



Hastings River Oyster Farmers Environmental Management System

Version 1.7

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Acknowledgments

The Hastings River Oyster Farmers would like to acknowledge the outstanding effort that has been made by all in putting together this EMS, particularly those growers who spent many hours working through the process to develop the EMS. Special thanks to Northern Rivers Catchment Management Authority for funding this project and also to Department of Primary Industries Aquaculture Section and Port Macquarie-Hastings Council for their time and support in this process. This project has achieved many outcomes, but of most importance is the bringing together a large number of individual oyster businesses into a unique powerful group representing the Hastings River Oyster Industry to drive sustainable change for the Hastings River and its oyster industry into the future.

Comments

The term “Hastings River Oyster Farmers” refers to those growers that have undertaken this EMS process and committed to undertake best practices in the management of their local industry in order to maintain and improve the health of the Hastings River (see Appendix A- Commitment sheet).

This document is owned by the NSW Farmers Association Hastings River Branch Committee.

Our EMS is a living document that will be reviewed and updated every year. Please forward any comments you might have to the Hastings River EMS Coordinator (Mr Paul Wilson) on 0414 243 624 or portoyster@bigpond.com in order to be considered in the upcoming version of the document.

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1. INTRODUCTION

Hastings River Oyster Farmers recognise that they have a continuing responsibility to cultivate oysters on behalf of the community in a sustainable way through the adoption of best practice technology and techniques.

This Environmental Management System (EMS) provides a mechanism for the ongoing identification and management of environmental impacts, risks and opportunities for the Hastings River oyster industry. It is an industry-based initiative that seeks to contribute to the sustainability of oyster farming and the health of the Hastings River, as well as increase community understanding of cultivation methods used and the management and regulations that apply to the industry.

This EMS documents how Hastings River Oyster Farmers (HROF) are already meeting their regulatory obligations and are striving for best practice to continually improve their performance in light of new technologies and methods. It also documents how growers work with natural resource managers and the community to manage Hastings River estuarine resources in a sustainable way.

2. About this Environmental Management System

Our EMS was developed by oyster farmers in the Hastings River through a series of workshops between March 2010 and May 2011 with a facilitator, Anissa Lawrence from TierraMar Consulting. The project was a part of a broader project of the Northern Rivers Catchment Management Authority to assist coastal and marine resource users to develop and implement environmental best management practices across the Northern Rivers region.

This EMS has been developed in conformance to the International Standard *ISO 14001:2004 Environmental management systems -- Requirements with guidance for use*, using the Australian seafood industry EMS methodology available through the Seafood Services Australia Seafood EMS Resources.

2.1. SCOPE AND PURPOSE OF THE ENVIRONMENTAL MANAGEMENT SYSTEM

This EMS aims to:

- manage the identification and adoption of new techniques and technology to continually improve operations;
- provide a basis for the Hastings River Oyster Farmers to communicate and cooperate with natural resource managers and the community on the environmental management of oyster cultivation, the Hastings River and its catchment;
- document how the Hastings River Oyster Farmers are currently meeting their responsibility to operate sustainably and responsibly; and
- be a 'living' document that will be reviewed and updated annually to adapt and manage new risks and opportunities.

The scope of this EMS is limited to:

- the environmental aspects concerning all operations of the Hastings River Oyster Farmers; and
- the ways in which the Hastings River Oyster Farmers may work with other stakeholders on improving the environmental quality of the Hastings River, its tributaries and its catchment.

2.2. EMS IN RELATION TO OTHER MANAGEMENT MECHANISMS

This EMS has been designed to provide a mechanism for Hastings River Oyster Farmers to demonstrate environmental best practice with respect to oyster operations, as well as work with other natural resource managers to ensure the sustainable management and use of Hastings River estuarine resources. To that end the EMS does not replace, but rather complements existing laws, regulations and policies under which oyster farming and natural resource management in the Hastings River are controlled and managed, including:

- NSW Fisheries Management Act 1994;
- NSW Fisheries Management (General) Regulation 2002;
- NSW Threatened Species Conservation Act 1995
- Environment Protection and Biodiversity Conservation Act 1999;
- Environment Protection and Biodiversity Conservation Regulations 2000;

- NSW Marine Parks Act 1997;
- NSW Oyster Industry Sustainable Aquaculture Strategy 2006;
- NSW Shellfish Program under the NSW Food Act, 2003;
- Crown Land Act 1989;
- Marine Pollution Act 1987;
- Marine Safety Act 1998;
- Commercial Vessels Act 1979;
- Environmental Planning and Assessment Act 1979;
- Protection of the Environment Operations Act 1997;
- Northern Rivers Catchment Action Plan (developed by Northern Rivers Catchment Management Authority);
- Hastings River Estuary Management Plan (developed by Port Macquarie Hastings Council); and
- Other NSW and local government legislation and regulations.

Through this EMS, the Hastings River Oyster Farmers have made a commitment to implement the voluntary best practice standards outlined in Section 7 of the NSW Oyster Industry Sustainable Aquaculture Strategy (OISAS).

2.3. EMS REVIEW AND COMMUNICATION

This EMS is based on a framework of continuous improvement and to that end requires a regular review of progress to ensure actions are being addressed in accordance with the timetable established and that the EMS remains relevant and current, in line with emerging new technologies and best practice methods. On an annual basis, the owners of this document, the NSW Farmers Association Hastings River Branch will undertake a review of Hastings River Oyster Farmers performance against the EMS and update the document as required. The NSW Farmers Association Hastings River Branch will also as a part of this review process provide opportunity for the community and other stakeholders to provide comment on the performance of Hastings River Oyster Farmers against the EMS.

This EMS provides a forum for natural resource managers and the community to access information about environmental best practice management for Hastings River Oyster Farmers and for growers to work with these groups in the development of environmental initiatives to improve the sustainability of the Hastings River, its tributaries and its catchment. The NSW Farmers Association Hastings River Branch will provide progress updates to these groups from time to time to improve communication between all stakeholders. Refer actions 6.4.1 and 6.4.3 for more information.

2.4. EMERGENCY RESPONSE

The response of Hastings River Oyster Farmers to an emergency such as a major flood or outbreak of disease has been examined as a part of the risk assessment process. A number of actions have been identified to ensure Hastings River Oyster Farmers are well prepared and have a contingency plan in place for dealing with extreme events. Refer to action 6.2.9 for details.

Hastings River Oyster Farmers are unlikely to contribute significantly to water pollution. The importance of protecting and enhancing the habitats of the Hastings River have been identified through the risk assessment process. Actions that the Hastings River Oyster Farmers will undertake to ensure the ongoing protection and conservation of estuarine habitats includes working with Northern Rivers Catchment Management Authority and the local council to identify priority areas for onground works (action 6.1.1), working with key groups to identify potential solutions to control erosion and sediment input from oyster operations (action 6.1.2) and to maintain an extensive water quality monitoring program (action 6.1.5).

2.5. EMS CONTRAVENTION

This EMS is a voluntary commitment by the Hastings River Oyster Farmers to document, implement and maintain environment best practice management. It is not enforceable. All growers who have made this voluntary commitment have “signed on” to the EMS (refer Appendix 1) and in doing so have committed to implementing the actions identified in the EMS in accordance with the timetable established by them.

Where a grower(s) however fails to reasonably comply with this EMS, the incident will be recorded and investigated by the NSW Farmers Association Hastings River Branch. Failure to comply could be:

- intentional or unintentional
- an indication of inappropriate policy or actions within the EMS
- due to highly unusual circumstances; or
- a combination of the above.

Corrective actions applied could include a review of the EMS, training for the grower(s), or no action. Any EMS contravention will also be noted in the annual EMS review.

The Hastings River Oyster Farmers cannot be responsible for the actions of growers in other estuaries or for growers in the Hastings River who have not committed to follow the EMS. Hastings River Oyster Farmers will however encourage all Oyster Farmers operating within the catchment area to work with the same duty of care as outlined in the EMS.

3. OUR COMMITMENT

Hastings River Oyster Farmers are committed to uniting oyster growers in the Hastings River to pursue goals and outcomes of common interest and benefit to individual growers, businesses, the local community and the environment. This commitment has driven the development of this EMS.

Hastings River Oyster Farmers Environmental Policy

Our Vision

“To continue to be a leader in growing premium quality oysters and to monitor and maintain a high water quality standard for the Hastings catchment and the community to enjoy into the future.”

Our Environmental Policy

The Hastings River Oyster Farmers recognise that the Hastings River and its catchment are a shared resource.

The Hastings River Oyster Farmers will continually monitor for improvements in environmental best practice relevant to their operations and work to adopt them.

In addition to complying with all relevant regulations and management mechanisms the Hastings River Oyster Farmers will strive to meet the following objectives:

1. Protect and enhance the habitat of the Hastings River and its catchment.
2. Cultivate oysters in a sustainable manner - minimising resource consumption, waste production and pollution.
3. Recognise and protect the cultural and aesthetic values of the Hastings River and its catchment.
4. Conduct environmental management in a transparent and cooperative manner.
5. Contribute to scientific research and management innovation relevant to oyster cultivation and estuarine environments.

These objectives form the basis of our Environmental Action Plan found in Section 6.

4. ABOUT THE HASTINGS RIVER OYSTER FARMERS

The oyster industry is the largest aquaculture industry in NSW by production value (around 70%) and represents approximately 30% of NSW commercial fisheries production. The NSW oyster industry in 2010/2011 was worth \$50 million (DPI 2011), is the fourth largest aquaculture industry in Australia (the others being bluefin tuna, pearling and Tasmania salmon) and is also Australia's largest producer of edible oysters. Not only is it NSW's most valuable fishery, but it is one of the state's most valuable per hectare agricultural enterprises with long term gross average production up to as high as \$35,000 per hectare in some estuaries. Around 75% of all oysters grown in NSW are sold within the state, the remaining oysters being shipped to interstate markets.

The Hastings River has long history of oyster harvesting and cultivation beginning as early as the 1830's. There are currently 28 active oyster growers on 21 oyster Industry related land base tenures covering 114 ha in the Hastings River system. These are located in Limeburners Creek or Hastings River and consist of leases, expired leases on holding over provisions, licences and permissive occupancies. The greatest concentration of leases is in the lower Limeburners Creek and Big Bay area. Hastings River oyster production was worth \$1.5m wholesale valued in 2010/11 (DPI 2011) The Hastings also accounts for a large proportion of seed oyster production \$1.1m (DPI 2011). The average annual amount of oysters produced in the Hastings estuary is 266,497 dozen (DPI 2009b). The Hastings River is the third most productive river in terms of oyster production (dozen) on the north coast of NSW (DPI 2009a).

4.1. RECENT ENVIRONMENTAL ACHIEVEMENTS OF THE HASTINGS RIVER OYSTER FARMERS

Hastings River Oyster Farmers are committed to supporting their local community and demonstrating their environmental stewardship for the Hastings River and its catchment. Many of our members are actively involved in local community groups and activities. Several of our members have also served in the Volunteer Rural Fire Service for many years. Hastings River Oyster Farmers have also improved operations and increased environmental awareness through the uptake of new technologies and techniques.

In 2008 the NSW Farmers' Association Hastings River Branch in partnership with the Port Macquarie Council received at the NSW Oyster Industry Environmental Championship Awards a Highly Commended Award for acid sulphate soil and acid drainage remediation, as well as the Commendation Award for our Clean-up Australia Day activities.

Over many years the Hastings River Oyster Farmers have been involved with the Clean Up Australia campaign and use that opportunity to clean up the waterways in the estuary.

Concerned about water quality (associated with pollution/stormwater) and periodic bouts of oyster mortality, the local farmers employed scientists to substantiate claims that acid sulphate run off into the river was detrimental to marine life. Our efforts were vindicated when the government allocated grants to complete the research and commence rehabilitation of the offending floodgates and education of landowners. The work done on the Hastings River has been a catalyst for remedial works nation wide on how to deal with acid soil.

Oyster farmers sit on many committees that oversee environmental concerns affecting the River, and regularly have input planning in the Hastings catchment. From landfill sites, sewage treatment plant sites, storm water catchment, agricultural run off from farming and plantation industries, dredging, ship yard pollution, pump out stations, riparian zone fencing

and many other issues, the oyster industry has representation. Oyster farmers play an important ongoing stewardship role in monitoring and reporting estuarine ecosystem health in partnership with relevant authorities, e.g. NSW Food Authority.

4.2. SYDNEY ROCK OYSTERS (*SACCOSTREA GLOMERATA*)

The Sydney rock oyster is endemic to Australia and is found in bays, inlets and sheltered estuaries from Harvey Bay in Queensland south to Wingan Inlet in eastern Victoria (AFR, 1993). It is capable of tolerating a wide range of salinities and occupies the intertidal zone to 3m below the low water mark. Within this range they are common on hard rocky substrates but can survive and grow on soft substrates (AFR, 1993).

