Environmental Risk and Impact Assessment of the Pearling Industry

Dr P. Jernakoff

Project No. 2001/099

TITLE: Environmental Risk and Impact Assessment of the Pearling Industry

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Contents

ABBREVIATIONS

AQIS	Australian Quarantine and Inspection Service
EMS	Environmental Management System
ERA	Environmental Risk Assessment
ESD	Ecological Sustainable Development
DFWA	Department of Fisheries Western Australia
IRCE	IRC Environment
ISO	International Organisation for Standardisation
MSC	Marine Stewardship Council
PPA	Pearl Producers Association Inc.
R&D	Research and Development
SCFA	Standing Committee of Fisheries Aquaculture

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OBJECTIVES:

1. Identify key environmental issues and risks facing the Pearling Industry.
2. Identify gaps that would need to be addressed in current Pearling Industry procedures in order to develop a PPA Environmental Code of Practice in line with the requirements of an Environmental Management System such as ISO 14001.
3. Source and obtain ecological information to assist the industry in identifying what environmental characteristics are key elements of successful pearl farming.
4. Recommend what environmental parameters should be used in monitoring program to ensure that any potential environmental impact of pearl farming on the marine environment is detected.
5. Recommend research priorities on pearl oyster fishing / farming environmental issues.
6. Provide information that is transferable to similar types of aquaculture eg black lipped pearl fishery, abalone hatchery operations.
7. Position the Pearling Industry to satisfy the Environment Australia/SCFA ESD assessment processes.

NON TECHNICAL SUMMARY

OUTCOMES ACHIEVED

The following outcomes align with the project objectives:

- Integration with the SCFA Ecological Sustainable Development (ESD) process.
- Demonstration of environmental due diligence and environmental stewardship of the Pearl fishery.
- A strategy with which the Pearling Industry can enhance its position in the light of current government policy.
- The development of a PPA Environmental Code of Practice along the lines of an Environmental Management System (EMS) (eg, ISO14001).
- Provision of knowledge that could be transferred to similar fisheries such as black lipped pearls and abalone hatcheries.
- A report outlining gaps in key environmental information required to address government policy issues on sustainability.
- A report outlining gaps in the current management system in the Pearling Industry and an ISO 14001 fishery.
- A report of the ecological risk assessment workshop.

To achieve the objectives and outcomes that the PPA set, essentially four tasks were required.

- Task 1: Evaluation of current Pearl Industry practices and procedures;
- Task 2: Environmental risk assessment workshop;
- Task 3: Gap analysis of key environmental information; and
- Task 4: EMS gap analysis.

Task 1: Evaluation of current Pearl Industry practices and procedures

A site visit was conducted to evaluate current Pearl Industry practices and procedures. The objectives of the site visit were to:

- visit at least 3 pearl farms, fishing vessels and interview staff to assess how the fishery operates and how closely its procedures and practices are in line with those required of an internationally recognised environmental management system.
- assess the degree to which existing practices and procedures are implemented.
- report on the site visit and evaluate physical conditions, existing practices and procedures of a pearl industry in operation in the Broome, Darwin and Kimberley region.

The locations visited were Bynoe Harbour, Kuri Bay and Talbot Bay. During the visit the observed farming activities included growout, seeding and harvesting. The physical conditions were observed in which the activities operated and the extent to which management systems were implemented.

Task 2: Environmental Risk Assessment Workshop

The PPA required a comprehensive and scientifically defensible assessment of the impact of fishery and farming operations to the ecosystem (environmental and ecological risk assessment). A risk assessment was carried out based on existing knowledge, considering all aspects of the fishery, identifying and prioritising gaps in knowledge and producing a set of prioritised risks. The broad intent of the Environmental Risk Assessment Workshop was to provide a register of the main potential environmental and ecological risks that arise from the various activities carried out by the *Pinctada*

maxima industry. This risk register is used to identify the underlying issues so that these may be addressed through the development of an appropriate management strategy. This enables the fishing activities to focus on reducing the risk of deleteriously affecting the ecosystem in which the industry occurs.

The aim was also to integrate the workshop with the broader Ecological Sustainable Development (ESD) research program by providing a session of the workshop for the Department of Fisheries Western Australia (DFWA) to address environmental and ecological risks for the Wild Harvest component of the *Pinctada maxima* fishery. The risk assessment workshop was held during September 2001 at the Fremantle Sailing Club, Western Australia. The risk assessment results were incorporated into the development of an industry code and can also be used to assist the industry if it chooses to seek MSC accreditation.

Task 3: Gap analysis of key environmental information

The identification of key environmental issues as identified from Task 1 assisted in determining if adequate information on those issues exists or if information is required following a review of national and international literature.

A significant feature of this review was to ensure that all recommendations are outcome based and applicable to the needs of the Pearling Industry as opposed to those that are of theoretical or of academic interest. The review, built on the report by Enzer (1998), identified appropriate information or key gaps that are required to be answered to meet the PPA's outcomes. Relevant research strategies were recommended to address those gaps.

Task 4: EMS Gap analysis

The PPA members are required to ensure that environmental issues are integrated into pearling business activities. An outcome of this effort is to position the PPA members as industry leaders in the area of environmental stewardship of fisheries and marine resources from both a national and international perspective. One of the goals of the PPA is to have its environmental achievements and activities recognised by an objective, transparent and internationally accepted method. The PPA sees achieving and demonstrating compliance to an internationally recognised standard such as ISO 14001 as a solution to this requirement. The gaps were significant enough to prevent pearling companies from achieving the requirements of the Standard at the present time (and therefore certification to ISO 14001).

The gap analysis used information collected during Task 1 and compared the current procedures and systems used by pearling companies with those required by an ISO 14001 EMS. The gap analysis also identified areas where a Pearling Industry environmental code of practice could be developed.

Environmental Code of Practice

The PPA's members have prepared an environmental code of practice to provide minimum standards for environmental performance. The PPA will encourage all pearlers to adopt this Code as a statement of the industry's commitment to ecologically sustainable development. The outcome for pearlers should be to continue to:

- operate in an environmentally responsible manner; and
- be known as an industry that is environmentally benign, producing a high quality product with minimal, if any, modifications to the environment.

KEYWORDS: ecologically sustainable development (ESD), environmental impact, pearling, environmental management system (EMS), risk assessment.

ACKNOWLEDGMENTS

This work benefited from the expertise, input and discussions with the following individuals:

- Mr Brett McCallum, PPA
- Dr Dave Mills, Paspaley Pearls

The report "Environmental Effects of Pearling (*Pinctada maxima*), Gaps in Present Knowledge" was prepared by Dr Fred Wells, Enzer Marine Environmental Consulting to address Task 3: Gap analysis of key environmental information (Appendix 5).

The following individuals participated in the environmental risk and impact assessment workshop:

- Mr Jim Penn, DFWA
- Ms Robin Clarke, DFWA
- Mr Colin Chalmers, DFWA
- Dr Rick Fletcher, DFWA
- Mr Ross Gould, DFWA
- Ms Jo Bunting, DFWA
- Dr Kim Freidmann, DFWA
- Mr Greg Finlay, DFWA
- Mr Brett McCallum, PPA
- Mr John Kelly, PPA
- Mr Dave Mills, Paspaley Pearls
- Ms Jenny Carey, Conservation and Land Management
- Mr Andrew Bartleet, Fisheries Regional Manager Broome
- Ms Astrida Mednis, Environment Australia
- Ms Harriet Paterson, Sustainable Fisheries Office, Conservation Council
- Mr Owen Bunter, MG Kalis

The Department of Fisheries Western Australia provided Figures 1 – 5, which show the four Western Australian managed fishery zones for *Pinctada maxima*.

The following PPA member companies responded to the EMS gap analysis questionnaire (refer to Appendix 6, Task 4: EMS gap analysis):

- Australian Sea Pearls Pty. Ltd;
- Broome Pearls Pty. Ltd;
- Cygnet Bay Pearls;
- Exmouth Pearls;
- Hamaguchi Pearls;
- Paspaley Pearling Co;
- Pearls Pty Ltd;
- Morgan & Co; and
- Roebuck Pearl Producers.

The project work was funded in part by financial or support-in-kind contributions from the following bodies:

- Fisheries Research and Development Corporation
- WA Industry Development Unit
- Pearl Producers Association
- International Risk Consultants

1 BACKGROUND

At the Commonwealth Government level, policies on Ecologically Sustainable Development (ESD), including Australia's Ocean Policy will have a significant impact on the Pearling Industry. In preparation to the changing government policy on fisheries including pearling, the Pearl Producers Association (PPA) commissioned the report: "The Environmental impact of pearling (*Pinctada maxima*) in Western Australia" (Enzer 1998).

The report described the general environment in which pearling occurs, the pearling activities that may cause an environmental impact, suggestions for a monitoring programme and advice on the possible components of an environmental code of practice for the Pearling Industry.

Enzer (1998) concluded that the environmental effects of the Pearling Industry were minor and that the industry was environmentally benign. The review suggested that the objectives of a proposed code of practice should include:

- establishing procedures to ensure Australia's reputation for producing high quality pearls is maintained and enhanced through the application of ESD principles;
- ensuring that pearl farms operate in a manner acceptable to the public and other users of the marine environment; and
- providing guidelines for use by industry to ensure best practice techniques are adopted for the various activities undertaken.

The Enzer report (1998) provided an important benchmark summary of the current industry. It highlighted what was known within the industry. Through its synthesis it provided the R&D subcommittee of the PPA with an opportunity to review current environmental issues.

At the State Government level, Fisheries Management Paper, Marine farm planning and consultation processes in Department of Fisheries Western Australia (DFWA), described a number of issues affecting the Pearling Industry in the consultation process. These included:

- a need for a more strategic framework for the assessment of applications based on ESD principles;
- ESD issues need to be addressed at the early stages of the development of the aquaculture industry and proceed with the utmost caution;
- the principal issues of public concern with pearl farms are safety and access for navigation and recreational fishing;
- guidance is needed in determining resource sharing principles and trade offs between competing interests; and
- a need for areas free of encumbrance for aquaculture to be defined through planning studies in identified areas.

2 NEED

Based on the Government ESD and Oceans Policies the Pearling Industry is currently facing several significant concerns. These include the need to:

- objectively demonstrate that pearling activities have minimal, if any, adverse ecological impact on the marine environment;
- identify challenges and threats to the fishery's continued viability from an ESD perspective;
- objectively demonstrate that the fishery is environmentally sustainable;
- obtain broad ecological information to assist the industry in identifying what environmental characteristics are key elements of successful pearl farming; and
- identify what areas of research are required to substantiate the Pearling Industry's claim of ongoing ESD.

3 OBJECTIVES

The overall project objectives include:

1. Identify key environmental issues and risks facing the Pearling Industry.
2. Identify gaps that would need to be addressed in current Pearling Industry procedures in order to develop a PPA Environmental Code of Practice in line with the requirements of an Environmental Management System such as ISO 14001.
3. Source and obtain ecological information to assist the industry in identifying what environmental characteristics are key elements of successful pearl farming.
4. Recommend what environmental parameters should be used in monitoring program to ensure that any potential environmental impact of pearl farming on the marine environment is detected.
5. Recommend research priorities on pearl oyster fishing/farming environmental issues.
6. Provide information that is transferable to similar types of aquaculture eg black lipped pearl fishery, abalone hatchery operations.
7. Position the Pearling Industry to satisfy the Environment Australia/SCFA ESD assessment processes.

To achieve the objectives that the PPA set for itself, essentially four tasks were required.

- Task 1: Evaluation of current Pearl Industry practices and procedures;
- Task 2: Environmental risk assessment workshop;
- Task 3: Gap analysis of key environmental information; and
- Task 4: EMS gap analysis.

Table 3.1 details where the task related reports can be found (i.e. which Appendix to refer to), which project objectives are related to each task and the relevant outcomes.

Table 3.1: Project Objectives, Outcomes, Tasks and Relevant Reports

#	Project Objectives	Outcomes	Tasks	Appendix
1.	Identify key environmental issues and risks facing the Pearling Industry	• Integration with the SCFA ESD process; • Demonstration of environmental due diligence and environmental stewardship of the Pearl fishery; • A strategy with which the Pearling Industry can enhance its position in the light of current government policy; • The development of a PPA Environmental Code of Practice along the lines of an EMS (eg, ISO14001); and • Provision of knowledge that could be transferred to similar fisheries such as black lipped pearls and abalone hatcheries.	• Task 1: Evaluation of current Pearl industry practices and procedures; • Task 2: Environmental Risk Assessment workshop; • Task 3: Gap analysis of key environmental information; and • Task 4: EMS gap analysis.	3, 4, 5 and 6.
2.	Identify gaps that would need to be addressed in current Pearling Industry procedures in order to develop a PPA Environmental Code of Practice in line with the requirements of an Environmental Management System such as ISO 14001	• Demonstration of environmental due diligence and environmental stewardship of the Pearl fishery; • A strategy with which the Pearling Industry can enhance its position in the light of current government policy; • The development of a PPA Environmental Code of Practice along the lines of an EMS (eg, ISO14001); and • A report outlining gaps in the current management system in the Pearling Industry and an ISO 14001 fishery.	• Task 1: Evaluation of current Pearl industry practices and procedures; • Task 3: Gap analysis of key environmental information; and • Task 4: EMS gap analysis.	3, 5, 6 and 7.
3.	Source and obtain ecological information to assist the industry in identifying what environmental characteristics are key elements of successful pearl farming	• Demonstration of environmental due diligence and environmental stewardship of the Pearl fishery; • A strategy with which the Pearling Industry can enhance its position in the light of current government policy; and • Provision of knowledge that could be transferred to similar	• Task 1: Evaluation of current Pearl industry practices and procedures; • Task 2: Environmental Risk Assessment workshop; and	3, 4 and 5.

#	Project Objectives	Outcomes	Tasks	Appendix
		fisheries such as black lipped pearls and abalone hatcheries.	• Task 3: Gap analysis of key environmental information.	
4.	Recommend what environmental parameters should be used in monitoring program to ensure that any potential environmental impact of pearl farming on the marine environment is detected	• Demonstration of environmental due diligence and environmental stewardship of the Pearl fishery; • A strategy with which the Pearling Industry can enhance its position in the light of current government policy; and • Provision of knowledge that could be transferred to similar fisheries such as black lipped pearls and abalone hatcheries.	• Task 2: Environmental Risk Assessment workshop; and • Task 3: Gap analysis of key environmental information.	4 and 5.
5.	Recommend research priorities on pearl oyster fishing / farming environmental issues	• A strategy with which the Pearling Industry can enhance its position in the light of current government policy; and • Provision of knowledge that could be transferred to similar fisheries such as black lipped pearls and abalone hatcheries.	• Task 2: Environmental Risk Assessment workshop; and • Task 3: Gap analysis of key environmental information.	4 and 5.
6.	Provide information that is transferable to similar types of aquaculture eg black lipped pearl fishery, abalone hatchery operations	• Provision of knowledge that could be transferred to similar fisheries such as black lipped pearls and abalone hatcheries.	• Task 2: Environmental Risk Assessment workshop; and • Task 4: EMS gap analysis.	4 and 6.
7.	Position the Pearling Industry to satisfy the Environment Australia/SCFA ESD assessment processes	• Integration with the SCFA ESD process; • Demonstration of environmental due diligence and environmental stewardship of the Pearl fishery; • A strategy with which the Pearling Industry can enhance its position in the light of current government policy; and • A report outlining gaps in key environmental information required to address government policy issues on sustainability.	• Task 2: Environmental Risk Assessment workshop; and • Task 3: Gap analysis of key environmental information.	4 and 5.

4 METHODS

The four tasks listed below comprise the overall project with each task having its own report. These four main reports are provided as appendices within this report.

- Task 1: Evaluation of current Pearl industry practices and procedures - Firstly, IRC consultants evaluated current Pearl fishery procedures and practices;
- Task 2: Environmental risk assessment workshop - An environmental risk assessment workshop to identify and prioritise environmental and ecological risks and impacts associated with the Pearling Industry;
- Task 3: Gap analysis of key environmental information - A review of key knowledge gaps (eg, environmental quality requirements for pearling, environmental indicators, monitoring techniques, pearl oyster carrying capacity etc) that are both relevant and appropriate for the Pearling Industry; and
- Task 4: EMS gap analysis - A gap analysis of Pearling Industry practices against an environmental management system such as ISO 14001. The gap analysis information was used to developed a Pearling Industry environmental code of practice.

Each task has its own method which is detailed in the relevant report. In summary the methods for each task are:

4.1 Task 1: Evaluation of current Pearling Industry practices and procedures

A site visit was conducted to evaluate current Pearl Industry practices and procedures. The objectives of the site visit were to:

- visit at least 3 pearl farms, fishing vessels and interview staff to assess first hand how the fishery operates and how closely its procedures and practices are in line with those required of an internationally recognised environmental management system.
- assess the degree to which existing practices and procedures are implemented.
- report on the site visit and evaluate physical conditions, existing practices and procedures of a pearl industry in operation in the Broome, Darwin and Kimberley region.

The locations visited were Bynoe Harbour, Kuri Bay and Talbot Bay. Figures 1 – 5 show the Western Australian sites that were visited as four managed fishery zones. During the visit the observed farming activities included growout, seeding and harvesting. The physical conditions were observed in which the activities operated and the extent to which management systems were implemented.

