utilise. Little historical bathymetric data is available so it is difficult to determine if bathymetry has changed over time or if certain areas are more prone to short or long term variations (NGH Environmental, 2008). Sedimentation changes will be investigated further as part of the Pambula Lake Estuary Processes Study.

According to management classifications, Pambula Lake estuary is largely in good condition with moderately low susceptibility to human impact based on current land use (NGH Environmental, 2008). However, as coastal development increases, the catchment could be severely impacted if inappropriate planning and development occurs.

4.2 Catchment protection and rehabilitation

A number of catchment protection and rehabilitation projects are underway within the Pambula Lake catchment and waterways. These include the Pambula Estuary Management Plan, upgrades to unsealed roads and tracks, a community water quality monitoring program, river rehabilitation, treated effluent re-use, aquatic pest species control and lake foreshore clean up.

The Pambula Lake Oyster Growers have been instrumental in instigating the development of the Pambula Estuary Management Plan and are represented on the steering group. The first stage of the process has been completed (Data Compilation Study) and the Estuary Processes Study is now underway. PLOG have also been pivotal in identifying issues within the catchment and assisting initiatives to minimise impacts.

Concerns regarding future plans for treated effluent re-use on Pambula flats led to the Pambula Estuary and Catchment Group (Section 4.5) and Southern Rivers CMA obtaining funding through the Australian Government for a baseline community catchment monitoring program (Section 5.5.2).

Unsealed roads and tracks have been identified as a significant contributor to poor water quality within sensitive coastal waterways and their catchments. Road runoff increases the sediment load (turbidity) and in some cases, the nutrient load of these waterways. Several priority sites have been identified in the Pambula Lake catchment in recent years, and have formed the focus of road upgrade projects.

Bega Valley Shire Council (BVSC), with funding support from Southern Rivers CMA and in-kind support from PLOG, completed an upgrade of Pambula Landing Road in 2008. This project included sealing a 150m length of road and 600m^2 car park immediately adjacent to the Pambula Lake foreshore. Oyster farmers assisted with revegetation along the road. BVSC, with funding support from Southern Rivers CMA has undertaken an upgrade of Nethercote Rd in 2010-11 which will lead to 2.25km of sealing along a section of road immediately adjacent to Old Hut Creek, a tributary of the Yowaka River.

As part of the Pambula Estuary Processes Study, a River Rehabilitation Plan will be developed to help prioritise reaches of the catchment for rehabilitation. However, through the Pambula Estuary and Catchment group, several sites requiring rehabilitation were identified and works completed between 2008 and 2011. Projects included fencing and revegetation of 500m of a tributary of the Yowaka River, erosion control works and fencing and revegetation of a 500m section of Yowaka River, and stock management and revegetation along 750m of the Pambula River. Funding for these projects included contributions from NSW DPI, Southern Rivers CMA, and BVSC.

PLOG, together with NSW DPI and Southern Rivers CMA, have been actively controlling aquatic pests including Pacific oysters (*Crassostrea gigas*), a declared noxious species. During 2008-09, three working bees led to the removal of more than 4500 Pacific oysters from the lake foreshore and bed. Oyster growers also monitor the presence of the European Green Shore Crab (*Carcinus maenus*) as part of a project within the larger oyster industry aimed at controlling and managing this pest species on the Far South Coast.

PLOG have also been conscious of the presence of waste around the Pambula Lake foreshore. In 2008-09, oyster growers removed and disposed of more than 50m^3 of derelict oyster infrastructure as part of an industry clean up funded by the Australian Government and Southern Rivers CMA. In 2010, with Southern Rivers CMA and NSW DPI support, oyster growers instigated a foreshore clean-up day resulting in collection and removal of over 20m^3 of rubbish.

4.3 Other industries within the catchment

Pambula Lake offers a wide range of activities for recreational users including swimming, fishing, sailing, water-skiing and canoeing. Pambula Lake is a recreational fishing haven, bringing large numbers of visitors especially during holiday season, to the lake. Commercial fishing is permitted in certain sections and there is also one boat tour operator in the lake.

Broadwater Engineering, a ship yard, is located on the southern shoreline of Pambula Lake. This business has previously maintained large industrial vessels but current activity is significantly lower, being limited by shallower channels within and at the mouth of the lake which do not provide sufficient clearance. Broadwater Engineering is involved in estuary management meetings and has been consulted as part of the EMS process.

An Aboriginal cultural camp providing opportunities for Aboriginal people to undertake traditional and contemporary activities is located at Haycock Point. The camp is linked with the Eden Local Aboriginal Land Council at Jigamy Farm, also located on the Pambula Lake foreshore.

4.4 Catchment development

The majority of Pambula Lake foreshore is well vegetated, however there are some residential dwellings along the foreshore which create risk of stormwater and sewage leachate runoff from on-site sewage management systems, potentially impacting the estuarine water quality.

Another potential source of pollution is town sewage. Increasing urban development has led to increased volumes of human waste that must be disposed of or recycled. BVSC is the regulatory authority responsible for management of sewage and disposal of treated effluent. The Merimbula Sewage Treatment Plant (STP) is currently being upgraded, and options for disposal of treated effluent are under investigation. The preferred options for disposal of treated effluent in NSW coastal towns has been through ocean outfall or exfiltration systems and, increasingly, through application on land as discharges to the ocean have been linked to algal blooms and skin irritations for swimmers.

Certain areas on Pambula flats have been determined to be appropriate re-use sites for a proportion of the treated effluent from the Merimbula STP. Oyster farmers remain concerned about potential contaminated run-off and groundwater discharge compromising the ecosystem health of Pambula Lake and reducing the economic viability of the industry.

Another potential source of chemical pollution is from disturbance of acid sulphate soils in the catchment. These soils contain high levels of iron sulphides and dissolved aluminium which are widely recognised as detrimental to water quality in aquatic ecosystems (Sammut *et al*, 1996).

4.5 Stakeholder community groups

To take into account all the processes and activities in the Pambula Lake catchment, a Pambula Estuary and Catchment Group was formed in 2008 with the primary aim of identifying current and future risks threatening the pristine condition of the Pambula area. The group comprises community and other members represented by the Southern Rivers CMA, BVSC, Far South Coast Landcare Association, PLOG, Pambula Wetlands and Heritage Project Inc., Eden Local Aboriginal Land Council, local landowners and businesses, Pambula Recreational Fishing Club, NSW Government agencies including Department of Environment, Climate Change and Water (DECCW), Maritime Authority, NSW DPI - Fisheries, Forests NSW and the Australian National University. As a first step on the development of the Pambula Estuary Management Plan, the group provided input to the Pambula Estuary Data Compilation Study (NGH Environmental, 2008).

5 Overview of Pambula Lake oyster industry

Diminishing world wild caught fisheries together with rapid growth in the global population has led to a reliance on aquaculture to meet growing world demand for fish protein. Aquaculture is the fastest growing primary industry in Australia. Edible oysters are one of the five highest value species in Australian production. Edible oysters in NSW contributed around 80% of the total Aquaculture GVP (Gross Value of Production) in the state for 2006-07 (ABARE, 2008). The SRO industry is the state's most valuable fishery and it is also one of the most valuable agricultural enterprises on an area basis with long term gross average annual production of $8,000/ha across the state, reaching values as high as $35,000/ha in some NSW estuaries (White, 2001).

The current NSW OISAS has as its primary goal the sustainable production of 120,000 bags of premium oysters by 2013 (NSW Department of Primary Industries, 2006). The strategy will work towards establishing the regulatory environment in order to achieve this production target (Figure 2). Consequently there is a need to ensure best operational and management practice within oyster farming, including a commitment to protect and secure the environment.

SRO cultivation in Australia commenced simultaneously in NSW and southern Queensland around the 1870s (Malcolm, 1987; Nell, 1993; Fletcher*, et al.*, 2004). However, there is a much longer history of the use of natural stocks of oysters in NSW. Aboriginal kitchen middens, commonly found along the NSW coast, contain shell deposits carbon-dated to 6,000 B.C (Malcolm, 1971).

With European colonisation, oysters were collected for food and to provide lime for building mortar from burning oyster shells (alive and dead). Consequently by the mid 1800's, when natural oyster stocks were depleted and the burning of oyster shells was prohibited, a regulated commercial oyster industry in NSW was established (Malcolm, 1971).

NSW SRO production grew steadily for 30 years reaching approximately 140,000 bags by the mid-1970s (Figure 2). This peak was attained mainly through a peak production of 43,000 bags in Port Stephens (NSW Department of Primary Industries, 2006). For approximately a decade, oyster production stabilised, however this was followed by a consistent decline despite efforts from oyster growers and the introduction of new technologies. The long term declines have been

attributed to: disease outbreaks such as QX in the Georges River in 1994 and in the Hawkesbury River in 2004, wiping out two of the major oyster producing estuaries in NSW; introduction of the Pacific oyster; degradation of water quality in many coastal areas; and market competition from oysters grown in other Australian states. The last factor is reflected in the recent changes in edible oysters GVP and production value across various Australian states (NSW DPI, 2007).

This report concentrates on those activities associated with the commercial cultivation of the SRO (*Saccostrea glomerata*) although some growers in Pambula Lake also cultivate the native Flat Oyster (*Ostrea angasi*). In 2005, an oyster farmer in Pambula Lake was one of only a few growers in Australia granted export licence approval from the Australian Quarantine Inspection Section (AQIS) to ship Flat Oysters to overseas markets. Annual production of SROs has stabilised at around 60,000 bags, approximately 8 million dozen oysters (Figure 2). The main export market targeted by Pambula Lake growers is Asia, which, if successful, could possibly triple the current value of their oysters (Baker, 2008).

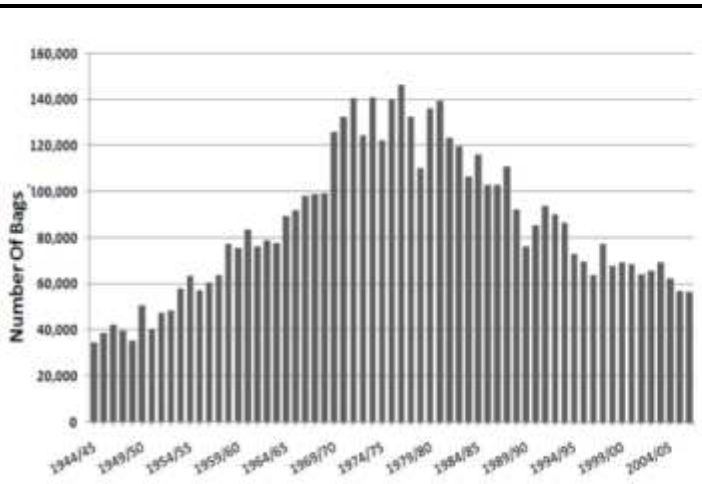

Figure 2: Total NSW SRO production (Number of bags sold) from 1944/45 to 2006/07

(Source: NSW DPI - Fisheries from annual production reports by permit holders)

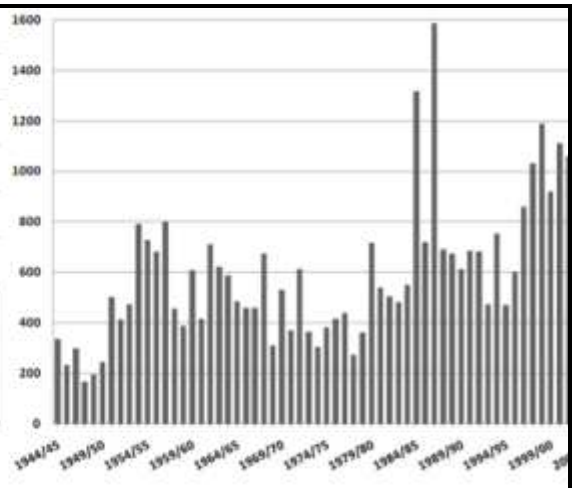

Figure 3: Total SRO production for Pambula Lake (Number of bags sold) from 1944/45 to 2006/07

(Source: NSW DPI - Fisheries from annual production reports by permit holders)

5.1 Oyster production - Pambula Lake

In 2011, the Pambula Lake oyster industry comprises 25 growers, some of whom also hold oyster leases in nearby areas such as Bermagui, Merimbula, Nelson and Wapengo Lakes. Six of the 25 are small or part-time businesses. Pambula Lake oyster production contributes 3% to overall NSW production and 8.2% to south coast production (NSW Department of Primary Industries, 2007). NSW DPI Fisheries mapped 97.3ha of priority oyster aquaculture leases in the lake.