Sydney rock oysters generally spawn in summer. Peak spawning usually occurs at water temperatures of 26° C plus and time of spawning varies between localities (AFR, 1993). The main spawning season in the Hastings River is from December to March. Oysters are termed 'broadcast spawners', as their male and female gametes are released into open water, where fertilisation occurs. Within hours of fertilisation the eggs develop into free-swimming planktonic larvae (AFR, 1993). The larvae swim in estuarine and coastal waters for up to 3 weeks during which they develop transparent shells and a retractable foot. The larvae then settle on a clean substrate using the foot to find a suitable site. The foot is resorbed once the larvae are attached, the shell darkens and the small animal takes on the appearance of an adult oyster (AFR, 1993). Settled, footless oyster larvae are known as 'spat'. Adult oysters are sessile, i.e. they are fixed to the substrate.

Growth rates vary with local conditions but generally Sydney rock oysters reach 40–60g in 3-4 years, with spawning first occurring at 1 year of age. Sydney rock oysters change sex during life and first function as males but later change to females. A later sex reversal is possible but generally 75% of prime eating oysters are female (AFR, 1993).

Sydney rock oysters are filter feeders, straining planktonic algae from the water. Mortality is highest in the free swimming and early settlement phases and at this stage oysters are prey to a variety of fish. Once the shell has hardened they are less vulnerable to fish predation but stingrays (*Myliobatidoidei*), mud crabs (*Scylla serrata*), whelks (*Neogastropoda*) and starfish (*Asteroidea*) all feed on adult oysters (AFR, 1993).

The Sydney rock oyster industry in New South Wales has been threatened by the introduction of the Pacific oyster (*Crassostrea gigas*), which was introduced to Tasmania from Japan for aquaculture purposes. Pacific oysters can dislodge or grow over newly settled Sydney rock oysters and have a faster growth rate which could potentially out-compete native species. Port Stephens, the Hawkesbury River, Shoalhaven River and Wallis Lake are the only estuaries in NSW where the Pacific oyster is grown commercially. It is a recognised pest in all other NSW waters.

4.3. HOW WE FARM OYSTERS

Collectively the operations of the Hastings River Oyster Farmers utilise almost every existing method to commercially cultivate oysters. Techniques range from the conventional 'stick and tray' method to more recently developed cultivation techniques such as 'long-line and floating bags' and 'floating rafts'. Each method has its pros and cons and the selection of a particular method or combination of methods depends on personal preference as well as the location and features of various leases. The Hastings River Oyster Farmers are predominately focused on producing high quality Sydney rock oysters

Water based activities

Catching Spat

Spat for cultivation is self-sourced by harvesting naturally occurring spat in the Hastings River system. The Hastings River is the primary supplier of wild caught spat to other growers across NSW (40% or 13.7 million in 2010/11 (DPI 2011)). There are numerous different techniques used for spat collection but the basic principle for all methods is similar. Spat collectors must be constructed of a material that encourages the settlement of spat, whilst providing the maximum amount of surface area for settlement to occur, they also have to provide enough protection for the juvenile oysters from predators such as fish, and be able to be harvested from, or adaptable to the settled spat being on- grown in situ.



Plastic slats (50mm x 1m) are laid in packs approx. 25mm apart in layers containing 120 to 150 slats. These packs are tied to rails at the optimum catching height, which is usually about 100mm below the optimum growing height for intertidal oysters on trays. The slats are laid out ideally in the last week of February and the first week of March to take advantage of the major spawning period of early autumn. The oysters will continue to fatten and spawn over the coming months even as late as June.

Photo: Spat collecting on slats

The Sydney Rock oyster is a hermaphrodite, with the larger oysters usually becoming females. When the oysters spawn, which happens a few days after the full moon, both male and female eggs are released into the water. In a process of random selection the eggs fertilise and are carried in the water column for up to 3 weeks before they settle onto the catching surfaces and form a protective shell.

Handling spat from slats

The slats are left in the water until late winter or until the spat is 5 or 6 months old and large enough to strip (4mm-10mm). When the slats are brought in, the oysters are removed by flexing the slat. The spat is then either graded into different sizes by sieving through different size mesh or put straight into fine mesh tumblers or floating bags.

In 6 to 8 weeks, the tumblers or bags are brought in to regrade into different sizes and thin out. The larger spat is put into 10mm mesh bags (900mmx450mm) and attached to a long line rope or plastic trays (900mmx900mm) suspended from pontoons. The smaller spat is put back into 3mm to 8mm bags or tumblers until large enough to be moved on to larger mesh sizes.



Photo: Mesh bags containing spat on pontoons

It is always best practice to separate the larger spat from the crop because they will dominate the available food and the growth and health of the smaller spat can be compromise.

Managing the crop

During the growing period, the oysters must be regularly handled and reset to achieve optimum growth rates.



Photos: Floating bags (left), subtidal pontoon culture (right), Intertidal rack (below).



Whether the farmer is using floating bag culture, subtidal pontoon culture or intertidal rack culture, it is a rule of thumb that in good conditions the oysters need thinning every 4 months until they reach marketable size.

All subtidal growing methods are removed from the marine waters every month or so to air dry and kill (starve) any over catch (oyster spat, barnacle or other marine growth), 3 to 4 days is usually sufficient. Intertidal trays or baskets need to be brought to the bank to be

dried. Timeframes for air-drying stock are dependant on intensity and size of overcatch as well as weather conditions.

Finishing off the crop

When oysters are approaching marketable size, 30 to 36 months of age, they are graded into approximate sizes and placed into timber or plastic trays and laid onto intertidal rack. The height of the rack has been determined over years of experimentation to achieve the best results which is about mid tide level. In the event of any environmental changes, farmers may have to change infrastructure settings.



Photo: Trays being “blanched”

Intertidal crops are exposed to over catch so during June or July. The trays are either brought into the depot to be air-dried or are “blanched” out on the lease. Blanching entails the dipping of the tray (with oysters) into water heated in a gas-fired vat at 82°C, for three seconds and then cooled back in the water.

Harvesting the crop

Throughout the year there is a testing regime carried out by the Hastings River Shellfish Quality Assurance Program (QAP). The water is regularly tested for phytoplanktons and biotoxins. Prior to opening the harvest areas, water and meat samples are taken to ensure that any faecal coliforms levels present are below statutory standards, pre and post harvest testing continues on a regular basis during the harvest period.

In the Hastings there are two classifications of harvest zones according to Australian Shellfish Quality Assurance Program (ASQAP) criteria. Limeburners Creek is classified as Conditionally Approved which is a direct harvest area and oysters can be sold directly from the leases. The other zones, Big Bay, Riverside and Rawdon Island, are classified as Conditionally Restricted which requires oysters to be put into depuration tanks for 36 hours prior to sale.

When oysters start to increase in condition they are graded into sizes ready for sale. The recommended, market sizes are: Small 45-55mm, bottle 55-65mm, bistro 65-75mm, plate 75-85mm and extra large 85mm+. These sizes are of overall shell length. Grading is done by varying methods, most often manually by barrel sieves using a mechanically operated computerized grading machine.



Photos: Grading of oysters

Seed production

Some of the Hastings River Oyster Farmers sell juvenile stock to oyster farmers in other estuaries for on growing. This river is the largest supplier of wild caught single seed oysters to other rivers in the state. The supply of stock to other estuaries has become a vital part of many growers production schedule.

Land based activities

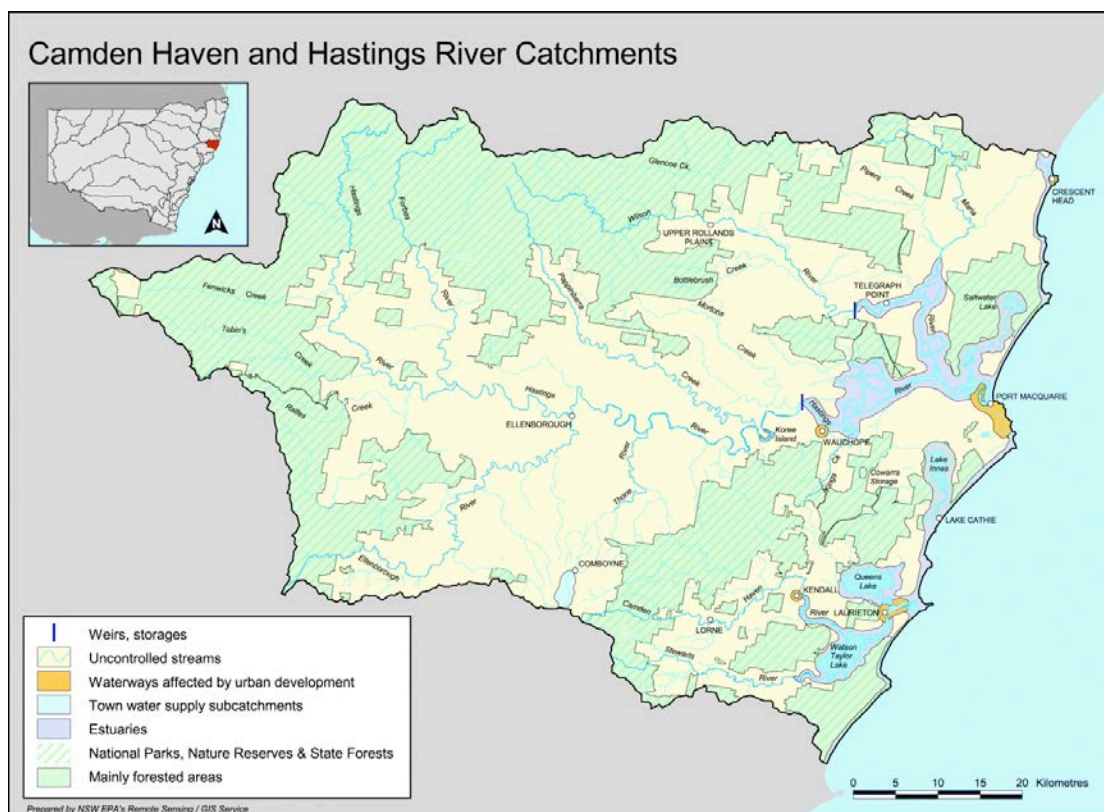
The nature of commercial oyster cultivation not only requires significant water based infrastructure but also necessitates a functional land base from which efficient operations can be conducted. Most permit holders on the Hastings River have a lease arrangement with the Department of Lands allowing the growers a small section of waterfront land for the facilitation of their business this will include grading and resetting oysters, manufacture and construction of infrastructure, housing of work and depuration sheds and storage of equipment etc.

The Hastings River Oyster Farmers land based facilities are situated on the banks of the estuary and are usually a short distance from their farms.

5. THE HASTINGS RIVER

The Hastings River is located on the New South Wales North Coast approximately 420km north of Sydney and 510km south of Brisbane (figure 1). The Hastings and its tributaries drain a 3,595 km² catchmentⁱ that is mainly undeveloped with 77% covered in native vegetation (DEC 2005)ⁱⁱ, being mostly State Forest, and National Park (PMHC 2008)ⁱⁱⁱ. The main arm of the river is approximately 120 km long (DNR no date) with the town of Port Macquarie (population 42,200) (PMHC 2008) located at the entrance. The second largest populated area is about 21km upstream at Wauchope (population 6, 000). The southern shoreline of the river is more densely populated than the northern shore, however the area to the north is expanding due to population increases across the region. Port Macquarie is a key tourist destination, particularly for recreational fishing in NSW.

The Hastings River system contains many significant areas of mangroves, seagrass, saltmarsh and wetlands and is recognised by the NSW Government as a river of High Conservation Value (HCV) (DNR no date). Several major tributaries enter the Hastings in the tidal zone (~32km from the mouth) including Fernbank Creek, Carecorara Inlet, Twin Rivers, Balyngara Creek, Tommy Owens Creek, Rawdon Creek, Munns Channel, Rawdon Channel, Caswell Channel, Hughes Inlet, Pipers Creek, Wilson River, Kooloonbung Creek, Limeburners Creek, Saltwater Lake, and Maria River.



Map source <http://www.environment.nsw.gov.au/ieo/Hastings/map.htm>

5.1. OYSTER FARMING AND ESTUARY HEALTH

Hastings River Oyster Farmers have an intimate understanding of the estuarine environment, and depend on its health and productivity for their livelihood. They are a unique resource for the management of these systems that the government, natural resource managers and the community can draw on.

The Oyster Farmers of the Hastings River like all oyster farmers, operate according to a very simple equation.

good water quality = good product = regional employment and investment

Estuaries are highly complex, dynamic and fragile environments that support an enormous range of plant and animal species. Oysters are recognised as critical indicators of estuary health because they are filter feeders, extracting phytoplankton, bacteria, suspended solids and inorganic particles from the surrounding water as their food source (HRC, 2003). In this way, they concentrate substances in the water and their reactions provide clear and early warnings of potential declines in estuary health.

No anthropogenic inputs such as pesticides, fertilisers or artificial feeds are used in oyster farming, so the viability of farms mostly depends entirely on estuary health. In turn, estuary health depends on an enormous range of factors, over most of which oyster growers have little or no control.