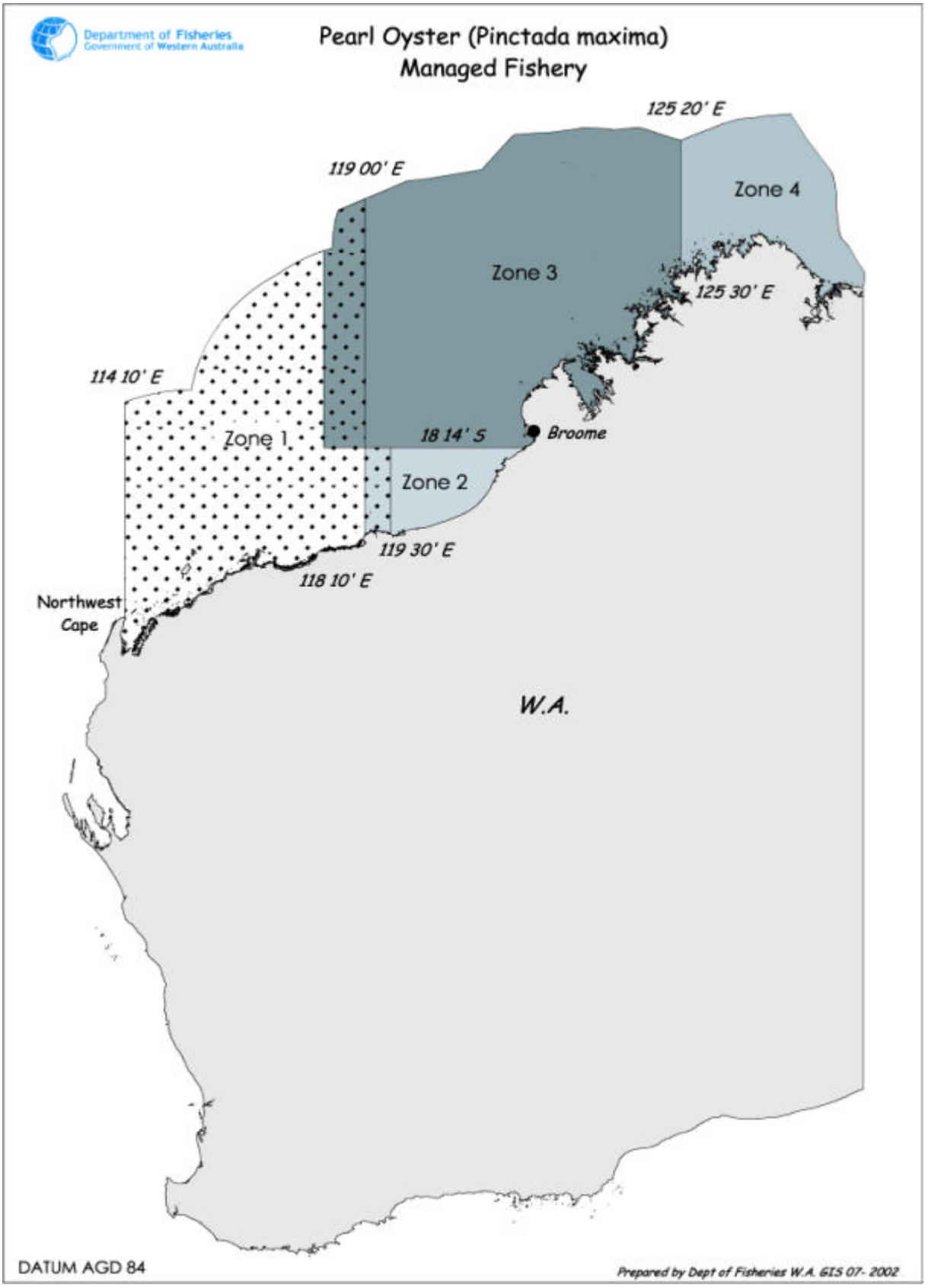


Figure 1: Pearl Oyster (Pinctada maxima) Managed Fishery

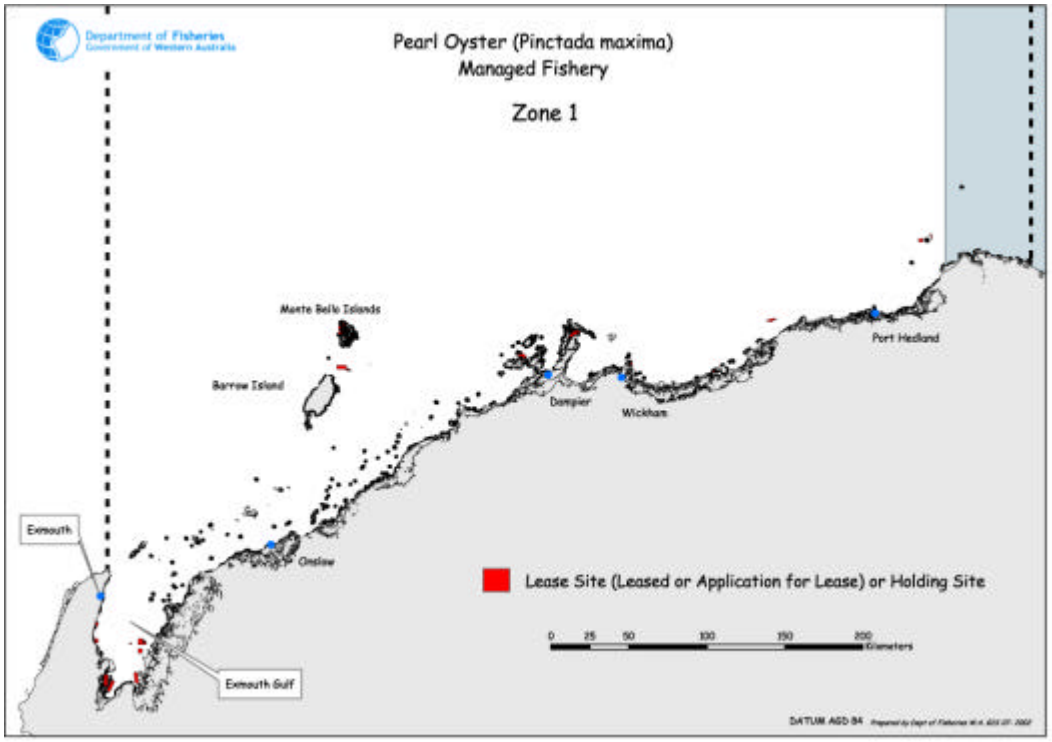


Figure 2: Pearl Oyster (*Pinctada maxima*) Managed Fishery, Zone 1

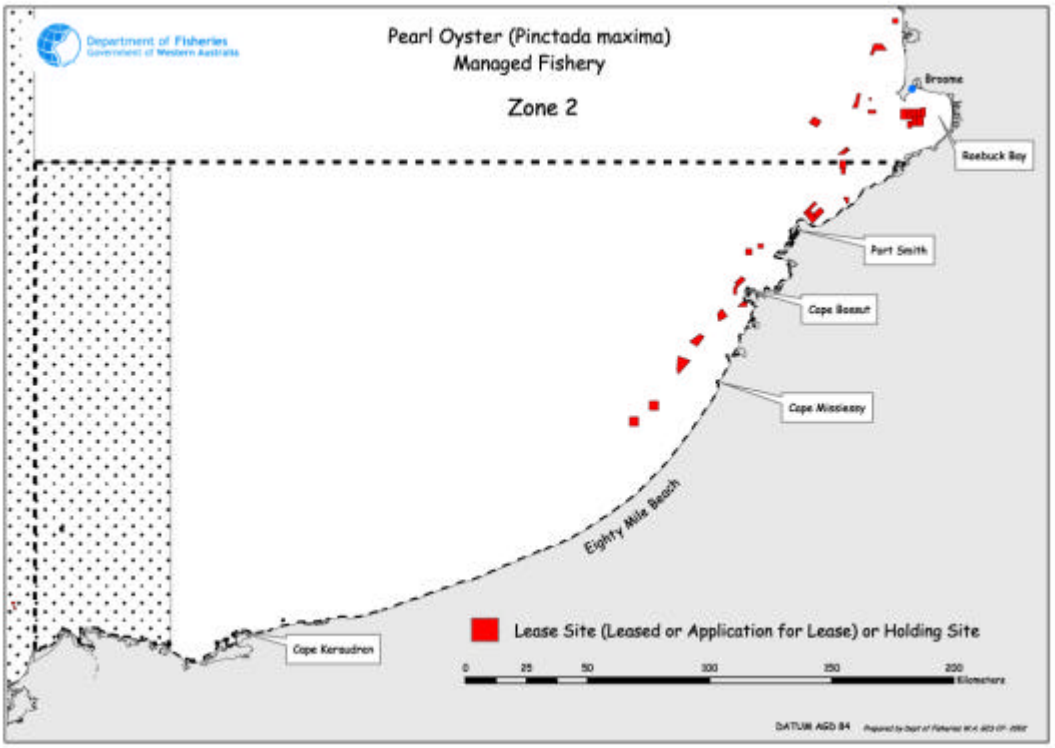


Figure 3: Pearl Oyster (*Pinctada maxima*) Managed Fishery, Zone 2

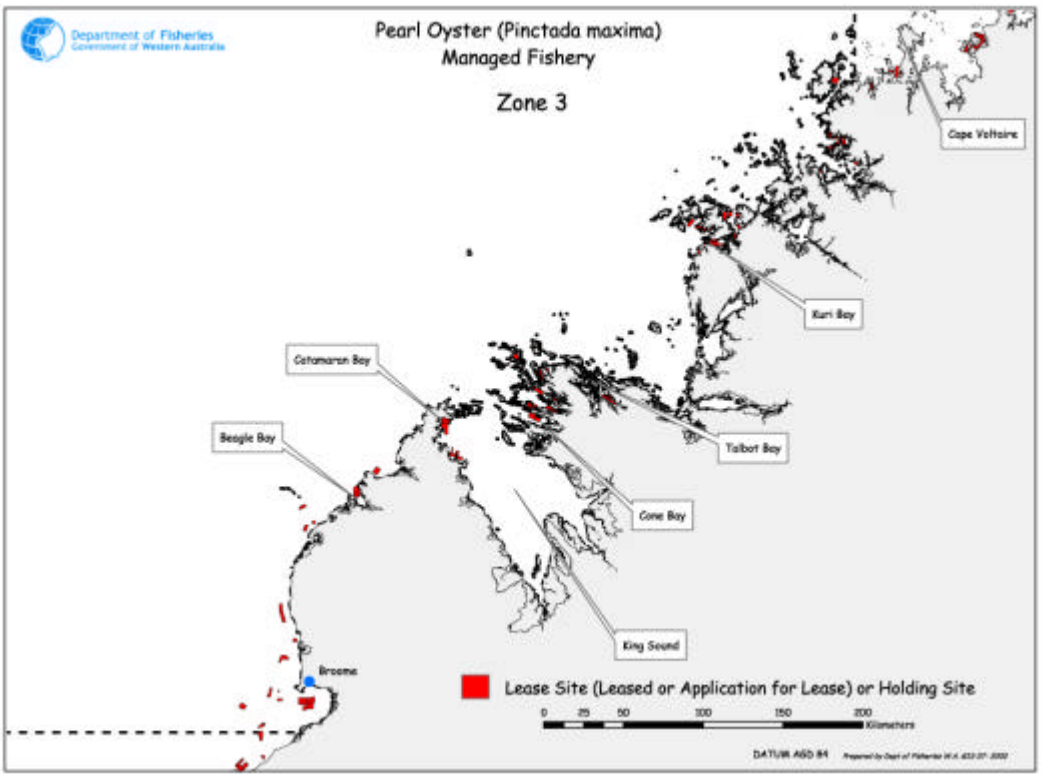


Figure 4: Pearl Oyster (*Pinctada maxima*) Managed Fishery, Zone 3

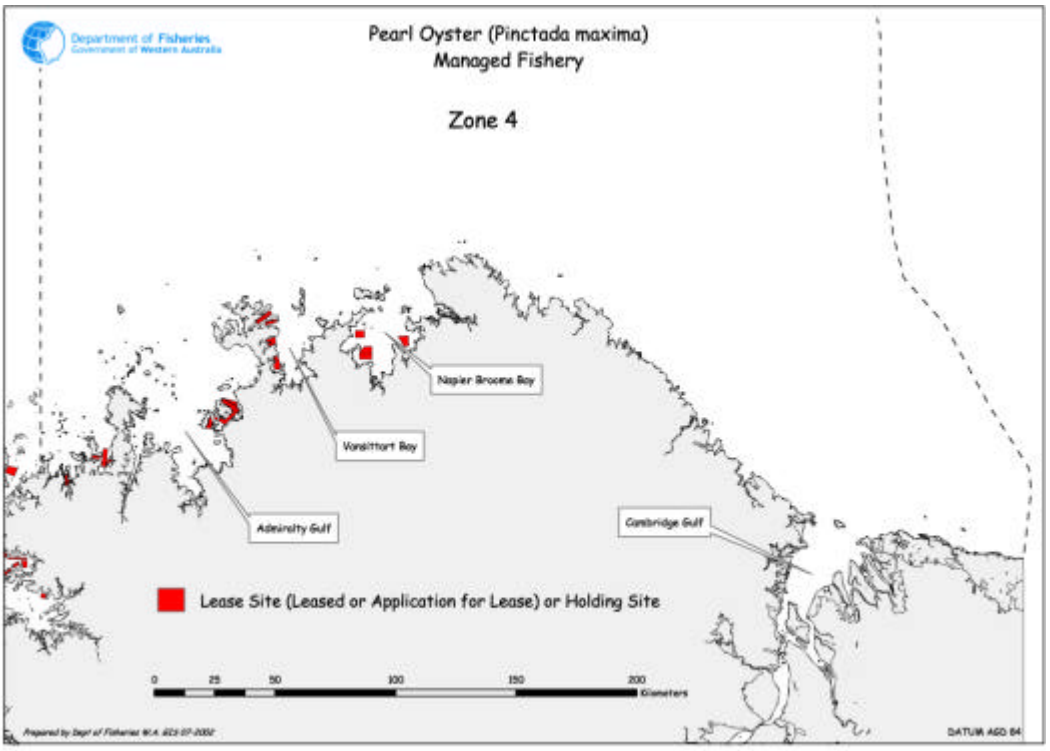


Figure 5: Pearl Oyster (*Pinctada maxima*) Managed Fishery, Zone 4

4.2 Task 2: Environmental risk assessment workshop

The environmental risk assessment workshop was conducted over the period of a day and included invited representatives of the Pearling Industry, government and environmental groups.

During the workshop, the environmental (including ecological) hazards and impacts were identified. Impacts were assigned likelihood and consequence ratings to give an overall risk rating. The workshop results were used to develop recommendations for minimising the risks and impacts identified.

The risk assessment results were incorporated into the development of an industry code and can also be included in to an EMS and used to assist the industry if it chooses to seek Marine Stewardship Council (MSC) accreditation.

4.3 Task 3: Gap analysis of key environmental information

The identification of key environmental issues as identified from Task 1 highlighted whether adequate information on those issues exist or if information is required following a review of national and international literature.

A significant feature of this review was to ensure that all recommendations are outcome based and applicable to the needs of the Pearling Industry as opposed to those that are of theoretical or of academic interest. The review built on the report by Enzer (1998) to identify appropriate information or key gaps that are required to be answered to meet the PPA's required outcomes. For identified gaps, recommendations were made such as relevant research strategies to address those gaps.

4.4 Task 4: EMS gap analysis

The gap analysis used information collected during Task 1 and compared the current procedures and systems used by the PPA with those required by an ISO 14001 EMS. The gap analysis identified areas where a Pearling Industry environmental code of practice could be developed.

5 RESULTS AND DISCUSSION

5.1 Task 1: Evaluation of current Pearling Industry practices and procedures

Task 1 involved the evaluation of current Pearling Industry practices and procedures via interviews with staff, a review of environmental management documentation and by physical inspection of the farms visited.

All staff interviewed were aware of the need to preserve environmental quality for both the general sake of the environment and the need for high quality and productive pearl farming activities.

None of the pearl farms visited had a documented/formal EMS in place. Although all staff interviewed were aware of their environmental responsibilities, there was a lack of written procedures on environmental management that would be characteristic of an EMS. An industry code of practice for diving operations was cited but it was verified that there was no industry environmental code of practice.

A gap analysis questionnaire that identifies the major knowledge and procedural gaps that the industry currently faces compared with having an EMS or a code of practice was sent to PPA members (the questionnaire findings are discussed in Task 3, Appendix 5). The PPA aimed to seek feedback from all member companies to ensure that the results are representative of the industry as a whole.

The findings from Task 1 were key to the development of tasks 2, 3 and 4.

5.2 Task 2: Environmental Risk Assessment workshop

In total, 13 environmental and ecological issues were identified across the *P. maxima* fishery. No high risks were identified during the workshop. Risks associated with the issues identified were ranked as either moderate (23%) or low (77%). The moderate risk rankings included:

1. Introduction of disease from seeding
2. Attraction of other fauna
3. Introduction of exotic organisms

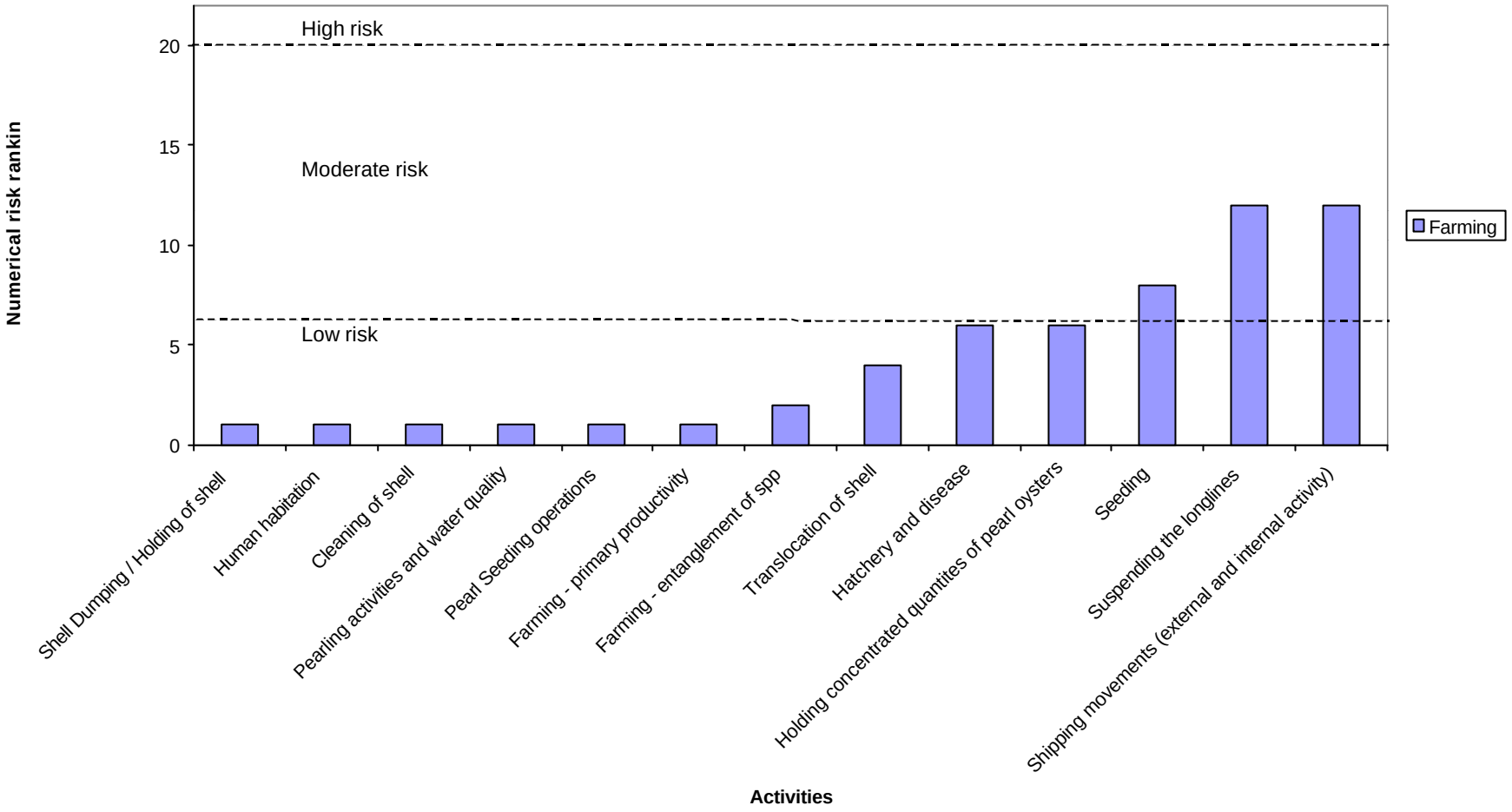
Within the low risk category, the risks were:

4. Spread of disease;
5. Introduction of disease from hatchery;
6. Introduction of disease from translocation;
7. Impact to protected and endangered species resulting from entanglement;
8. Impact of habitat;

9. Impact to protected and endangered species resulting from farm lighting;
10. Nutrient impacts in sediment;
11. Perceived change in water quality;
12. Potential for litter eg plastic zip tie tags, plastic bags, buoys to enter water; and
13. Reduction of primary productivity.

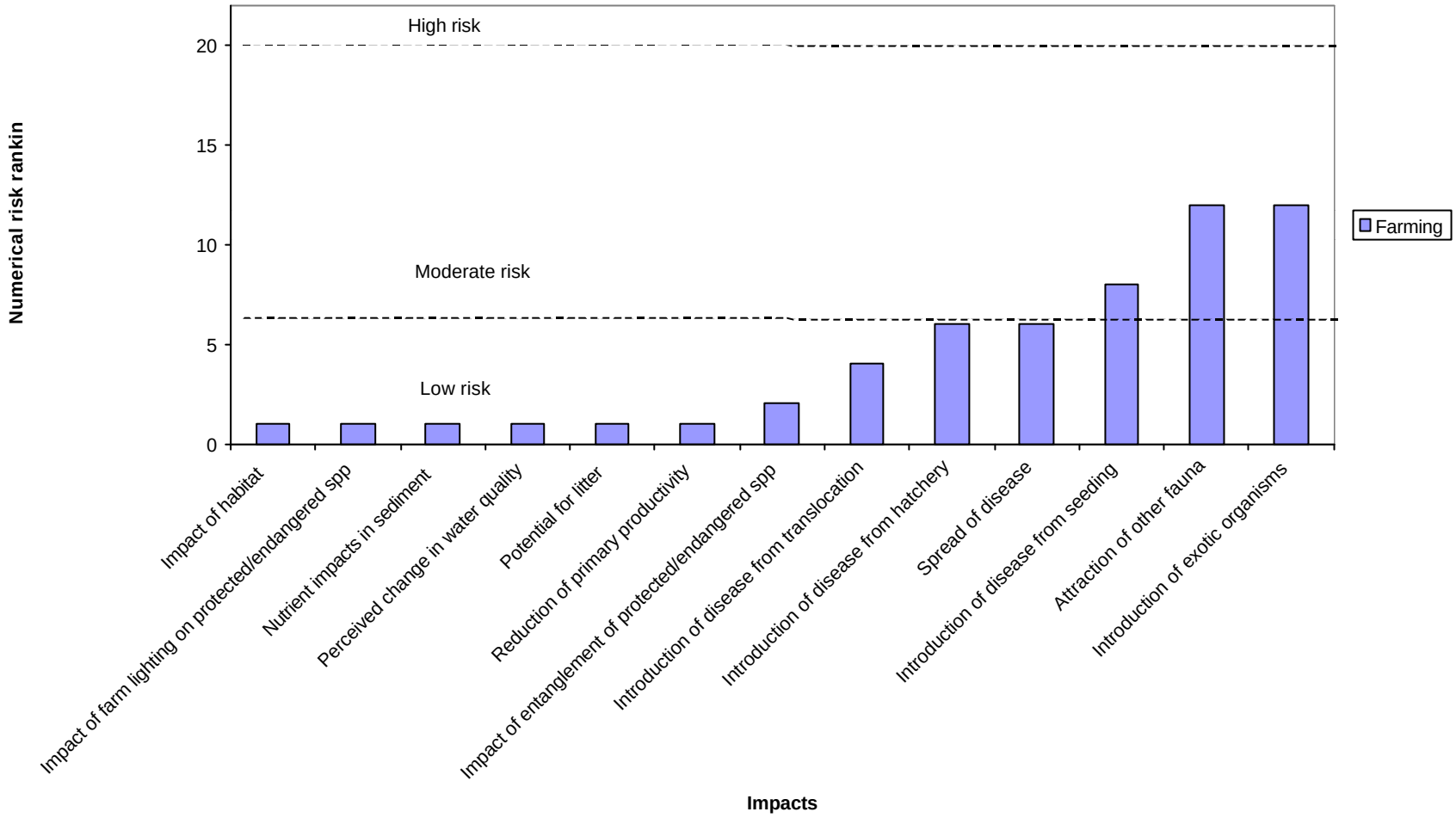
The following figures 6 and 7 shows the Impact and Numerical Risk Distribution for all risks identified.