Pambula Lake oyster production was generally steady until the early 1980's when production began to increase reaching the highest levels of production in recent years (Figure 3). The historic peak in oyster production for Pambula Lake was recorded for the period 2006/07 with 1,697 bags sold (NSW Department of Primary Industries, 2007). In 2010 approximately 1,500 bags of oysters were produced.

Pambula oysters are generally sold in Sydney, Melbourne and locally. Pambula Lake production currently comprises 20% plate (large), 35% bistro (medium) and 45% bottle (small) grade oysters. The lake has seen a number of new enterprises commence in recent years, generally run by young, enthusiastic, local farmers with high expectations of the industry and eager to both protect the area and earn a good living.

5.2 Oyster growth requirements

The basic requirements for oyster growth and survival are:

- Availability of space.

- Food availability in the water for the oysters – oyster growers cannot artificially fertilise the water to increase the food source. Based on the food levels and the capacity of the estuary/lake to replenish consumed food, oysters need to be cultivated at specific density levels in order to maintain oyster numbers within the capacity of the waterway (guidelines are provided in OISAS) (NSW DPI, 2006).

- Maintenance of optimal environmental conditions. Oyster production can be affected indirectly by altering the water quality through anthropogenic activities such as logging, agriculture, vegetation clearing and urbanisation. These activities could result in increased particulate loads in the waterways increasing the turbidity and nutrients levels.

Current and predicted future changes in climate can have a significant effect on oyster cultivation. Physical factors such as temperature and salinity set limits on the spatial distribution of oyster species and on their metabolic performance (such as growth, reproduction and immune response). In addition, oceans are slowly becoming more acidic, and shellfish, like oysters, are especially vulnerable to this kind of change because they rely on steady carbonate ion concentrations in order to develop strong and healthy shells (Section 6.1.2.10).

5.3 Farming methods in Pambula Lake

Cultivation methods in NSW have changed considerably since the early days of the industry. Initially, sandstone rocks or stone leases were used, with mangrove and wattle sticks taking over as movable clutch material that could be easily transferred to different areas and estuaries. Other materials such as fibrous cement slats, tarred hardwood stakes and cement-coated stakes have been subsequently used. Over the last five years there has been a trend in oyster farming to implement single seed techniques. This process promotes a more regular oyster shape, highly valued in the marketplace.

Each cultivation method used for oysters has strengths and weaknesses, and growers decide on techniques based on personal preferences and take into consideration: the scale of their business; investment level; geographical characteristics, such as depth, substrate type, slope, current and flows within their leases; and environmental impact of their operations.

5.3.1 Spat collection

5.3.1.1 Plastic slats

In Pambula Lake the majority of natural spat fall is collected using plastic slats (Figure 4). These slats are made of calcium-infused, arced or soft plastic so they can be twisted to remove the oysters that settle on them. The plastic slats are arranged in layers onto a frame that sits on the catching lease (Figure 4). This technique has quite variable rates of success. Oysters remain on the catching units for a period of 8 to 10 months. Oyster spat are normally caught in the more saline lower reaches of the estuary/coastal lake and subsequently moved to less saline, higher nutrient areas for growth and fattening.

5.3.1.2 Hatchery spat

An alternative source is hatchery-produced oysters from the existing breeding program for SRO undertaken by NSW DPI Fisheries Research, Port Stephens, which is designed to improve growth and disease resistance (from for example, QX and winter mortality diseases). Currently, growers rely on hatchery oyster spat to provide at least one third of their annual production.

Oyster spat (size 800-100µm) leave the hatchery to be grown in upwellers, nursery rearing systems based at certain farms in estuaries (Figure 5). Oceanic/estuarine, nutrient-rich water is actively pumped from close-by and pushed through the tanks holding the upwelllers. These seawater flow-through systems are feasible for land bases (Figure 5) however depending on the geographical location and therefore water quality, temperature and salinity levels, some nurseries perform better than others.

Figure 4: Plastic slats for catching oyster spat (Source second picture: P. Skeers)

Figure 5: Upweller nursery system to grow oyster spat

5.3.2 On-growing techniques

Once oyster spat is flexed off the catching units, or single seed oysters are received from other growers or sourced from a hatchery, they are placed in cultivation cylinders/baskets with different mesh sizes to accommodate the different oyster sizes (juvenile to market size). Once again the selection or combination of certain cultivation techniques depends on a grower's personal preference.

A brief description of each cultivation technique used in Pambula Lake follows.

5.3.2.1 Long-line system

The long-line cultivation system is a relatively recent innovation and is becoming increasingly popular in the NSW oyster industry (Figure 6). Different types of bags are used in this system which is designed to minimise handling as the baskets can easily be unclipped, processed and returned rapidly to the lines with minimal labour. These growing systems offer practical, efficient and durable alternatives to old cultivation units. The method is also well suited for rough and weedy conditions.

Tumblers or cylinders (100 x 15cm; *l* x *r,* volume of ~70L): made of polypropylene mesh and allow continuous rotation driven by the moving tide and currents that is facilitated by a floater that is placed inside (Figure 6). These units are typically used for very small size oysters for approximately 6 to 8 months.

Floating bags or pillows: made of polypropylene plastic mesh and in most cases have some form of polyurethane flotation device attached to the outside of the bag (Figure 7). Growers arrange bags on opposite sides of the long line so that they can flip bags from one side of the long line onto the other to dry the oysters instead of pulling or adjusting the line (Figure 8).

SEAPA baskets: frequently used in the industry as they are purpose built to simplify and increase the efficiency of oyster farming. These types of baskets have a hard defined frame with lids on both sides that help to reduce oyster loss by giving a positive, easy seal (Figure 9).

Figure 6: Floating tumblers or cylinders

Figure 7: Floating bags running in parallel

Figure 8: Floating bags drying, one lot resting on the top of the parallel line of bags

Figure 9: Hard frame baskets with different mesh size and volume for adult and spat oysters

5.3.2.2 Intertidal racks and baskets

Oyster racks are made of posts drilled upright into the seabed to act as the main supporting structure. Attached to these, post-rails run parallel to the seabed and hold up the various intertidal cultivation units described below. Old rail materials, such as tarred and treated timber with PVC posts, are being replaced by plastic sheathed wooden rails and plastic rails made of recyclable materials.

The rack and basket method: rectangular shaped baskets, handmade from tough polypropylene mesh, secured to the racks by two wooden sticks which are generally re-used (Figure 10).

Figure 10: Intertidal rack & basket method.

Recyclable plastic **intertidal trays** (180 x 91 x 4 cm; *w* x *l* x *d*): light and requiring little maintenance compared with the old wooden trays (Figure 11), these trays are partitioned to prevent overcrowding as a consequence of oyster movement by wind and wave action. They also have lids to protect them from marine animals (rays, fish, starfish and octopus) and birds.

Figure 11: Intertidal trays – wooden trays with different partitions (top left) and examples of plastic trays.

The different methods used by PLOG have been developed to best suit the physical factors of the site as well as the size of oysters transferred on to the farm. Each grower has the option of utilising any of these methods to grow their oysters as long as they are using best practices.

5.4 Land-based activities

Commercial oyster cultivation requires both water-based infrastructure (oyster leases) and a functional land base where oyster operations such as grading, drying stock, infrastructure storage, packing and marketing take place (Figure 12). The NSW oyster industry has lease arrangements for land bases with the Land and Property Management Authority (LPMA).

Figure 12: Land base sheds at Pambula Lake, and examples of some of the grading and sorting machines that are currently used in the oyster industry

5.5 Environmental Monitoring

5.5.1 NSW Shellfish Quality Assurance Program

PLOG maintain a regular water and meat quality monitoring regime as part of the NSW Shellfish Quality Assurance Program (SQAP) (administered by the NSW Food Authority under the umbrella of the Australian SQAP) ensuring that immediate action can be taken if pollution levels threaten the health of the lake and the safety of oyster consumption. In recognition of the significant contribution growers play in monitoring the condition of the water quality, and that growers are not the polluters, since 2005 the NSW Government has subsidised 50% of monitoring costs. Monitoring is required to maintain the current status of the Lake's management plan as conditionally approved for harvest (ie direct harvest).

Direct harvest is extremely important for the management of oyster production within Pambula Lake. Due to the proven excellent water quality within Pambula Lake farmers have been able to move away from the costly and prohibitive process of depuration. Farmers are now in a much better position to react to domestic demand and access export markets.

A large number of NSW and Victorian holiday-makers stay at or near Pambula Lake and as a consequence, a wide range of negative impacts can affect the water quality. Oysters have been associated worldwide with outbreaks of a range of human diseases because of their ability to bio-accumulate pathogens and toxins derived from the water in which they grow, and because they are typically eaten uncooked. As a result, PLOG intensively monitors the quality of the water and the oysters for a range of parameters such as faecal coliforms, salinity, temperature, microalgal biotoxins and heavy metals. This monitoring is of vital importance for public health protection. However through monitoring, the water quality classification has been improved and longer periods of harvesting have been possible, thus demonstrating a return on the growers' efforts.

After the occurrence of extreme events (such as heavy rainfall which results in runoff of nutrients and pathogenic micro-organisms from inappropriately treated faecal material) an oyster growing area may be closed for harvest as per specifications of the local management plan and the NSW SQAP until the system is cleared for harvest. During the closure period oyster farmers are unable to harvest oysters which can significantly affect their cash flow and profits.

5.5.2 Water quality

Estuarine health depends on a large range of factors over which, in most cases, growers have little control. Oyster farmers are diligent in their monitoring of the waterways to ensure water quality and safe oyster consumption. In addition to ASQAP sampling, since 2008 PLOG have participated in a community water monitoring program that will run until 2011 with funds from the Australian Government. The program aims to: gain a better understanding of long-term health and trends for the Pambula estuary; monitor potential threats to estuarine health; maintain or enhance the long-term health of the estuary; and address threats identified through the monitoring.

This program is working in close collaboration with the local community and local associations such as Landcare, BVSC, the local Aboriginal community and Southern Rivers CMA. Through this collaboration a number of projects to improve catchment processes and thereby enhance the long term security of the local oyster industry will be undertaken.

5.5.3 Benthic sampling: seagrasses

Seagrass beds are one of the most important parts of the aquatic ecosystem in Pambula Lake (Section 4.1) and they play a vital role in the functioning of a healthy system. Seagrass beds are extremely fragile habitats that can be easily destroyed if care is not taken. In 2009, PLOG took part in a community seagrass training session designed to enhance the monitoring of the distribution and condition of seagrasses in the lake so that any decline in their health could be identified as early as possible. Development of an appropriate monitoring technique is being considered so that long-term trends can be captured.