5.2. HASTINGS RIVER HEALTH

In general terms, river and stream water quality in the Port Macquarie-Hastings area is in a good state. A survey of bottom dwelling habitat in the Hastings River (Maher *et. al*, 2007) indicated that the Hastings River estuary appears to be healthy in terms of habitat coverage, productivity and State Forests and National Parks occupy a large proportion of the area acting as a natural filter. The extensive landuse activities however occurring on the Hastings catchment means that there are a range of potential impacts on the estuary, many of which can have a detrimental affect on the oyster industry. Key landuses potentially impacting on estuarine health for the Hastings River include dairying, grain, vegetable and silage cropping and beef cattle and tea tree plantations and potentially going forward coal seam gas extraction. Until 2006 acid discharge was also a major problem however, all 60 known acid discharging drains have since been remediated.

Port Macquarie is also a key tourist destination in NSW, particularly for recreational fishing and boating. It has a growth rate that is higher than the state average, with Port Macquarie-Hastings population growth continuing to be amongst the highest growth rates in regional NSW (PMHC 2008). This population pressure has the potential for impacts on water quality as well as increased boating traffic to the area.

Hastings River Oyster Farmers work with the Council and other agencies as well as the local community to address these issues, for example, through holding a position on the Estuary Management Committee and having regular dialogue with the Council on issues identified.

5.3. WATER QUALITY MONITORING

The Hastings River Quality Assurance Program (QAP) runs a testing regime that has been designed by NSW Food Authority in accordance with the Australian Shellfish Quality Assurance Program and complies with Australian food safety standards. There are five Hastings River oyster harvest areas, with each having its' own set of parameters specific to the conditions and environment of that area.

- Upper and Lower Limeburners can be tested to open for harvest when water salinity reaches 19ppt (parts per thousand) for depuration or 21ppt for direct harvest. Both water samples and oyster meat samples must return levels of faecal coliforms and *e.coli* below those set by NSW Food Authority. These harvest areas will return to harvest and depuration after 30mm of rain in 24 hours and be closed after 50mm of rain in 48hours.

- Big Bay can be tested for opening at 19ppt for harvest and depuration and will close after 50mm of rain in 48hours.
- Riverside can be tested for opening at 18ppt for harvest and depuration and will close after 50mm of rain in 48 hours.
- Rawdon Island can be tested for opening at 18ppt for harvest and depuration and will close to harvest after 25mm of rain in 24hours.

Once a harvest area is open, it is not retested until there is either a rain event eg: excess of 25mm in 24 hours, or an event occurs that may be considered detrimental to the water quality. Growers however, each maintain a monthly testing regime of any shipments of oysters intended for consumption.

Deterioration of Water Quality

The QAP program is checked by having an adverse testing regime, which means testing after rainfall of between 30-49mm within 48hours as many times as possible through the year in Big Bay and Riverside. Rawdon Island has parameters of 15-24mm within 24 hours and Limeburners Creek, both upper and lower have 20-29mm within 24hours when in direct harvest mode. Rainfall is measured at BOM Port Macquarie Airport (060139) for all areas except Rawdon Island which is BOM Wauchope (060035).

At least twice per year an adverse test is done when there is a peak river event being staged, such as a regatta or similar event.

There are 17 water testing sites and 9 shellfish testing sites throughout the harvest areas.

Photoplankton testing is done twice a month year round and biotoxin testing is done once a month year round.

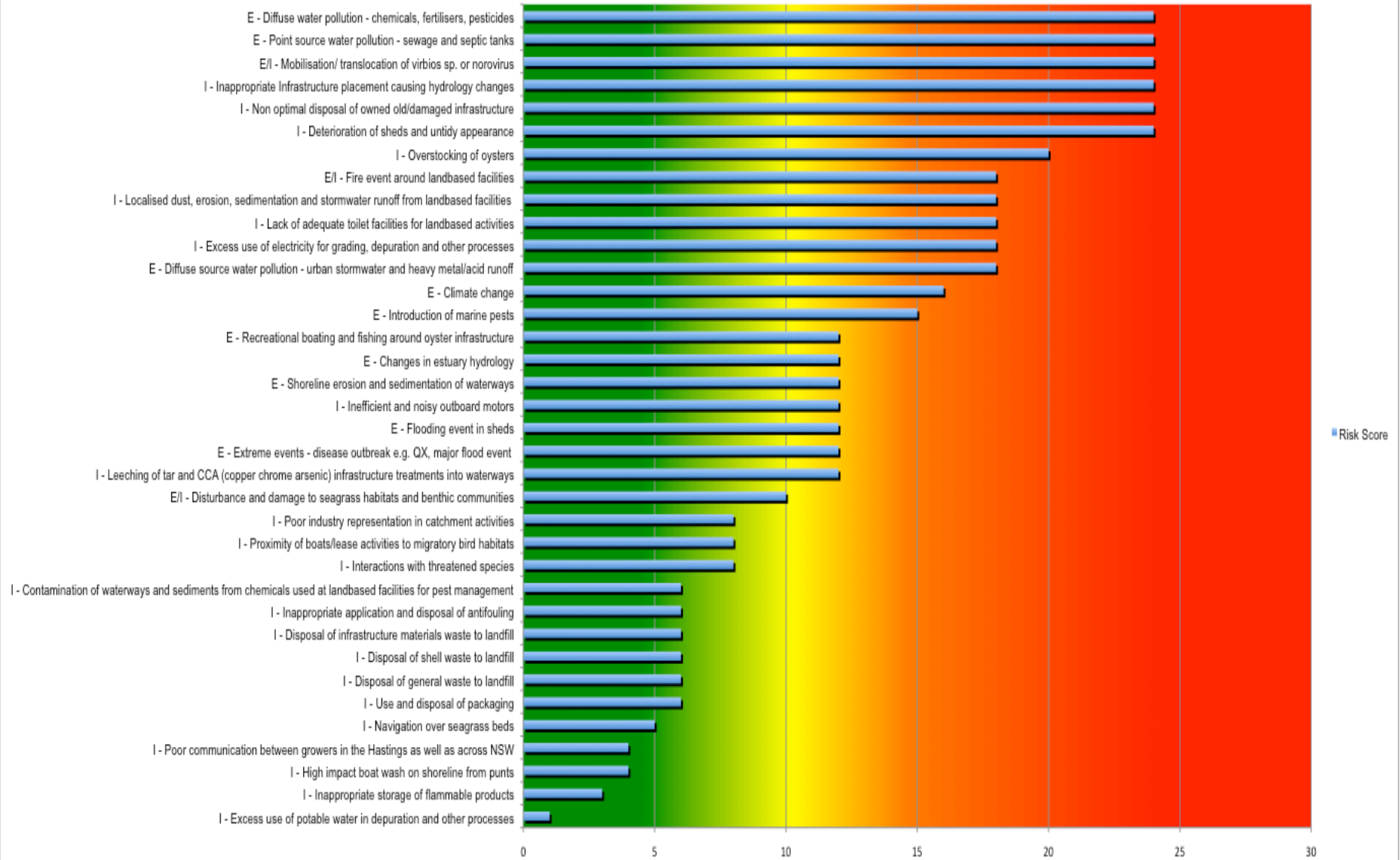
Requests to change the management plans and testing regime can be made by the QAP, but are subject to approval by all local growers and NSW Shellfish Program – management still needs to fit within Australian Shellfish Quality Assurance Program requirements.

6. ENVIRONMENTAL ACTION PLAN

Hastings River Oyster Farmers have undertaken an environmental risk assessment to identify and assess the environmental impacts of all operations for Hastings River oyster enterprises and address any unacceptable risks that their activities pose to the environment. All risks identified have been prioritised according to the potential impact that an activity may have on the environment as well as the likelihood of that impact occurring. Addressing all high risk activities as well as some medium risk activities through appropriate actions forms the basis of this EMS in its first years.

The risk assessment methodology and results table presented in Appendix 2 provides a summary of the existing and proposed measures that Hastings River Oyster Farmers have/will put in place to address each priority risk activity identified. Priority risks have been defined to include all high and medium risks identified. The justification and background for each of the priority risks impacting the Hastings River Oyster Farmers is provided in this section. Figure 1 provides a summary of the risks identified by growers and the risk level scored through the risk assessment. Risks have been split in two main categories: 1) industry-related activities, which are those primarily controlled and managed by the oyster industry and 2) external activities, which are those impacting the oyster industry but, in most cases, they are beyond the control of the oyster industry. The Hastings River Oyster Farmers will seek to work with key stakeholders and the community collaboratively towards minimising the external risks.

Figure 1. Identified risks prioritised according to potential impacts and likelihood of occurrence (Note: I relates to potential industry related risk impacting on the environment and E relates to potential external risk impacting on industry)



6.1. OBJECTIVE 1 PROTECT AND ENHANCE THE HABITAT OF THE HASTINGS RIVER AND ITS CATCHMENT.

The actions identified against Objective 1 aim to mitigate and address priority risks (note no high risks have been identified against this objective) to protect and enhance the habitat of the Hastings River and its catchment.

Industry related risks

- Disturbance or damage to seagrass habitats and benthic communities
- Localised dust, erosion, sedimentation and stormwater runoff
- Inadequate industry representation in catchment activities
- Inappropriate Infrastructure placement - hydrology changes
- Fire event around landbased activities
- Proximity of boats/lease activities to migratory bird habitats
- Interactions with protected species

External risks

- Shoreline erosion and sedimentation into waterways
- Changes in estuary hydrology
- Introduction of marine pests
- Deterioration of water quality from point source sources - sewage and septic tanks
- Deterioration of water quality from diffuse sources – urban stormwater, heavy metals and acid discharge
- Deterioration of water quality from diffuse sources - chemicals, fertilisers, pesticides

Shoreline erosion and sedimentation into waterways, changes in hydrology and water quality

Action 6.1.1 Assist the Northern Rivers Catchment Management Authority, OceanWatch Australia, WetlandCare Australia and Port Macquarie Hastings Council in identifying priority areas requiring on-ground works. Ensure regular liaison with local council and NSW Maritime and participate in key meetings. Participate in implementation of onground works were possible.

Responsibility	Performance Target	Action owner
HROF	Work underway in 4 projects in priority areas as identified by HROF by December 2012	NSW Farmers Association Hastings River Branch Committee
OceanWatch Australia	Work underway in 4 projects (10 ha) in priority areas as identified by HROF by	Simon Rowe, Tide to Table Manager

Responsibility	Performance Target	Action owner
	December 2011	
WetlandCare Australia	Work underway in 4 projects (10 ha) in priority areas as identified by HROF by December 2012	Josh Keating, Regional Coordinator, WetlandCare
Port Macquarie-Hastings Council	Work underway in 4 projects (10 ha) in priority areas as identified by HROF by December 2012	Thor Aaso, Natural Resources Officer, Port Macquarie – Hastings Council
NRCMA	Work underway in 4 projects (10 ha) in priority areas as identified by HROF by December 2012	NRCMA Community Support Officer/ Industry Partnerships Officer
HROF	Regular participation in Estuary Management Committee.	NSW Farmers Association Hastings River Branch Committee

Background

The Hastings River contains many significant areas of mangroves, seagrass, saltmarsh and wetlands. Funding is available from various sources and programs administered by the Australian including Caring for our Country, NSW Environmental Trust as well as funding administered by NRCMA for onground works to undertake bank stabilisation works, rehabilitate river and estuarine habitats, reduce erosion and improve water quality off farms. The NRCMA has indicated that effective and efficient investment can only be achieved through partnerships with existing landowners, land managers and industry. For example, while funding may be available, other organisations, individuals can assist projects through contributing expertise and/or labour and machinery.

OceanWatch Australia is currently delivering a recreational fishing trust project in the Hastings River as a part of its Tide to Table program. The Tide to Table program could be used as a model to facilitate coordination of government agencies and community groups for the benefit of commercial fishers, recreational fishers and oyster farmers. Tide to Table is about drawing the connection between activities that occur in the upper catchment to the delectable seafood on our dinner plates. The project is operating across the Sydney Metropolitan, Hawkesbury Nepean and Hunter Central Rivers regions in NSW and the SE QLD, Burnett Mary and Burdekin Dry Tropics regions in Queensland. Funded under the Caring for our Country (CFOC), it concentrates on partnering water based primary producers and land based primary producers with the community to restore fish habitat. It strives to highlight the importance of land management activities in the catchment that impact on estuarine wetlands and water quality and have a flow on effect to the productivity of the seafood industry.

The classification of estuaries for oyster harvesting, as part of the Shellfish Harvest Area Classification (HAC) scheme compiled by the NSW Food Authority required comprehensive studies of each estuary to assess influences and risks regarding water quality. In a relatively undeveloped catchment (NLWRA 2001) such as the Hastings, the Hastings River Oyster Farmers see the potential in using this information as a benchmark of river status, to which a database of water quality (administered and maintained by the Oyster Farmers, described in section 5.3 & action 6.1.5) could be compared to over a long-term to see if correlation exists between completed on-ground works and improvements in water and shellfish quality.