Figure 6: Risk ranking of pearl farm activities



The following figure shows the impacts associated with the various activities outlined in Figure 6.

Figure 7: Risk ranking of impacts from pearl farm activities



5.3 Task 3: Gap analysis of key environmental information

Particular attention is paid to issues and concerns raised at the environmental risk assessment workshop (Task 2) to identify and prioritise environmental risks and impacts associated with the Pearling Industry. The workshop identified six knowledge gaps:

1. Do diseases overseas relate to *Pinctada maxima?*
2. Is there any overlap between farms and breeding sites of endangered, (vulnerable and other specially protected) species?
3. What is known of the impacts of organic matter from the long lines on the benthic community?
4. Is there an integrated planning framework in the Kimberley?
5. What is the impact of the holding dumps on the habitat?
6. Is there benefit to the environment and pearl production from the discharge of untreated sewage compared to sewage treated with chemicals?

The knowledge gaps are addressed:

1. The industry suffered substantial mortalities during the 1980s which were eventually traced to the bacterium *Vibrio harveyi*. Handling and farming practices for pearl oysters were modified extensively, and survival rates improved substantially. However, the industry is concerned about the possibility of a recurrence of losses through diseases, and the various aspects of this are discussed in detail in the report *Environmental Effects of Pearling: Gaps in Present Knowledge* (Appendix 5).
2. A second concern expressed during the environmental risk assessment workshop was the potential for interactions between pearl farms and breeding sites of endangered, (vulnerable and other specially protected) species. The level of interaction is in general low, with the most likely interactions being with salt water crocodiles (*Crocodylus porosus*). Monitoring and reporting of interactions is recommended.
3. On the farms the seeded pearl oysters are cleaned of fouling organisms every 3-5 weeks, and the fouling organisms discarded into the water. Concern was expressed over the impacts of the discarded material on the benthic community, and the possible attraction of other fauna to the area. A study is recommended to provide detailed information on the amount of material being removed, the taxonomic composition of the material cleaned, its fate when returned to the water, possible build-up on the bottom, and the species such as fish which are attracted to the stream of material entering the water from the cleaning process.
4. Once pearl oysters have been collected, cleaned, and placed in tagged panels they are stored on the sea floor in holding dumps until needed for seeding. A minor amount of damage is caused to organisms growing on the bottom, but these are not sensitive areas; environmentally sensitive areas such as coral reefs do not occur in the areas where fishing for pearl oysters occurs.

5. Grey water from the toilets and domestic sinks on boats and on shore camps is discarded directly into the sea. The only unusual feature of the use of boats by the Pearling Industry is that those on farms may be moored in the same area for prolonged periods of time with a small crew of eight to 10 people on board at one farm, and up to 30 or 35 during peak periods some farms. This creates a potential for the accumulation of wastes in a small area. This is considered to be a minor problem but a study is recommended to verify this conclusion.
6. There has been considerable press in recent years over the dangers of introducing exotic organisms into the Australian marine environment, including tropical waters. As the pearl industry operates entirely within a single biogeographical region, it is considered unlikely to introduce exotic species into the region. Species introduced by other sources, such as international shipping are likely to come from other biogeographic regions. The best approach is to prevent the arrival of these species; once they have colonised northern Australia there is little which can be done to remove them.

In summary, the environmental effects of the Pearling Industry are small and a number of studies are recommended to further document and verify the level of environmental impacts of the Pearling Industry (refer to section 7).

5.4 Task 4: EMS gap analysis

From available EMS documentation and responses to a questionnaire, a number of gaps were found to exist in meeting the requirements of ISO 14001. Examples of such gaps relate to key components of an EMS including the:

- Environmental policy (the policy is a statement by an organisation of its intentions and principles in relation to its overall environmental performance which provides a framework for action and for the setting of its environmental objectives and targets);
- Environmental aspects (aspects are the elements of a company's activities, products or services that can interact with the environment); and
- Environmental objectives and targets (an objective is the overall environmental goal, arising from the environmental policy, that an organisation sets itself to achieve, and which is quantified where practicable and a target is the detailed performance requirement, quantified where practicable, that arises from the environmental objectives and that needs to be set and met in order to achieve those objectives).

The gaps were significant enough to prevent pearling companies from achieving the requirements of the Standard at the present time (and therefore certification to ISO 14001). It is commendable however, that 100% of PPA member companies who responded to an EMS questionnaire had already begun to formalise their environmental management through the development of systems. These companies are yet to fully implement their EMS systems.

6 BENEFITS

The environmental risk and impact assessment of the Pearling Industry project benefits are summarised below:

- An environmental risk assessment report that clearly identifies environmental and ecological impacts and ranks the key environmental and ecological risks and identifies management recommendations in terms of importance from an industry and regulator perspective.
- A gap analysis report that identifies the major knowledge and procedural gaps towards developing a code of conduct based on an environmental management system such as ISO14001.
- A report that identifies key environmental information necessary for determining the key environmental characteristics necessary for successful pearl farming.
- The identification of key environmental parameters necessary for monitoring environmental performance and impacts of pearl farming.
- A report that clearly identifies research priorities on pearl oyster fishing/farming environmental issues.

7 FURTHER DEVELOPMENT

This section provides a summary of recommendations, activities or steps that may be taken by the Pearling Industry to assist it with making decisions on the sustainable management of the fishery. A summary is provided for the four main project tasks.

7.1 Task 1: Evaluation of current Pearling Industry practices & procedures

This task involved site visits to pearl farms to evaluate the current Pearl industry practices and procedures. As the findings from this activity were key to the development of tasks 2, 3 and 4, further development in this area is outlined in the following tasks 2 – 4.

7.2 Task 2: Environmental risk assessment workshop

Nine recommendations arose from the workshop relating to farming activities and impacts. They were:

1. A cleaning protocol requires developing and implementing for personal items brought to the farm e.g. material attached to shoes, AQIS protocol to include pearling activities (Activity = Seeding; Impact = Introduction of disease).
2. The application process should highlight the obligations of the applicant in relation to conservation issues for farm personnel, this is a suggested inclusion into the code of practice, staff inductions (Activity = Human habitation; Impact = Impact on high conservation areas such as nature reserves).

3. Identify the overlap of farms and breeding sites (Activity = Human habitation; Impact = Impact to protected and endangered species resulting from farm lighting).
4. High priority to maintain communication of PPA with other users (Activity = Farm site selection; Impact = Perceived alienation of areas from other users).
5. High priority to maintain communication of PPA with other users (Activity = Farm site selection; Impact = Perceived loss of aesthetic value of sites/wilderness and culture/visual).
6. Monitoring to determine if any impacts (Activity = Holding and dumping of shell; Impact = Impact on habitat).
7. Develop a code of practice and consider alternatives to disposable closures i.e. reusable tags (Activity = Pearl seeding operations: Impact = Potential for litter etc to enter the water).
8. Include in the code of practice a response plan, justify the risk rating (Activity = Farming; Impact = Impact to protected and endangered species from entanglement).
9. Determine the feasibility of exemption from using chemicals to sterilize sewage in high energy environments, low populations (Activity = Waste discharge; Impact = reduction in water quality resulting from sewage treatments from boats).

7.3 Task 3: Gap analysis of key environmental information

The following studies are recommended to further document and assess the environmental impacts of the Pearling Industry:

- monitoring of farms to determine if there are any long term impacts;
- material cleaned from oysters after capture; and
- survival of oysters removed from the bottom.

In addition, the following study is recommended to assist the industry in understanding the biological basis for their success and to develop techniques which might enhance the industry:

- environmental characteristics required for successful pearl farming.

7.3.1 Monitoring of farms to determine if there are any long term impacts

One of the key environmental concerns about the Pearling Industry is whether or not there are long term environmental impacts. All of the available evidence suggests the environmental impacts are in fact low. However, a study should be undertaken to document whether this is in fact the case and to determine the actual level of the environmental impacts of the industry. The study would have four components:

- quantification and identification of material cleaned from oysters on lease sites;
- assess build up of material cleaned from oysters on lease sites;

- disposal of grey water from vessels and shore camps; and
- monitor interactions with protected fauna.

7.3.1.1 Quantification and identification of material cleaned from oysters on lease sites

The environmental risk assessment (ERA) workshop identified the following knowledge gap: What is known of the impacts of organic matter from the cleaned oysters on the benthic community? The information is limited. A study needs to be undertaken to determine the amount and type of material which is being cleaned from the shells and returned to the water. The study would incorporate seasonality of cleaning and the different geographical areas in which the fishery operates.

7.3.1.2 Build up of material cleaned from oysters on lease sites

At the same time the study would determine whether there is a build up of material under the long line sites. This is important in determining optimal usage of the farm leases.

7.3.1.3 Disposal of grey water from vessels and shore camps

A short-term examination of this practice could determine whether or not there is an issue to consider further. A small scale bacteriological sampling programme should be undertaken around a vessel in the Kimberley with high staff numbers on neap tides when water movement is minimal. Under these conditions faecal coliform bacterial concentrations would be maximal.

The same procedure should be undertaken at one location in the Pilbara where tidal ranges are much lower.

7.3.1.4 Interactions with protected fauna

Pearl farms are in general located well away from breeding areas of protected species of marine fauna. However, there is little data on the interactions between pearl farms and protected fauna. Pearl farm staff are on the water frequently during the routine maintenance of the equipment and cleaning of the pearl oysters. It would be very easy to establish a formal system of simply recording the presence of protected fauna on the leases, and any nearby breeding areas of protected species.

7.3.2 Material Cleaned From Oysters After Capture

Little data is available on the amount and nature of material cleaned from the pearl oysters after capture. As the material consists of fouling organisms which grow naturally in the area and they are dispersed widely when the shells are being cleaned, there will be little environmental effect. However, a relatively simple one off study should be undertaken to determine how much material is being discarded and the composition of the discards.

7.3.3 Survival of Oysters Removed From the Bottom

A simple, one-off study could be undertaken in conjunction with the study of material cleaned from the oysters after capture. This would provide information on the numbers of oversize

and undersize pearl oysters collected during the season, and the potential effects on populations of *Pinctada maxima.*

7.3.4 Environmental Characteristics Required For Successful Pearl Farming

A fairly simple monitoring strategy could be established on all farms which would monitor physical, chemical and biological conditions on the farms. Data obtained would improve understanding of the requirements for successful pearl farming, and would lead to improved knowledge of this issue.

Examples of such monitoring programmes would include:

- measurement of phytoplankton densities and types in the water as they are food for the pearl oysters;
- monitoring of temperatures as extreme temperatures stress the animals and the animals should be left alone at this stage;
- monitoring of water quality; and
- monitoring for diseases e.g. *Vibrio* bacteria.

7.4 Task 4: EMS Gap analysis

7.4.1 EMS Manual outline

The EMS Gap analysis report (see Appendix 6) recommended that PPA member companies consider the best means to demonstrate to an external body that **systems** exist, that they are in place and working. One method is to document the way in which a company currently manages and intends to continue to manage environmental issues associated with their business activities. It is recommended that the companies develop an EMS manual based on the requirements of ISO 14001 and that it is structured to allow for future integration of management systems such as safety and quality.

7.4.2 Certification to ISO 14001

It is recommended that the PPA conduct a cost/benefit exercise to determine whether ISO 14001 certification is a worthwhile investment in terms of cost and effort of achieving certification and the benefits that certification might deliver.

7.4.3 Environmental Code of Practice

The PPA intends to develop an Environmental Code of Practice. The PPA will encourage all pearlers to adopt this Code as a statement of the industry's commitment to ecologically sustainable development.

It is recommended that the Code of Practice include a requirement to "Develop, implement and maintain an environmental management system". It is further recommended that practical guidance be available to assist companies in meeting this requirement.

8 PLANNED OUTCOMES

The project's outputs have contributed to a number of outcomes (see dot points below). Outputs include four main reports and are provided as appendices within this report. The information that these reports contain is required by the Pearling Industry to make decisions on the sustainable management of the fishery. Results and conclusions from these reports will be used to further assist both government and industry to manage, in a sustainable manner, pearl farming activities.

The following planned project outcomes align with the objectives listed in section 3:

- Integration with the SCFA ESD process.
- Demonstration of environmental due diligence and environmental stewardship of the Pearl fishery.
- A strategy with which the Pearling Industry can enhance its position in the light of current government policy.
- The development of a PPA Environmental Code of Practice along the lines of an EMS (eg, ISO14001).
- Provision of knowledge that could be transferred to similar fisheries such as black lipped pearls and abalone hatcheries.
- A report outlining gaps in key environmental information required to address government policy issues on sustainability.
- A report outlining gaps in the current management system in the Pearling Industry and an ISO 14001 fishery.
- A report of the environmental risk assessment workshop.

9 CONCLUSION

The environmental risk and impact assessment of the farming component (the Fisheries Department of Western Australia is assessing the wild harvest component) of the *Pinctada maxima* pearling industry indicated that current practices are ecologically sustainable. Ecological impacts of the industry are minimal although current practices and procedures could be improved though the development of a code of practice and an environmental management system for the industry. These improvements would further reduce the current low level of impacts on the environment that are caused by the industry. By addressing gaps in the current level of ecological knowledge, the industry will be able to improve its management and mitigation measures, thus enhancing its environmental stewardship.

The extent to which the findings of the present study could be transferred to similar fisheries such, as black lipped pearls and abalone hatcheries, are probably limited to those areas that have similar activities. For example, findings on the use of boats and the operation of shore camps are readily transferable to other aquaculture activities where boat based operations or shore camps are established in remote areas.

Environmental risk and impact assessment is a dynamic and on ongoing process and the PPA should consider a review of its activities on a regular basis (every 3-5 years) to ensure current activities and environmental risks have not changed, and that its management measures are appropriate for the level of impact and risk identified.

Finally, it is recommended that the PPA prepare a plan to schedule and resource the tasks and recommendations detailed in this report. The plan should include a timeframe and allocate responsibility for each task.

10 REFERENCES

The four main reports are provided as appendices within this report. Each report has a reference section specific to the references cited within the respective report. Table 3.1 details where the task related reports and their references can be found (i.e. which Appendix to refer to).

APPENDICES

Appendix 1
Intellectual Property

Intellectual Property = Nil

Appendix 2
Staff

Name	Position
Dr Peter Jernakoff	Principal Environmental Scientist
Ms Sarah Brown	Principal Environmental Consultant
Dr Fred Wells	Principal Environmental Scientist
Mr Shane Chaplin	Aquatic Biologist

Appendix 3
Task 1: Evaluation of current Pearling Industry practices and procedures

Pearl Producers Association

Evaluation of current Pearl industry practices and procedures

Site Visit

DATE: 26 JUNE 2002

PROJECT: J01-032

DOC NO.: E-REP-01-032-001 REV 1

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Contents

ABBREVIATIONS

EMS	Environmental Management System
FRDC	Fisheries Research and Development Corporation
ISO	International Organisation for Standardisation
MSC	Marine Stewardship Council
PPA	Pearl Producers Association Inc.

1 INTRODUCTION

This document reports on the site visit to the Pearling farms as part of the Fisheries Research and Development Corporation (FRDC) project: 2001/099 "Environmental risk and impact assessment of the pearling industry". The overall project comprised of four tasks. The site visit was the first of these four tasks as described and listed below. Section 2 of this report describes the interrelation of Task 1 with the other 3 tasks.

2 FOUR PROJECT TASKS

2.1 Task 1: Evaluation of current Pearl industry practices and procedures

Task 1 involved the evaluation of current Pearl industry practices and procedures. The findings from this activity were key to the development of tasks 2, 3 and 4. Task 1 comprised of site visits to pearl farms which is described in section 4.

2.2 Task 2: Environmental Risk Assessment workshop

An environmental risk assessment workshop was conducted which drew on information collected from the site visits and included invited representatives of the pearling industry, government and environmental groups.

During the workshop, environmental and ecological hazards and impacts were identified. Impacts were assigned likelihood and consequence ratings to give an overall risk rating. The workshop results were used to develop recommendations for minimising the risks and impacts identified.

2.3 Task 3: Gap analysis of key environmental information

The identification of key environmental issues as identified from Task 1 highlighted whether adequate information on those issues exist or if information is required following a review of national and international literature.

The review built on the report by Enzer (1998) to identify appropriate information or key gaps that are required to be answered to meet the PPA's required outcomes. For identified gaps, recommendations were made such as relevant research strategies to address those gaps.

2.4 Task 4: EMS Gap analysis

The gap analysis used information collected during Task 1 and compared the current procedures and systems used by the Pearl Producers Association Inc. (PPA) with those required by an ISO 14001 environmental management system (EMS). The gap analysis identified areas where a Pearling Industry environmental code of practice could be developed.

3 SITE VISIT OBJECTIVES

The objectives of the site visit were:

- To visit at least 3 pearl farms, fishing vessels and interview staff to assess first hand how the fishery operates and how closely its procedures and practices are in line with those required of an internationally recognised EMS.
- To assess the degree to which existing practices and procedures are implemented.
- To report on the site visit and evaluate physical conditions, existing practices and procedures of a pearl industry in operation in the Broome region.

4 SITE VISIT SUMMARY

The logistical support supplied by Paspaley Pearls Ltd, meant that it was possible extend the site visit to cover a greater range of the pearl farm operations from Darwin to Kuri Bay in Western Australia. Operations were therefore not restricted to the Broom region. Locations visited were:

- Bynoe Harbour;
- Kuri Bay; and
- Talbot Bay.

Figures 1 – 5 show the Western Australian sites that were visited as four managed fishery zones.