5.6 Recent environmental achievements by Pambula growers

The Pambula oyster industry is one of the best examples of good stewardship of the local environment as it is proactive in its actions to protect the lake, evidenced through:

- Representation in catchment related committees (e.g. Pambula Estuary and Catchment Group, BVSC Coastal Management and Planning Committee);
- Partnership with Southern Rivers CMA identifying sediment sources to the lake, particularly roads, and potential rehabilitation sites in the catchment;
- Collaboration with local Landcare groups and the Pambula Wetlands and Heritage Project Committee;
- Participation in marine pest monitoring studies (eg European Green Shore Crab, Pacific oyster);
- Participation in research projects investigating heavy metals and other chemicals accumulated in the sediment of the lake;
- Establishment of an oyster industry education program in local schools;
- Securing funding for a stormwater education program in Pambula and Merimbula townships;
- Pambula Lake foreshore clean-up 2010; and
- Presentation of the EMS at the 2010 Australasia Aquaculture Conference.
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6 ACTION PLAN

As part of the risk analysis, Pambula Lake Oyster Growers performed an environmental audit which identified operational and infrastructure risks for all the Pambula oyster enterprises. Additional environmental, social and economic impacts of the industry were also considered. The major objective for using risk assessment techniques was to assist in the separation of minor acceptable risks from major unacceptable risks.

Through a series of workshops, PLOG identified industry-related and external factors that they considered a risk to the industry and ranked them according to the level of impact based on the consequence and likelihood scores used in the risk analysis. A summary of the risk analysis table and ratings used to score each activity identified by the Pambula Lake oyster industry has been included in Appendix 5 and Appendix 6.

Figure 13 summarises the risks identified by growers and the rank of each risk. The risks have been split into two main categories: industry-related activities, which are those primarily controlled and managed by the oyster industry; and external activities, which are those impacting the oyster industry but, in most cases, are beyond the control of the oyster industry.

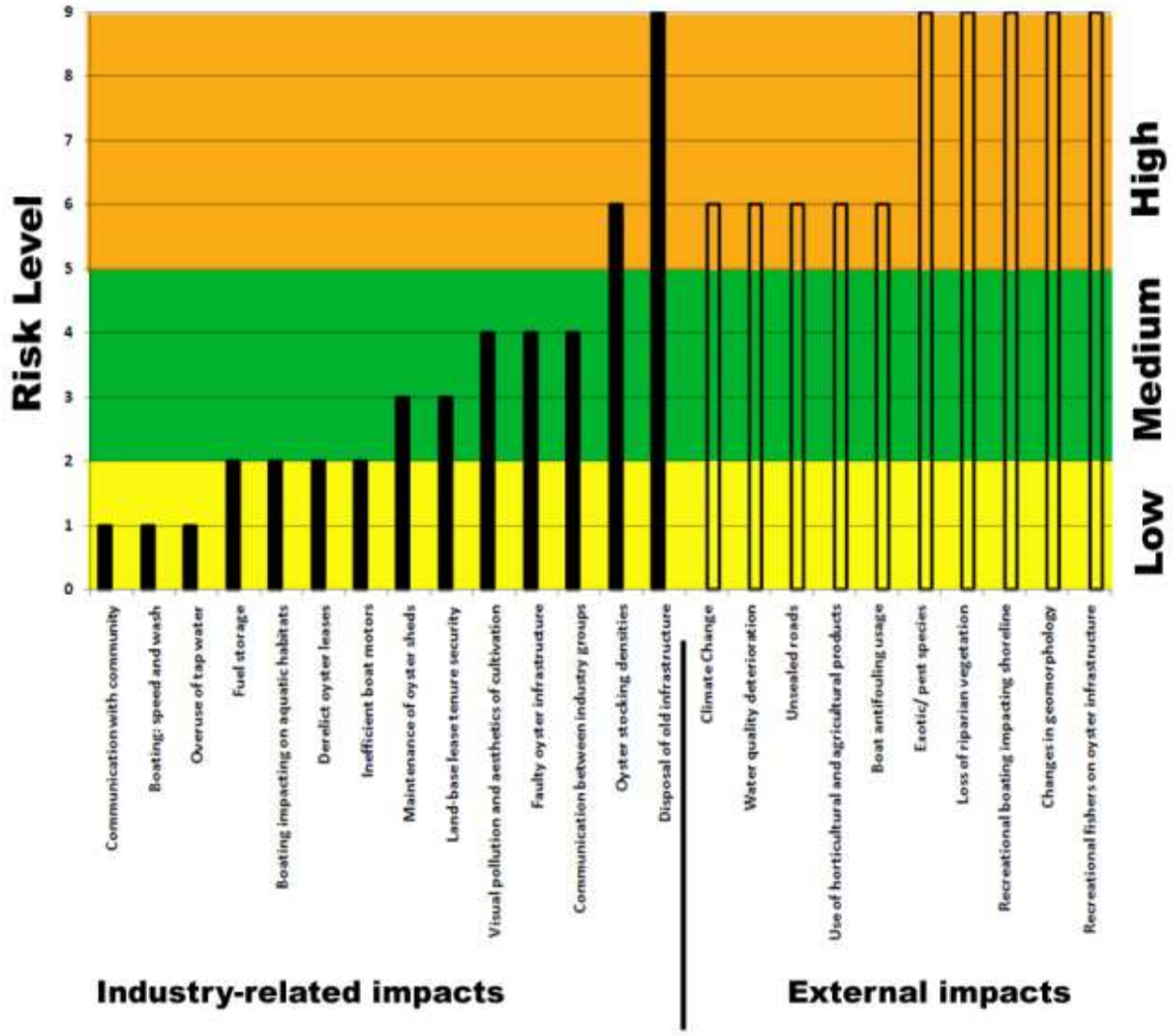


Figure 13: Summary of risks impacting the Pambula Lake Oyster industry. Each risk was scored through a risk analysis (see Appendix 5) in which LOW risks correspond to scores 0-2; MEDIUM risks to scores 3-5; HIGH risks to scores 6-9

'High' and 'Medium' risks have been targeted in the first years of EMS implementation. The risk table presented in Appendix 6 includes a summary of the current and future measures that PLOG have or will put in place for each targeted risk. Explanation and background of each of the high and medium risks impacting the Pambula Lake oyster industry are provided in Section 5. PLOG will liaise with community and stakeholders in order to work collaboratively towards minimising the external risks.

6.1 High risks

This section focuses on the 'high risks' impacting the sustainability of the industry as per the risk matrix in Appendix 5. Risk values that ranked between 6 and 9 (out of a maximum possible score of 9) are considered 'Not desirable' (Appendix 5). The management response for these types of risks involves continuation of strong management action that requires a full performance report

and immediate/specific response. A summary of the actions that PLOG have committed to in order to minimise these has been included in the risk table (Appendix 6, "Future Actions" column).

6.1.1 Industry-related activities

6.1.1.1 Disposal of old infrastructure

Oyster farmers have to date used timber posts treated with highly toxic and hazardous chemicals such as creosote or tar as part of the oyster lease rack. These products are now known to be hazardous with carcinogenic, mutagenic and toxic properties that can have severe impacts on marine organisms (Smith, 2008). Oyster farmers throughout NSW are now phasing out the use of tarred and treated timber by using low maintenance, recyclable plastic materials.

A consequence of upgrading to more environmentally-friendly cultivation infrastructure is large volumes of old infrastructure which require appropriate disposal. Because of the logistics and cost of disposal, old infrastructure tends to pile up in land-based areas. In 2008-09 the Australian Government, through Southern Rivers CMA, provided funds to the industry to clean up these areas resulting in removal of more than 50 m^3 of waste. Growers will continue to organise periodical clean-ups and appropriate disposal of waste to remove potentially toxic materials and minimise visual impact around oyster land-based areas.

6.1.1.2 Oyster stocking densities

Oyster farming as generally practised in Australia has not been identified as having a significant negative environmental impact because oysters are not cultivated using intensive farming systems (Crawford, 2003). Of course if growers try to cultivate more oyster stock than they are capable of managing, detrimental effects such as low oyster production levels and impact on the benthos under the oyster leases could occur.

By quantifying oyster food levels and by collating the number of oysters being cultivated in the lake at any given time, PLOG can contribute to the support of a sustainable oyster industry. PLOG also takes into consideration the recommendations provided by available oyster research studies (Crawford*, et al.*, 1996; Underwood*, et al.*, 2002; Troup*, et al.*, 2005; Rubio, 2008) and the NSW OISAS. Consequently, subject to acquisition of equipment, PLOG wish to monitor food levels in the lake through measurements of chlorophyll-a and will explore options for a whole-lake stock control system.

6.1.2 External activities

6.1.2.1 Mooring to leases by lake users

PLOG, as part of their oyster cultivation licence, are required to adopt best practice standards for lease marking, navigational aids and lease maintenance as per the NSW OISAS. In order to ensure safe navigation across oyster aquaculture areas, individual oyster lease areas must be marked in a consistent and appropriate manner. Oyster growers use white posts to mark the boundaries of their leases. These posts need to be constructed of materials that are long lasting and pose no

significant risk of environmental harm (NSW DPI, 2006). As compliance with marking requirements is mandatory, fines are applied for non-compliance.

Lease marker posts are currently used by some recreational fishers to temporarily moor their boats while fishing. In some cases, this results in loss and/or damaged infrastructure as these posts are not designed to serve as moorings. Consequently, PLOG faces repairs of their infrastructure caused by external users and in some cases, the resulting damaged infrastructure can become a navigational hazard for lake users and/or result in a fine for non-compliance. As a result, PLOG are seeking to install NSW DPI "Do Not Tie Up" signs on major lease posts as well as signage at the public boat ramp.

6.1.2.2 Changes in geo-morphological processes

Sediment quality in Pambula Lake is typical of an undisturbed estuary with relatively good rates of tidal flushing and tidal velocities. Catchment activities may have an indirect impact on the hydrology of the waterway due to changes in the sedimentation processes. For instance, unsealed roads adjoining or crossing waterways within the Pambula catchment could contribute to increased levels of fine suspended particles in the water column affecting the aquatic ecosystems and potentially impacting on the local oyster industry. The actions to address this risk are directly related to the actions proposed for other high risks in this section such as oyster stocking densities (6.1.1.2) and unsealed roads (6.1.2.9).

Large-scale intensive oyster farming may affect natural sedimentation by accumulating sediments around oyster infrastructure, potentially altering water flow. Despite this, no significant changes in hydrology or ecological processes in the aquatic ecosystem due to oyster infrastructure have been observed in Pambula Lake. However, some oyster growers have noted that sediments in some parts of the lake have shifted and that some navigational channels appear to be more shallow and drifting, which raises concerns about the mouth of the lake and possible closures in the future. PLOG will monitor depth at certain areas in the lake and will investigate alternative cultivation/operation processes for projected water levels in the future. Oyster growers will also liaise with NSW Maritime to relocate navigational markers in the lake as appropriate.

6.1.2.3 Boat wash by lake users

As a result of the large fish stocks in Pambula Lake, an active recreational fishery is present in the area. Large and powerful boats create boat wash in sensitive areas of the lake, damaging oyster infrastructure and shell middens which have significant cultural and heritage value. Consequently, there is a need to minimise this impact through informing boat users of the impact of their activities. PLOG, in collaboration with Southern Rivers CMA, will coordinate with NSW Maritime and NPWS to install 'No-Wash' signs close to midden areas and around other problematic spots in the lake. In addition PLOG will work towards monitoring erosion and levels of sedimentation in certain areas of the lake.

6.1.2.4 Loss of riparian vegetation

PLOG has identified loss of riparian vegetation as a major problem for its industry. This may result from land clearing in the catchment and/or livestock access along waterways. Poor stock

management practices in the upper catchment can lead to lower water quality and loss of buffer zones along the shoreline of the waterways. It also has the potential to impact on sensitive ecological habitats such as mangroves, saltmarsh and seagrasses. Fencing and re-vegetation has taken place in some areas of the catchment through projects undertaken by Pambula Wetlands and Heritage Project Committee, Landcare, BVSC, Southern Rivers CMA, NSW DECCW, NSW DPI and associated riparian landowners.