Localised dust, erosion, sedimentation and stormwater runoff from Sandfly Alley

Action 6.1.2 Work with the Port Macquarie-Hastings Council to identify potential solutions and possible funding sources to control land based erosion problems along Sandfly Alley. Develop a Sediment Control Plan for Sandfly Alley.

Responsibility	Performance Target	Action owner
HROF	Practical and economically viable solution identified and planning commenced to address erosion issues by December 2011. Remediation works commenced by December 2012	NSW Farmers Association Hastings River Branch Committee
HROF/ Port Macquarie-Hastings Council	Funding application submitted to allow for commencement of planning by June 2012.	Thor Aaso, Natural Resources Officer, Port Macquarie – Hastings Council
HROF	Sediment Control Plan established and implemented by December 2012	NSW Farmers Association Hastings River Branch Committee

Background

The Hastings River’s water quality can be affected by sediment runoff and/or bank erosion, impacting on water clarity and consequently, light penetration through the water column - an essential requirement for phytoplankton and seagrass growth. Dust and sedimentation runoff also has an Impact on turbidity, which in turn can impact on oyster depuration.

Sandfly Alley is a public road that is maintained by the Port Macquarie Council via regular grading to maintain dust levels. These maintenance regimes however do not prevent the sediment runoff that can occur, particularly after heavy rainfall. Sediment associated with runoff generated from the land based facilities access road was an issue regarded as a high priority by HROF members. Sediment input through land based activities, e.g. cleaning oysters, baskets and trays, was also noted with concern. HROF have proposed that they liaise with the Council to identify a solution, preferably to have the road sealed. HROF have also committed to establishing a sediment control plan in which catchment drains can be installed in front of land based work sheds to mitigate sedimentation and runoff input into the catchment.

Seagrasses and benthic communities

Action 6.1.3 Minimise effects on seagrasses and benthic communities. Report significant changes in seagrass to Department of Primary Industries (Fisheries branch). Liaise with NSW Maritime to identify channels that will minimise seagrass disturbance.

Responsibility	Performance Target	Action owner
HROF	Changes in seagrass coverage or condition reported to Department of Primary Industries as identified on an ongoing basis.	NSW Farmers Association Hastings River Branch Committee
HROF	Best Practice procedures for navigation and cultivation around seagrass maintained and updated in line with improvements in technology on ongoing basis.	NSW Farmers Association Hastings River Branch Committee
HROF	Liaison with NSW Maritime completed by December 2011 and seagrass disturbance minimisation channels for industry use identified	NSW Farmers Association Hastings River Branch Committee

Background

Oyster farming methods of the past, have been known to affect seagrasses and benthic communities (i.e groups of plants and animals living on the floor of a water body) via the placement of infrastructure, the shade that infrastructure casts on the floor of the water body.

Stick and tray farming methods have been used on the Hastings River for many years. Studies completed in other estuaries, for e.g. Crawford, 2003; Lasiak and Underwood, 2002; Porat, 2001, indicated oyster growing activities do not have any widespread impacts on seagrass or benthic communities, with any dieback or community change strictly localised to the immediate vicinity of the oyster leases.

It should be noted that while seagrass dieback is of major concern in NSW, oyster farming is very rarely identified as one of the causes. The National Oceans Office (1997) stated that *“Increased sedimentation and nutrients from catchments have been linked with massive die-back of seagrasses in many areas.”*

Impacts from waste material generated by oysters are generally only associated with highly intensive farming (Crawford, 2003), a method not employed by the Hastings River Oyster Farmers.

The extensive removal of large volumes of derelict infrastructure throughout the Hastings catchment has reduced shading and allowed regrowth of seagrass, however more work needs to be achieved in this area. (Refer action 6.2.6)

The use of tumblers in early production stages (see section 4.3) raft culture and long- line and floating bags in the grow-out phase significantly reduces shading through less infrastructure, and the tendency for these methods to move with the wind and tide. Oysters have differing requirements at different ages and in order to maximise productivity trays are rotated between areas. This process also rests certain areas allowing seagrass shaded by trays or sticks to re-establish itself.

Inappropriate Infrastructure placement - hydrology changes

Action 6.1.4 Minimise effects on natural sedimentation. Report significant changes in sedimentation to the Department of Primary Industries (DPI).

Responsibility	Performance Target	Action owner
HROF	Best Practice procedures for infrastructure placement and stocking densities maintained and updated in line with improvements in technology on ongoing basis. 60% increase use of more environmentally sustainable infrastructure such as floating rafts and plastics in place by December 2014.	NSW Farmers Association Hastings River Branch Committee
HROF	Changes in sedimentation coverage or condition reported to Department of Primary Industries as identified on an ongoing basis. Seagrass, mangrove and saltmarsh extent maps obtained from Department of Primary Industries by July 2011.	NSW Farmers Association Hastings River Branch Committee

Background

The long-established oyster farming industry of the Hastings River has not lead to any apparent changes in the local sedimentation regime. More widely, sedimentation is rarely considered as a significant environmental effect associated with the types of oyster farming generally employed in Australia (Crawford, 2001). As mentioned in action 6.1.3 new methods being employed by a number of HROF reduces seafloor-based infrastructure, further reducing the potential of oyster cultivation to affect natural sedimentation processes.

HROF have had initial discussions with I&I in regard to a Stock Density Management Plan.

Deterioration in water quality

Action 6.1.5 Maintain existing water quality monitoring program. Report detected or suspected pollution incidents immediately to the NSW Food Authority. Discuss options with agencies for specific action to deal with point source pollution causing mass mortality to oysters and establish monitoring program with university.

Responsibility	Performance Target	Action owner
HROF	Hasting River Shellfish Quality Assurance Program water quality monitoring maintained in accordance with regulatory requirements	NSW Farmers Association Hastings River Branch Committee
HROF	All poor performance water quality results identified reported on timely basis to NSW Food Authority.	NSW Farmers Association Hastings River Branch Committee
	Source points of pollution in areas where oyster mortality regularly occurs (monitoring of oyster mortality) identified by December 2010 Liaison with Department of Primary Industries/Office of Environment and Heritage (formerly DECCW) to have sampling program established for river by December 2012. Liaison with Newcastle University and SCU for an honours student to undertake monitoring of high risk mortality areas identified by December 2011.	Paul Wilson
HROF	Investigate potential to lessen expense of water quality monitoring.	NSW Farmers Association Hastings River Branch Committee

Background

The Hastings River Oyster Farmers maintain a regular water and shellfish quality monitoring regime as a part of the Hastings River Shellfish Quality Assurance Program (QAP) to ensure harvest does not occur when environmental parameters or water and shellfish quality do not meet program requirements action. Currently the monitoring program consists of 5 water quality (WQ) testing harvest areas that have their own management plans specific to the conditions and environment of that area. There are 17 water quality testing sites and 9

shellfish testing sites throughout. Oyster samples are conducted monthly to monitor bio-toxins (can be produced by some species of phytoplankton and can accumulate in shellfish which can present a consumer health risk). Phytoplankton levels are also tested fortnightly and all Hastings River Oyster Farmers shellfish destined for human consumption are required to undergo tests - each farmer is required to test one batch of depurated shellfish from their depuration plant once per calendar month. In addition to their regular testing the Hastings River Oyster Farmers, in order to maintain their Harvest Area Classification must undertake an adverse testing regime which means testing after 30-49mm of rainfall within 48 hours for Big Bay and Riverside, 20-29mm/24hr for Upper and Lower Limeburners Creek, and 15-24mm/24hr for Rawdon Island, as many times as possible throughout the year.

The NSW Oyster Industry is often the first to detect local pollution events such as sewage spill, toxic algae, chemical and fuel spills (NSW Shellfish Program 2012 pers.comm). Potential pollution events not only threaten the local oyster industry, but also have severe implications for public and ecological health within the catchment. The QAP also uses set parameters and sampling regimes, which are standardized in accordance with the ASQAP and therefore comparable among all NSW estuaries, as well as oyster harvest areas across Australia and in some cases, internationally. This is not true of other water quality monitoring programs, such as local governments, which vary considerably in terms of parameters measured and frequency of sampling.

Port Macquarie Hastings Council conducts regular chemical and bacteria sampling once every 4 months along the Hastings River. The council is also monitoring the status of the 4,600 septic systems in use across the catchment (PMHC 2008), however there is much more work that needs to be done. The number of septic systems in use is growing as a direct reflection of increasing rural and rural residential development, but with this growth is improved monitoring of on-site sewage management systems by Council. The total annual number of inspections represents only a small percentage of the total number of on-site sewage management systems in the local government area. Many systems, particularly in the outlying rural areas have not been inspected to date. Detailed inspections of septic systems are categorised using an On-site Septic Management System (OSMS) whereby each septic system in the area is ranked according to the risk it is to the surrounding environment. Septics are given a 1,2 or 5 rating that refers to year(s) between the required follow-up inspection (i.e. a rating of one is a high risk - due to its proximity to water courses, within 100 year flood limit etc.). On inspection of septic systems, all associated plumbing and fittings, tank contents, absorbent trenches and transpiration beds are all checked to ensure there is no risk of contamination risk to the surrounding environment or waterways.

The intensive testing required by all oyster growers comes at a considerable cost to a grower and the Hastings River Oyster Farmers will investigate the possibility of being compensated to broaden their water quality monitoring regime to cover other agency standards (councils, state government etc.) in an attempt to offset the expense incurred by each grower.

Action 6.1.6 Report all suspected pollution incidents to Department of Primary Industries and Office of Environment and Heritage (formerly DECCW Environment Protection Authority).

Responsibility	Performance Target	Action owner
HROF	All water pollution incidents identified reported to Department of Primary Industries (DPI) and the Office	NSW Farmers Association Hastings River Branch

Responsibility	Performance Target	Action owner
	of Environment and Heritage (OEH) on ongoing basis.	Committee
HROF	Liaison with DPI/OEH/Council to have a chemical sampling program for priority areas established for the river completed by December 2011 with intention that monitoring underway by at least December 2012. Liaison with Newcastle University and Southern Cross University for an Honours student to undertake monitoring project completed by December 2011.	Paul Wilson
HROF	Investigation for HROF to be trained in incident response and maintain a fuel containment kit for on water incident response to support local authorities completed by June 2012. Selected growers trained in senior first aid by June 2012.	Kingsley Searle

Background

Agricultural and urban runoff, acid sulphate soils, fuel and chemical spills may lead to water pollution incidents. Oyster Farmers have a unique understanding of the estuary in which they work, with an ability to identify point sources of pollution through their rigorous water quality regime.

The local council and NSW Maritime are responsible for dealing with events which involve oil and/or fuel spillages. It may be beneficial for such agencies to equip Hastings River oyster grower representatives with spill containment kits, to control and reduce impact of spills and the spread of pollutants. This may be through provision of absorbent barriers to apply to affected areas.

NSW Shellfish Program incorporate testing for persistent organic pollutants (POPF) in shellfish as part of the triennial heavy metal (assessing Zinc, Copper, Lead, Arsenic, Selenium, Mercury) survey of shellfish from each oyster producing estuary, including the Hastings River. Nil residue was detected for POPF in the 2005 and 2008 surveys of Hastings River oysters (nil residue also for all estuaries tested). Heavy metal concentrations were within limits specified in the Australian Food Standards Code. 2012 survey results are pending, but there is not expected to be any high results. The NSW OEH also conducts testing for chemicals in the Hastings.

Fire management around land based facilities

Action 6.1.7 Develop and implement a best practice fire policy around the shed area along oyster industry land based working areas.

Responsibility	Performance Target	Action owner
HROF	Fire management policy developed and implemented for Sandfly Alley by December 2011 and expand to other areas by December 2012.	Kingsley Searle

Background

The forested nature of area surrounding the land-based facilities along Sandfly Alley and the volume of gear stored on-site pose a significant risk in the event of a fire. Over the next twelve months the Hastings River Oyster Farmers will work toward developing and implementing a fire policy to minimise these risks. The creation of asset protection (buffer) zones through actions associated with the removal of waste and disused infrastructure in and around the shed area is the first step in minimising the potential for rapid spread between dwellings and to surrounding bushland in the event of fire.

Marine Pests

Action 6.1.8 Ensure all Hastings River Oyster Farmers have a copy of marine pest identification cards and best practice biofouling guidelines for aquaculture being developed by the National Introduced Marine Pest Coordination Group (NIMPCG). Report with a sample if possible, any detection of an unusual plant or animal. Follow requirements of government agencies in combating marine pests.

Responsibility	Performance Target	Action owner
HROF	Marine Pest Identification Guide and best practice biofouling guidelines for aquaculture obtained and distributed to all growers by August 2011.	NSW Farmers Association Hastings River Branch Committee
OceanWatch Australia/ DPI	Marine Pest Identification Guide and best practice biofouling guidelines for aquaculture distributed to HROF by August 2011	NSW SeaNet Officer DPI Biosecurity Officer

Background

Translocation of marine pests and subsequent settlement is an increasing risk in Australian waters as populations become more mobile and exposure to potential sources increase (eg. contaminated bilge water from merchant vessels, translocation of species from other regions by travelling fishers). Introduction of such species can have severe impacts on native species and lead to a total deterioration of ecological processes.