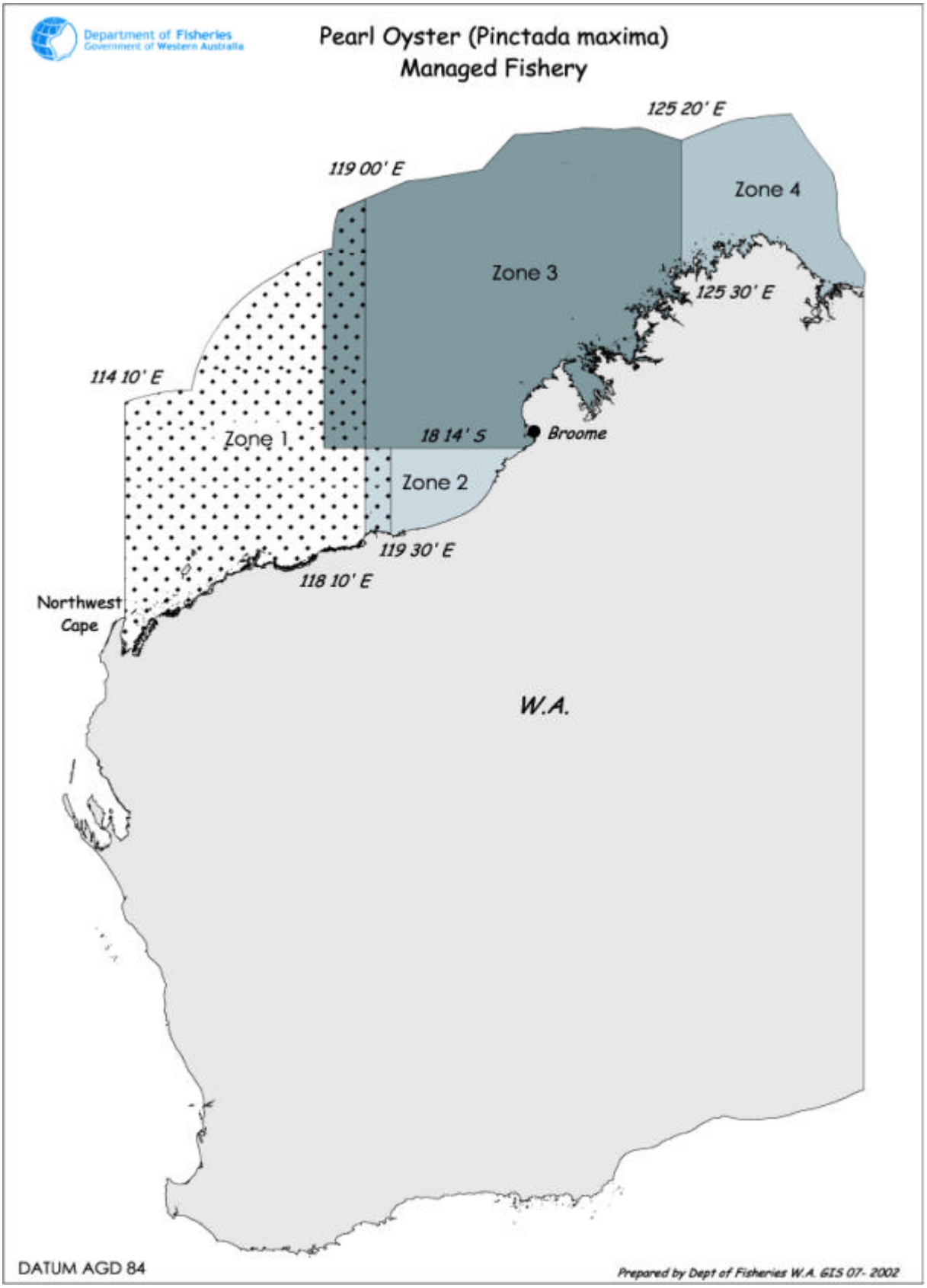

Figure 1: Pearl Oyster (Pinctada maxima) Managed Fishery

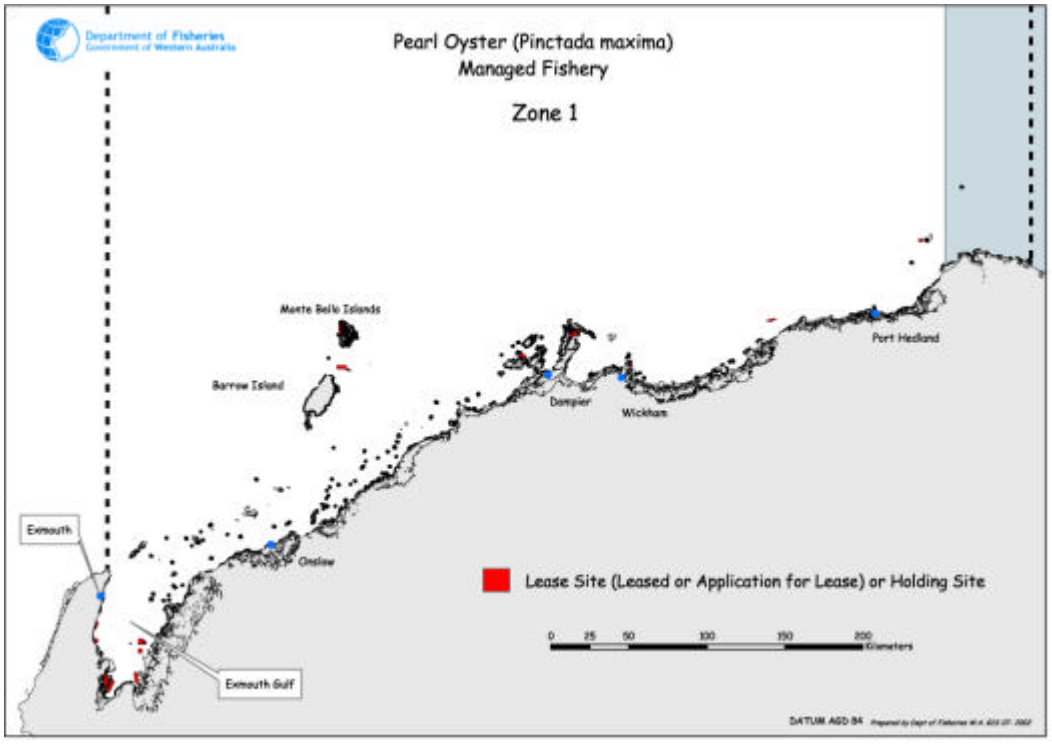

Figure 2: Pearl Oyster (*Pinctada maxima*) Managed Fishery, Zone 1

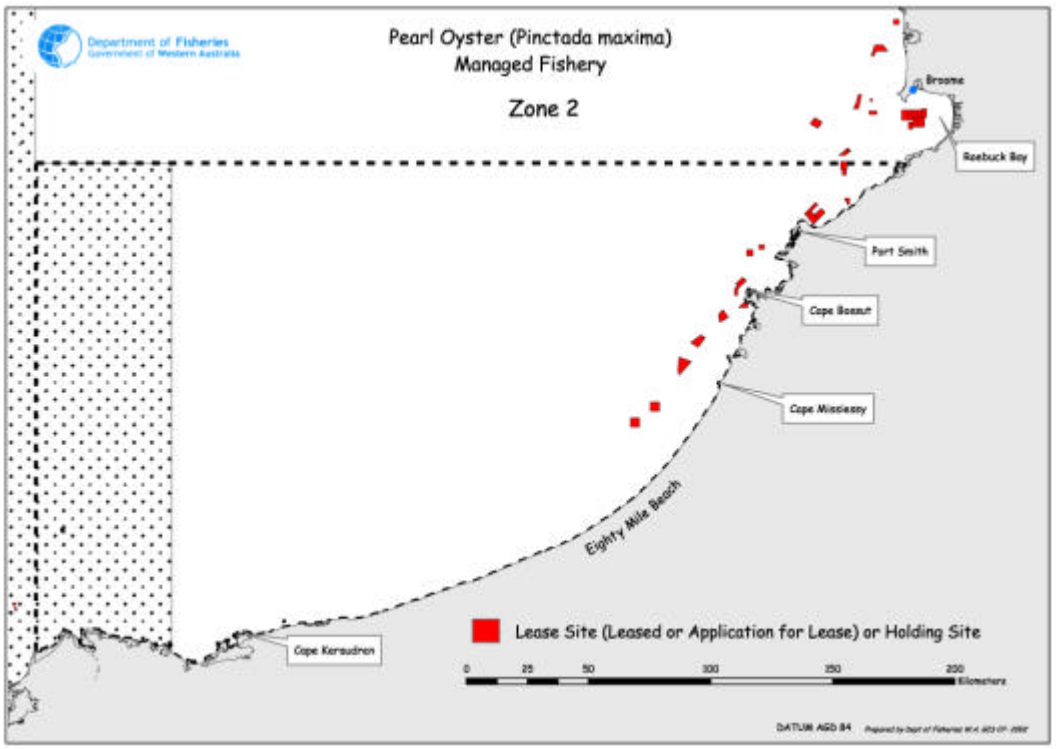

Figure 3: Pearl Oyster (*Pinctada maxima*) Managed Fishery, Zone 2

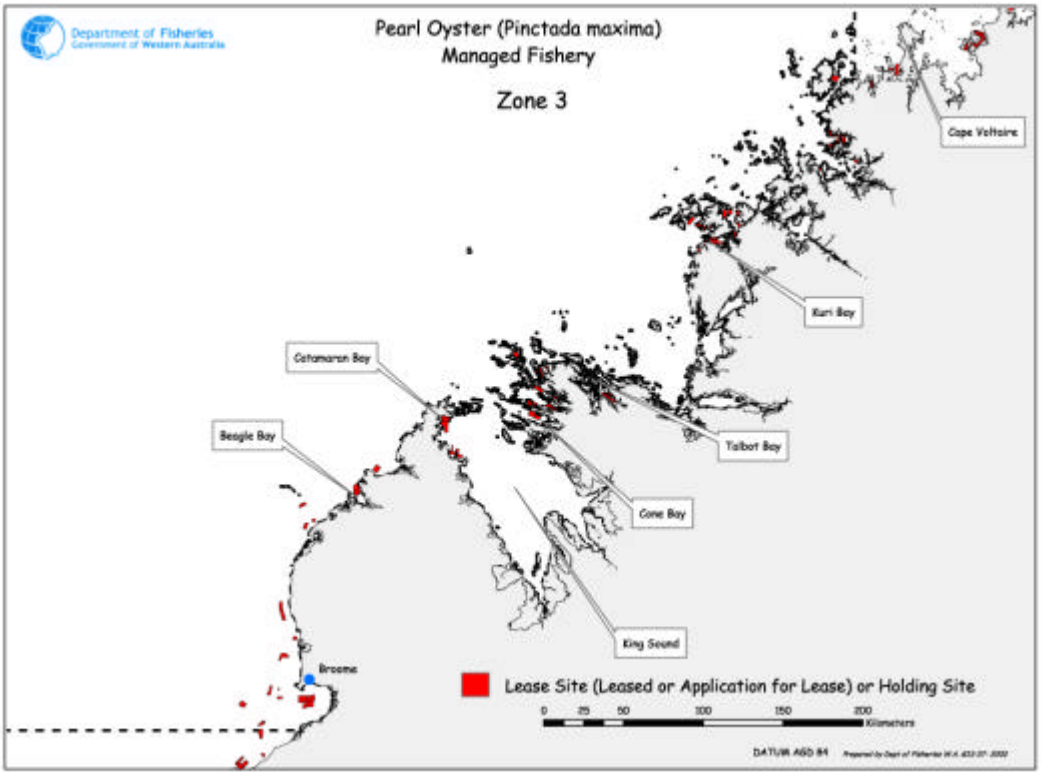

Figure 4: Pearl Oyster (*Pinctada maxima*) Managed Fishery, Zone 3

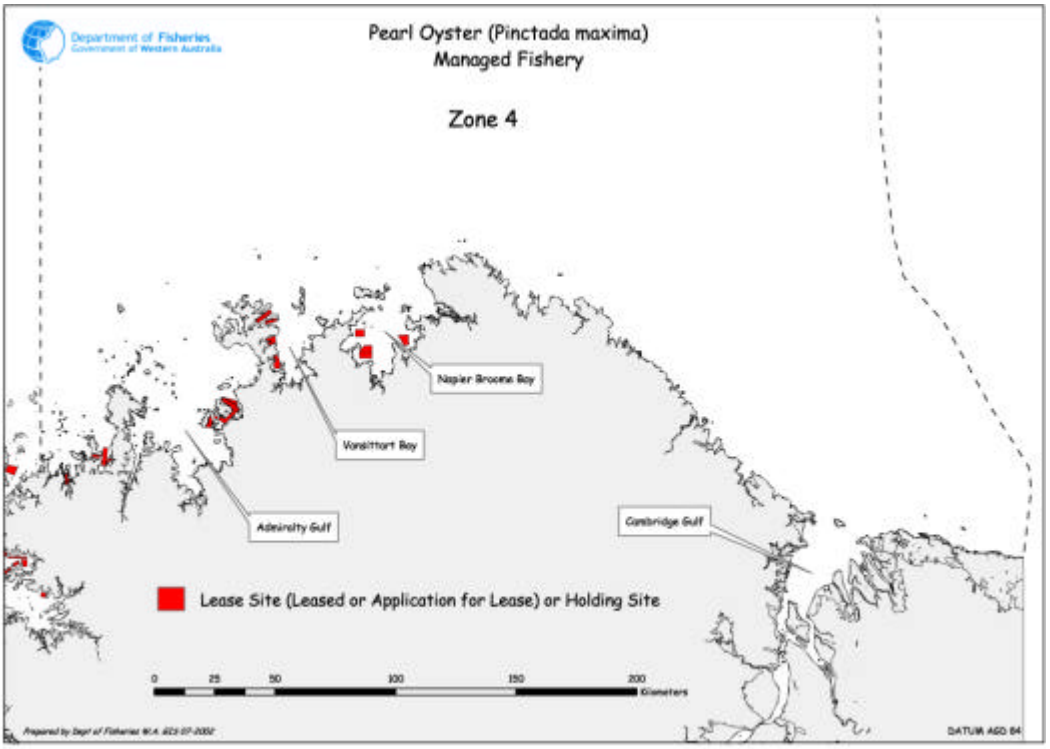

Figure 5: Pearl Oyster (*Pinctada maxima*) Managed Fishery, Zone 4

During the visit, the observed farming activities included growout, seeding and harvesting. It was possible to observe the physical conditions in which the activities operated and the extent to which environmental management systems were implemented.

All locations were in relatively remote areas where tidal movement was substantial. This tidal movement means that any liquid or other waste from vessels (eg sewage) or material from cleaning shells (eg algae) was dispersed rapidly. The farms relied on clean environmentally pristine conditions for farming activities and there was no observable evidence to suggest that the surrounding environment was being degraded by the farming activities.

Discharge from vessels was restricted to sewage and grey water. Non-solid food scraps were discharged overboard but all other material was kept for transportation to disposal or recycling in Darwin.

Activities based on preserving environmental quality were observed to include:

- Erosion control of coastal areas with the use of spent tyres;
- Separation of glass and cans prior to transport to recycling facilities;
- Recycling of ropes;
- Transportation of waste oil and bilge water for disposal in Darwin;
- The use of solar energy for power;
- Clear notification on land based farms that the surrounding areas are designated as a fauna/flora reserves; and
- The use of biodegradable and low toxicity chemicals (e.g. phosphate free household cleaning products/detergents).

All staff interviewed were aware of the need to preserve environmental quality for both the general sake of the environment and the need for high quality and productive pearl farming activities.

None of the pearl farms visited had a documented/formal EMS in place. Although all staff interviewed were aware of their environmental responsibilities, there was a lack of written procedures on environmental management that would be characteristic of an EMS. An industry code of practice for diving operations was cited but it was verified that there was no industry environmental code of practice.

A gap analysis questionnaire that identifies the major knowledge and procedural gaps that the industry currently faces compared with having an EMS or a code of practice was sent to PPA members. The PPA aimed to seek feedback from all member companies to ensure that the results are representative of the industry as a whole. (Refer to Attachment 6: Task 4: 'EMS Gap Analysis' for further information on the gaps identified).

Appendix 4
Task 2: Risk assessment workshop

Pearl Producers Association

Workshop Report: Environmental Risk and Impact Assessment of the Pearling Industry

DATE: 26 JUNE 2002

PROJECT: J01-032

DOC NO.: E-REP-01-032-002 REV 1

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Contents

Attachment 3 Environmental Risk and Impact Assessment Workshop Results

Attachment 4 Participant Comments on Workshop Minutes

ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
AQIS	Australian Quarantine and Inspection Service
AS/NZS	Australian Standards/New Zealand Standards
CALM	Conservation and Land Management
CEO	Chief Executive Officer
DFWA	Department of Fisheries Western Australia
EMS	Environmental Management Strategy
ESD	Ecological Sustainable Development
FRDC	Fisheries Research and Development Corporation
IRC	International Risk Consultants
PHA	Preliminary Hazard Analysis
PPA	Pearl Producers Association
R&D	Research and Development
WA	Western Australia

EXECUTIVE SUMMARY

The environmental risk and impact assessment, conducted by IRC Environment (part of International Risk Consultants) was the result of an initiative by the Pearl Producers Association Inc (PPA). This report is based on a risk assessment workshop undertaken in September 2001 at the Fremantle Sailing Club, Western Australia.

The broad intent of the workshop was to provide a register of the main potential environmental (including ecological) risks that arise from the various activities associated with the *Pinctada maxima* Pearling Industry. The aim was also to integrate the workshop with the broader Ecological Sustainable Development (ESD) research program by providing a session of the workshop for Department of Fisheries Western Australia (DFWA) to address environmental and ecological risks for the Wild Harvest component of the *P. maxima* fishery.

The workshop also considered the environmental and ecological aspects of the Farming component of the fishery for the PPA (see Attachment 2 for the Workshop Agenda). **The present report deals only with the Farming component of the fishery activities**. DFWA will be providing a report on the Wild Harvest component of the fishery. The workshop had 15 participants which included representatives from Conservation and Land Management (CALM), DFWA, PPA, Environment Australia, the Sustainable Fisheries Office of the Conservation Council, as well as industry and company representatives (see Attachment 1 for the Workshop Participants). The risk ranking process, using a working group of experts, delivers the ability to prioritise risks and therefore focus on the relevant management actions required for the *P. maxima* fishery. A group of experts also avoids the need for time consuming sourcing and review of data during the workshop. Data known to exist was referenced prior to and during the workshop to support the allocation of risk levels. The risks were described using the factors consequence (where 1 represented negligible to 6 representing catastrophic) and likelihood (where 1 represented remote to 6 being likely).

In total, 13 environmental and ecological issues were identified across the *P. maxima* fishery. No high risks were identified during the workshop. Risks associated with the issues identified were ranked as either moderate (23%) or low (77%). The following figures 1 and 2 shows the Impact and Numerical Risk Distribution for all risks identified.

Figure 1: Risk ranking of pearl farm activities

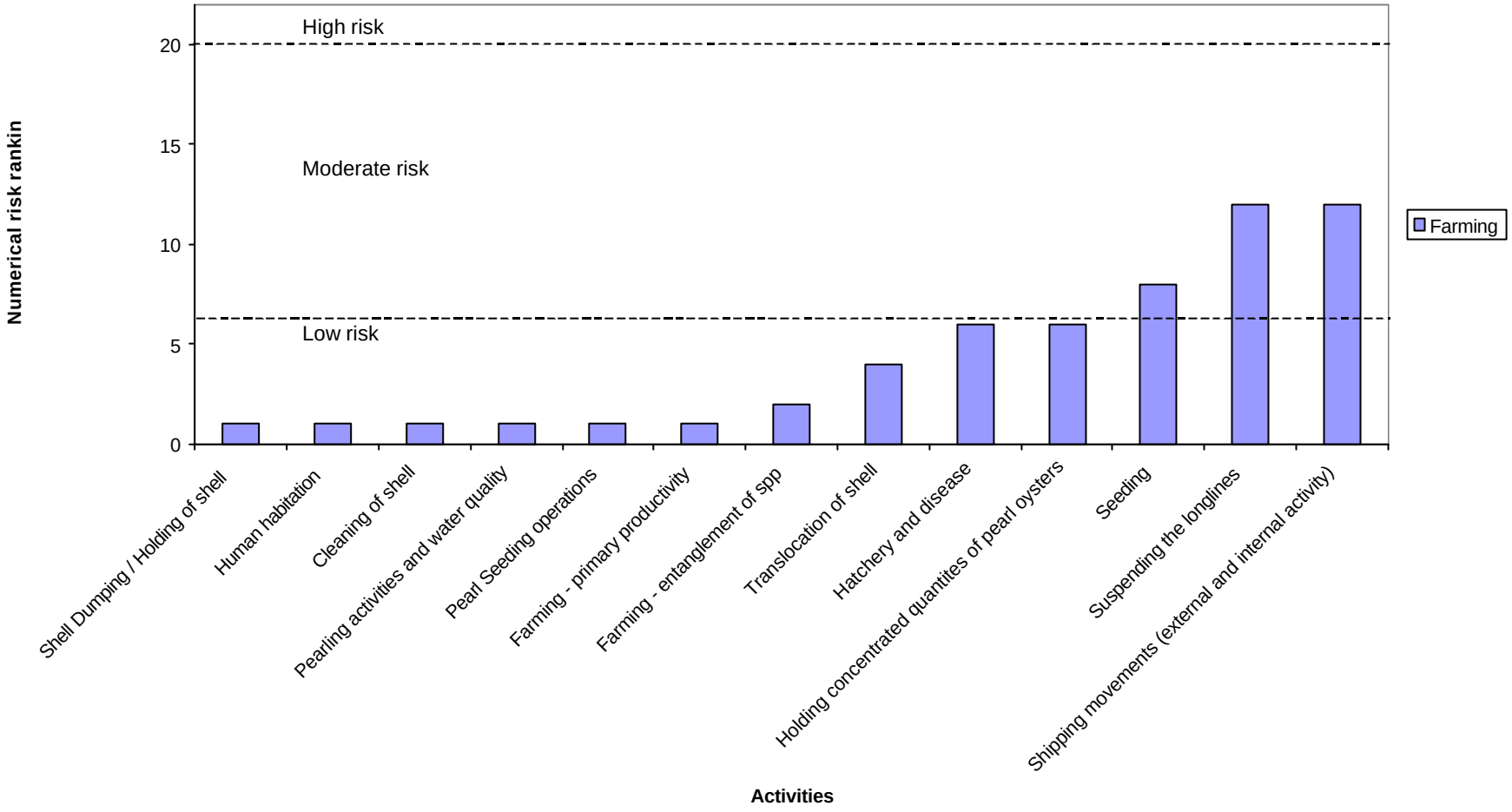
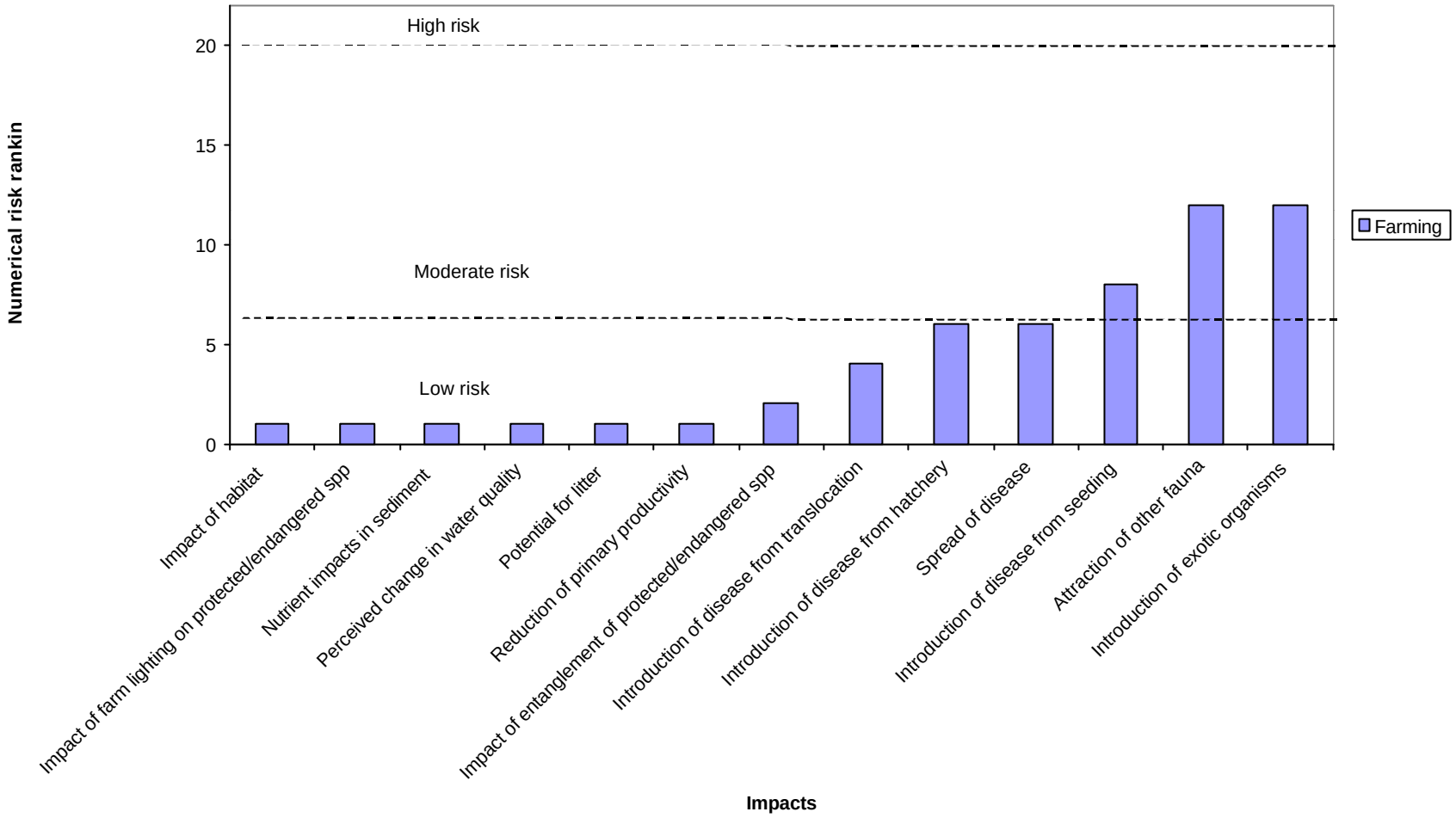


Figure 2 shows the impacts associated with the various activities outlined in Figure 1.