Priority sites for rehabilitation will be identified through the Pambula River Rehabilitation Plan to be completed by Southern Rivers CMA in 2011. This Plan will form part of the Estuary Processes Study and will help focus future rehabilitation and protection efforts. PLOG have been and will continue to be actively involved in community projects that support rehabilitation.

6.1.2.5 Marine exotic species and fouling

Introduced species are a most significant threat to Australia's biodiversity and natural resources. Their impact on aquatic ecosystems is in most cases poorly understood. Consequently great effort needs to be exerted in the identification of pest species and their preferred habitat so that appropriate control or eradication measures can be put in place. PLOG currently report the detection of any unusual plant or animal, and are following requirements of government agencies in combating marine pests.

Education programs have been put in place with material being disseminated among oyster farmers. At present, one of the highest risks for the oyster industry is the Green Shore Crab (*Carcinus maenus*), a voracious predator with a broad diet that has been implicated in the decline of shellfish populations including the SRO on the Far South Coast. The Sapphire Coast Marine Discovery Centre, in partnership with the Eden Local Aboriginal Land Council, NSW DPI and Southern Rivers CMA commenced a monitoring program in 2009 in those areas where oyster growers have reported the crab's presence. A large number of Green Shore Crabs have at times been reported in Pambula Lake, resulting in a full commitment from PLOG to assist in field work towards research on this pest species.

Another pest species that PLOG contend with is the Pacific Oyster (*Crassostrea gigas*). Pacific Oysters are declared noxious fish under the *Fisheries Management Act 1994* in all NSW waters except Port Stephens, Georges River, Shoalhaven River, Wallis Lake and Hawkesbury River. PLOG comply with the Pacific Oyster Control Program managed by NSW DPI, under which the permit holder must make every effort to eradicate this species from oyster infrastructure in the lease. In Pambula Lake, industry clean-up campaigns have also been organised in collaboration with NSW DPI and Southern Rivers CMA.

Formal Pacific Oyster Management Plans have been recently developed by the SRO industry and NSW DPI but are only in operation in Wagonga (Narooma) and Batemans Bay waterways. Consequently, PLOG are developing a protocol to address the management and handling of inter-estuary oysters arriving at Pambula Lake. In addition, PLOG have committed to organise lease clean-ups for Pacific Oysters before each Christmas season, (typical spawning season for this type of oyster) and shoreline clean-ups, particularly in Pacific Oyster hot-spots. PLOG will liaise with

NSW DPI in order to develop management protocols to minimise settlement of Pacific Oysters on the new floating cultivation structures.

PLOG are also concerned about the introduction of pest species such as Caulerpa (*Caulerpa taxifolia*), known to exist in nearby lakes such as Wallagoot. Most recreational fishers using Pambula Lake also fish in Wallagoot Lake so there is significant potential for Caulerpa to spread to Pambula Lake if extra care is not taken. Pambula growers will organise information sessions on Caulerpa through the Aquatic Biosecurity Unit of NSW DPI, so that lake users are well informed about this pest species. PLOG also wish to put signs at the boat ramp with regard to management controls for Caulerpa and will lobby for boat wash facilities at Wallagoot Lake in order to minimise the potential of its introduction to Pambula Lake.

6.1.2.6 Deterioration of water quality

As discussed previously, PLOG recognise that numerous external activities can impact on the water quality of Pambula Lake. Through partnership with Southern Rivers CMA, BVSC and NSW DECCW - National Parks, several rehabilitation projects have been undertaken in the catchment with flow-on benefits to the lake water quality. Factors that may potentially affect water quality in Pambula Lake have been identified by the oyster growers as:

1. Camping close to waterways
2. Forestry activities
3. Urban development;
4. Agricultural runoff (related to risk 6.1.2.8)
5. Loss of riparian vegetation and uncontrolled stock access to waterways (see 6.1.2.4)
6. Chemical leachate (see 6.1.2.7)
7. Unsealed roads (see 6.1.2.9)

Camping close to waterways

During holiday periods, large numbers of campers occupy areas close to the shoreline for long periods of time (eg holidaying family groups and camps organised by Jigamy Farm). These unofficial campsites usually have no toilet facilities and ad hoc waste disposal measures (such as digging holes) may lead to effluent reaching the waterway. PLOG would like to ensure that stakeholders allowing this type of camping on their properties are sensitive to these issues.

Forestry activities

In 2010, logging activities occurred within the Nullica State Forest located to the south and west of Pambula Lake. Logging can cause erosion and sedimentation, impacting water quality downstream (Croke & Nethery, 2006). While forestry in the Pambula catchment is not located along the foreshore of the waterways, operations do occur further upstream along the Yowaka and Pambula Rivers where the road network (unsealed and sealed) can also have a significant impact on sedimentation rates within the catchment (6.1.2.2). At present a PhD project administered by the Australian National University is investigating the soil hydrology of the Pambula floodplain. This may assist to determine any changes within the soil that might be caused by catchment activities.

Urban development

A major threat to the oyster industry is urban development with its potential impact on the physical, chemical and biological characteristics of the catchment. Land clearing in particular can result in changes to water quality and water flow in oyster growing areas within the lake.

According to the NSW OISAS (Chapters 4 & 8) and the NSW Environment Protection Authority, development in estuarine catchments must result in no deterioration of the environmental conditions of the catchment and therefore, no impact on the local oyster industry. Consequently, any development applications in the Pambula catchment should address the maintenance of existing water quality and flow characteristics in Pambula Lake. This could be achieved by establishing links between the requirements for sustainable cultivation of healthy oysters (OISAS) and catchment and water use planning. Proposed development applications that require land clearing should address the impact on the priority oyster aquaculture areas (Appendix 4) and include specific mitigation measures that will result in the protection of water quality.

Urban development can also result in additional risks to the local oyster industry as a result of increased volumes of human waste generated, often dependent on the methods of disposal. In most coastal and rural areas, sewage management is decentralised and domestic wastewater is usually treated and disposed of on-site. Local reticulated sewerage infrastructure is currently expanding and new technologies are being implemented in coastal areas in order to reduce the number of decentralised sewage systems in the catchments. BVSC also undertakes a regular inspection of high risk On-site Sewage Management Systems (OSMS) as part of its 'Septic Safe' survey program.

Urban development can also result in stormwater management issues, particularly as a result of water quality from townships. This has been identified as an area of concern for both Pambula and Merimbula oyster growers, due to the presence of the Pambula and Merimbula urban areas and Pambula industrial area within the catchments, and located close to oyster harvesting areas. A stormwater education project underway in 2011 will include developing solutions for identified hot spots, as well as educating the community and local businesses about the impacts of their behaviours on the local waterways.

Actions and concerns of oyster growers in relation to urban stormwater are also consistent with the objectives and actions of the NSW Diffuse Source Water Pollution Strategy (DECC NSW 2009) which recognises the need to reduce pollutant loads from stormwater as well as activities such as farming and land clearing.

PLOG needs to be informed of proposed development applications affecting their oyster leases to ensure that proposals take into consideration the provisions of the OISAS and State Environmental Planning Policy 62 (NSW DPI), and any measures to protect the oyster industry are evaluated and if approved, enforced during and after development takes place.

Agricultural runoff

Agricultural and urban runoff, acid sulphate soils, and fuel and chemical spills may also lead to water pollution incidents. Pollution sources in general can be detected quickly by PLOG who are diligent in both watching for changes in the system and monitoring water quality regularly.

6.1.2.7 Boat antifouling

As discussed in Section 4.3, Broadwater Engineering is a boat maintenance business located on the Pambula Lake foreshore. In 2005, oysters in Pambula Lake, in particular at the lease close to the Broadwater Engineering land base, showed effects of chemical poisoning resulting in stunted oysters. Following this incident, Broadwater Engineering improved its management protocols: for example, containment areas were constructed on site in case of spills, and waste material is transported to Sydney for appropriate disposal. Since 2005, heavy metal monitoring programs have been put in place with no positive results found.

PLOG will continue their heavy metal monitoring program and through involvement with various research projects through the Australian National University, may obtain additional information on the chemical levels in the sediment around the lake.

Pambula Lake has also until recently been home to a boat tour operator, with the vessel moored in the lake. However, in 2011 the vessel was placed on dry docks under repair, and the future of the business venture in Pambula Lake is uncertain.

6.1.2.8 Use of horticultural and agricultural products in the catchment

Through runoff after heavy rainfall, agricultural products, such as fertilisers and pesticides used on land within the catchment will almost invariably reach the waterways, potentially having an impact on the flora and fauna of the lake. Because of their filtration system, oysters in particular could be easily impacted if the water quality is compromised through the presence of chemical products. It is important that stakeholders in a catchment recognise the post-effect that some of their activities might have in the overall catchment. To raise awareness amongst landholders, PLOG will ensure that landholders receive a copy of the EMS providing them with an opportunity to consider any of their practices that may negatively impact the lake.

6.1.2.9 Unsealed roads

Unsealed roads have been identified as the largest producer of dust and fine sediments which have the potential to be transported easily to waterways. This transport results in increased turbidity levels which has detrimental effects on the overall processes of the aquatic ecosystem and in particular, on benthic organisms such as oysters (see Section 4.2).

PLOG have committed to set-up community groups to help with activities such as tree and shrub planting along roads in order to stabilise banks and to create a buffer to reduce run-off during rainfall events.

6.1.2.10 Climate change

It is widely agreed that human activities have significantly increased atmospheric concentrations of carbon dioxide (CO_2) since the start of the industrial revolution and that this has contributed to a number of significant changes to physical, chemical and biological systems.

Changes and the potential impacts on oyster farming include the following.

- Australia's air temperatures have increased by approximately 0.8°C over the last century (Intergovernmental Panel on Climate Change (IPCC), 2007), and based on model projections temperatures could go up considerably more over the coming century. Raised temperatures can have major direct and indirect effects on oyster cultivation such as inducing rapid growth, varying reproduction cycles and interfering in spawning events. High temperature-induced evaporation implies less soil moisture and can lead to exacerbated drought conditions. Less rainfall in an area results in minimal land-nutrient input to waterways, reducing nutrient levels and in some cases, productivity of the area. Changes in rainfall and temperature can also alter the frequency and severity of fire events.

- Sea levels have risen globally by about 20cm as a result of oceanic thermal expansion and melting of land ice (IPCC, 2007). It is predicted that sea levels will continue to rise impacting on some oyster cultivation systems, in particular intertidal systems.

About one third of anthropogenic CO_2 has been absorbed by the oceans, reducing pH by about 0.1 of a unit and significantly altering carbonate chemistry (Miller*, et al.*, 2009). Projections suggest that it could fall by a further 0.4 units by the end of the century (IPCC, 2007). As more and more CO_2 is produced oceans are becoming more acidic, and shellfish like oysters are especially vulnerable to this kind of change. Oysters rely on constant carbonate ion concentrations to produce the calcium carbonate needed to develop their shells (Guinotte & Fabry, 2008).

An understanding of the effects of climate change on estuarine systems requires a thorough understanding of the links between the biological and physical systems and the associated variability. This is still relatively poorly understood, in large part because there is a lack of sufficient, high quality environmental baseline data for estuaries and oysters (Ringwood & Keppler, 2002). For the majority of systems, determining effects of climate change is difficult, however taking advantage of current weather anomalies to gain insight into future impacts is critical. For instance, understanding how environmental properties and nutrients behave in estuaries/lakes under drought conditions is imperative in order to establish data baselines upon which anthropogenic impacts can be reasonably assessed.

Following on from research on genetic resistance (Parker *et al* 2008), research programs to breed SRO lines resistant to predicted climate change environmental conditions have commenced under NSW DPI (Fisheries). PLOG will endeavour to keep informed of the results of this research work for potential implementation.

6.2 Medium risks

This section focuses on the 'medium risks' impacting the Pambula Lake oyster industry as per the risk matrix (Appendix 5). Risk values that ranked between 3 and 5 are considered 'Acceptable'. The management response for these types of risks is a continuation of the risk control measures in place which requires a performance report detailing current arrangements and, in some cases, responses to minimise the risk.