Education in the identification of pest species and correct reporting mechanisms of those with a unique understanding of the estuarine environment, such as commercial fishers and oyster growers will greatly assist in early identification of such species, a key process in preventing the spread of marine pests. Currently a National System for the Prevention and Management of Marine Pest Incursions is being developed by the National Introduced Marine Pest Coordination Group (NIMPCG), which includes members from Commonwealth and State agencies, scientific organisations, and industry representatives. Part of the project objectives is the development and dissemination of educational material to oyster growers, which will be incorporated into future versions of this EMS upon completion.

Protected species, migratory shorebirds and their habitats

Action 6.1.9 Provide information to conservation and management organisations regarding important bird habitats.

Responsibility	Performance Target	Action owner
HROF	Intellectual knowledge provided to relevant organisations to identify key habitat areas on an ongoing basis to Office of the Environment and Heritage (OEH formerly DECCW National Parks and Wildlife) and Birds Australia.	NSW Farmers Association Hastings River Branch Committee

Background

Estuaries provide important habitat for nesting and breeding birds, including migratory and resident threatened species. The Hastings River Oyster Farmers have a unique understanding of the environment in which they work and will assist OEH North Coast Shorebird Recovery Program if required to identify areas that provide important habitat.

Action 6.1.10 Report incidents of bird entanglements to Australian Seabird Rescue and Office of the Environment and Heritage (National Parks and Wildlife). Train HROF in seabird rescue.

Responsibility	Performance Target	Action owner
HROF	Selected Hastings River Oyster Farmers trained in bird rescue by December 2012. All injuries and entanglements identified reported to Australian Seabird Rescue and OEH on ongoing basis.	NSW Farmers Association Hastings River Branch Committee

Background

Birds can become entangled in litter and lost fishing line. Oyster farmers spend extended periods of time on the water, and are in an ideal position to report bird entanglements. The Hastings River Oyster Farmers will assist in seabird rehabilitation and release where able and report sightings of entangled or injured birds to Australian Seabird Rescue and OEH. An

informal workshop educating oyster farmers about correct handling procedures for birds could assist in this process.

Action 6.1.11 Suspend operations immediately in the event of an interaction with a protected or threatened species. Allow the animal to escape without harm. Develop a Code of Conduct for Hastings River Oyster Farmers.

Responsibility	Performance Target	Action owner
HROF	Zero interactions with protected or threatened species eg, dolphins or turtles	All members
HROF	Any Interactions reported to Department of Primary Industries	All members
HROF OceanWatch Australia	Code of Conduct developed and implemented by all HROF members by December 2012. All members provided with copy of Protected Species Handling Manual from OceanWatch Australia by June 2012.	NSW Farmers Association Hastings River Branch Committee NSW SeaNet Officer

Background

Protected and threatened species include those listed, at a state level, under Part 2 Div 1 of the Fisheries Management (General) Regulation 2002, and Schedules 1 and 2 of the Threaten Species Conservation Act 1995. At a Commonwealth level, approximately 2000 species are listed under the Environment Protection and Biodiversity Conservation Act 1999.

It is highly unlikely that any commercial oyster farming activities will interact or harm a protected or threatened species, but as responsible oyster growers HROF have provided actions that would be taken by the HROF in the rare event of this happening.

Any interaction with protected or threatened species must be reported to Department of Primary Industries.

Industry representation in catchment activities

Action 6.1.12 Continue to participate in key catchment planning and policy activities, and ensure membership to key natural resource management committees. Collaborate with key stakeholders to develop partnerships for onground action and continue to provide support to community events.

Responsibility	Performance Target	Action owner
HROF/NRCMA/ NSW Farmers/ Local Councils	Hastings River stakeholder/cross sector meeting, including a connectivity type tour with farmers to discuss upstream downstream impacts	NSW Farmers Association Hastings River Branch Committee NRCMA Catchment Officer

Responsibility	Performance Target	Action owner
	and potential partnership based solutions conducted by June 2012.	NSW Farmers Association – Richard Widows
HROF	Participation in at least 2 regional or river based Community events by December 2011.	NSW Farmers Association Hastings River Branch Committee
HROF	Request for membership on Kempsey Estuary Management Committee made by July 2011.	NSW Farmers Association Hastings River Branch Committee

Background

The diversity of stakeholders within the Hastings Catchment and the variety of commercial and non commercial activities occurring warrants a forum within which stakeholders can come together to discuss natural resource management issues and collaborate on onground partnerships to improve natural resource management and work towards environmental best practice management across all sectors.

The Hastings River Oyster Farmers have expressed concern for the lack of cross sector engagement that has occurred within the catchment to date and have identified a priority to establish a mechanism, through a forum or meeting where different groups can come together to improve cross sector dialogue and collaboration. Working in conjunction with NSW Farmers Association and the NRCMA they have proposed a stakeholder meeting to initiate improved communication across the sectors.

6.2. OBJECTIVE 2 CULTIVATE OYSTERS IN A SUSTAINABLE MANNER - MINIMISING RESOURCE CONSUMPTION, WASTE PRODUCTION AND POLLUTION.

The actions identified against Objective 2 aim to mitigate and address priority risks to cultivate oysters in a sustainable manner – minimizing resource consumption, waste production and pollution.

Industry related risks

- Inefficient motor emissions and noise pollution
- Excess use of electricity
- Lack of adequate toilet facilities
- Overstocking of oysters
- Non optimal disposal of old/damaged infrastructure
- Mobilisation/translocation of viruses
- Deterioration of water quality from leaching of tar and timber treatments

External risks

- Extreme events - floods
- Extreme events - disease outbreak eg QX
- Climate change

Outboard motor emissions, efficiency and noise

Action 6.2.1 Upgrade outboard motors to meet the current appropriate fuel efficiency and emissions standards.

Responsibility	Performance Target	Action owner
HROF	100% of outboard motors in use meeting appropriate emissions standards by December 2012.	NSW Farmers Association Hastings River Branch Committee
HROF	Regular updates on latest technologies provided to HROF at meetings.	NSW Farmers Association Hastings River Branch Committee

Background

The Office of Environment and Heritage (formerly the DECCW EPA) currently adopts the USEPA emissions standards as a means of rating the environmental performance of outboard motors. Motors meeting these standards have significantly lower air and water emissions than conventional outboard motors and are also more fuel-efficient.

Australia does not manufacture any outboard motors and subsequently we have no control over the development of standards specific to Australian conditions. Fortunately the levels set in other countries is quite high, and the OEDA (Outboard Engine Distribution Association) in Australia through discussions with the Australian Government has formed a rating benchmark similar to energy ratings seen on electrical appliances. This will increase the marketing opportunities of manufacturers that produce motors with a lower emission rating than required by the standards and allow consumers to make choices based on environmental performance.

HROF members have upgraded from older style 2--stroke engines, to those with a superior emission standard which reduces the use of fossil fuels and eliminates contaminants entering the waterways.

Action 6.2.2 Minimise fuel consumption and improve vessel stability, longevity.

Responsibility	Performance Target	Action owner
HROF	Suitable vessels injected with foam by December 2012	NSW Farmers Association Hastings River Branch Committee

Background

Traditionally, timber punts were used in the oyster industry. However, the use of aluminum style punts is now considered the norm. Aluminum punts are constructed generally from hollow cell aluminum planks welded together. In the past 2 years, improvements in marine foam applications have resulted in the direct injection of older/ wearing punts with marine foam. These changes mitigate water absorption into the aluminum cells, reducing the weight of the punt and reducing fuel consumption. This proved to be very effective, and consequently improved floatation, stability and visually reduced the punt wake/wash (helping to control river bank erosion).

Alternate energy

Action 6.2.3 Review alternate energy programs to identify options for Hastings River Oyster Farmers, participate in programs and access funding for alternate solutions, particularly solar and wind.

Responsibility	Performance Target	Action owner
HROF/Office of Environment and Heritage (OEH)	Regular updates on latest technologies and opportunities for opportunities for funding provided to HROF at meetings. Suitable funding identified and application for pilot project submitted by August 2012.	Kingsley Searle DPI - Aquaculture Branch OEH Sustainability Advantage Officer
HROF	Pilot program with growers developed to trial solar/wind power solutions for grading and depuration by December 2012.	Kingsley Searle

Background

Electricity is a key input and one the HROF are keen to reduce the cost of. To that end, alternate energy opportunities are being explore, particularly in relation to the use of solar and wind power to generate depuration tanks and grading equipment.

Stock management

Action 6.2.4 Develop a stock management plan for the Hastings River

Responsibility	Performance Target	Action owner
HROF/ Department of Primary Industries	Stock management plan developed for the Hastings River by December 2014	NSW Farmers Association Hastings River Branch Committee Department of Primary Industries – Tim Gippel

Background

Oyster farming generally employed in Australia has not been identified as an activity impacting on the environment (Crawford, 2003). Oysters are not cultivated using intensive farming systems as mentioned in Section 4.3. If growers try to cultivate more oyster stock than their enterprise or the environment is capable of managing, detrimental effects could come about due to inadequate husbandry or by exceeding the carrying capacity of the system, respectively. Therefore, by not overstocking the lease areas, growers will ensure maximum productivity and a healthy lease area.

Hastings River Oyster Farmers have had initial discussions with Dr Ana Rubio and Department of Primary Industries to consider stocking densities in the Hastings River and develop a Stock Management Plan. Through this project, growers will gather information on growth performance and survival rates.

Hastings River Oyster Farmers will incorporate the above project findings and the recommendations provided by available oyster research studies (Troup et al 2005, Rubio, 2008) and the NSW Oyster Industry Sustainable Aquaculture Strategy, into their management to ensure optimum production and long-term sustainability of the Hastings River oyster industry.

Management of water based infrastructure

Action 6.2.5 Work toward eliminating the use of tar and treated timber.

Responsibility	Performance Target	Action owner
HROF	100% of trays converted from treated timber to polyurethane by December 2014.	NSW Farmers Association Hastings River Branch Committee
HROF	No lease areas using tarred/treated timber rails by December 2012.	NSW Farmers Association Hastings River Branch Committee
HROF	All tarred/treated timber disposed of correctly	NSW Farmers Association Hastings River Branch Committee

Background

For many years, tarred or CCA (copper chrome arsenic) treated timber has been used for the sticks and trays on which oyster larvae are caught and grown into oysters. This increases the durability of the timber and protects it from marine borers and pests. There is no evidence indicating that this contaminates the oysters or neighbouring species (White, 2001), however, there is potential for chemicals to leach into the surrounding waters.

Oyster farmers throughout NSW are now phasing out the use of tarred and treated timber by using specially produced polyurethane trays, plastic sleeves around timber posts and sticks, or adopting alternative farming methods (as described in section 1.3.).

HROF members have utilised extruded plastic products (built from recycled materials) for use in oyster cultivation infrastructure, including extruded plastic rails, plastic sleeves, posts and trays. The price per metre is more expensive than using timber products. The use of these recycled materials will eliminate ongoing maintenance and potential contaminants entering the river.

Collectively, HROF are phasing out the use of timber through the utilisation of new technologies. Ongoing infrastructure maintenance ensures active replacement at opportune stages of production. Many of the growers are working toward the exclusive use of polyurethane trays, and other plastic products. The process of changing over technologies is costly, time consuming and a labour intensive task. Conversion to non--degradable products will ultimately save the growers time and money, however, the sheer logistics of such an operation means the change will not occur overnight.

Action 6.2.6 Remove and where possible recycle or reuse decommissioned infrastructure. Conduct annual clean ups of infrastructure and lease areas targeting waterbased infrastructure.

Responsibility	Performance Target	Action owner
HROF	Annual clean up of infrastructure and leases targeting water based infrastructure undertaken by June 2012. Liaison with OEH/DPI undertaken by December 2011 to discuss timetable for removal of infrastructure under their management.	NSW Farmers Association Hastings River Branch Committee

Background

The Hastings River Oyster Farmers have already been proactive in instigating group clean-ups and the Council has assisted by waiving tipping fees. Hastings River Oyster Farmers will communicate with Port Macquarie-Hastings Council on this initiative to assist in the process to make it more economically viable for the ongoing appropriate disposal of removed derelict infrastructure. Currently, it is not economically feasible to appropriately store or dispose of derelict infrastructure. To assist in reducing the economic burden to individual Hastings River Oyster Farmers members achieving environmental cleanup activities in the catchment, a request will be made for ongoing waiving of Council Tip fees for derelict infrastructure disposal.

The ongoing practice of adopting recycled plastic materials, e.g. replacing damaged infrastructure (prev. tarred posts and racks) will eliminate any further introduction of these problems).

Toilets

Action 6.2.7 Review options for establishing portable toilet facilities at priority locations (the bridge Limeburners east, upper Limeburners west and Big Bay).