Figure 2: Risk ranking of impacts from pearl farm activities



When sorted according to the risk level, the register of risks has identified the following main issues for the *P. maxima*. Within the moderate risk category, the associated potential issues include:

- Introduction of exotic organisms (Consequence 3 Likelihood 4) (Activity = Shipping Movements);
- Attraction of other fauna (Consequence 2 Likelihood 6) (Activity = Suspending of longlines); and
- Introduction of disease from seeding (Consequence 4 Likelihood 2) (Activity = Seeding).

For identified issues with moderate risk, these risks are acceptable, as long as risk reduction is applied to reduce risks to as low as reasonably practicable (ALARP). In these instances a management strategy needs to be implemented. The focus of this report is in line with risk assessment methodology (section 4 of this report) which involves the review of the risk rankings to determining if the risk is acceptably low, or if management actions are required to reduce the risk to ALARP for the main risks identified during the workshop. As no high risks were identified, moderate risks become the focus of risk management. Low risks are included in this report, but are not dealt with in detail.

The environmental risk and impact assessment workshop participants provided 9 recommendations to address the identified risks to the *P. maxima* fishery. These recommendations are included in Attachment 3 in context with the respective issues, impacts and risks that the recommendations are designed to address.

These recommendations (not in any order of priority) are:

1. Cleaning protocol for personal items brought to the farm e.g. material attached to shoes, AQIS protocol to include pearling activities (Activity = Seeding; Impact = Introduction of disease)
2. Application process should highlight the obligations of the applicant in relation to conservation issues for farm personnel, suggest inclusion into code of practice, staff inductions (Activity = Human habitation; Impact = Impact on high conservation areas such as nature reserves).
3. Identify overlap of farms and breeding sites (Activity = Human habitation; Impact = Impact to protected and endangered species resulting from farm lighting).
4. High priority to maintain communication of PPA with other users (Activity = Farm site selection; Impact = Perceived alienation of areas from other users).
5. High priority to maintain communication of PPA with other users (Activity = Farm site selection; Impact = Perceived loss of aesthetic value of sites/wilderness and culture/visual).
6. Monitoring to determine if any impacts (Activity = Holding and dumping of shell; Impact = Impact on habitat).

7. Develop a code of practice and consider alternatives to disposable closures i.e. reusable tags (Activity = Pearl seeding operations: Impact = Potential for litter etc to enter the water).
8. Include in code of practice, response plan, justify risk rating (Activity = Farming; Impact = Impact to protected and endangered species from entanglement).
9. Determine feasibility of exemption from using chemicals to sterilize sewage in high energy environments, low populations (Activity = Waste discharge; Impact = reduction in water quality resulting from sewage treatments from boats).

Because managing risk for the *P. maxima* fishery is an ongoing process, it is recommended that a risk management culture continue to be developed. This culture requires participants in the fishery to be a part of the ALARP process by actively inputting into the development of an impact and risk register, and assist in defining the fisheries' environmental and ecological risk profile.

1 INTRODUCTION

1.1 Background

This report presents the results and findings of an Environmental Risk and Impact Assessment Workshop that was conducted for the *P. maxima* fishery in Western Australia.

The workshop was the result of an initiative by the Pearl Producers Association Inc (PPA). IRC Environment was contracted by the PPA to perform the work.

IRC Environment facilitated a risk assessment workshop during September 2001 at the Fremantle Sailing Club, Western Australia. **This report deals only with the Farming component of the fishery activities** and documents the findings of the workshop that was comprised of expert representatives from a variety of organisations (Attachment 1). DFWA will be providing a report on the Wild Harvest component of the fishery.

1.2 Environmental (including Ecological) Risk Assessment

The PPA required an assessment of the fishery and farming operations to the ecosystem (environmental and ecological risk assessment). The risk assessment was based on existing knowledge, should consider risks of all aspects of the fishery, identify and prioritise gaps in knowledge, produce a set of prioritised risks. In future, the PPA can use this prioritised set of risks to develop strategies to assist with the fisheries' commitment to ESD.

1.3 Risk Assessment Definitions

It is useful to include definitions of "Environment", "Risk", "Risk Assessment" and "Ecological Risk Assessment".

Environment *is made up of physical, biological, chemical and social components* (HB 203: 2000).

Risk *is defined (in AS/NZS 4360) as the chance of something happening that will have an impact on objectives. It is measured in terms of consequence and their likelihood*.

Risk Assessment *is the overall process of risk analysis and risk evaluation* (HB 203: 2000).

Ecological Risk Assessment *evaluates the likelihood that adverse ecological affects may occur or are occurring as a result of exposure to one or more stressors'* (U.S. EPA, 1992).

1.4 Workshop Intent

The broad intent of the Environmental Risk and Impact Assessment Workshop was to provide a register of the main potential environmental and ecological risks that arise from the various activities carried out by the *P. maxima* fishery.

This risk register is used to identify the underlying issues so that these may be addressed through the development of an appropriate management strategy. This enables the fishing activities to focus on reducing the risk of deleteriously affecting the ecosystem in which the fishery occurs.

Section 1.2 outlined the requirement to identify and prioritise gaps in knowledge. This was done during the workshop and the information gaps for the highest risk identified, the moderate risks, are presented in Attachment 3.

1.5 Workshop Benefits

Provided that the results are used correctly, the risk assessment results can provide a number of benefits to the *P. maxima* fishery and the marine environment in which the fishery operates, including:

- Help safeguard the economic and biological integrity and sustainability of the *P. maxima* fishery, its environment and related ecosystem;
- Identify and manage the main risks;
- Provide a transparent, objective and auditable risk management process which demonstrates that a risk assessment has been carried out for the relevant fishing activities;
- Develop a set of baseline risk assessment data in the form of a risk assessment report whereby improvements may be made to the risk management activities over a period of time following the initial workshop. This should involve the ongoing capture of data to improve any estimates made or it may involve refinements to the risk treatment options employed;
- Identify and assess risks such that management may make informed decisions regarding the management philosophy of the *P. maxima* fishery;
- The risk ranking process delivers the ability to prioritise any actions required for the fishery;
- Provide confidence to third parties interested in the *P. maxima* fishery activities that an appropriate risk management process has been conducted;
- The potential to identify under-addressed risks, but also to maximise opportunities;
- Improve commercial performance due to the better control over unwanted occurrences and the associated costs; and
- Improved understanding by industry personnel of the risk management methodology and the main environmental and ecological risks. This is important if risks are to be managed by individuals.

2 OBJECTIVES

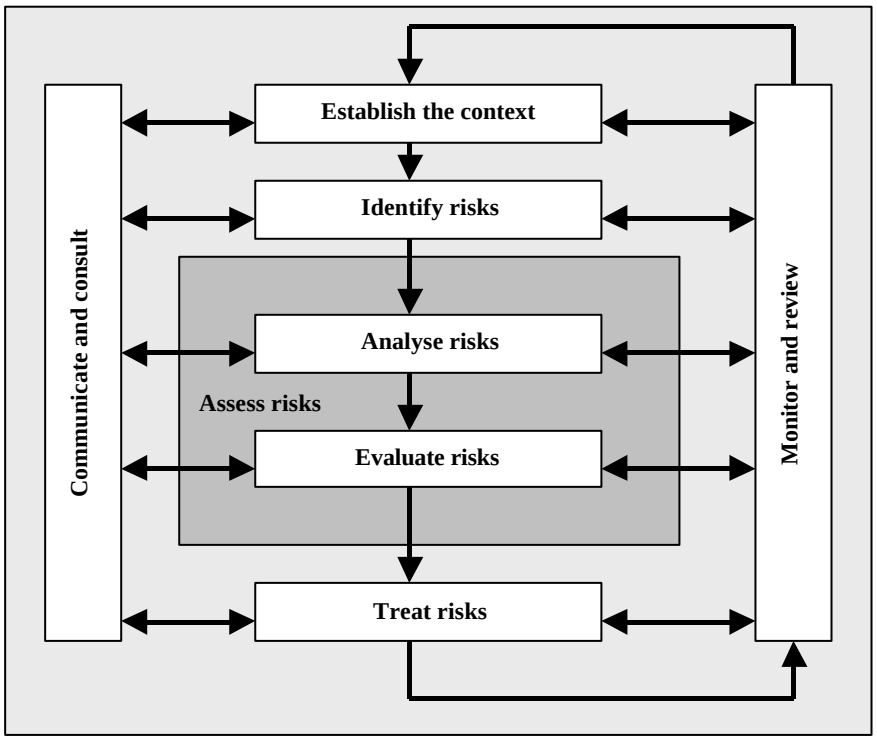
The objectives of the Environmental Risk and Impact Assessment Workshop were to:

- Carry out an environmental (including ecological) risk assessment workshop to identify and prioritise environmental risk and impacts associated with the *P. maxima* Pearling Industry.
- Integrate the workshop with the broader ESD research program by providing a session of the workshop for the Department of Fisheries WA to address environmental and ecological risks for the Wild Harvest component of the *P. maxima* fishery.

3 RISK ASSESSMENT FRAMEWORK

The risk assessment framework that was applied to the workshop was in line with the Standard HB 203: 2000 Environmental risk management – Principles and processes (which is based on the Standard AS/NZS 4360: 1999 Risk Management), concentrating on the hazard identification and risk assessment components of the whole risk management process. Assessment of environmental and ecological risk is an iterative process consisting of well-defined steps which, taken in sequence, enable better decision-making by more clearly defining the risks and their impacts (AS/NZS 4360:1999). The key stages of the assessment of risks in this report are shown in Figure 3.

Figure 3: The risk management process (taken from AS/NZS 4360:1999 Risk Management).



4 ENVIRONMENTAL RISK AND IMPACT ASSESSMENT METHODS

Assessment of risk is an iterative process consisting of well-defined steps which, taken in sequence, enable better decision-making by more clearly defining the risks and their impacts (AS/NZS 4360:1999). The key stages of the assessment of ecological risks in this report are:

- Establish the Context;
- Hazard (leading to impact) Identification;
- Risk Analysis;
- Risk Evaluation; and
- Risk Treatment.

The workshop focused on all of the above stages. Risk Treatment was explored for the moderate risks and where time permitted, the low risks were addressed.

4.1 Establish the Context

4.1.1 Context

The following key features define the context of the Environmental Risk and Impact Assessment Workshop:

- The fishery being studied is the *P. maxima* fishery which operates in Western Australia and the Northern Territory;
- The risk assessment focuses on the main environmental (including ecological) issues across the fishery, and does not include the processing activities associated with the fishery;
- The Environmental Risk and Impact Assessment did not focus on the resource assessment and management of the *P. maxima* fishery which is covered annually and reported in the State of Fishery Report.
- The Environmental Risk and Impact Assessment did not focus on safety, liability, business interruption, production loss, or reputation & integrity issues;
- The Environmental Risk and Impact Assessment was conducted as a snapshot in time, capturing the risk profile of the fishery in September 2001. The risk profile may change over time; and
- The segmentation of the fishery, based on the Fisheries Research and Development Corporation (FRDC) Ecological Sustainable Development (ESD) Case Study Report

(FRDC 2000), into components, sub-components, items and fishing activities provided a better 'system' definition.

4.1.2 Workshop Structure and Format

The definition of the components, sub-components and items allowed a structured approach to the conduct of the Environmental Risk and Impact Assessment workshop. The workshop was held over a period of 1 day.

The format of the workshop consisted of presentations about the *P. maxima* fishery, the ESD process, and the risk assessment process. These presentations set the scene for the environmental (includes ecological) risk assessments for both the Wild Harvest component of the fishery (for Department of Fisheries WA) and for the Farming component of the fishery for the PPA (see Attachment 2 for the Workshop Agenda). The present report deals only with the Farming component of the fishery.

4.1.3 Consistent Assignment of Consequence and Likelihood

The Environmental Risk and Impact Assessment workshop involved many people from a variety of organisations such as Conservation and Land Management (CALM), PPA, DFWA, Environment Australia, the Sustainable Fisheries Office of the Conservation Council, as well as industry and company representatives (Attachment 1). It was therefore important to ensure that a consistent approach was taken.

This would ensure that each workshop participant had a common understanding of the risk terminology being used and that the assignment of consequence and likelihood levels was being done consistently during the workshop.

To achieve this, the participants were provided with a presentation before the workshop about the following:

- The aim of the Environmental Risk and Impact Assessment workshop;
- Definitions and guidelines for the use of terminology such as hazard, consequence, likelihood, risk, risk ranking, causes & safeguards;
- An outline of the risk management methodology being used;
- An overview of the software used to document the workshop findings;
- An explanation about the use of the risk matrix, consequence and likelihood tables;
- A sample hazard identification checklist, which included the hazard categories; and
- The importance of and opportunity to contribute to the workshop group and to ask questions at any time.

A representative from the *P. maxima* fishery would provide an overview of the fishing activity being studied to ensure that there was a common understanding amongst the workshop group.

The risk ranking process using a working group of experts delivers the ability to prioritise risks and therefore focus on the relevant management actions required for the *P. maxima* fishery. A group of experts also avoids the need for time consuming sourcing and review of data during the workshop. Data know to exist was referenced prior to and during the workshop to support the allocation of risk ranking.

The depth of the risk assessment workshop was dependent on the amount of time that was available for review within each component, sub-component and item, however, a top down approach was taken whereby the main issues were explored first.

4.2 Risk Perception

The individuals from different organisations brought a wealth of knowledge and experience to the workshop, however these same individuals perceive risk differently. This should be considered when reviewing the output of the workshop in Attachment 3. Attachment 3 is a record of the information supplied during workshop. Grammar and spelling are the only modifications made to the workshop minutes. Wherever possible, information was recorded to support the risk ranking as well as compiling a list references both during and after the workshop.

4.2.1 Information Capture

The success of risk assessment workshops is dependent upon the contribution by the workshop participants. The capture of this information is assisted by the use of specialist software (**PHA-Pro® 5)** designed to save time and effort, and therefore money, while producing comprehensive and efficient risk assessment.

Issues identified by the participants within the various components, sub-components and items were documented as the study proceeded and were displayed to the workshop group through the use of a laptop linked to a data projector. This process enabled all participants to see what information and consensus decisions were recorded. This provided the opportunity for the workshop participants to debate and agree on the decisions being made about the workshop output. Justification to support the assignment of likelihood and consequence was also recorded.

The data captured within **PHA-Pro® 5** has been exported to an Excel spreadsheet such that the PPA has an electronic copy of the workshop output. This data may then be imported to the *P. maxima* fishery when developing the environmental management strategy.

4.3 Hazard Identification

Hazard Identification involved the brainstorming and identification by the workshop participants of the potential sources of environmental and ecological impact i.e., those fishing activities that could result in a negative ecological impact.

The workshop group was encouraged to identify the major concerns that they had about environmental and ecological issues within the *P. maxima* fishery within each component, sub-component and item listed.

Through hazard identification, the what, why and how risks can arise were identified and were used as the basis for further analysis.

Following the identification of the hazards or the potential sources of harm, the 'Environmental and Ecological Impact' was then determined. In ecological terms, the hazard generally becomes real when a habitat, population or community come into contact with it. A list of impacts was compiled, relevant to the activity and hazard being studied.

4.4 Safeguards

Safeguards can be divided into prevention and mitigation:

- prevention methods reduce the likelihood of realising an impact; and
- mitigation methods reduce the consequence of an impact.

Likelihood and consequence ratings are applied after taking into account the existing safeguards.

4.5 Risk Analysis

4.5.1 Risk Assessment Matrix

Risk Assessment considers the range of potential consequences and how likely those consequences are to occur. Consequence and likelihood are combined to produce an estimated level of risk associated with the particular hazardous event in question.

Table 4.1 shows the *P. maxima* fishery risk assessment matrix that was used to determine the level of risk associated with an impact, issue or fishing activity. The matrix was designed to allow conformity with the matrix used by DFWA for risk assessments carried out for other fisheries.

Table 4.1: Risk Matrix

		Consequences					
		1	2	3	4	5	6
Likelihood		Negligible	Minor	Moderate	Severe	Major	Catastrophic
6	Likely	6	12	18	24	30	36
5	Occasional	5	10	15	20	25	30
4	Possible	4	8	12	16	20	24
3	Unlikely	3	6	9	12	15	18
2	Rare	2	4	6	8	10	12
1	Remote	1	2	3	4	5	6

The shading of each area indicates the risk ranking (using equal weight on consequence and likelihood and a linear scale):

Risk Level	Score	Description/Action
H	Greater than and equal to 20	**High Risk**. Immediate action is required. For example, PPA staff attention required to advise CEO and Minister, call a special meeting of PPA and undertake immediate action, eg to clean up oil spill.
M	Greater than and equal to 8 but less than 18	**Moderate Risk**. Risks are acceptable as long as risk reduction is applied to reduce risks to ALARP. For example, Fisheries staff attention is required to prepare report with recommendations.
L	Less than 6	**Low Risk**. Risks are broadly acceptable and are managed by current procedures.

Table 4.2: Species Level (Target / Byproduct / Non-retained species) Consequence Categories

#	Level	Descriptor
1	Negligible	Undetectable for this population. Insignificant impacts to habitat or population. Unlikely to be measurable against background variability.
2	Minor	Localised and no impact on population size or dynamics. Insignificant impacts to habitat or populations. Rapid recovery measured in days to months.
3	Moderate	Full exploitation rate where long term recruitment/dynamics not adversely impacted. Recovery measured in months.
4	Severe	Affecting recruitment levels of stocks/or their capacity to increase. Recovery measured in months to years.
5	Major	Likely to cause local extinctions. Recovery period measured in years to decades.
6	Catastrophic	Local extinctions are imminent/immediate. Long-term recovery period measured in decades.

Table 4.3: Habitat Level Consequence Categories

#	Level	Descriptor
1	Negligible	Affecting < 1% of area of habitat. Insignificant impacts to habitat or population. Unlikely to be measurable against background variability.
2	Minor	Affecting < 5% of total habitat area. Localised or insignificant impacts to habitat. Rapid recovery would occur if activity stopped, measured in days to months.
3	Moderate	5-30% of habitat affected; OR If occurring over wider area, the impact to habitat from activity is not severe. Recovery measured in months.
4	Severe	30–60% of habitat is affected/removed. Recovery measured in months to years.
5	Major	60-90% of habitat is affected/removed. Recovery period measured in years to decades.
6	Catastrophic	>90% of habitat is affected/removed. Long-term recovery period measured in decades.

Table 4.4: Ecosystem Level Consequence Categories

#	Level	Descriptor
1	**Negligible**	Interactions may be occurring, although unlikely that there would be any change outside of natural variation. Insignificant impacts to habitat or population. Unlikely to be measurable against background variability.
2	**Minor**	Localised and insignificant impact. Only minor changes in relative abundance of other constituents. Rapid recovery measured in days to months.
3	**Moderate**	Measurable changes to the ecosystem components without there being a major change in function. No loss of function. Recovery measured in months.
4	**Severe**	Ecosystem function altered measurably and some function or components are missing/declining/increasing outside of historical range and/or allowed/facilitated new species to appear. Recovery measured in months to years.
5	**Major**	Detrimental effect that will cause a significant effect on local ecosystem structure and function (different dynamics now occur with different species/groups now the major targets of capture). Recovery period measured in years to decades.
6	**Catastrophic**	Large scale detrimental effect that is likely to cause a highly significant effect on local ecosystem factors such as water quality, nutrient flow, community structure and food webs, biodiversity. Long-term recovery period measured in decades.