6.2.1 Industry-related activities

6.2.1.1 Maintenance of oyster sheds

Some of the Pambula Lake oyster sheds are located on Crown land, with a group of them on the waterfront leased by the Imlay Oyster Growers (a sub-group of PLOG). It is the responsibility of all growers with sheds on Crown land to maintain and repair them. All PLOG with sheds on the waterfront will continue to ensure that rooves and gutters are regularly cleaned and maintained in order to control stormwater and therefore minimise erosion and sediment run-off into the waterway. They will also ensure appropriate disposal of oyster shells and other by-products and will keep the land-base sites tidy at all times.

6.2.1.2 Water and land lease tenure

Oyster cultivation requires both water and land bases. Currently PLOG have a 15-year agreement for their water-based areas. Approximately half of the Pambula growers have land bases on public land and until 2010, the leases for these land-based areas were renewed on an annual basis, resulting in business insecurity. Growers, through their national oyster committee, have recently successfully negotiated 20-year leases with the LPMA to address this lack of security.

6.2.1.3 Visual pollution and aesthetics of oyster cultivation

PLOG are aware of the potential visual impact and aesthetics that oyster infrastructure can have, in particular at low tide when oyster cultivation units are exposed. In some cases, growers use additional structures around the end of the lease as wave breaking walls, particularly in areas with strong winds or boat wash due to high speed traffic. Although it is highly beneficial for protecting and improving oyster growth, this can have a significant visual impact. PLOG will ensure that oyster leases remain tidy and as uniform as possible, complying with the NSW OISAS. This strategy outlines the criteria for acceptable lease materials and maintenance as well as visual amenity. PLOG will develop educational materials covering this aspect of their operations for public display and distribution in the community.

6.2.1.4 Faulty oyster infrastructure

Oyster cultivation units must be made of materials that will last in the marine environment. As infrastructure and cultivation methods age, there is a high probability of breakage which could lead to navigational hazards and accumulation of faulty infrastructure littering the shoreline of Pambula Lake. In particular, modern cultivation units have floating devices which can drift if they become unattached. Consequently, PLOG will undertake frequent maintenance checks of the

water infrastructure, will organise annual shoreline clean-ups and will tag cultivation units for easy identification in order to ensure a prompt response.

6.2.1.5 Communication between industry groups

PLOG are concerned about the poor communication between oyster growing industry areas in NSW and other states. Oyster growers attend industry events only infrequently despite these events providing good networking opportunities for growers to share ideas, experience and knowledge. These events also promote partnerships between the oyster industry and fishery groups, NSW Farmers Association, oyster consortia, research groups and government, which opens avenues for these groups to work together to achieve positive environmental, economic and positive social outcomes. Establishing formal meetings and strong networks will benefit the Pambula Lake oyster industry by providing the latest information on such things as research, farming methods, funding sources and training opportunities. Joining existing industry-related associations (such as NSW Farmers Association), industry newsletters (such as NSW DPI, ARAC, Seafood CRC, FRDC) and attending industry-related conferences such as the Australasian Aquaculture Conference, will provide additional forums for wider communication and as valuable sources of fresh ideas.

In order to improve the communication of PLOG with other members of the industry, this group will explore the cost of establishing and maintaining a website, will put together a list of programs and events for at least one member of their group to attend and will ensure that PLOG have a representative at the NSW Farmers Association. To improve internal communication within the Pambula Lake oyster industry, a notice board will be erected at the sheds so that growers have easy access to the latest news.

6.2.2 External activities

Through the risk assessment process, no medium level risk activities impacting the Pambula Lake oyster industry were found for external activities.

6.3 Low risks

This section lists the 'low risks' impacting the Pambula Lake oyster industry as per the risk matrix (Appendix 5). Risk values that ranked between 1 and 2 are considered 'Acceptable' with no specific control measures needed at this stage. The management response for these types of risks requires a short justification which has been included in the risk assessment table (Appendix 6). PLOG have identified these activities as potential sources of risk in the future if current conditions change, and include the following.

6.3.1 Industry-related activities

- Insufficient communication with community and stakeholders.
- Inappropriate boat handling and driving by industry members.
- Overuse of tap water while opening and selling opened oysters.

- Careless fuel storage in land-based areas.
- Impact on seagrass beds from oyster operations.
- Inadequate maintenance/clean-up of derelict oyster leases.
- Insufficient maintenance and checks of oyster vessels.
- Impact on migratory bird habitat from oyster operations.

6.3.2 External activities

No low risk activities were found through the risk assessment for external activities impacting the Pambula Lake oyster industry.

6.4 EMS implementation

6.4.1 EMS Review

This EMS documents an ongoing process of environmental management and therefore requires periodic review to ensure that the main objectives are still relevant and adequate, and actions are being maintained or introduced in line with the relevant responsibilities, timeframes and targets. The EMS will be reviewed annually at a PLOG meeting. The 'best practice' benchmarks may change from year to year in line with changes in production technology and consumer demands.

6.4.2 EMS report distribution

The EMS report will be made available to stakeholders on request and to stakeholders who have commented on or shown interest in the operations of PLOG, or groups cited in the document in relation to activities ranked as 'high risk' and potentially impacting the oyster industry.

PLOG will ensure that stakeholders are informed of progress in the implementation of the EMS and are also given the opportunity to comment on the environmental management of their operations. Open and frequent communication is one of the main aims of this EMS. The EMS is a forum for natural resource managers and the community to obtain information about the environmental management of the industry and for PLOG to work with these stakeholders on the ongoing development/implementation of environmental management initiatives.

6.4.3 EMS compliance

This EMS is not enforceable by law. It is a voluntary commitment to document and maintain environmental best practice by the PLOG.

Incidents where PLOG fail to reasonably comply with the EMS will be recorded and investigated. Failures may be:

- Intentional or unintentional;
- An indication of inappropriate policy or actions in the EMS;
- Due to highly unusual circumstances; or
- Some combination of the above.

Responses may include no action, a review of the EMS and/or training for the PLOG. Any EMS contravention will be noted in the following EMS report.

PLOG cannot be held responsible for the actions of oyster growers within this lake who are not part of the PLOG or oyster growers in other estuaries. However, PLOG will encourage all growers operating in the area to work with the duty of care outlined in this EMS.

7 BENEFITS OF THE EMS

PLOG are implementing a system that will help to:

1) Care for the environment;
2) Secure optimum oyster growing conditions; and
3) Inform regulatory agencies, the community and consumers about the industry's management framework and future aims.

Well before this process started, oyster growers were already involved in many monitoring programs and research activities for the benefit of both the industry and the environment. This EMS recognises and highlights these important activities, some of which are already benefiting the wider catchment community. In summary, the benefits of both the ongoing and future activities discussed in this EMS are:

- Transparency of environmental performance;
- Environmental programs implemented in Pambula Lake which provide for ongoing collection of information that will allow the measurement of environmental changes over time eg water quality;
- Maintenance of and improvement to market access through a form of eco or environmental labelling in line with the EMS and its outcomes. This is particularly relevant for export markets as countries place restrictions on imports that do not come from environmentally-certified production systems;
- Improving industry morale and sense of stewardship;
- Increasing the profile of the industry with the aim of enhancing community support for it; and
- Increasing dialogue with the community, customers, suppliers and regulatory and research bodies.

8 APPENDICES

APPENDIX 1: PAMBULA LAKE OYSTER GROWERS COMMITMENT

In partnership with Southern Rivers CMA, Oyster growers from Pambula Lake have developed this EMS for their industry. The following list has been compiled to document those members who agree to uphold their responsibilities under the environmental commitment and action plan described in this EMS.

Name / Business	**Signature / Date**
Allan, P (PA)	
Baker A & K (AB)	
Boyton C (CB)	
Brunette, G (GB)	
Burton, B (BB)	
Carton, G (GC_1) & McIntyre, S (SMcI)	
Comerford, G (GC_2)	
Dawson, J (JD) & G (GD)	
Dwyer, T (TD)	
Ferguson, P (PF)	
Gill, Neil (NG)	
Hansen, M (MH)	
Martin D & B (DM)	
McIntyre, A (AMcI)	
McIntyre, RG (RGMcI) & EA (EAMcI)	
McKay, J (JMcK)	
Mills B (BM^1) & M (MM)	
Moore, J & J (JM)	
Moorey, B (BM)	
Simmons, G (GS)	
Skeers, P (PS)	
Tynan R (RT) & C (CT)	
Whatman, P (PW)	
Wood, B (BW)	
Young, M (MY)	

APPENDIX 2: EMS DEVELOPMENT

Over some years, Pambula oyster growers have been involved in a series of projects in the catchment that aim to protect the environment and enhance water quality but growers also aim to maintain a secure and sustainable oyster industry in Pambula Lake. At the 2008 Annual Oyster Field Day, environmental awards were announced and the Clyde River Farmers Cluster Group received an award for the implementation of their EMS in the estuary two years before. Growers had worked in collaboration with the Department of Lands and Southern Rivers CMA on various sediment control, clean-up and revegetation projects. This award resulted in great interest from the oyster growers of the Far South Coast. Because of this interest, the Southern Rivers CMA organised a workshop with Dr Ana Rubio, one of the coordinators of the development of the Clyde River EMS, Mr Kevin McAsh and members of the Far South Coast oyster industry. At the workshop the idea of an EMS was explained together with how it was developed and implemented in the Clyde River and how it could benefit oyster growing enterprises.

Pambula growers recognised the benefit of an EMS for Pambula Lake and moved forward with the initiative, receiving funds from the Australian Government's National Heritage Trust through the Southern Rivers CMA to develop it. These funds were used to engage Dr Ana Rubio to assist with the development of the EMS. Dr Rubio has been involved with the NSW oyster industry for six years, four of which while undertaking a PhD on environmental influences on the sustainable production of the Sydney Rock Oyster. Most of Dr Rubio's research took place in the Clyde and Crookhaven/Shoalhaven Rivers.

The actions outlined in this EMS have been developed to allow growers to continue their individual methods of farming oysters as long as the overall environmental objectives described in the EMS are met. For instance, not all of the operational requirements listed in the Action Plan will be applicable to all growers: some growers may already be using alternative practices that achieve the same environmental aim.

The EMS is compiled with regard to *AS/NZS ISO 14001:1996 Environmental management systems – Specification with guidance for use (Standards Australia 1996),* the Australian and New Zealand guidelines which meet international standards. An EMS is defined by the ISO as 'the part of the overall management system that includes organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy".

The following steps were, or will be, followed in the development and implementation of this EMS.

1) An initial one-day, onsite workshop explaining the concept of an EMS, the benefits of operating under such a program, and what steps are required for initial implementation.
2) A one-day site visit carried out to perform an environmental audit and identify operational and infrastructure risks for the Pambula oyster enterprises. At least 80% of the Pambula Lake Oyster Growers were consulted at an individual level.
3) A third day dedicated to explaining the concept of an environmental risk matrix, how it is developed and its operational implementation. Growers then ranked risks and planned additional measures to implement in upcoming years. Actions related to high risks were implemented immediately.
4) Report on progress of implementation process.
5) Final report to Southern Rivers CMA, including an Executive Summary, on the benefits of the EMS to the industry and how the industry is addressing the high risks. This document will be made public and will be used to promote the profile of the industry as a whole.

The Seafood EMS Chooser (Seafood Services Australia, 2005) was used through the process.

Figure 14: Eight easy-to-follow steps of the EMS (Source: Seafood Services Australia, 2005)

1. **Planning:** identifies the scope of the EMS, major environmental impacts and develops a set of objectives

2. **Implementation & operations:** puts in place a set of procedures for the achievement of the identified targets.