Responsibility	Performance Target	Action owner
HROF	Suitable toilet facilities installed in priority locations by June 2012.	Kingsley Searle

Background

As well as spending considerable amount of time on the water tending their leases, the nature of commercial oyster cultivation also requires the growers to spend extended periods at their shore based facilities, whether it be culling, grading or maintaining equipment.

Mobilisation/translocation of viruses

Action 6.2.8 Review of farm management practices to ensure adequate infrastructure placement for preventing the mobilisation or translocation of viruses.

Responsibility	Performance Target	Action owner
HROF/DPI	Review undertaken as a part of the development of Stock Management Plan and recommendations implemented if required by June 2014.	Kingsley Searle

Background

Food safety best practice recommends all wash downs to be conducted at low tide or when tide is going in direction opposite to where growers are working. Where there are a number of rafts located in amongst the intertidal area and oysters remain feeding, the risk of *vibrios* sp. or bacteria/microbes being disturbed during the washdown process and translocated onto other rafts increases.

Contingency planning for extreme events

Action 6.2.9 Contingency plans to be developed to address Hastings River Oyster Farmers response to extreme events.

Responsibility	Performance Target	Action owner
HROF/DPI	Contingency Plan developed by December 2012	NSW Farmers Association Hastings River Branch Committee

Background

Extreme events, whether they be drought, flood events, black water or disease outbreaks etc. can have a devastating impact on an oyster industry as has been seen in recent years with the outbreak of QX in the Hawkesbury and water quality problems in the Kalang River and

Tiligery Creek. The HROF have identified as a priority the need to be better prepared for extreme events such that the impacts to growers can be mitigated as much as possible. To that end HROF have identified a number of actions around training/communication and infrastructure design and mitigation techniques that require further exploration. Following this a Contingency Plan will be developed for all growers to follow in extreme events.

Climate change

Action 6.2.10 Maintain ongoing participation in climate change discussion and in the development of an adaptation plan for the industry.

Responsibility	Performance Target	Action owner
HROF	Participation in key climate change discussions and in the development of an adaptation plan for the industry on an ongoing basis.	NSW Farmers Association Hastings River Branch Committee

6.3. OBJECTIVE 3 RECOGNISE AND PROTECT THE CULTURAL AND AESTHETIC VALUES OF THE HASTINGS RIVER AND ITS CATCHMENT.

The actions identified against Objective 3 aim to mitigate and address priority risks to recognise and protect the cultural and aesthetic values of the Hastings River and its catchment.

Industry related risks

- Deterioration of sheds and infrastructure
- Non optimal disposal of old/damaged infrastructure

External risks

- Recreational boating and fishing around oyster infrastructure

Infrastructure aesthetics

Action 6.3.1 Keep all sheds and leases tidy and uniform. Discuss with Council and appropriate government agencies re options to assist in process of demolition of sheds.

Responsibility	Performance Target	Action owner
HROF	Identification of options for assistance with demolition of sheds. Participation in Clean Up Australia Day 2012.	NSW Farmers Association Hastings River Branch Committee

Background

The leases used by the Hastings River Oyster Farmers are integral to the industry that has been part of the economy, appearance and culture of the Hastings River for over 120 years.

The development of the NSW Oyster Industry Sustainable Aquaculture Strategy, outlines criteria for an acceptable lease and shed site e.g. materials, maintenance and visual amenity.

Hastings River Oyster Farmers take great pride in the appearance of their leases and sheds. Extensive work has already been initiated on infrastructure improvements and derelict infrastructure removal; in adherence to this strategy. Hastings River Oyster Farmers recognise that more work needs to be done though to demolish and remove derelict sheds.

Navigation

Action 6.3.2 Work with NSW Maritime and NSW Department of Primary Industries to maintain all navigation and marking requirements in line with regulations. (Linked to Action 6.2.6)

Responsibility	Performance Target	Action owner
HROF	No infringements of navigation and marking regulations.	NSW Farmers Association Hastings River Branch Committee

Background

Derelict infrastructure can become a navigational hazard. Hastings River Oyster Farmers members are proactively removing disused and derelict infrastructure from the catchment.

Theft

Action 6.3.3 Report occurrence of theft to police and Department of Primary Industries.

Responsibility	Performance Target	Action owner
HROF	Authorities alerted of theft and vandalism through Operation Trident and on an ongoing basis.	NSW Farmers Association Hastings River Branch Committee
Community	HROF members and the NSW Food Authority alerted to any unregulated sale of oysters.	NSW Farmers Association Hastings River Branch Committee

Background

Unregulated sale of oysters can pose a serious health threat to unsuspecting consumers as they may have been stolen during times when it was unsafe to directly harvest from the leases. It also has a significant financial impact for the industry and therefore, working in partnership with the community and regulators to reduce theft is a priority. In the event of an illness outbreak, either from product harvested legally or illegally, the local and broader NSW industry will be affected, as will local tourism, seafood consumption sales etc.

Respecting culture and other river users

Action 6.3.4 Respect the indigenous culture of the Hastings River catchment.

Responsibility	Performance Target	Action owner
HROF	No complaints received from Traditional Owners in relation to	NSW Farmers Association Hastings

Responsibility	Performance Target	Action owner
	oyster industry activities	River Branch Committee

Action 6.3.5 Respect other users of the Hastings River system. Identify hotspot areas where conflicts occur. Liaise with the appropriate agencies to develop information awareness on accessing waterways around leases and the recreational take of oysters. Liaise with Maritime to develop signage for dangers and channel identification, speed zones.

Responsibility	Performance Target	Action owner
HROF	Hotspot areas where conflicts occur between oyster growers and other users identified in consultation with authorities by December 2011.	NSW Farmers Association Hastings River Branch Committee
HROF	Awareness campaign for recreational and other users entering oyster farms and taking oysters for recreational use at designated locations in place by December 2012. Industry concerns raised to DPI.	NSW Farmers Association Hastings River Branch Committee DPI
HROF	Signage developed and installed at key problem locations by December 2012.	NSW Farmers Association Hastings River Branch Committee
NSW Maritime	Recreational Boating Handbook updated by December 2012.	Maritime Boating Officer

Background

Hastings River Oyster Farmers members realise the importance of maintaining and promoting a harmonious relationship with other uses of the Hastings River catchment, commercial fishers, recreational anglers, locals and tourists.

Hastings River Oyster Farmers members are happy to educate the broader community and give a detailed explanation of their operations to interested people.

A number of health and safety concerns have been identified by Hastings River Oyster Farmers related to recreational boating and fishing on oyster farms, as well as the legal taking of oysters for recreational use at designated locations when the river is closed to commercial harvest. Here, taking of oysters outside of the food safety mechanisms put in place by the NSW Shellfish Program can pose a major health risk.

6.4. OBJECTIVE 4 CONDUCT ENVIRONMENTAL MANAGEMENT IN A TRANSPARENT AND COOPERATIVE MANNER.

The actions identified against Objective 4 aim to mitigate and address priority risks to facilitate Hastings River Oyster Farmers to conduct environmental management in a transparent and cooperative manner.

Industry related risks

- Inadequate industry representation in catchment activities

External risks

- None

EMS reporting, stakeholder comment and review

Action 6.4.1 Report on progress of EMS annually. Allow stakeholders to comment on EMS report. Review EMS annually.

Responsibility	Performance Target	Action owner
HROF	EMS reviewed annually and documented for circulation to key stakeholders by June each year.	NSW Farmers Association Hastings River Branch Committee

Background

Continual improvement, fundamental to the success and implementation of EMS actions, requires regular reporting and review of the document by Hastings River Oyster Farmers business members. Each year, the Hastings River Oyster Farmers will report on the progress and maintenance of each action in relation to their responsibility, performance target(s) and timeframe(s).

The EMS report will be made available to all stakeholders on request and to all stakeholders who have commented on, or shown interest in the operations of Hastings River Oyster Farmers. Following documentation and circulation of the report, the Hastings River Oyster Farmers will review the EMS, considering:

- stakeholder comments
- an assessment of the adequacy and relevance of the environmental policy (see environmental policy);
- changes in oyster farming technology and management; and
- emerging issues in the environmental management of the Hastings River and its catchment.

One or more of these events may trigger a review outside of the annual review process. In response to a review, any part of the EMS may be changed and reports and past versions of the EMS will be kept as records.

Action 6.4.2 Compile a record of stakeholders. Provide a process for all stakeholders to comment on the EMS generally and the annual EMS report.

Responsibility	Performance Target	Action owner
HROF	Mailing list established by June 2011. Process for receiving comments developed by June 2011.	NSW Farmers Association Hastings River Branch Committee

Stakeholders will include:

- Department of Primary Industries
- NSW Food Authority
- Northern Rivers Catchment Management Authority
- Port Macquarie-Hastings and Kempsey Shire Councils
- Key State Government agencies involved in catchment and natural resource management'
- Community groups and community members and other stakeholders

Community Education

Action 6.4.3 Establish a process that provides the community information on the operation and environmental management of the Hastings River oyster industry.

Responsibility	Performance Target	Action owner
HROF	Community Communication and Education Strategy developed by December 2012.	NSW Farmers Association Hastings River Branch Committee

Background

Hastings River Oyster Farmers actively seek to provide opportunities for the local community to obtain more information/education about the oyster industry and the environmental management of their operations in an informed manner, for example through talks within schools and combined estuary field days.

6.5. OBJECTIVE 5 CONTRIBUTE TO SCIENTIFIC RESEARCH AND MANAGEMENT INNOVATION RELEVANT TO OYSTER CULTIVATION AND ESTUARINE ENVIRONMENTS

The actions identified against Objective 5 aim to mitigate and address priority risks to facilitate Hastings River Oyster Farmers to contribute to scientific research and management innovation relevant to oyster cultivation and estuarine environments.

Industry related risks

- Outboard efficiency, emissions and noise
- Excess use of electricity
- Lack of adequate toilet facilities for the public on North Shore
- Overstocking of oysters
- Non optimal disposal of old/damaged infrastructure
- Mobilisation/translocation of viruses and *Vibrio sp*
- Disturbance or damage to seagrass habitats and benthic communities
- Inadequate industry representation in catchment activities
- Inappropriate Infrastructure placement - hydrology changes

External risks

- Extreme events - floods
- Extreme events - disease outbreak eg QX
- Climate change

Participation in research

Action 6.5.1 Provide assistance, wherever possible, to government agencies and researchers investigating improved farming practices and environmental management.

Responsibility	Performance Target	Action owner
HROF	Inkind support provided to all key research projects that are of relevance to HROF.	NSW Farmers Association Hastings River Branch Committee

Background

Hastings River Oyster Farmer members have been of great assistance to research projects completed and ongoing on the Hastings River, including issues that affect the entire catchment. Hastings River Oyster Farmer members currently practice an extensive water quality monitoring program, which could prove valuable for external agencies concerned with river health. These attributes place the members in a unique position to assist catchment managers.

The Hastings River Oyster Farmers have been involved in many research and development projects.

A significant research project resulted with the local association in conjunction with the Hastings Council being awarded one of the Environmental Champions Award for work done with acid sulphate soils. This work led to the adoption of a Local Environment Plan (LEP) for the Port Macquarie Hastings Council which was the first in the state, and a precursor to many other councils adapting their own LEP's. Acid sulphate soils has since become a national issue resulting in numerous remediation works.

The Hastings River Oyster Farmers have contributed to many development programs that are ongoing, in relation to alternate nursery and grow out systems for oysters. Using both hatchery and wild caught stock, innovative ideas have been developed on this river that have been subsequently used throughout the industry. The Hastings River Oyster Farmers have a reputation as being innovative and resourceful, with a willingness to share information and results. Local growers have consistently been early adopters of new technology and continue to progress towards the future.

APPENDIX 2. RISK ASSESSMENT TABLE

Risk is the chance of something happening that will have an impact on the oyster industry, the wider industry and/or the environment. Risk Analysis involves consideration of (i) the sources of risk and (ii) the consequences and likelihood that those consequences may occur.

A risk assessment can help to separate and highlight major unacceptable risks from minor acceptable risks.

Each specified risk identified by the HROF has been ranked by the HROF, using the scoring system in the tables below, according to the consequence and likelihood of the risk.