Table 4.5: Likelihood Assessment Guidelines

#	Level	Descriptor
1	**Remote**	Never heard of
2	**Rare**	May occur in exceptional circumstances
3	**Unlikely**	Could occur at some time
4	**Possible**	Some evidence to suggest that it is possible
5	**Occasional**	Will probably occur in most circumstances
6	**Likely**	It is expected to occur in most circumstances

4.5.2 Assignment of a Consequence Level

In assigning a level of consequence to an issue, activity or impact, the workshop group took into consideration the following factors:

- The present state of safeguards & controls;
- Existing physical and working environment conditions;
- Existing equipment condition;
- Existing procedures, administration, documentation and management systems; and
- Existing levels of training, experience, skills, education, etc. of personnel.

Having considered the above, a realistic estimate was made by the group for the consequence level. In other words, whilst a 'catastrophic' level of consequence could occur for most of the issues, activities or impacts, it would not be realistic for this to occur in all instances where the issue, activity or impact occurs.

4.5.3 Assignment of a Likelihood Level

In assigning a level of likelihood, the workshop group considered the likelihood of an impact and associated consequence and then assigned a level. The group made a realistic estimate.

4.5.4 Risk Level & Risk Ranking

The difference between the Risk Level and Risk Ranking needs to be made clear.

Risk Ranking is the assignment of one of three categories: High, Moderate and Low. It is a coarse ranking of risk, which results from the use of the risk assessment matrix.

Risk Level on the other hand is the mathematical product of the consequence and likelihood levels and is derived from the basic equation for risk, Risk = Consequence x Likelihood. It is a less coarse measurement of risk. Given that there are 6 levels of consequence and 6 levels of likelihood, there are 18 possible Risk Levels: 36, 30, 25, 24, 20, 18, 16, 15, 12, 10, 9, 8, 6, 5, 4, 3, 2 & 1.

4.6 Risk Evaluation

Risk evaluation involves the review of the risk rankings, i.e. determining if the risk of an activity or impact is acceptably low, or if management actions are required to reduce the risk to as low as reasonably practicable (ALARP). Table 4.1: the Risk Matrix includes Risk Ranking descriptions and clearly highlights the appropriate level of management involvement required for a given level of risk.

4.7 Risk Treatment

Risk treatment involves management actions to reduce ecological and environmental risks to 'as low as reasonably practicable' (ALARP). This component of the risk management strategy was developed by the workshop group. The recommendations suggested by the workshop participants employed the ALARP principle. This risk treatment information is incorporated into the Environmental Risk and Impact Assessment workshop results in Attachment 3. It should be noted that the output of the Environmental Risk and Impact Assessment workshop identifies likelihood and consequence values with existing safeguards in place and *prior to* additional management actions being implemented.

4.8 Review Process

The workshop participants were invited to review the workshop minutes which included the risk rankings. They were given three weeks to comment.

5 ENVIRONMENTAL RISK AND IMPACT ASSESSMENT RESULTS

5.1 Risk Assessment Workshop

The following are some broad statistics about the risk assessment workshop:

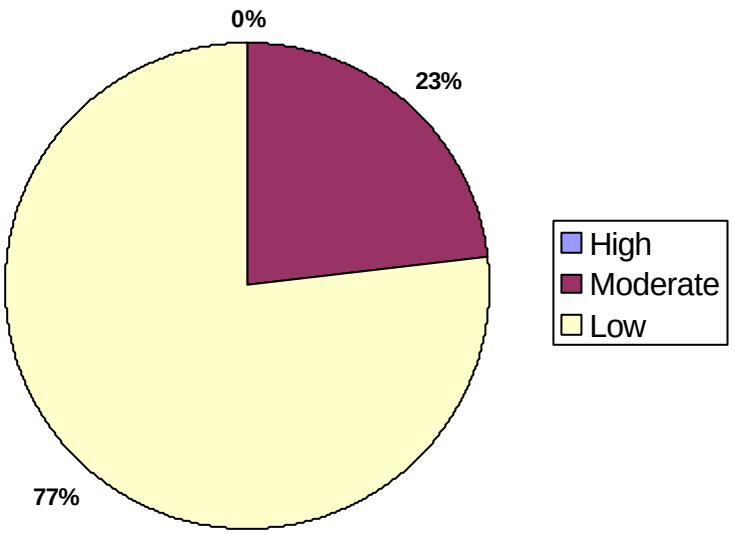
- Number of Participants – 15 (see Attachment 1)
- Number of Workshop Days - 1
- Total number of Issues Identified – 13

5.2 Risk Ranking Distribution

Figure 4 shows the risk ranking distribution for *all* the environmental and ecological issues identified during the workshop.

There were 10 pearl farming activities that had a low risk ranking, 3 with a moderate risk ranking and no activities were ranked as high (Figure 5).

Figure 4: Proportion of high, moderate and low risks for pearl farming activities



The three activities with a moderate ranked risk were associated with seeding, suspending the longlines and shipping (an external threat) (Figure 5). The highest ranked of the low risk activities were associated with hatcheries and disease, and holding concentrated quantities of pearl oysters. Figures 5 and 6 each show the 13 risks identified. Figure 5 emphasises the pearl farm activities. Figure 6 shows the impacts associated with the various activities outlined in Figure 5. As such, the two tables are linked and can be read concurrently.

Figure 5: Risk ranking of pearl farm activities

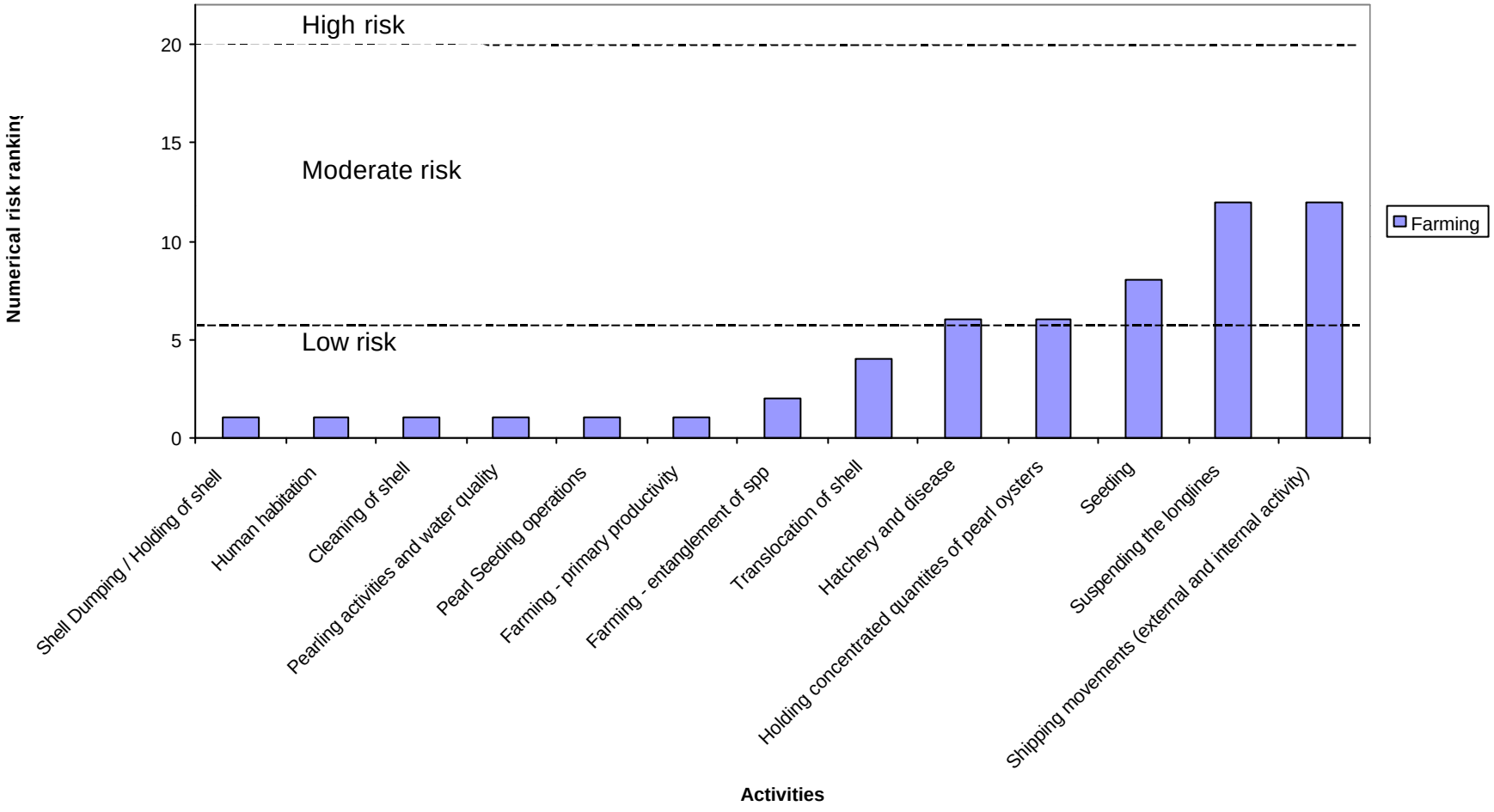
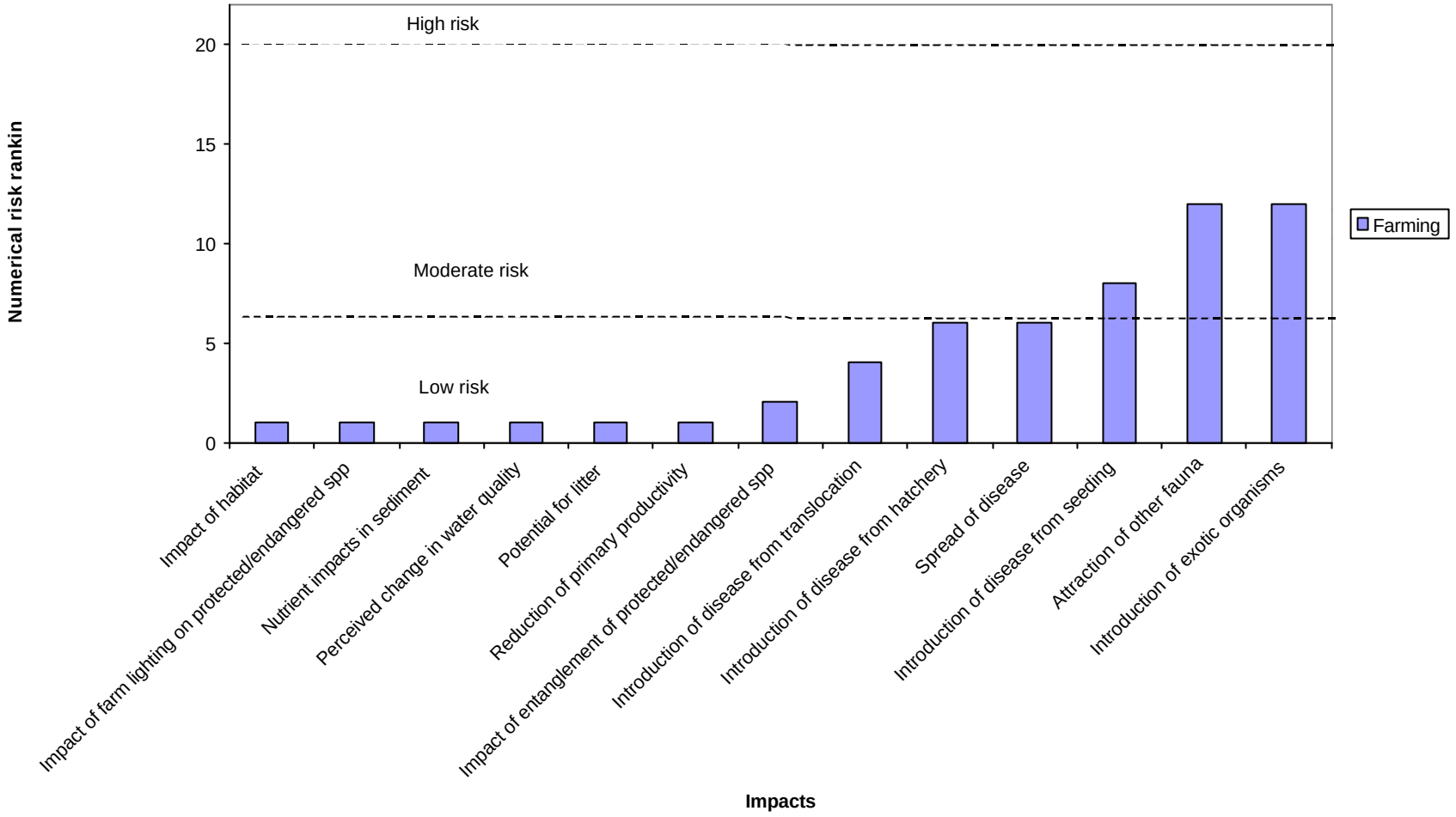


Figure 6: Risk ranking of impacts from pearl farm activities



5.3 Impact and Numerical Risk Distribution

Figure 5 shows the Impact and Numerical Risk Distribution for all risks identified. When sorted according to the risk level, the register of risks has identified the following main issues for the *P. maxima*. No high risks were identified during the workshop. Within the moderate risk category, the potential impacts include: These are moderate risks that have a risk level of either 12 or 8.

- Introduction of exotic organisms (Consequence 3 Likelihood 4) (Activity = Shipping Movements);
- Attraction of other fauna (Consequence 2 Likelihood 6) (Activity = Suspending of longlines); and
- Introduction of disease from seeding (Consequence 4 Likelihood 2) (Activity = Seeding).

Within the low risk category, the risks ranked highest were:

- Spread of disease (Consequence 3 Likelihood 2).
- Introduction of disease from hatchery (Consequence 2 Likelihood 3);
- Introduction of disease from translocation (Consequence 2 Likelihood 2); and
- Impact to protected and endangered species resulting from entanglement (Consequence 1 Likelihood 2).

The remaining six low risks have a consequence of 1 and likelihood of 1:

- Impact of habitat;
- Impact to protected and endangered species resulting from farm lighting (Consequence 1 Likelihood 1);
- Nutrient impacts in sediment (Consequence 1 Likelihood 1);
- Perceived change in water quality (Consequence 1 Likelihood 1);
- Potential for litter eg plastic zip tie tags, plastic bags, buoys to enter water (Consequence 1 Likelihood 1); and
- Reduction of primary productivity (Consequence 1 Likelihood 1).

5.4 Main Risks

Figures 5 and 6 provide a list of the top 3 risks. Although these are ranked as moderate, they are the top ranking risks and management actions are required to reduce these ecological risks to 'as low as reasonably practicable' (ALARP). The recommendations suggested by the workshop participants employed the ALARP principle.

5.5 Dynamic Nature of the Risk Profile

Section 5.2 of this report shows the risk ranking distribution for *all* the environmental and ecological issues / hazards identified. It is important to acknowledge that:

- The risk profile will change over time; and
- The proportion of moderate risks may reduce as the ALARP principle is implemented.

6 RECOMMENDATIONS

Nine recommendations arose from the workshop relating to farming activities and impacts. They were:

1. Cleaning protocol for personal items brought to the farm e.g. material attached to shoes, AQIS protocol to include pearling activities (Activity = Seeding; Impact = Introduction of disease)
2. Application process should highlight the obligations of the applicant in relation to conservation issues for farm personnel, suggest inclusion into code of practice, staff inductions (Activity = Human habitation; Impact = Impact on high conservation areas such as nature reserves).
3. Identify overlap of farms and breeding sites (Activity = Human habitation; Impact = Impact to protected and endangered species resulting from farm lighting).
4. High priority to maintain communication of PPA with other users (Activity = Farm site selection; Impact = Perceived alienation of areas from other users).
5. High priority to maintain communication of PPA with other users (Activity = Farm site selection; Impact = Perceived loss of aesthetic value of sites/wilderness and culture/visual).
6. Monitoring to determine if any impacts (Activity = Holding and dumping of shell; Impact = Impact on habitat).
7. Develop a code of practice and consider alternatives to disposable closures i.e. reusable tags (Activity = Pearl seeding operations: Impact = Potential for litter etc to enter the water).
8. Include in code of practice, response plan, justify risk rating (Activity = Farming; Impact = Impact to protected and endangered species from entanglement).
9. Determine feasibility of exemption from using chemicals to sterilize sewage in high energy environments, low populations (Activity = Waste discharge; Impact = reduction in water quality resulting from sewage treatments from boats).

In addition to the recommendations generated by the workshop participants, the following table 7.1 lists recommendations for the moderate risks identified during the workshop.

Table 7.1: Recommendations for the Moderate Risks Identified During the Workshop

#	Activity	Impact	Recommendation
1	Seeding	Introduction of disease	Cleaning protocol, AQIS protocol to include pearling activities (Activity = Seeding; Impact = Introduction of disease
2	Shipping movements (external and internal activity)	Fouling and mortality of oysters, introduction of exotic organisms eg black striped mussels.	[1]Continue support for AQIS protocol to prevent the introduction of exotic organisms
3	Suspending of longlines	Attraction of other fauna.	[1]Monitor and record the number of incidents where fauna were attracted to longlines to validate the level of risk assigned

[1] *These recommendations were developed on completion of the environmental risk assessment workshop*.

7 KNOWLEDGE GAPS

Six knowledge gaps were identified during the workshop. They were:

1. Do diseases overseas relate to *P. maxima*?
2. Is there any overlap between farms and breeding sites of endangered species?
3. What is known of the impacts of organic matter from the long lines on the benthic community?
4. Is there an integrated planning framework in the Kimberley?
5. What is the impact of the holding dumps on the habitat?
6. What is the benefit to the environment of untreated sewage compared to sewage treated with chemicals?

These knowledge gaps are addressed in detail in the report "Environmental Effects of Pearling (Pinctada Maxima) Gaps in Present Knowledge" (ref: E-Rep-01-032-003 Rev 1).

8 REPORT REFERENCES

AS/NZS 4360: 1999. *Risk Management*. Prepared by the joint technical committee OB/& Risk Management. Australian Standards, New Zealand Standards.

HB 203: 2000. *Environmental risk management – Principles and processes*. Standards Australia, Standards New Zealand.

USEPA 1992. *Framework for ecological risk assessment*. Risk Assessment Forum, U.S. Environmental Protection Agency, Washington, DC.

ATTACHMENTS

Attachment 1
Invitees and Attendees of the Environmental Risk and Impact Assessment Workshop

Attachment 1: Invitees and Attendees of the Environmental risk and impact Assessment Workshop (5 September 2001)

Title	First Name	Surname	Organisation	Attended
Mr	Jim	Penn	DFWA	Yes
Ms	Robin	Clarke	DFWA	Yes
Mr	Colin	Chalmers	DFWA	Yes
Dr	Rick	Fletcher	DFWA	Yes
Mr	Ross	Gould	DFWA	Yes
Ms	Jo	Bunting	DFWA	Yes
Dr	Kim	Freidmann	DFWA	Yes
Mr	Greg	Finlay	DFWA	Yes
Dr	Fred	Wells	WA Museum	No
Dr	Nic	Dunlop	Conservation Council of WA	No
Mr	Brian	Jones	WADPIF	No
Mr	Martin	Holtz	Recfishwest	No
Mr	Guy	Leyland	WA Fishing Industry Council	No
Mr	Paul	Bowers	Aboriginal Lands Trust	No
Ms	Emma	Hopkins	DEP	No
Mr	Mark	Jefferies	DEP	No
Mr	Nick	Miller	Maxima Pearls	No
Mr	Brett	McCallum	PPA	Yes
Mr	John	Kelly	PPA	Yes
Mr	Dave	Mills	PPA	Yes
Ms	Jenny	Carey	Conservation and Land Management	Yes

Attachment 1: Invitees and Attendees of the Environmental risk and impact Assessment Workshop (5 September 2001) (*continued*)

Title	First Name	Surname	Organisation	Attended
Mr	Chris	Simpson	Conservation and Land Management	No
Dr	John	Humphrey	NT DPIF	No
Dr	Murray	Barton	NT DPIF	No
Ms	Jane	Prince		No
Mr	Mick	Buckley		No
Ms	Penny	Arrow	Arrow Pearl Co.	No
Ms	Edwina	Davies-Ward	Marine and Coastal Community Network	No
Mr	Andrew	Bartleet	Fisheries Regional Manager Broome	Yes
Mr	Steve	Riley	Kimberly Charter Boats Association	No
Mr	Ross	McCulloch	WA Tourism Commission - invite sent to Northern Area Manager	No
Ms	Astrida	Mednis	Environment Australia	Yes
Ms	Harriet	Paterson	Sustainable Fisheries Office (Conservation Council)	Yes
Mr	Owen	Bunter	MG Kalis	Yes

Attachment 2
Workshop Agenda

ATTACHMENT 2: WORKSHOP AGENDA

08:30 – 1700, 05 September 2001, Fremantle Sailing Club, Marine Terrace, Fremantle.