3. **Checking & corrective action:** monitors the success of the EMS and implements corrective measures where protocols are not being followed or the system is in some way deficient

4. **Management review:** review the EMS and the degree of achievement of the goals that were created in the context of the environmental policy.

APPENDIX 3: DISTRIBUTION AND CONTENTS OF SHELL MIDDEN DEPOSITS ON PAMBULA LAKE

Sites noted by Anderson (1890), numbered 1-17, and additional sites Sullivan (1981), A-D

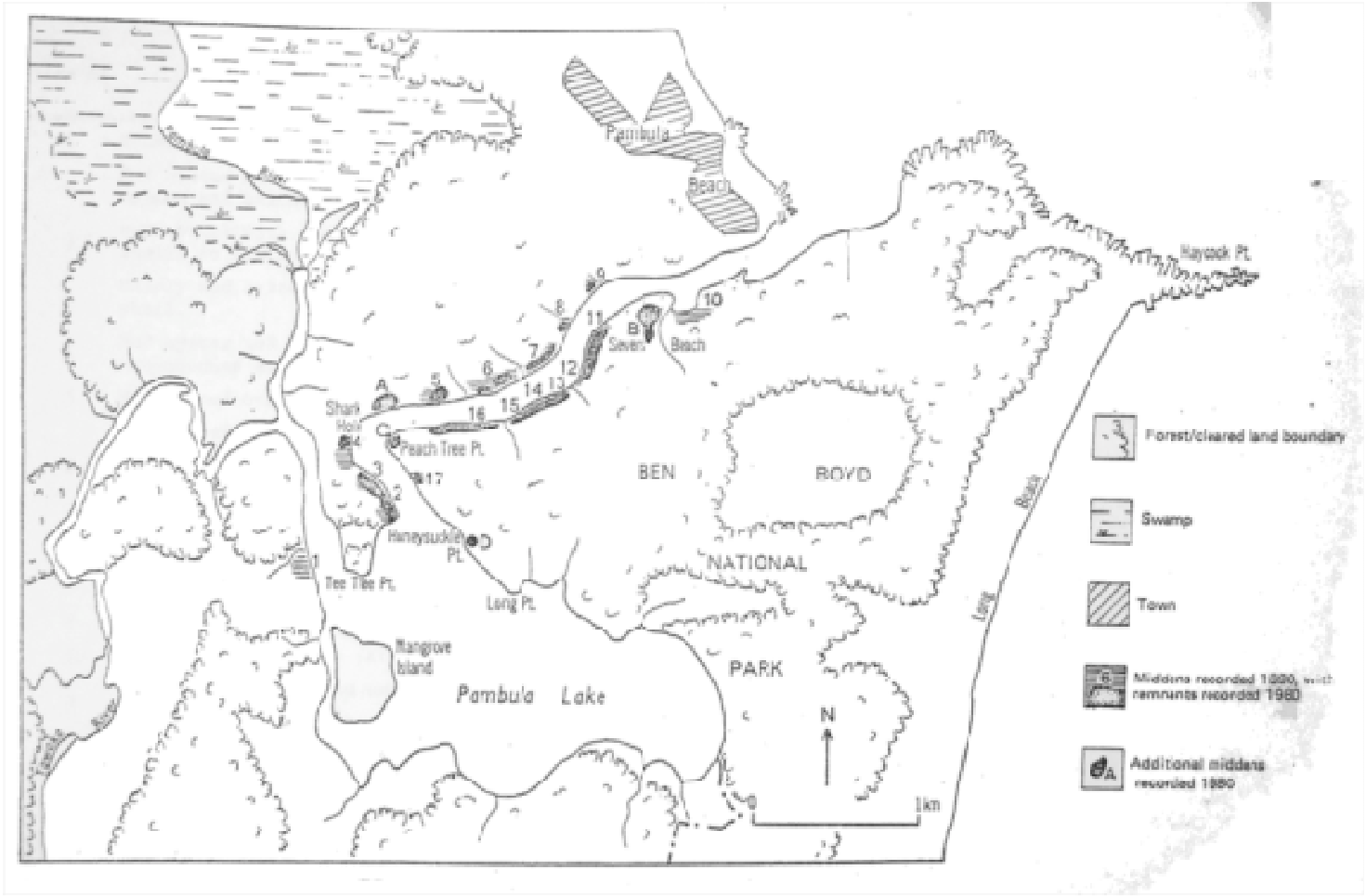
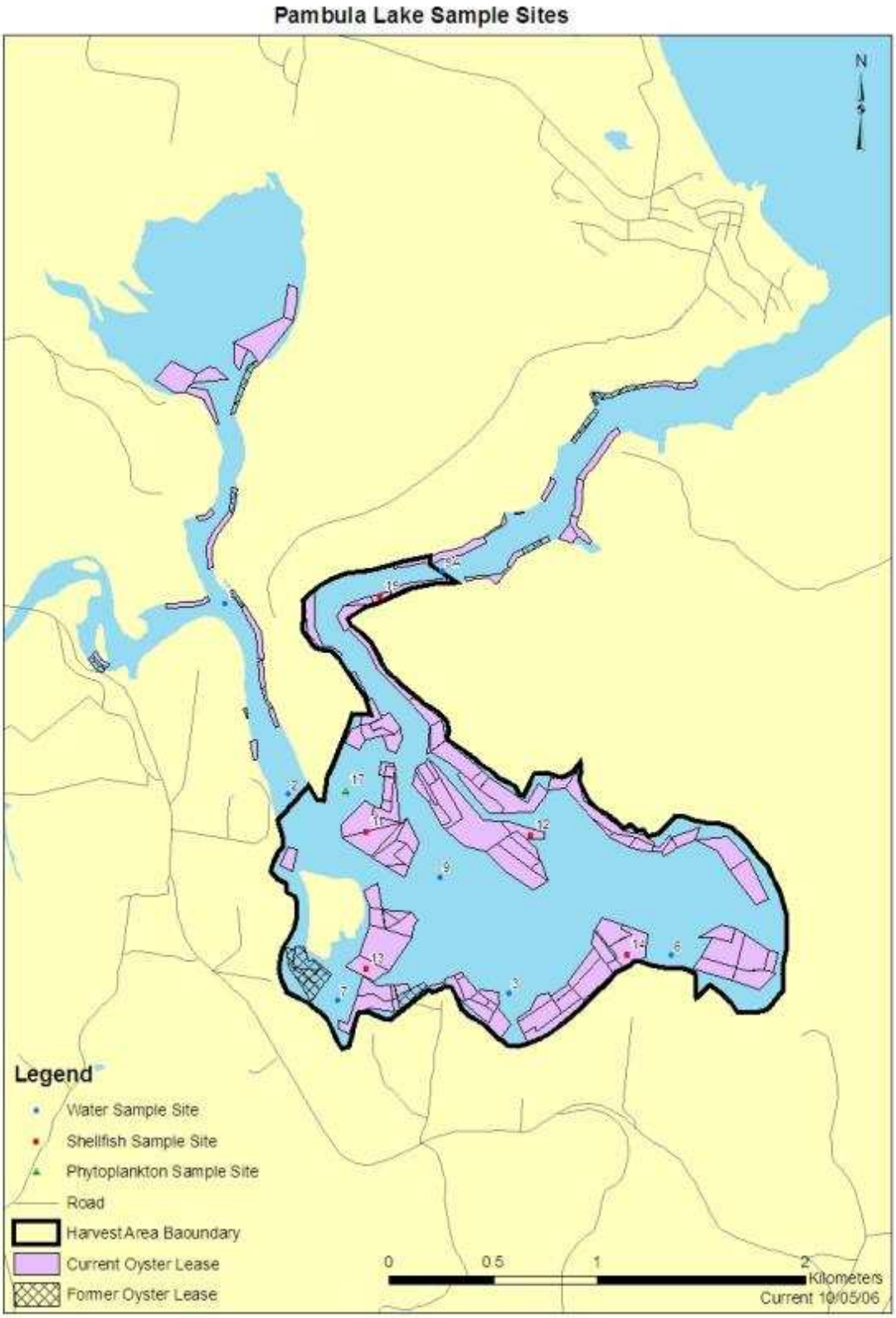


Table 2 Shell midden deposits on Pambula Lake

Site no.	Site contents	Approx. volume (m^3) 1980	Estimated approx. volume (m^3) 1890
1	Cockle and mud oyster shells in patches on hillslope.	5	500
2	Mud oyster with some cockle, rock oyster and mud whelk shells in mounds and patches.	500	500
3	Mud oyster with cockle, mud whelk, rock oyster and some rock platform shells in six mounds. Chipped stone noted.	3,000	3,000
4	Mainly mud oyster shells in a single mound with adjacent scattered shell.	100	100
A	Mud oyster and rock oyster shells in a single mound and associated non-mounded deposits.	40	Not recorded Minimum 40
5	Mainly mud oyster shells exposed in six well vegetated mounds.	300	300
6	Mud oyster shells with cockle, rock oyster, mud whelk and mussels (*Mytilus planulatus* and *Trichomya hirsutus*) and stone fragments in a deposit built up into break of slope at base of hill. Some scattered shell.	6,500	7,000
7	Mud oyster shells exposed in four oval mounds on headland.	2,000	2,000
8	Mainly compact mud oyster shells in a mound on headland with adjacent scattered shell.	1,000	1,000
9	Mainly mud oyster shell in three small steep mounds on headland.	100	100
10	Mud oyster shells in patches remaining from a disturbed mound.	10	700
B	Mainly mud oyster and mussel shells in a complex of mounded and non-mounded deposits.	20,000	Not recorded Minimum 20,000
11-16	Continuous deposits of mainly mud oyster shells along shoreline and on hillslopes, more concentrated on western sides of small gullies.	20,000	20,000
C	Mainly mud oyster shells in four mounds on lower slopes of headland.	1,500	Not recorded Minimum 1,500
17	Mainly mud oyster shells in a mound and surrounding deposit. Some scattered shell.	60	60
D	Mainly mud oyster shells in a mound and surrounding deposit.	50	Not recorded Minimum 50

(Source: Sullivan, 1981)

APPENDIX 4: DIRECT HARVEST MAP & OPERATIONAL PROCEDURE FOR PAMBULA LAKE



Source: NSW Food Authority

Revised February 2007

Pambula Lake Harvest Area
(Conditionally Approved)
Pambula River
Operation Under Rainfall Conditions

Special and Routine Testing

Rainfall & Salinity Criteria

Rainfall of 30 mm or more in 48 hours or 50 mm or more (7 days) or salinity less than 28 ppt.

Yes →

Harvest Area Closed
AQIS notified (les.johns@aqis.gov.au) Following cessation of rainfall measure salinity at Site 2. If salinity at mid ebb tide is at least 27 ppt (28 ppt recommended) proceed with sample collection.

No

No Action
Harvest area remains open for direct harvest.

Sample Collection

Collect water samples from all sites.
Collect oyster samples from all sites.
Submit to a NATA laboratory for bacterial testing.

Lab Results

1. Water Samples (MF) - presumptive faecal coliform count

2. Oyster samples (DPM or MPN) - confirmed *E coli* levels.

Routine Testing
5 rounds of testing in the open status under adverse conditions are required to maintain classification.
Adverse includes:
Rainfall 20-29 mm 2 days
30-49 mm 7 days
January or Easter holidays
(Limit to 1 per year where possible).