Table 1 Likelihood of risk occurring (Source Seafood Services Australia 2006)

Likelihood	Score	Definition
Remote	1	Never heard of, but not impossible
Rare	2	May occur in exceptional circumstances
Unlikely	3	Uncommon, but has been known to occur
Possible	4	Some evidence to suggest this may possibly occur
Occasional	5	May occur
Likely	6	It is expected to occur

Table 2 Consequence if risk does occur (Source Seafood Services Australia 2006)

Consequence	Score	Definition
Negligible	0	Very insignificant impacts. Unlikely to be measurable
Minor	1	Possibly detectable but minimal impact on structure/function
Moderate	2	Maximum acceptable level of impact - recovery measured in months or years
Severe	3	Will result in wider and longer term impacts - recovery measured in years
Major	4	Very serious impacts with relatively long time frame likely to be needed to restore to an acceptable level – recovery measured in years to decades
Catastrophic	5	Widespread and permanent/irreversible damage or loss will occur – unlikely to ever be fixed

Table 3 Risk Ranking – likelihood x consequence (Source Seafood Services Australia 2006)

	Consequence					
Likelihood	Negligible	Minor	Moderate	Severe	Major	Catastrophic
Remote	0	1	2	3	4	5
Rare	0	2	4	6	8	10
Unlikely	0	3	6	9	12	15
Possible	0	4	8	12	16	20
Occasional	0	5	10	15	20	25
Likely	0	6	12	18	24	30

Table 4 Risk score (Source Seafood Services Australia 2006)

Score	Category
0 =	Negligible risk
1-6 =	Low risk
8-12 =	Moderate risk
15-18 =	High risk
20-30 =	Extreme risk

Industry-related activities

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
Industry related land based activities									
Buildings and surrounding infrastructure Unused infrastructure under management of industry.	Deterioration of sheds and untidy appearance Non-optimal disposal of old/damaged infrastructure	Visual impacts and aesthetics. Use of limited landfill resources Potential chemical leakage if tarred infrastructure stored for long periods in an area Breeding for worms – disease/ pest breeding grounds etc	Issued with clean up and pull down notices from Lands Department as part of lease agreements. Annual clean ups of infrastructure and leases required under operating permits. Have already cleaned up most of infrastructure on banks but not in water – 200	6	4	24	Discuss with Council/ Lands Department re options to assist in process of demolition, eg. Waiver of tipping fees, transport and removal/ equipment costs. Participate in Clean Up Australia Day Remove and where possible recycle or reuse decommissioned infrastructure. Conduct annual	December 2012	NSW Farmers Association Hastings River Branch

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
			tonnes removed to date. 100s of tonnes remaining in water.				clean ups of infrastructure and lease areas targeting waterbased infrastructure.		
Tap water usage	Excess use of freshwater	Waste of water resources Unnecessary cost	Most growers use tank water and do not use freshwater other than for drinking, maintenance etc	1	0	1	None given low risk score		
Electricity usage	Excess use of electricity for grading, depuration and other processes	Waste of energy resources Unnecessary cost	Some solar/winds panels used	6	3	18	Review alternate energy programs to identify options for oyster industry and to participate in programs and access funding.	December 2012	Kingsley Searle
Toilets	Lack of	Potential	Access to some	6	3	18	Review options for	June 2012	Kingsley

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
	adequate toilet facilities for land based activities	pollution from septic or chemical systems Runoff of untreated effluent into river and tributaries	toilets closed – eg on north shore. Port-a-loos/ septic pumpouts used 10 people (30%) industry have this problem				establishing portable toilet facilities at priority locations (the bridge Limeburners east, upper Limeburners west and Big Bay).		Searle
Vehicular access to sheds	Dust, erosion and sedimentation issues (eg Sandfly Alley)	Impacts on turbidity for depuration. Reduced light penetration smothering seagrass and phytoplankton	Council maintains Sandfly Alley through regular road grading. Shell waste used to compact road and cover potholes.	6	3	18	Discuss with Council options for establishing drainage and road sealing. Develop a Sediment Control Plan for Sandfly Alley	December 2012	NSW Farmers Association Hastings River Branch
Fuel and chemical storage areas	Multiple storage places of potential ignition	Explosive spread in event of fire	Minimal holding of chemicals and fuel stored	3	1	3	None given low risk score		

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
	sources Leakage from poor storage or adverse events	Reduced water quality and localised fish kills	by each grower						
Fire	Fire event around land based facilities	Loss of facilities and impacts on production	All growers required for fire extinguishers in punts and sheds. All growers hold property Insurance Long periods of time when unoccupied, eg during depuration. Some clearing around sheds occurs to reduce bushfire	6	3	18	Develop and implement a best practice fire policy around the shed area along oyster industry land based working areas	December 2012	Kingsley Searle

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
			impacts.						
Flood	Flooding event in sheds	Loss of facilities and impacts on production	Some shed high risk for weather events. Raise key equipment up high to be above flood levels.	6	2	12	Refer Contingency Planning action below.		NSW Farmers Port Macquarie Shellfish Branch
Packaging and transport of single seed to other estuaries and transport of mature product to market	Use and disposal of single use packaging Use of diesel fuel and refrigerants by trucks	Resource wastage Greenhouse Gas emissions and air pollutants	Food safety regulations around packaging. Single seed transfer packaging reused – Heshan /poly bags No alternate cost/time efficient method	6	1	6	None given low risk score		

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
			for transporting						
Disposal of general garbage	Non-recyclable and recyclable waste	Use of limited landfill resources	Take to tip for disposal currently. Not large quantities – several wheely bins per mth 60kg – 100kg per mth per grower No council pick up for recycling due to cost.	6	1	6	None given low risk score		
Disposal of waste shells	Not reused or used as road base	Use of limited landfill resources	To landfill or roadbase to mend potholes in Sandfly Alley 1-5 tonnes per grower per year generated.	6	1	6	None given low risk score		

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
Disposal of infrastructure materials waste	Non recyclable and recyclable waste	Use of limited landfill resources	<p>Recycling of materials where possible.</p> <p>Goes to landfill 1 tonne per year per grower to tip.</p> <p>Big Cleanup each year – over 1 -2 mths... derelict leases, rubbish etc 2-3 tonnes per grower per year</p>	6	1	6	None given low risk score		
Punt maintenance	Inappropriate application or disposal of antifouling	Chemical leaks into the environment	<p>Not allowed to use antifouling for punts.</p> <p>Defouling on banks once a year.</p> <p>Some vessels</p>	6	1	6	None given low risk score		

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
			remain out of water when not in use.						
Tarring and treated timber	Leaching from application areas Leaching from infrastructure in water	Reduced water quality and stress on oysters Issue high on public agenda	3 growers still using tar for maintenance of existing trays etc but most changed to plastics. New treated timber not used on site – rather use plastic infrastructure. Some treated timber remains in use however.	6	2	12	Work toward 100% elimination of the use of tar and treated timber	December 2013	NSW Farmers Port Macquarie Shellfish Branch
Disposal of old infrastructure/ derelict leases not under	Non-optimal disposal of old/damaged infrastructure	Use of limited landfill resources Potential	Leases, racks, poles, old punts...infrastructure, shell	6	4	24	Liaise with Department of Lands/ Department of	December 2012	NSW Farmers Port Macquarie Shellfish

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
management of industry (ie OEH responsible for those in national park areas)		chemical leakage if tarred infrastructure stored for long periods in an area Navigation hazard at low tide Breeding for worms – disease/ pest breeding grounds etc	beds. Some tar but most likely to have leached away.				Primary Industries regarding the clean up of leases – re timetable and plan and to develop partnership opportunities for assisting in clean ups.		Branch
Pest control around land based facilities	Poisons and chemicals leaking into the environment.	Reduced water quality Impacts of estuarine health	NSW Food Authority management plan covers.	6	1	6	None given low risk score		

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
Industry related water based activities									
Oyster stocking densities	Overstocking of oysters in estuaries	Depletion of food resources due to high stocking densities Increased of oyster disease Reduced oyster growth rates	Development of stock management plan	5	4	20	Review and develop options for stock management plan.	December 2014	NSW Farmers Port Macquarie Shellfish Branch
Changes to hydrology from industry activities	Inappropriate Infrastructure placement	Decreased water flow and increased siltation Sediment build up Disruption to natural processes	Move to floating cultivation will address. Baskets do not appear to be impacting. Depends on depth of water	6	4	24	Best Practice procedures for infrastructure placement and stocking densities maintained and updated in line with improvements in technology on ongoing basis.	December 2014.	NSW Farmers Port Macquarie Shellfish Branch

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
							<p>Increase use of more environmentally sustainable infrastructure such as floating rafts and plastics</p> <p>Minimise effects on natural sedimentation.</p> <p>Report significant changes in sedimentation to Department of Primary Industries.</p>		
Oyster boating activities - shoreline	High impact boat wash on shoreline from punts	<p>Navigation collision</p> <p>Loss of habitat</p> <p>Destruction of sensitive areas ie saltmarsh,</p>	<p>Compliance with speed limits/no wash zones on river.</p> <p>Hull shape create less bow</p>	4	1	4	None given low risk score		

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
		unstable banks	wave.						
Oyster boating activities – aquatic habitats	Navigation over seagrass beds	Loss or damage of seagrasses reducing habitats for juvenile fish and other animals, sediment stabilisation	Tend to avoid areas and use same travel path. Use poling instead of motors in shallow water.	5	1	5	None given low risk score		
	Mobilisation/ translocation of viruses / <i>virbios</i> sp.	Oyster stress and mortality Human health issues	Food safety regulations address wash.	6	4	24	Review of farm management practices to ensure adequate infrastructure placement for preventing the mobilization or translocation of viruses during washdown processes. (done	December 2014	NSW Farmers Port Macquarie Shellfish Branch

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
							in conjunction with stock management plan development)		
Inefficient motors	Fuel and oil spill Noise pollution	Greenhouse Gas emissions Reduced water quality Impacts on wildlife eg birds, turtles Unhappy water neighbours	All motors moving to 4 strokes Still some old motors in use though. Maybe up to 10 being used.	6	2	12	Minimise fuel consumption and improve vessel stability, longevity. Upgrade outboard motors to meet the current USEPA fuel efficiency and emissions standards. Keep up to date with new technology in outboards etc.	December 2012	NSW Farmers Port Macquarie Shellfish Branch
Lease establishment	Benthic Habitat/ seagrass shading,	Disruption of ecological functioning of	Movement to floating bag cultivation will	5	2	10	Minimise effects on seagrasses and benthic		

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
	substrate damage	estuary	address this. Following of areas occurs for season or two. Some areas are too deep for seagrass and these get used.				communities. Report significant changes in seagrass to Department of Primary Industries (Fisheries branch). Liaise with NSW Maritime to identify channels that will minimise seagrass disturbance		
Tarred and treated timber used for leases	Chemicals leaching into water and sediment	Reduced water quality High profile issue with public	Use of tarred and treated timber being phased out but stays on banks for few weeks to dry out before used.	6	2	12	See above for land based actions related to tar and treated timber.		NSW Farmers Port Macquarie Shellfish Branch

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
Migratory bird habitats	Proximity of boats/lease activities to migratory bird habitats	Reduced breeding success and disturbance to feeding patterns	Current oyster growing practices have not been found to interfere with migratory bird habitats. Possibly creating food source and habitat.	2	4	8	Provide information to conservation and management organisations regarding important bird habitats. Report incidents of bird entanglements to Australian Seabird Rescue and OEH. Train HROF in seabird rescue	June 2012	NSW Farmers Port Macquarie Shellfish Branch
Protected species (ie estuary cod, marine turtles, dolphins, ospreys)	Boat strike Interactions or entanglement Bycatch in pontoons and trays	Injury or mortality to protected species	Speed limits on river complied with.	2	4	8	Suspend operations immediately in the event of an interaction with a protected or threatened	December 2011 and ongoing	NSW Farmers Port Macquarie Shellfish Branch

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
							species. Allow the animal to escape without harm. Develop a Code of Conduct for Hastings River Oyster Farmers		
General									
Interaction with community & stakeholders	Poor oyster representation in catchment activities	Lack of engagement in catchment activities/decisions	Membership of estuary mgt committee but have other councils that have role in catchment like Kempsey Council where have no engagement with, Chamber in Commerce - no	4	2	8	Stakeholder meeting for the river – and connectivity type tour with farmers to show downstream impacts. Membership on Kempsey Estuary management committee.	June 2012	NSW Farmers Port Macquarie Shellfish Branch

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
			<p>involvement but need representation</p> <p>Forestry or NPWS – no engagement at present time but should consider.</p> <p>NSW Farmers representation – membership on Oyster branch,</p> <p>No cross sector engagement but could be considered.</p> <p>Stakeholder meeting for the river needed</p>				Stakeholder meeting – cross Sector engagement with NSW Farmers branches for the region.		
Communication among oyster industry	Poor communication between	Slower industry development	Hastings growers - Branch	4	1	4	Facebook page for oyster farmers to engage with		

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
members	growers in Hastings River and with NSW and other states oyster members	Lack of integration for Hastings River oyster industry. Miss out in industry related opportunities- no sharing of ideas and effort No communication pathways with authorities and related agencies	meetings about 20 out of 28 on average attend. Word of mouth. NSW Farmers communicate through branch secretary. Mail from agencies and meetings as required.				each other. None given low risk score		
External activities									
Deterioration of water quality with increased urban growth	1) Point sources: - Sewage and septic tanks including untreated	Contamination of waterways = closure of harvest area Oysters unsafe for consumption	Shellfish Quality Assurance Program Onground works underway by Council and	6	4	24	Assist the Northern Rivers Catchment Management Authority, OceanWatch Australia,	December 2012	NSW Farmers Port Macquarie Shellfish Branch