0830	Introductions (Brett McCallum)
0840	Background to Workshop (Brett McCallum)
0850	Overview of ESD and SCFA Process (Rick Fletcher)
0910	Overview of the Pearling Fishery (Dave Mills)
0930	Overview of Risk Assessment Process (Sarah Brown)
1000	Review and Verification of Retained Species Trees (Peter Jernakoff/Sarah Brown)
1030	Morning Tea
1045	Risk Assessment on Retained Species Components (Peter Jernakoff/Sarah Brown)
1200	Lunch
1230	Review and Verification of Non-retained Species Component Trees (Peter Jernakoff/Sarah Brown)
1300	Risk Assessment on Non-retained Species Components (Peter Jernakoff/Sarah Brown).
1400	Review and Verification of Other Impacts on the Environment Component Trees (Peter Jernakoff/Sarah Brown)
1430	Afternoon Tea
1445	Risk Assessment on Other Impacts on the Environment Components (Peter Jernakoff/Sarah Brown)
1600	Review of Risk Assessment Findings (Peter Jernakoff/Sarah Brown)
1630	The Next Step (Brett McCallum)
1700	Close of Workshop

Attachment 3
Environmental Risk and Impact Assessment Workshop Results

Component: 1. Retained Species

Subcomponent: 1.1. Pearl Oyster- Farming

Item	Activities	Impacts	Prevention Safeguards	Mitigation Safeguards	C	L	RR	Potential Causes	Recommendations	Knowledge Gaps	Comments	References
1.1.1. Pinctada maxima												
	1. holding concentrated quantites of pearl oysters	1.1. spread of disease	1.1.1. minimal handling, use of dump sites, protocol for longlines, appropriate stocking densities, high flow rates in tanks, farm site selection, disinfection of technician's gear (PPA protocol), translocation, and disease testing protocol, hatcheries have to be tested for health and certified, 5 & 2 nm rule, trigger threshold mortality event to notify FWA, farm dump site rotation		3	2	Low	1.1.1. handling process, stress, moving of equipment (internal PPA activities)				
	2. shipping movements (external and internal activity)	2.1. fouling and mortality of oysters, Introduction of exotic organisms eg black striped mussels	2.1.1. 2 & 5 mile rule, internal zoning, legislative, quarantine regulations	2.1.1. Healthy waters, and predator populations	3	4	Mod	2.1.1. Ship's ballast water & hulls (external forces outside PPA activities), introduced marine species				
	3. Seeding	3.1. Introduction of disease	3.1.1. Technician equipment sterilisation, 2 & 5 nm rule, codes of practice,		4	2	Mod	3.1.1. translocation of disease of technicians	1. Shoe cleaning protocol, AQIS protocol to include pearling activities	3.1.1. do diseases overseas relate to P maxima		

Component: 1. Retained Species

Subcomponent: 1.1. Pearl Oyster- Farming

Item	Activities	Impacts	Prevention Safeguards	Mitigation Safeguards	C	L	RR	Potential Causes	Recommendations	Knowledge Gaps	Comments	References
1.1.1. Pinctada maxima												
	3. cont'd	3.1. cont'd	3.1.1. cont'd level of hygiene on vessels									
	4. hatchery	4.1. Introduction of disease	4.1.1. Fisheries dept protocol, availability of skilled staff, active compliance program	4.1.1. Regular inspections	2	3	Low	4.1.1. Hatchery provides a vector - failure or poor implementation of disease protocol to detect disease				4.1.1. Brian Jones to provide Fishery Protocol
	5. translocation of shell	5.1. Introduction and spread of disease	5.1.1. import restrictions, compliance to approvals, quarantine sites, 5 & 2 rule, translocation protocol, approval from fish health pathologist		2	2	Low	5.1.1. moving shell from one location to another				

Component: 2. Non-retained Species

Subcomponent: 2.1. Piggy-back species - Farming

Item	Activities	Impacts	Prevention Safeguards	Mitigation Safeguards	C	L	RR	Potential Causes	Recommendations	Knowledge Gaps	Comments	References
2.1.1. Piggy -back species												

Component: 2. Non-retained Species

Subcomponent: 2.2. Non-captured protected species

Item	Activities	Impacts	Prevention Safeguards	Mitigation Safeguards	C	L	RR	Potential Causes	Recommendations	Knowledge Gaps	Comments	References

Component: 3. Other Environmental Issues

Subcomponent: 3.1. Impact on Biological Community - Farming

Item	Activities	Impacts	Prevention Safeguards	Mitigation Safeguards	C	L	RR	Potential Causes	Recommendations	Knowledge Gaps	Comments	References
3.1.1. Trophic interactions - from concentration eg. filtering												
	1. Farming	1.1. reduction of primary productivity			1	1	Low	1.1.1. filtering				1.1.1. Kim has reference
3.1.2. Human impacts												
	1. Human habitation	1.1. Impact on high conservation areas such as nature reserves	1.1.1. application process which includes environmental agencies, management plans, Ministerial policy guideline					1.1.1. increased population	2. Application process should highlight the obligations of the applicate in relation to conservation issues for farm personnel, suggest inclusion into code of practice, staff inductions		1. MPG8 licencing and lease assessment	
		1.2. impact to protected and endangered species resulting from farm lighting	1.2.1. limited overlap of farms and turtles		1	1	Low	1.2.1. impacts of lighting on turtles	8. Identify overlap of farms and breeding sites	1.2.1. overlap of farms and breeding sites		1.2.1. Astrida to provide references,
3.1.3. Translocation - genetic biodiversity. Parasites and pathogens.												
3.1.4. Benthic Biota - mechanical damage from long-lines, reef pins, shucking dumps												
3.1.5. Benthic Biota - shading												
3.1.6. Nutrient addition - nitrogenous wastes												

Component: 3. Other Environmental Issues

Subcomponent: 3.1. Impact on Biological Community - Farming

Item	Activities	Impacts	Prevention Safeguards	Mitigation Safeguards	C	L	RR	Potential Causes	Recommendations	Knowledge Gaps	Comments	References
3.1.7. FAD effects												
	1. Suspending the longlines	1.1. attraction of other fauna	1.1.1. regular cleaning, water movement, spatial separation of longlines, relatively small area of lease farms compared to total area		2	6	Mod	1.1.1. artificial habitat (physical structure and increased organic matter)		1.1.1. knowledge of impacts of organic matter on benthic community)		
3.1.8. Wildlife Disturbance												
3.1.9. Cleaning of shells												
	1. Cleaning of shell	1.1. nutrient impacts in sediment	1.1.1. cleaning involves high pressure seawater , no detergents	1.1.1. high tidal energy environment prevents this being an issue outside low tidal areas	1	1	Low				1. Local effects only	
3.1.10. Site Selection												
	1. Site selection of farm	1.1. Perceived alienation of areas from other uses.	1.1.1. Distance between pearl farms, large areas unsuitable for pearl farming, stock holding formula, licence and non exclusive leases.					1.1.1. Competition for sheltered waters, recent growth of pearling industry, growth of tourism	3. High priority to maintain communication of PPA with other users	1.1.1. lack of integrated planning framework in the Kimberley	1. PPA & FWA undertaking disucssions with Charter boat operators and Kimberley tourism. Tourism use Pearling as part of the tours. Perception of increased pearl leases but it has been a reorganisation of lease area only. In last 3-4 yrs there has been a large number of aquaqculture licences (trochus) from aboriginal communities	
		1.2. Perceived loss of aesthetic value of sites/wilderness and culture/visual							4. High priority to maintain communication of PPA with other users			
3.1.11. Shell Dumping/holding/turning operations												
	1. Shell Dumping / Holding of	1.1. impact of habitat	1.1.1. small holding area, hard		1	1	Low		5. Monitoring to determine if any impacts	1.1.1. process not formally assessed		

Component: 3. Other Environmental Issues

Subcomponent: 3.1. Impact on Biological Community - Farming

Item	Activities	Impacts	Prevention Safeguards	Mitigation Safeguards	C	L	RR	Potential Causes	Recommendations	Knowledge Gaps	Comments	References
3.1.11. Shell Dumping/holding/turning operations												
	1. cont'd shell / turning operations	1.1. cont'd	1.1.1. cont'd substrate/sand layer/soft growth/some hard coral									
3.1.12. Pearl Seeding operations												
	1. Pearl Seeding operations	1.1. potential for litter eg plastic zip tie tags, plastic bags, bouys to enter water	1.1.1. waste is collected, quality of husbandry has improved, increased environmental awareness, awards offered for returned bouys, general education		1	1	Low	1.1.1. strong winds, accidental loss overboard	6. Develop code of practice	1.1.1. alternative closures reuseable)	1. public perception and communication issue	
3.1.13. Impact of increased population												
3.1.14. Entanglement of protected and endangered species												
	1. Farming	1.1. impact to protected and endangered species resulting from entanglement	1.1.1.	1.1.1. location of farms, structure and distribution of longline systems, regular monitoring of lines, small lease area	1	2	Low	1.1.1. entanglement in culture equipment	7. Include in code of practice, response plan, justify risk rating		1. public perception is high consequence and leglislative requirement under EPBC Act	

Component: 3. Other Environmental Issues

Subcomponent: 3.2. Other - Farming

Item	Activities	Impacts	Prevention Safeguards	Mitigation Safeguards	C	L	RR	Potential Causes	Recommendations	Knowledge Gaps	Comments	References
3.2.1. Long-line Pearl Culture												
3.2.2. Water Quality - sewage and gallery, chemical and oily wastes												
	1. Waste discharge	1.1. reduction in water quality resulting from sewage from boats		1.1.1.				1.1.1. legislatively required chemical treatment of sewage	9. Seek exemption from using chemicals to steralise in high energy environments, low populations	1.1.1. relative advantages of treated vs untreated sewage		
	2. pearling activities	2.1. perceived change in water quality		2.1.1. animals are not fed artificially, no input of chemicals in water	1	1	Low	2.1.1. antifoulant				2.1.1. KF to supply references 2.1.2. no risk ranking as antifoulant is not used
	3. pearling activities	3.1. perceived use of TBT antifoulants	3.1.1. no TBTs used									
3.2.3. Debris - ropes, floats and baskets												
3.2.4. Antifoulants - hulls, shell and gear												

Attachment 4
Participant Comments on Workshop Minutes

Dr Jim Penn's comments on the Pearl Farming ERA worksheets, which he had originally forwarded in handwritten form.

Point 1.1.1.2, shipping movements

"Likelihood" column (currently listed as "4"): Likelihood should be a "1" as all pearling vessels are fully maintained and have antifouling etc.

"Potential" risk is from recreational yachts and Indonesian fishing boats. This is clearly outside of the industry's control and should not be included here.

1.1.1.3, seeding

"Likelihood" column (currently listed as "2"):

Given the protocols in place, this seems to have been overestimated in terms of likelihood.

3.1.7.1, suspending the longlines

In "Impacts" column add "(fish)" after the word "fauna".

"Consequence" column (currently shown as "2"): Consequence should be "1" as aggregation of fish from FAD effect has little or no effect on overall fish populations in these remote areas.

"RR" column (currently shown as "Mod"): Should be "Low".

-----Original Message-----

From: Astrida Mednis [mailto:Astrida.Mednis@ea.gov.au]

Sent: Tuesday, 13 November 2001 6:20 AM

To: peterj@intrisk.com.au

Subject: Re: pearling ecological risk assessment worksheets

Peter

Thank you for providing the draft report. The record seems to be accurate, however we offer a few comments for your consideration.

General

It would be prudent to ensure that the best possible case is presented in the Report regarding the impacts of the pearl farm operation on matters of national environmental significance outlined under the Commonwealth Environment Protection and Biodiversity Conservation Act

1999.

3.1.2 Human impacts

Turtle issues. We provide text for inclusion in the record. Please note that the text is derived from the Draft Recovery Plan for Marine Turtles as prepared under the requirements of Commonwealth EPBC Act. It is expected that the plan will be finalised by the end of this year.

Pearl Farming and Other Aquaculture Activities

Concern has been expressed about the potential impact on marine turtles through light disturbance and entanglement in equipment used in pearl farming and aquaculture. There is no available evidence to suggest any mortality due to pearl farming and aquaculture but a precautionary approach would seem appropriate. Actions are identified below.

Actions to mitigate incidental mortality resulting from pearl farming and aquaculture

Prescribed Action: Fisheries managers to encourage pearl farming and aquaculture licensees to use appropriate, non-disturbing, lighting technology. (M) Managers: WACALM, Fisheries WA, PWCNT, NT DPIF

Criteria for success: Appropriate lighting is used.

Prescribed Action: Operators to monitor any incidental mortality of marine turtles in aquaculture operations. (M) Managers: WACALM, Fisheries WA, PWCNT, NTDPIF

Criteria for success: Marine turtle mortality and bycatch is reported to lead agencies.

Recovery Actions includes:

Pearl farming and other aquaculture activities, assigned priority 2 (from a range of 1-3), Feasibility high and estimated cost of actions a total of 25 thousand dollars over 5 years @ five thousand per annum.

3.1.9 Cleaning of shells

Is it possible to comment further on what are the local effects and if not, why not an issue.

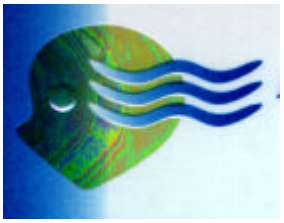
3.1.14 Entanglement of protected and endangered species

Would be appropriate to list the relevant species under 1.1 and under the recommendation (as identified under State and Commonwealth legislation i.e. EPBC Act). Provide a good case regarding nature of the significance of impact to address EPBC Act requirements.

All the best

Astrida

Appendix 5
Task 3: Gap analysis of key environmental information



Pearl Producers Association Inc.

Environmental Effects of Pearling (*Pinctada maxima*) Gaps in Present Knowledge

DATE: 26 JUNE 2002

PROJECT: J01-032

DOC NO.: E-REP-01-032-003 REV 1

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REV	DESCRIPTION	AUTHOR	REVIEW	APPROVAL	DATE
A	Internal review	Fred Wells	Peter Jernakoff		09 February 2002
B	Issued to client for comment	Fred Wells	Sarah Brown		12 March 2002
0	Issued to client	Fred Wells	Sarah Brown	Peter Jernakoff	20 March 2002
1	Includes FRDC comments	Sarah Brown	Peter Jernakoff	Peter Jernakoff	26 June 2002

Contents

ABBREVIATIONS

AQIS	Australian Quarantine and Information Service
AEL	Australian Environmental Laboratories
CALM	Conservation and Land Management
DFWA	Department of Fisheries Western Australia
ERA	Environmental Risk Assessment
EPA	Environmental Protection Authority
ERA	Environmental Risk Assessment
FDWA	Fisheries Department of Western Australia
FWA	Fisheries of Western Australia
IRC	International Risk Consultants
ISO	International Organisation for Standardisation
PPA	Pearl Producers Association Inc.
WAM	Western Australian Museum
WA	Western Australian

EXECUTIVE SUMMARY

The Pearl Producers Association Inc. contracted International Risk Consultants (IRC) to undertake a study of the pearling industry to assess the current environmental status of the industry and make recommendations for future best practice management. The present report by Enzer Marine Environmental Consulting reviews key knowledge gaps that are both relevant and appropriate to the pearling industry. This report is based on the report "The environmental impact of pearling (*Pinctada maxima*) in Western Australia" undertaken by Enzer in 1998, supplemented by more recent information. Particular attention is paid to issues and concerns raised at an environmental risk assessment workshop undertaken by IRC to identify and prioritise environmental and ecological risks and impacts associated with the pearling industry. The major concerns addressed are:

The industry suffered substantial mortalities during the 1980s which were eventually traced to the bacterium *Vibrio harveyi*. Handling and farming practices for pearl oysters were substantially modified, and survival rates improved substantially. However, the industry is concerned about the possibility of a recurrence of losses through diseases, and the various aspects of this are discussed in detail in the present report.

A second concern expressed during the environmental risk assessment workshop was the potential for interactions between pearl farms and breeding sites of endangered, (vulnerable and other specially protected) species. The level of interaction is in general low, with the most likely interactions being with specially protected salt water crocodiles (*Crocodylus porosus*). Monitoring and reporting of interactions is recommended.

On the farms the seeded pearl oysters are cleaned of naturally occurring fouling organisms every 3-5 weeks, and the fouling organisms discarded into the water. Concern was expressed over the impacts of the discarded material on the benthic community, and the possible attraction of other fauna to the area. A study is recommended to provide detailed information on the amount of material being removed, the taxonomic composition of the material cleaned, its fate when returned to the water, possible build-up on the bottom, and the species such as fish which are attracted to the stream of material entering the water from the cleaning process.

Once pearl oysters have been collected, cleaned, and placed in tagged panels they are stored on the sea floor in holding sites until needed for seeding. A minor amount of damage is caused to organisms growing on the bottom, but these are not sensitive areas; environmentally sensitive areas such as coral reefs do not occur in the areas where fishing for pearl oysters occurs.

Grey water from the toilets and domestic sinks on boats and on shore camps is discarded directly into the sea. The only unusual feature of the use of boats by the pearling industry is that those on farms may be moored in the same area for prolonged periods of time with a small crew of eight to 10 people on board at one farm, and up to 30 or 35 during peak periods of about two weeks on some farms. This creates a potential for the accumulation of

wastes in a small area. This is considered to be a minor problem but a study is recommended to verify this conclusion.

There has been considerable press in recent years over the dangers of introducing exotic organisms into the Australian marine environment, including tropical waters. As the pearl industry operates entirely within a single biogeographical region, it is considered unlikely to introduce exotic species into the region. Species introduced by other sources, such as international shipping are likely to come from other biogeographic regions. The best approach is to prevent the arrival of these species; once they have colonised northern Australia there is little which can be done to remove them.

The environmental effects of the pearling industry are small. The following studies are recommended to further document and assess the environmental impacts of the pearling industry:

- monitoring of farms to determine if there are any long-term impacts;
- material cleaned from oysters after capture; and
- survival of oysters removed from the bottom.

In addition, the following study is recommended to assist the industry in understanding the biological basis for their success and to develop techniques which might enhance the industry:

- environmental characteristics required for successful pearl farming.

The relevance of the present report to other pearl industries and in the abalone fisheries in Western Australia is examined. The findings of the present report are readily transferable to other aquaculture activities where boat based operations or shore camps are established in remote areas.

Most of the information on the effects specifically related to the pearl fishery can be transferred to other species of *Pinctada,* if they are cultured in the same way.

Three commercial species of abalone in Western Australia: *Haliotis laevigata, H. roei* and *H. conicopora.* Most interest in aquaculture centres around *H. laevigata* on the south coast. There is a lesser degree of interest in culturing *H. roei* and *H. scalaris* on the west coast. There are significant differences in the biology of abalone and pearl oysters. These differences mean that there are no similarities between the wild caught abalone fisheries and farming of wild caught pearl oysters.

1 BACKGROUND

The Pearl Producers Association Inc. contracted International Risk Consultants (IRC) to undertake a study of the pearling industry to assess the current environmental status of the industry and make recommendations for future best practice management. A key aspect of the project is to provide Environment Australia with sufficient information to assess the environmental sustainability of the pearling industry under the new *Environmental Protection and Biodiversity Conservation Act (1999).* IRC undertook four tasks for the project:

1. an evaluation of the current fishery procedures and practices;
2. an environmental risk assessment (ERA) workshop to identify and prioritise environmental risks and impacts associated with the pearling industry – both wild harvest and farming;
3. a review of key knowledge gaps that are both relevant and appropriate to the pearling industry; and
4. a gap analysis of pearling industry practices against an environmental management system such as ISO 14001. The gap analysis would identify areas where a pearling industry code of practice could be developed.

The present report by Enzer Marine Environmental Consulting provides a review of key knowledge gaps that are both relevant and appropriate to the pearling industry for Task 3.

At the workshop, the environmental risk assessment process was divided into two components: wild harvest, which will be handled by Fisheries Western Australia, and farming, which will be undertaken by IRC for the PPA. Accordingly, the present report deals essentially with farming issues, but comments are made on wild harvest where information has been generated incidentally.

2 METHODS

Enzer (1998) undertook a major study on "The environmental impact of pearling (*Pinctada maxima*) in Western Australia" for the Pearl Producers Association Inc. The report was wide ranging, and was intended to develop basic information on all aspects of the pearling industry. The report was based on the following sources:

- An extensive search of the Australian and international literature was undertaken to obtain information on the industry and the possible environmental effects of it. This included analysis of unpublished reports held by the Fisheries WA library at Watermans Bay.
- Copies of regulatory requirements were obtained from appropriate agencies.
- Discussions about the perceived environmental effects of the industry were held with officers of relevant government agencies and other people both within and outside the industry.
- An eight-day field trip to the North West was undertaken to obtain first hand knowledge of the industry and its practices. The following activities were undertaken:
- A brief visit to the pearl oyster hatchery in Broome was made on arrival from Perth to examine the hatchery and discuss methods used in the hatchery.
- Three days were spent on the fishing grounds off Eighty Mile Beach to observe how fishing operations are undertaken. Several dives were made on various bottom types during the collection of pearl oysters and on shell sites to examine for any effects of the bottom longlines.
- One day was spent in Roebuck Bay on a bottom culture farm to observe the effects of shell culture and structures close to the bottom in various bottom types in the area.
- Three days were spent in King Sound to examine how surface longline farms operate, the cleaning process, methods of handling various wastes and rubbish, etc. Two types of farms were visited, a shore-based farm and two which are sea based.