Repeat Sample Collection Protocol

No

Results are not acceptable

Acceptable Results

1. Water - all samples collected within the harvest area must demonstrate results of less than 14 cfu/100ml
2. Oyster - all samples will be <2.3 *E coli*/g (DPN or MPN)

Yes

All results and environmental conditions acceptable

Direct Harvest Resumes
AQIS notified of opening.
Keep under review subject to further adverse conditions

Notes:

1. Rainfall is measured at Pambula and reported by the Bureau of Meteorology
2. Formal closure and re-opening of harvest area is the responsibility of the NSW Food Authority.
3. NSW Food Authority will enforce closure of the harvest area.
4. It is the responsibility of each farmer to ensure that the area is open prior to harvest.
5. **Salinity is measured on mid ebb tide at Site 2.**
6. **Required water sites are 1, 2, 3, 5A, 6, 7 & 9.**
7. **Required shellfish sites are 11, 12, 13, 14 & 15.**
8. **Required phytoplankton site is 17. Sample on incoming tide as oceanic water arrives at the Broadwater.**
9. The NSW SP and PRSP Coordinator will liaise regarding environmental conditions and sampling arrangements.

APPENDIX 5: RISK RATING – LIKELIHOOD AND CONSEQUENCE VALUES

Likelihood ranking

Likelihood	Score	Definition
Rare	Low (1)	May occur in exceptional circumstances, ie. once every 10 years
Possible	Moderate (2)	Uncommon, some evidence to suggest this may occur , i.e once in 1-3 years
Likely to occur	High (3)	Highly probable to occur in most circumstances, i.e. 2-4 times a year

Consequence ranking

Consequence	Score	Definition
Minor	Low (1)	Insignificant or minimal impact on structure/function dynamics. Unlikely to measure from the existing natural background variability
Severe	Moderate (2)	Maximum appropriate/acceptable level of impact on environment (recovery months/years)
Major	High (3)	Very serious impacts now occurring with relatively long time frame and/or permanent/irreversible damage or loss (recovery years/decades/unlikely to ever be fixed)

Risk Matrix

	Consequence		
Likelihood	**Minor (1)**	**Severe (2)**	**Major (3)**
Rare (1)	1	2	3
Possible (2)	2	4	6
Likely to occur (3)	3	6	9

Management Response

Risk Level	Description	Reporting	Likely Management
Low (1-2)	Acceptable - no specific control measures needed but recommendable	Short justification needed	None specific
Moderate (3-5)	Acceptable - with current risk control measures in place	Full performance report	Specific response required (Continue current arrangements)
High (6-9)	Not desirable - continue strong management action - new or further risk control measures to be introduced in near future	Full performance report	Immediate / Specific response with urgency

APPENDIX 6: RISK ASSESSMENT TABLE FOR PAMBULA LAKE

Risks have been organised based on high priorities and split into 'Industry-related risks' and 'External risks'.

Responsibility:

Initials correspond to names of growers from Appendix 1.

Additional initials: HD, Helen Davies (Southern Rivers CMA); AR, Ana Rubio (consultant scientist); PLOG: Pambula Lake Oyster Growers.

Where the action is the responsibility of PLOG this implies all growers committed to this EMS are expected to contribute to the action.

All actions will be reviewed at the AGM audit session and if achieved will be moved to Appendix 7, or risk level modified accordingly.

Industry-related risks

Activity	Risk description by event or cause of risk	Potential Impact	Current Control Measures	Further measures/ Actions	Performance Indicators	Responsibility	Time-frame	Like'hd	Cons.	Risk Level
Disposal of old infrastructure (6.1.1.1)	Non-optimal disposal of old/damaged infrastructure	1. Use of limited landfill resources 2. Chemical leakage if tarred infrastructure stored for long periods in an area	Clean-up programs organised & funded by SRCMA	Organise periodical clean-ups (hire of a skip bin). This action will target: 1. Lease clean-ups 2. Shoreline clean-up (all growers). Funds through QAP	Reduction in disposal to landfill. Reuse and recycle as much as possible	PS	Once a year (in winter)	3	3	9
Oyster operations - stocking densities (6.1.1.2)	Reduction in oyster productivity (growth & condition)	1. Depletion of food resources 2. Increased oyster disease (easy transfer) 3. Reduced oyster growth rates, longer period to reach market size	1. Good husbandry based on common sense -- no related regulations 2. Stocking based on knowledge and experience of previous oyster farmer generations	1. Aim to set up a monitoring program that results in a map of the lake based on available food levels (i.e Chlorophyll-a levels). Obtain instrument to measure Chl-a. Use samples collected as part of QAP. 2. Set-up stock control system 3. Revise OISAS guidelines	Optimal oyster growth through appropriate stocking levels	(1) AR (to liaise with SMcI & JD) (2) RT (3) AMcI & NG	1-3 By next AGM	2	3	6

Activity	Risk description by event or cause of risk	Potential Impact	Current Control Measures	Further measures/ Actions	Performance Indicators	Responsibility	Time-frame	Like'hd	Cons.	Risk Level
Visual pollution and aesthetics of oyster leases (6.2.1.3)	Bad community perception due to exposed oyster infrastructure	Negative attitude of community to oyster farming	OISAS guidelines	1. Confirm Fisheries and OISAS guidelines 2. Management of leases to keep clean 3. Education program for public	Community support for industry	(1) AMcI (2) PLOG (4) AB & SMcI	1-3 by next AGM	2	2	4
Faulty oyster infrastructure (6.2.1.4)	Shoreline accumulation of old oyster infrastructure	Accumulation of oyster products on shoreline - visual pollution	1. Regularly check soundness of infrastructure 2. Repair damage as soon as problem is observed	1. Annual shoreline patrols to collect float away infrastructure 2. Equipment tagged for easy identification of owner	Minimum number of navigational accidents and minimal visual pollution	PLOG	Current & on-going	2	2	4
Industry communica-tion (6.2.1.5)	Poor communication within NSW oyster industry and between States	1. Slower industry development 2.Miss out on industry related opportunities - lack of sharing of ideas and successes 3. No communication pathways with authorities and related agencies	Infrequent communication between oyster groups	1. Organise a web site for Pambula Lake Oyster Growers 2. Put together a list of programs/events for at least 1 Pambula grower to attend (e.g. Seafood Leadership Program; Australasia Aquaculture Conference) 3. Establish links with governmental centres and organisations for specific issues	Increase network paths across industry & participation in oyster events	(1) GC1 (2) PLOG (3) PLOG	By next AGM	2	2	4
Oyster growers communica-tion (6.2.1.5)	Poor communication within oyster growers in Pambula Lake	1. Slower industry development 2. Lack of integration for Pambula Lake oyster industry	Infrequent formal meetings	1. Separate activities that are non-QAP and set-up new account for PLOG 2. Obtain quote for set up a webpage for PLOGrs – set up the website ASAP 3. Erect a notice board for growers at land-base site	Increase communicatio n flow among growers	(1) SMcI and EAMcI (2) GC1 (3) SMcI & MM	(1) By next AGM (2) By next AGM (3) by next AGM	2	2	4
Buildings (oyster sheds) (6.2.1.1)	1.Deterioration of sheds and untidy appearance 2. Stormwater run-off/localised	1.Visual impact and aesthetics 2. Waterways contamination	1. Utilise appropriate building materials to minimise visual impact.	Continue current control measures 1. Maintain and clean roofs, gutters 2. Remove any redundant	Buildings and surrounds are maintained at all times	(1-3) PLOG (4) Imlay Oyster Producers	Current & on-going	3	1	3

Activity	Risk description by event or cause of risk	Potential Impact	Current Control Measures	Further measures/ Actions	Performance Indicators	Responsibility	Time-frame	Like'hd	Cons.	Risk Level
	erosion		2. Grounds / facilities kept well maintained/ tidy	material or equipment from premises 3. Biannual building maintenance check 4. Install new guttering, leafguard and rain tank						
Interaction with community & stakeholders (6.3.1)	Poor oyster industry representation in catchment activities	EMS Action Plan might not progress	Oyster growers are participants of the Estuary Management Committee	Keep active involvement with these groups Seek new volunteers from time to time	Oyster industry present in catchment committees	PLOG	Current & on-going	1	1	1
Boat navigation (6.3.1)	Navigation over seagrass beds	Loss or damage of seagrasses reducing habitats of juvenile fish and other animals, sediment stabilisation	Lift engine so no entanglement occurs	1. Monitor seagrass growth and extension 2. Continue with current control measures	Minimal seagrass damage	PLOG	Current & on-going	1	2	2
High boat speed by oyster boats (6.3.1)	High impact boat wash - erosion of shoreline	1. Loss of habitat 2. Destruction of ecologically sensitive areas in particular Aboriginal shell middens)	Low speed close to sensitive and ecologically important areas	Continue implementing control measures Assess whether to put up signs "No wash"	Compliance with low speed Minimal boat wash	PLOG	Current & on-going	1	1	1
Fuel Storage (6.3.1)	Fuel and oil spills from oyster shed	1. Contamination of ground and/or waterways 2. Fire risk 3. Loss of surrounding habitat	1. Fuel is stored in a safe area 2. Only small amounts of fuel are kept in sheds	1. Identify a suitable area for centralized, properly equipped fuel storage 2. Put up signs - 'No smoking/ Fuel' where fuel is stored	Minimal, if any, spills and/or contamination	PLOG	Current & on-going	1	2	2

Activity	Risk description by event or cause of risk	Potential Impact	Current Control Measures	Further measures/ Actions	Performance Indicators	Responsibility	Time-frame	Like'hd	Cons.	Risk Level
Tap water usage while washing oysters and equipment (6.3.1)	Overuse of fresh water	1. Misuse of water resource 2. Unnecessary cost	1. Limit usage to only necessary action 2. Use low flow and high pressure hose fittings 3. Ensure that taps do not leak	1. Regular maintenance of water taps 2. Continue with current control measures	Minimal water usage	PLOG	Current & on-going	1	1	1
Derelict leases (6.3.1)	1. Inappropriate disposal of tarred or treated timber 2. Navigational hazard 3. Available substrate for feral oyster species and other fouling oyster species 4. Visual impact	1. Potential chemical leaching into waterways 2.Boat accident 3. Unmanaged fouling practice 4. Public sentiment against oyster industry	1. Appropriate disposal of tarred products in DECC approved and controlled land fill sites 2. Keep up maintenance/clean up leases	Reuse materials were able	No derelict lease	PLOG	Current & on-going	1	2	2
Inefficient motors & water pumps (6.3.1)	1. Fuel and oil pollution 2. Noise pollution	1.Reduce water quality 2. Impact on wildlife (birds) 3. Irritate water neighbours	1. Minimise use of outboard motors 2. Regular maintenance of oyster vessels 3. Most engines kept in good shape	1. When outboard motors need replacing, will source motors that conform to EPA regulations for noise and emissions. 2. Follow OISAS recommendations (7.9)	All boat engines conform to EPA	PLOG	Current & on-going	2	1	2
Recreational fishers and other water users, tourist boats (6.1.2.1)	1. Mooring to oyster leases 2. Navigation over oyster infrastructure	1. Loss/damage of oyster infrastructure	Small prints of NSW DII Fisheries signs for lease posts	1. Large prints of NSW DII Fisheries signs to hang on major lease posts- get a quote. Liaise with Wapengo oyster growers 2.Organise an information poster/board on oyster leases and EMS to locate at boat ramp	Minimal lease infrastructure damage	AB	Next AGM	3	3	9