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
	<p>sewage entering waterways (i.e. vessel holding tanks, cattle, kangaroo, lack of public toilets on North Shore</p> <p>- Secondary treatment of effluent from STP into Koolanbung Creek)</p> <p>2) Diffuse sources</p> <p>- Disturbance of acidic soils or areas of heavy metals accumulated</p>	<p>Water acidification and/or chemically polluted= oyster mortalities, deformity, reduced production</p>	<p>others to address some issues eg Riparian fencing project in Big Bay through OceanWatch Australia.</p> <p>Some actions in Estuary Management Plan being implemented.</p> <p>Upgrading of septic to sewerage on North Shore is postponed (no date set) due to delays with Area 13 sewage</p>				<p>WetlandCare Australia and Port Macquarie Hastings Council in identifying priority areas requiring on-ground works.</p> <p>Ensure regular liaison with local council and NSW Maritime and participate in key meetings.</p> <p>Area 13 – ongoing discussions with Environment Department with Council regarding monitoring results, particularly for ASS and sewage issues, participate</p>	Ongoing	

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
	<p>in sediment (from slipway/ marina area)</p> <p>- Urban stormwater</p>		<p>system design.</p> <p>ASS discharge location issues have been addressed by Council, but Area 13 development has ongoing problems and liming occurring. Other hotspots are also undergoing remediation works</p> <p>Slipway permit requires 4 years to address metal contamination issues</p> <p>Stormwater – remains issue in</p>				<p>in council meetings.</p> <p>Maintain existing water quality monitoring program. Report detected or suspected pollution incidents immediately to the NSW Food Authority.</p> <p>Report all suspected pollution incidents to Department of Primary Industries and Department of Environment, Conservation, Climate Change and Water (OEH), formerly</p>	<p>Ongoing</p> <p>Ongoing</p>	

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
			<p>urban areas.</p> <p>A number of developments being proposed – key growth area. Biggest centre outside of Sydney, Newcastle, Wollongong</p> <p>Rain events generally result in river closures for oyster growers from 1 day – 1 mth). ASS has impacts on growth of oysters.</p>				Environment Protection Authority.		
Unsealed roads	Run-off into waterways	Reduction of oyster filtration	Shellfish program –	6	2	12	Ensure regular liaison with local	Ongoing	NSW Farmers Port

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
	Dust pollution Increased sedimentation in waterways	results in decreased production Increased turbidity levels decreases water quality and potential pollution of waterways	monitoring of water quality. North Shore is main problem area for dirt roads but no plans for upgrade.				council and participate in key meetings.		Macquarie Shellfish Branch
Loss of riparian vegetation from clearing and/or poor cattle infrastructure	Increased sedimentation in waterways Shore erosion due to livestock pathways down to waterways/ intertidal zone	Poor water quality Loss of buffer zone in shoreline Destruction of sensitive ecological habitats: mangroves and saltmarshes	Some areas in the catchment have been fenced off and re-vegetated with assistance of NRCMA and local council / Oceanwatch Rec Fishing Trust funding/ WetlandCare	6	2	12	As above for water quality NSW Farmers cross sector regional meeting to discuss issues with farmers. Liaise with Council Environment Department for identification of	December 2012	NSW Farmers Port Macquarie Shellfish Branch

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
			<p>funding for bank stabilisation.</p> <p>Estuary Mgt plan has not identified priority areas for riparian works</p>				<p>priority areas.</p> <p>Identify opportunities for partnership to access funding for onground works to address priority areas.</p>		
Changes in estuary hydrology	<p>Changes in natural sedimentation processes due to ocean processes and catchment activities</p> <p>Poor management of floodgates</p> <p>Dredging</p>	<p>Change of water flow quantity/ direction</p> <p>Change in food level availability for oysters</p> <p>Siltation, acidic sediment stirred up/ drainage problems all leading to stress of oysters</p>	<p>Moving to floating cultivation</p> <p>Carrying capacity program to develop a Stock Management Plan for industry – will examine river flow as part of this.</p>	6	2	12	<p>As above.</p> <p>Report significant changes in sedimentation to Department of Primary Industries</p> <p>Maintain regular discussions with Department of Primary Industries and local Council on programs addressing hydrology issues</p>	Ongoing	NSW Farmers Port Macquarie Shellfish Branch

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
							such as active floodgate management and barrier removal.		
Use of non-environmentally friendly horticulture & agriculture products (i.e. fertilizers, pesticides, mulch)	Chemical (nitrogen and phosphorous) pollution of waterways (eg from tea tree plantations into Limeburners Creek and Maria River), Bitou bush treatment at North Shore	Increase nutrient levels entering waterways leading to potential algae bloom Poor water quality Stress that can lead to mortality of oysters	Shellfish program does not test for chemicals. Reliant on condition of oysters. Have had massive kills related directly to spraying. Local Council undertakes monitoring every 4 months	6	3	18	Identify source points of pollution in areas where oyster mortality regularly occurs (monitoring of oyster mortality) Liaise with DPI/OEH to have sampling program established for river. Liaise with Newcastle University and SCU for an honours student to undertake	December 2012	Paul Wilson

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
							monitoring.		
Recreational fishers, water users, tourists	Mooring to and fishing around oyster leases Navigation over oyster infrastructure Boat wash (i.e. large vessels)	Loss/damage of oyster infrastructure Erosion of shoreline (i.e. protected areas) Impact on oysters	At high tide recreational fishers have access to water over leases. Regulations are in place to prevent touching of plant however this is not adhered to. Fisheries compliance or MSB compliance minimal on river.	6	2	12	Respect other users of the Hastings River system. Identify hotspot areas where conflicts occur. Liaise with the tourism authority to develop information awareness on accessing waterways around leases. Liaise with Maritime to develop signage for dangers and channel identification,	12 months	NSW Farmers Port Macquarie Shellfish Branch

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
							speed zones Identify hotspot areas where common for problems to occur.		
Pest species & other fouling species (eg Pacific Oysters, Caluierpa taxifolia)	Enhancement of exotic & fouling species settlement, growth and dispersion on oyster infrastructure/ cultivation units Transfer of pests & fouling species between sites/estuaries Impact on overall ecology of aquatic ecosystem	Competition for food sources by pest & fouling species Oyster mortalities and declines in production = Economic losses Impact on overall aquatic ecosystem	Growers have been trained on pest species identification & they are taking part of pest monitoring programs, particularly for pacific oysters and green shore crabs. Growers participate in monitoring/research Use of oyster	5	3	15	Ensure all Hastings River Oyster Farmers have a copy of marine pest identification cards and best practice biofouling guidelines for aquaculture being developed by the National Introduced Marine Pest Coordination Group (NIMPCG). Report with a sample if possible,	December 2010	NSW Farmers Port Macquarie Shellfish Branch

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
			shipment logbook/ Pest & Disease control program.				any detection of an unusual plant or animal. Follow requirements of government agencies in combating marine pests.		
Extreme weather events	Flood events	Changes to salinity and increased sediment Lost infrastructure Increased stress on oysters or mortality Navigation hazards Accumulation of oyster products on shoreline –	Quality Program monitoring. Weather forecasting No contingency plans – but infrastructure is lifted up or removed out of water and secured when warning of extreme event available.	6	2	12	Develop contingency plan, including: - Training/ communication to all growers information available to predict flooding and water levels (Manly Hydraulics Lab website). - Develop an appropriate	December 2012	NSW Farmers Port Macquarie Shellfish Branch

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
		visual amenity	Flood clears very quickly but tidal and storm surges – annual event 1-2 per year generally but will increase with climate change				pontoon design for Hastings River to manage flood events. - Training for growers on best practice design/mitigation techniques.		
Disease/ virus outbreak	QX, Others	Increased stress to oysters, deformity or mortality	Shellfish Quality Assurance Program Safeguards for estuaries that have outbreaks – through DPI (QX) and NSW Food Authority (virus).	2	6	12	Contingency planning as above		NSW Farmers Port Macquarie Shellfish Branch
Climate change	Sea level rise	Changes to	Government	4	4	16	Contingency	Ongoing	NSW

Activity	Risk Description	Potential Impacts	Current Mitigation Activities/ Controls	Likelihood Score	Consequence Score	Risk Score (L x C)	Proposed Risk Mitigation Actions	Timeframe	Action Owner
	<p>Increased storm and extreme events</p> <p>Changes to currents, water temperatures and rain events</p> <p>Acidification of the waterways</p>	<p>salinity, pH and food chain</p> <p>Increased stress on oysters or mortality due to oysters being incapable of adapting to environmental conditions</p>	<p>climate program</p> <p>Participation in climate change discussions for aquaculture</p>				<p>planning and changes to farming practices etc</p> <p>Ongoing participating in meetings</p> <p>Encourage seagrass growth through use of floating cultivation, mangrove and saltmarsh regeneration and participate in Blue Carbon Program with WetlandCare Australia.</p>		Farmers Port Macquarie Shellfish Branch

REFERENCES

- Australian Fisheries Resources. (1993).** Sydney Rock Oyster, published in 1993 by the Bureau of Rural Sciences and the Fisheries Research and Development Corporation. <http://www.edaff.gov.au/nfpd/atlas/23257006.cfm>, December 2005
- Crawford, C.M. (2001).** Environmental risk assessment of shellfish farming in Tasmania. Tasmanian Aquaculture and Fisheries Institute, University of Tasmania.
- Crawford, C. (2003).** Qualitative risk assessment of the effects of shellfish farming on the environment in Tasmania, Australia, *Ocean and Coastal Management*, 46: pp47-58
- Department of Environment and Conservation (2005).** UPPER HASTINGS AND FORBES RIVERS WERRIKIMBE NATIONAL PARK Wild River Assessment, Parks and Wildlife Division Department of Environment and Conservation June 2005 available from <http://www.environment.nsw.gov.au/resources/protectedareas/forbeshastingswra08364.pdf>
- Department of Primary Industries (2011).** Aquaculture Production Report 2010–2011, Raelene Trenaman, Aquaculture Unit, Port Stephens Fisheries Institute. State of New South Wales through NSW Department of Primary Industries 2011 <http://www.dpi.nsw.gov.au/fisheries/aquaculture/faqs/aquaculture-production-reports>
- Department of Primary Industries (2009a).** Aquaculture in NSW Facts and Figures, NSW Department of Primary Industries 2009 available from http://www.dpi.nsw.gov.au/__data/assets/pdf_file/0004/288643/Aquaculture-facts-figures-2009.pdf
- Department of Primary Industries (2009b).** Aquaculture production report 2008–2009 Author: Sheree Wiseman, Aquaculture Unit, Port Stephens Fisheries Institute
- Healthy Rivers Commission, (2003).** *Independent Review of the Relationship between Healthy Oysters and Healthy Rivers*. Healthy Rivers Commission of NSW, Sydney. http://www.hrc.nsw.gov.au/site/pdf/reports/oysters_final.pdf
- Lasiak, T.A. & A.J. Underwood, (2002).** Experimental assessment of potential ecological impacts of longline mussel farming in Twofold Bay, Eden. Final report for NSW Cultured Mussel Growers Association Inc.
- Maher, D, Squire, P., Eyre, B (2007)** *Benthic Habitat Mapping, Primary Productivity Measurements and Macrofauna Surveys in the Camden Haven and Hastings River Estuaries*. Centre for Coastal Biogeochemistry Southern Cross University October 2007
- National Oceans Office, (1997).** Biodiversity Conservation Issues Paper 7, National Oceans Office, Canberra.
- National Land and Water Resources Audit (2001).** Australian Water Resources Assessment 2000. Land and Water Resources Audit Canberra
- New South Wales Department of Natural Resources. (no date).** Estuaries of New South Wales available from <http://www.dnr.nsw.gov.au/estuaries/inventory/hastings.shtml>
- Port Macquarie Hastings Council (2008).** Annual Report 2007-2008 Part B State of the Environment Report available from

http://www.hastings.nsw.gov.au/resources/documents/Annual_Report_Part_B_SoE_0708_web.pdf

Porat, Y, (2001). Potential ecological impacts of oyster-farms in the Hawkesbury River. B.Sc. Honours thesis, University of Sydney.

Rubio, A. (2008). The dynamics and distribution of food supplies for the Sydney rock oyster (*Saccostrea glomerata*) in southern NSW estuaries. Canberra: FRDC final report series project no. 2004/ 224. 91 pp.

Seafood Services Australia, (2006). Seafood EMS Worksheets. Seafood Services Australia Ltd www.seafoods-services.com.au

Troup, A. J., Cairns, S. C. and Simpson, R. D. (2005), Growth and mortality of sibling triploid and diploid Sydney rock oysters, *Saccostrea glomerata* (Gould), in the Camden Haven River. *Aquaculture Research*, 36: 1093–1103. doi: 10.1111/j.1365-2109.2005.01326.x

White, I, (2001). Safeguarding Environmental Conditions for Oyster Cultivation in NSW, occasional paper for The Healthy Rivers Commission, Centre for Resources and Environmental Studies, Australian National University