External risks

Activity	Risk description by event or cause of risk	Potential Impact	Current Control Measures	Further measures/ Actions	Performance Indicators	Responsibility	Time-frame	Like'hd	Cons.	Risk Level
Rec fishers, other water users, tourist boats (6.1.2.3)	Boat wash (especially from large vessels)	1. Erosion of shoreline (in particular protected areas) 2. Impact on oysters – get washed to corner of cultivation – increases mortality 3. Potential capsize of heavily-loaded oyster punts		1.To liaise with NSW Maritime repeat offenders and more 'No-Wash' signs (also contact NPWS) 2. Monitor erosion and levels of sedimentation at 2 No-Wash zones (eg using posts) 3. Follow up studies on middens and the impact from ski boats and circulate results	Minimal boat wash and damage	(1) JD (2) JD (3) HD	(1,3) by next AGM (2) underway	3	3	9
Changes in geo-morphology (6.1.2.2)	1. Changes in natural sedimentation processes due to ocean processes and catchment activities	1. Change of water flow quantity/ direction 2. Change in food level availability for oysters 3. Shift of main navigational channels and lake's entrance	1. Monitor water level at entrance (through Manly Hydraulics Ltd Pty)	1. Related actions for unsealed roads/run-off, food levels (chl-a) & oyster stocking densities 2. Liaise with NSW Maritime to relocate marker locations in lake 3. Obtain MHL hydro-survey results 4. Investigate options for monitoring and maintaining entrance (e.g. student, BVSC) 5. Investigate alternative cultivation/operations processes if changes in water level	Minimal sediment impact/change Preparedness if there is change	(2) GC1 & JD (3) HD (4) BM to monitor mouth (5) PLOG	(2) By next AGM (3) By Dec-09 (4) 2011 (5) 2011	3	3	9
Pest species & other fouling species (6.1.2.5)	1. Enhancement of exotic & fouling species settlement, growth and dispersion on oyster infrastructure 2. Transfer of pests	1. Competition for food sources by pests & fouling species 2. Oyster mortalities (from for example, Green shore crab) 3. Impact on overall aquatic ecosystem	1. Growers have been trained on pest species identification & are taking part in pest monitoring programs 2. Use of oyster shipment logbook	1. Lease clean-up of Pacific Oysters before Christmas - reproduction season 2. Collaborate with Green Shore Crab officer from Marine Discovery Centre (eg keeping record sheets) 3. Investigate boat	Management and control of fouling and other pest species	(1) TD (2) HD and PLOG (3) HD	1-3 by next AGM	3	3	9

Activity	Risk description by event or cause of risk	Potential Impact	Current Control Measures	Further measures/ Actions	Performance Indicators	Responsibility	Time-frame	Like'hd	Cons.	Risk Level
	& fouling species between sites/estuaries		and Pest & Disease Control Program by NSW DII Fisheries	management at other lakes e.g. wash down facilities at Wallagoot						
Loss of riparian vegetation from clearing and/or poor cattle infrastructure (6.1.2.4)	1. Increased sedimentation in waterways 2. Shore erosion due to livestock access to waterways and intertidal zone	1. Poor water quality 2. Loss of buffer zone along shoreline 3. Destruction of sensitive ecological habitats: mangroves and saltmarshes	Some areas in the catchment have been fenced off and re-vegetated with assistance of SRCMA	1. Education Program with landholders	Improved and maintenance of good water quality	(1) AB, SMcI & HD	(1) by next AGM	3	3	9
Deterioration of water quality (6.1.2.6)	1. Sewage pollution (eg from septic tanks, pipe leaks, manholes) 2. Effluent of untreated sewage entering waterways (eg from vessel holding tanks) 3. Disturbance of acid sulfate soils or areas of heavy metals accumulated in sediment	1. Contamination of waterways - closure of harvest area, unsafe oyster consumption 2. Water acidification and/or chemical pollution - oyster mortalities, reduced production	1. Shellfish Quality Assurance Program & Community monitoring program 2. Involved in Council Coastal Committee (meetings every 3 months) 3. Awareness of BVSC Council Septic Safe Program	1. Continue with current monitoring activities 2. Liaise with other Bega Valley oyster growers to assess the need for an extension officer/growers rep who will maintain water quality program and other activities. Develop position description and calculate funding required 3. Follow-up seagrass community monitoring sampling technique with consultant Nick Ye	No closures, No pollution of waterways	(1) PLOG (2) SMcI & GC1 (3) HD	(1-3) 2011	2	3	6

Activity	Risk description by event or cause of risk	Potential Impact	Current Control Measures	Further measures/ Actions	Performance Indicators	Responsibility	Time-frame	Like'hd	Cons.	Risk Level
Use of horticultural & agricultural products (i.e. fertilizers, pesticides) (6.1.2.8)	Chemical (nitrogen and phosphorous) pollution of waterways	1. Increased nutrient levels entering waterways - potential algae bloom 2. Poor water quality	EPA guidelines for spraying	1.Incorporate findings in educational program	Minimal chemical input in waterways	(1) AB & SMcI	(1) by next AGM	2	3	6
Boat antifouling by users of lake (6.1.2.7)	Chemical leachate into waterways due to industrial waste	1. Reduced water quality 2. Reduced oyster biological processes 3. Unsafe oyster consumption due to accumulation of heavy metals 4. Accumulation of chemicals in sediment	1. Heavy metal testing every 3 years	1.Continue with current actions 2. Gather and share updated information from ANU researchers (Sara Beavis & David Ellis)	No usage of antifouling substances	(1) PLOG (2) AR	(1-2) by next AGM	2	3	6
Unsealed roads (6.1.2.9)	1. Run-off into waterways 2. Dust pollution 3. Increased sedimentation in waterways	1. Reduction of oyster filtration - decreased production 2. Increased turbidity levels - lower water quality and pollution of waterways	Work in collaboration with SRCMA: identifying problematic roads, sealing roads, diverting run-off, vegetating road side/banks. Set up of Estuary Management Committee	1. Work with council & SRCMA to prioritise problematic areas. Undertake survey after rain 2. Set-up a community group (eg. Landcare) to help with these activities 3. Liaise with Forests NSW re logging roads in Pambula catchment	1. Problematic sites identified immediately after rain events 2. Minimal run-off into waterways	(1) GC1 JD, HD (2) GC1	(1) Next rain event (2-3) 2011	2	3	6

Activity	Risk description by event or cause of risk	Potential Impact	Current Control Measures	Further measures/ Actions	Performance Indicators	Responsibility	Time-frame	Like'hd	Cons.	Risk Level
Climate change (6.1.2.10)	1. Increased in water temperatures 2. Changes in rainfall patterns 3.Sea level rise 4. Acidification of waterways	1. Acidification could impact: a) oyster production by reducing calcification rates b) food sources (e.g. calcareous phytoplankton) as per above 2. Loss of Land-based buildings 3. Adaptation of oysters to new environment	Community monitoring program (establishing base line data)	Ask SOCo and researchers to concentrate effort on oyster lines resistant to climate change predictions	Environmental monitoring program set-up for base line data in order to identify drifts/variations in norm levels	RT	Ongoing	2	3	6

APPENDIX 7: ACTIONS COMPLETED BY PLOG SINCE 2009

Activity	Risk description	Potential Impact	Control Measure/s Implemented	Date Completed	Personnel involved	Follow up required
Disposal of old infrastructure (6.1.1.1)	Non-optimal disposal of old/damaged infrastructure	1. Use of limited landfill resources 2. Chemical leakage if tarred infrastructure stored for long periods in an area	Shoreline clean up	May 2010	PLOG, SRCMA, community members	Annual event
Visual pollution and aesthetics of oyster leases (6.2.1.3)	Bad community perception due to exposed oyster infrastructure	Negative attitude of community to oyster farming	Liaise with NSW Fisheries re: research on leaching effects from plastic infrastructure	November 2010	GC_1, Fisheries staff	No
Industry communication (6.2.1.5)	Poor communication within NSW oyster industry and between States	1. Slower industry development 2.Miss out on industry related opportunities - lack of sharing of ideas and successes 3. No communication pathways with authorities and related agencies	Ensure that Pambula Lake Oyster Growers have a rep in NSW Farmers Association – Representative from Merimbula Lake.	2010	Stirling Cullenward	No
Changes in geo-morphology (6.1.2.2)	1. Changes in natural sedimentation processes due to ocean processes and catchment activities	1. Change of water flow quantity/ direction 2. Change in food level availability for oysters 3. Shift of main navigational channels and lake's entrance	Liaise with NSW Maritime to relocate marker locations in the lake	2010	JD	No
Pest species & other fouling species (6.1.2.5)	1. Enhancement of exotic & fouling species settlement, growth and dispersion on oyster infrastructure 2. Transfer of pests & fouling species between sites/estuaries	1. Competition for food sources by pests & fouling species 2. Oyster mortalities (from for example, Green shore crab) 3. Impact on overall aquatic ecosystem	1. Organise lake shoreline clean-up for Pacific Oysters hot spots 2. Liaise with NSW DII as management of new floating technologies result in higher number of PO 3. Prepare a protocol: management and handling of inter-estuary oysters arriving to Pambula Lake document. Control measures outlined in OISAS	1. 2009 2. 2010 3. 2010 4. 2010	1. PLOG 2. TD and NG 3. GD 4. HD	4. Ensure signage installed

Activity	Risk description	Potential Impact	Control Measure/s Implemented	Date Completed	Personnel involved	Follow up required
			guidelines 4. Liaise with NSW DII in regards to management of Caulerpa (eg monitor. boats from other lakes eg Wallagoot boats , signs at boat ramp, oysters coming from Caulerpa affected lakes) - signage organised.			
Loss of riparian vegetation from clearing and/or poor cattle infrastructure (6.1.2.4)	1. Increased sedimentation in waterways 2. Shore erosion due to livestock access to waterways and intertidal zone	1. Poor water quality 2. Loss of buffer zone along shoreline 3. Destruction of sensitive ecological habitats: mangroves and saltmarshes	Survey of potential sites for rehabilitation funding in conjunction with unsealed roads – underway with development of Pambula River Rehabilitation Plan	2010-2011	Pambula Estuary and Catchment group, PLOG, SRCMA	Yes, river rehabilitation plan to be completed
Deterioration of water quality (6.1.2.6)	1. Sewage pollution (eg from septic tanks, pipe leaks, manholes) 2. Effluent of untreated sewage entering waterways (eg from vessel holding tanks) 3. Disturbance of acid sulfate soils or areas of heavy metals accumulated in sediment	1. Contamination of waterways - closure of harvest area, unsafe oyster consumption 2. Water acidification and/or chemical pollution - oyster mortalities, reduced production	Increase liaison with BVSC. Raise issue of Septic Safe Program at next Council Coastal Committee meeting	2010	GC_1	Yes, ongoing representation at Coastal Committee meetings
Use of horticulture & agriculture products (i.e. fertilizers, pesticides) (6.1.2.8)	Chemical (nitrogen and phosphorous) pollution of waterways	1. Increased nutrient levels entering waterways - potential algae bloom 2. Poor water quality	Obtain copy of guidelines (e.g. DPI) and BVSC monitoring programs on use of horticultural and agricultural products on farms and community gardens. Find out appropriate buffers to minimise impacts	2010	EMcI	Yes. Information to be circulated as part of education program – incorporate into Pambula Catchment project

Activity	Risk description	Potential Impact	Control Measure/s Implemented	Date Completed	Personnel involved	Follow up required
Boat antifouling by users of lake (6.1.2.7)	Chemical leachate into waterways due to industrial waste	1. Reduced water quality 2. Reduced oyster biological processes 3. Unsafe oyster consumption due to accumulation of heavy metals 4. Accumulation of chemicals in sediment	Follow up potential stormwater-related leachate from industrial waste. Check Council's State of Environment reporting for stormwater and industrial runoff. Raise issue at next Council Coastal Committee meeting	2010	GC_1	Yes, Ensure industrial waste incorporated into 'Relieving Drain Strain' stormwater education program
Unsealed roads (6.1.2.9)	1. Run-off into waterways 2. Dust pollution 3. Increased sedimentation in waterways	1. Reduction of oyster filtration - decreased production 2. Increased turbidity levels - lower water quality and pollution of waterways	Work with council & SRCMA to prioritise problematic areas – Nethercote Rd identified as issue, and works underway	2010-11	GC_1, JD, HD	Works to be completed in 2011.
Lease tenure on water and land based sites (6.2.1.2)	Insecurity of long term tenure (in particular for land bases)	Business insecurity	Successful negotiations with NSW LPMA for 20-year leases for land bases on public land	2010	National oyster committee	No

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