The present report is based on information provided in Enzer (1998). It is supplemented by the results of the one day Environmental Risk Assessment workshop undertaken as part of the present project on 5 September 2001 and information obtained by Dr Peter Jernakoff and Ms Sarah Brown during visits to pearl facilities in the Kimberley and the Northern Territory. Enzer (1998) has been updated with analysis of the more recent literature and discussions with people knowledgeable about the industry. Particularly helpful was a document provided by Ms Jo Bunting of Fisheries WA on the status of the pearling industry.

3 ENVIRONMENTAL EFFECTS OF PEARLING

Enzer (1998) provided a detailed background to the pearling (*Pinctada maxima*) industry, and analysed the environmental effects of pearling. Enzer (1998) pointed out that in assessing the environmental effects of the pearling industry, it is important to remember that at all stages the industry is dealing with live animals which must be maintained in a healthy condition for at least two years to produce a high value product. The animals are collected from one area, held in storage areas in the sea for prolonged periods, operated on in a laboratory, transported to a grow out farm, and allowed to grow for two years. All of these activities produce stress on the animals, increasing the likelihood of mortalities and the requirement for favourable water conditions. Pearl oysters are sensitive to water quality and if stressed are susceptible to disease and produce poor quality pearls. Individual pearl oysters are maintained in natural conditions for two years before the pearls are harvested and, with reuse, some animals are kept for up to eight years. It is critical to the industry that the environment is maintained in as good a condition as possible to protect the investment made in the living animals.

Enzer (1998) divided the environmental effects of the pearling industry into two areas:

- universal features of boats and the operation of shore camps; and
- industry effects which are specific to the pearling industry.

As indicated in Section 2, the gap analysis is relies heavily on work undertaken by Enzer (1998). The information is not repeated here, but the present document should be read in conjunction with Enzer (1998).

4 KNOWLEDGE GAPS

The ERA workshop identified six knowledge gaps:

1. Do diseases overseas relate to *Pinctada maxima?*
2. Is there any overlap between farms and breeding sites of endangered, (vulnerable and other specially protected) species?
3. What is known of the impacts of organic matter from the long lines on the benthic community?
4. Is there an integrated planning framework in the Kimberley?
5. What is the impact of the holding sites on the habitat?
6. What is the benefit to the environment and pearl production of untreated sewage compared to sewage treated with chemicals?

The ERA workshop identified no areas with high risk rankings, and only three areas with moderate risk rankings:

1. Introduction of disease from seeding
2. Attraction of other fauna
3. Introduction of exotic organisms

Three issues with low risk rankings also related to disease:

1. Introduction of disease from translocation
2. Introduction of disease from hatchery
3. Spread of disease

Each of these perceived knowledge gaps is examined in the present section, except for item 4 (an integrated planning framework for the Kimberley), which is outside the scope of this report. Related concerns, particularly those of disease introduction and spread, are combined.

4.1 Do diseases overseas relate to *Pinctada maxima*, and how could they be spread in the industry?

4.1.1 Background

During the late 1970s serious problems of mortality of pearl oysters developed in the transportation phase of the industry and on pearl farms. Detailed studies showed that the majority of the diseased animals were infected with Vibrio bacteria. One common isolate, Vibrio harveyi, was shown in laboratory studies to cause diseases similar to the symptoms seen in the field. Vibrio naturally occurs widely in the marine environment, including the water column, in sediments and in the guts of marine animals. No other causal agents were found. Even though V. harveyi had not previously been shown to cause disease, it was implicated as the agent. The virus is present in the wild, but is known to cause disease only in the densely packed conditions of farm culture (Dybdahl et al., 1990).

The mortality occurred following transportation of the pearl oysters from collection areas to the lease sites. Instead of the expected 10 to 20% mortality, losses on lease sites were up to 80%. Surviving pearl oysters developed deformed nacre and were useless for half pearl or mother of pearl production. Water circulation in the tanks in which the oysters were transported was found to be ineffective, allowing the number of bacteria to increase dramatically during transport. Accumulations of mollusc faeces on the bottoms of the tanks favoured exponential increases in bacteria populations. The possibility was also raised that circulation was not as effective on culture rafts as on long lines, and bacterial densities were higher. While other infectious agents or causative factors could have been involved, it was concluded that pearl oysters were weakened during the low temperatures of winter, and

became infected when they came into contact with high bacterial concentrations (Wolf and Sprague, 1978; Pass and Perkins, 1985; Dybdahl and Pas, 1985; Pas et al., 1987, 1988).

The mortality experience has made pearl industry operators acutely aware that they are dealing with live animals that must be treated properly if high quality pearl production is to be achieved. A number of changes were made to the industry which have improved treatment of the animals. The various processes are now staged to allow the animals to recover from each procedure (collection, transportation, seed implantation, etc.) before the next stage is attempted. Water circulation during transportation has been improved considerably, and the water in tanks is now exchanged about every 10 minutes. The high density of raft culture has disappeared and been replaced with the lower stocking density of long lines.

More recently, the experience with the pilchard (*Sardinops neopilchardus*) industry has heightened concern over the possible introduction of diseases into commercially important fishery species. A *Herpesvirus* sp. of unknown origin swept through the fishery twice in recent years. The virus was first found in the eastern Great Australian Bight in March 1995. It spread rapidly both east and west at a rate of 30 km/day, quickly extending over the entire range of the population from Carnarvon, Western Australia to Noosa Heads, Queensland, and into New Zealand. The virus killed 10-15% of the WA biomass of the species. In October 1999 a second mortality event originated in South Australia and rapidly spread as far west as Albany, causing an estimated 30% mortality. While the mechanism it not known, the virus is thought to have recently been introduced to Australia (Fletcher et al., 1998).

Concern over diseases in pearl oysters was raised in a number of ways during the present project. In particular, the ERA workshop identified several concerns with diseases. There is a knowledge gap in whether diseases overseas relate to *Pinctada maxima.* Introduction of disease from seeding was one of only three concerns with moderate risk rankings. Three issues among the low risk category also related to disease: introduction of disease from translocation; introduction of disease from hatchery; and spread of disease. Because of these concerns, the possible introduction of disease is discussed in detail below.

There have already been a number of important initiatives developed to minimise the possibility of spread of diseases by the industry. Many were instituted after the disease problems encountered during the 1980s. The four most important were:

- resting of the oysters after each stage of handling;
- separation of holding areas and farms;
- reduced stocking densities on the farms; and
- mandatory pathology testing of all shell and spat prior to translocation.

4.1.1.1 Resting of the oysters after each stage of handling

The mortality experience has made pearl industry operators acutely aware that they are dealing with live animals that must be treated properly if high quality pearl production is to be achieved. A number of changes were made to the industry which have improved treatment of the animals. The various processes are now staged to allow the animals to recover from each procedure (collection, transportation, seed implantation, etc.) before the next stage is attempted. Water circulation during transportation has been improved considerably, and the water in tanks is now exchanged about every 10 minutes.

4.1.1.2 Separation of holding areas and farms

The Western Australian industry has developed a system of seeding pearls and holding them for a period on the pearling grounds every year prior to transferring the pearl oysters to the farm leases. The purpose of this is to allow the animals to recuperate after the stress of being collected, transported to the shell sites, and subsequently being operated on to implant the nucleus.

It is a mandatory requirement that the holding area of one licensee be approved by Fisheries as being clearly distinct from an adjacent operator, whether it is another holding area or a pearl farm. It is accepted by industry that the operator should minimise the effect of the holding area on the collection grounds of wild pearl shell. This is accomplished primarily by locating holding areas in localities not used for collecting shell.

The Ministerial Guidelines for the pearl oyster industry [Fisheries Department of Western Australia (FDWA), 1997a] require that applications for new holding areas should be refused if the:

1. proposed boundaries lie within two nautical miles of the nearest boundary of any other holding area or five nautical miles of the nearest boundary of any pearl oyster farm lease area unless there is mutual consent between the applicant and the pearling licensee of that pre-existing holding area;
2. company making the application already has an approved holding area within 20 nautical miles of the holding area being sought; or
3. total area of the application exceeds four square nautical miles.

The Western Australian pearling industry considers that there should be clear separation between adjacent farm lease areas and between farm leases and holding areas. The view developed initially as a result of concern over substantial mortality of pearl oysters, which industry considered may have been transmitted from one pearl oyster farm to another. Additional reasons for having a clear separation between operators include providing each farm with opportunities for expansion and security of their equipment and pearl oysters. The following guidelines apply to the issue of new pearl oyster farm leases (FDWA, 1997a):

"Where an application is made for the issue of a Pearl Oyster Farm Lease and the proposed boundaries of the proposed farm lease lie within five nautical miles of the nearest boundary of any pre-existing farm lease area or any holding area, the application should be refused unless:

1. there is a clear geographical division between the pre-existing and proposed farm lease area; or
2. the holder of such pre-existing farm lease provides written consent to the application."

The original licensee has the right to expand within the five nautical mile exclusion zone towards a new farm lease provided a minimum separation of two nautical miles is maintained from the new lease area. Distances between boundaries of adjacent leases are measured over water rather than across land formations.

4.1.1.3 Reduced stocking densities on the farms

The high density of raft culture has disappeared and been replaced with the lower stocking density of long lines. There is a formula that is used by Fisheries to regulate stocking density on the farms.

4.1.2 Do diseases overseas relate to *Pinctada maxima*?

The mortalities of pearl oysters in the 1980s led to a series of detailed studies of the causes of the mortalities and mechanisms by which the mortality could be overcome. Apart from that there have been only isolated studies such as Hine and Thorne (1998; 2000), who reported very low levels of several potential pathogens in wild caught and hatchery raised pearl oysters. Mass mortalities of *Pinctada maxima* in China were caused by a rickettsia-like organism (Wu et al., 1999), very different to the *Vibrio* bacteria that caused the mortalities in northwestern Australia.

4.1.3 Introduction of disease from seeding

The disease problems caused in Western Australia were the result of a naturally occurring vector which caused mortalities when the oysters had been stressed from handling and were in very crowded conditions. This was not a result of an introduced organism. All companies have introduced protocols to ensure maintenance of proper sanitary conditions in handling the oysters during seeding that will minimise the risk of introduction of pathogens. These include protocols for sterilising equipment used by technicians during seeding.

4.1.4 Introduction of disease from translocation

In order to manage wild shell stocks and translocation, the Western Australian pearl oyster fishery is divided into four zones:

Zone 1. All waters lying east of longitude 114°10'E, west of longitude 119°E, and north of latitude 22°30'33"S. Zone 1 includes all waters of Exmouth Gulf.

Zone 2. All waters lying east of longitude 118°10'E, south of latitude 18°14'S, and north of latitude 20°23'S.

Zone 3. All waters lying north of latitude 18°14'S and west of longitude 125°20'E, including any waters south of that part of the northern coastline of the State intersected by that longitude and west of longitude 125°30'E.

Zone 4. All those waters lying east of longitude 125°20'E, including any waters lying south of that part of the northern coastline of the State intersected by that longitude and west of longitude 125°30'E.

There is an overlap between Zones 1 and 2 in the region between longitudes 118°10'E and 119°E.

The development of hatchery technology has the potential of increasing the risk of the spread of disease and issues associated with translocation of pearl oysters from one area to another. Such issues are particularly important if the hatchery being used to produce spat is located in another area, either interstate or overseas. The Ministerial Policy Guidelines (FDWA, 1997a) and the Pearl Oyster Translocation Protocol (FDWA, 1997b) provide a detailed series of requirements for the handling of hatchery grown pearl oysters.

4.1.5 Introduction of disease from hatchery

The Western Australian pearling industry operates under a policy of "controlled expansion" where production is carefully linked to the capacity to sell the numbers of pearls produced profitably. Development and growth of the pearling industry may be limited by the need to limit catches for the sustainable exploitation of wild shell to use for seeding (Enzer, 1998). The use of hatcheries for the production of spat which can be grown to a size sufficient for seeding provides a mechanism for maintaining production and meeting the controlled expansion approach of the industry, ensuring a steady supply of stock, and in the future potentially reducing costs of obtaining pearl oysters for seeding. However, the extensive use of hatcheries has both positive and negative aspects that are discussed in the Ministerial Policy Guidelines for the pearl oyster fishery (FDWA, 1997a). In addition to providing additional stock and a steady supply, positive features include the ability to compete with overseas producers using hatchery technology. High quality Western Australian pearls are in limited supply and accordingly command a high price. On the negative side, if hatchery production commences on a significant scale, there is a danger that the number of high quality pearls will be increased sufficiently to cause the price to fall. Because of this, the number of pearl oysters which can be used for pearl production has been limited.

By their very nature, hatcheries are areas where diseases can occur. Brood stock is held in laboratory conditions, and large numbers of spawn are produced. The larvae are retained through settlement to the bottom, then are grown through the early juvenile stages until they are placed into the open sea. The high density conditions mean that if a pathogen is introduced it can spread quickly through the hatchery, killing many or all of the larvae.

Because of the concerns over possible introduction of diseases into a hatchery, Fisheries Western Australia developed, in consultation with industry, a detailed protocol for maintaining strict hygiene in pearl oyster hatcheries (FDWA 1996; 1997a).

Enzer (1998) described operations at the Broome hatchery in detail. Incoming water is obtained from the sea near the hatchery, piped to the hatchery, filtered, used in the hatchery, refiltered, cleaned and released back into the sea. Under the protocol developed by FDWA (1996; 1997), the outgoing water must pass through several processes, including sand filtration, to ensure no organisms are present in the spent water as it leaves the hatchery. FWA requires that the system be monitored. Table 1 presents results of analysis of samples by an independent laboratory from incoming water at the Broome jetty, the reservoir at the Broome hatchery and the bypass tank before it is returned to the sea. Water quality is very similar in the entry and exit water, and, if anything, slightly better in the outflow.

Table 1. Example of data from the Broome hatchery monitoring of incoming and outflowing water quality. Australian Environmental Laboratories undertook independent analyses in February 1997 (from Enzer, 1998).

Hatchery reference	Bypass tank	Reservoir	Jetty	
AEL reference	32902-1	32902-2	32902-3	
Sample type	Water	Water	Water	
Units	mg/L	Mg/L	mg/L	Method
PH (pH units)	8.5	8.2	8.2	PEW 001
Total Suspended Solids	43	70	84	PEW 003
Oil & Grease (grav)	2	2	2	PEO500
Total Phosphorus P	<0.05	<0.05	<0.05	PEW014
Ammoniacal Nitrogen NH_3-N	0.2	0.4	0.6	PEW010
Free Ammonia @ 20ºC NH_3-N	0.02	0.2	0.03	Calculation
Nitrate Nitrogen NO_3-N	<0.1	0.1	<0.1	PEW011/PEW020
Biochemical Oxygen Demand	<1	2	2	PEW018

Monospecific strains of temperate and tropical algal species are obtained from the CSIRO Marine Laboratories in Hobart for use in feeding the larval and juvenile pearl oysters. The phytoplankton are fed to the pearl oysters in quantities which ensure that they are fully consumed by the pearl oysters. This makes the process as cost effective as possible and helps to ensure the phytoplankton are not released into the environment. The phytoplankton are grown at 21ºC and are fed to the oysters at 29ºC. The resulting temperature shock kills all of the phytoplankton. Any remaining dead cells are filtered out in the sand filters before leaving the hatchery.

Hatchery reared larval and juvenile pearl oysters are culled at each stage to select only the most promising individuals. The hatchery protocol (FDWA, 1996; 1997a) requires that excess animals be deposited in land dumps to avoid any possible issues of translocation, genetic differences, etc.

The hatchery is shut down and thoroughly cleaned after each year's production is finished. This allows substantial time when all equipment is dry, cleaned and ready for the next year, and prevents the build-up of any problem that could potentially happen in a hatchery using various life stages simultaneously and operating year round.

Materials are acid cleaned on an annual basis at the end of the hatchery season. Sodium hydroxide is available to neutralise acid if necessary, but has never been required.

Individual companies operate other hatcheries under the same government requirements. While details of the methods vary, the basic procedures are the same. One variation is that some hatcheries produce smaller spatfalls in a batch but produce several batches in a season. There is still an extended period of two to three months each year when the hatchery is completely shut down.

The developing hatchery technology provides increased potential for mixing genetically distinct populations during culturing. To examine the existing natural situation, Johnson and Joll (1993) examined the genetic structure of Pinctada maxima collected from five widely separated areas: Exmouth Gulf and Cape Bossut, Western Australia; Flat Top Bank and Oxley Island, Northern Territory; and Thursday Island, Queensland. Most of the variation found was clinal between western and eastern populations, but comparisons between adjacent pairs of samples usually showed significant genetic differences. This includes the two locations in the Northern Territory which were only 320 km apart. Western Australian samples showed little subdivision over the 800 km from Exmouth Gulf to Cape Bossut. Johnson and Joll (1993) suggested that stocks are in general highly divided in northern Australia, but that there are also substantial connections that occur in Western Australia over long distances. The 80,000 to 100,000 P. maxima transported annually from Western Australia to farms in the Northern Territory do not seem to have had effect on adjacent natural populations.

4.1.6 Spread of disease

As indicated above, the mortalities experienced in the 1980s led to the introduction of a number of mechanisms which overcame the mortalities of the pearl oysters. Among these has been a number of translocation protocols aimed specifically at reducing the risk of spreading disease by movement of oysters and farming practices.

4.2 Is there any overlap between farms and breeding sites of endangered, (vulnerable and other specially protected) species?

Table 2 shows the endangered, (vulnerable and other specially protected) marine species that occur on the north coast of Western Australia and the Northern Territory. The list was obtained from the websites of Environment Australia and the Western Australian Department of Conservation and Land Management and species recorded in northern Australia by Dames & Moore (1997).

Congregations of these species are in general well away from areas utilised by the pearl industry. The two whale species are migratory and overwinter in the open waters off the north coast of Western Australia. Possible interactions with the pearl industry may occur in areas such as the Montebello Islands where the islands are offshore and whales may venture in between the islands. Similarly, occasional individuals may venture into the nearshore waters of the Kimberley. The only incident of a whale becoming entangled in ropes on a *Pinctada maxima* farm occurred in Flying Foam Passage in 1998. The whale was cut free, but it is not known whether or not the animal survived the incident (D. Cochrane, pers. comm.). A humpback whale was apparently killed in the Houtman Abrolhos in 2001 when it became entangled in the ropes of a *P. margaritifera* farm in relatively open water.

The largest population of dugong in Western Australia, and one of the largest in the world, is congregated in Shark Bay. There are approximately 10,000 individuals in this population. However, the Shark Bay dugong population is well outside the geographical area utilised by the *Pinctada maxima* industry. There are no other known areas of major concentrations of dugongs in Western Australia.

Table 2. Endangered, (vulnerable and other specially protected) marine species on the north coast of Australia.

Scientific name	Common name	Conservation status	
		Environment Australia	CALM
Mammals			
Balaenoptera acutorostrata	Southern Minke Whale	Vulnerable	Rare or likely to become extinct
Balaenoptera edeni	Bryde's Whale	Not listed	
Globicephala macrorhynchus	Short-finned Pilot Whale	Not listed	
Megaptera novaeangliae	Humpback Whale	Vulnerable	Rare or likely to become extinct
Dugong dugon	Dugong		Other specially protected fauna
Reptiles			
Crocodylus porosus	Saltwater crocodile		Other specially protected fauna
Caretta caretta	Loggerhead Turtle	Endangered	Rare or likely to become extinct
Chelonia mydas	Green Turtle	Vulnerable	
Eretmochelys imbricata	Hawksbill Turtle	Vulnerable	
Lepidochelys olivacea	Pacific Ridley, Olive Ridley	Endangered	
Natator depressus	Flatback Turtle	Vulnerable	
Fishes			
Rhincodon typus	Whale Shark	Vulnerable	

Turtles disperse in the sea for years then return to their nesting grounds to lay their eggs above the tide lines on sandy beaches. Individuals are likely to move through pearl farms from time to time, but it is the spawning areas that require most consideration. There are no known nesting areas in Western Australia for Flatback turtles, but at least three of the other four species do nest in WA. One of the largest breeding areas in the region is at Ashmore Reef, where there are an estimated 8,000-10,000 individuals. Three species are present at Ashmore: the green turtle is most common, but there are also hawksbills and loggerheads (ANPWS, 1989). Browse Island, off the Kimberley, is one of the most important breeding sites for turtles in Australia. While definite numbers are not known, they number in the thousands (Burbidge et al., 1991). Similarly, the Lacepedes Islands have an estimated

8,000-10,000 individuals. Other major breeding sites, though of lesser numbers of individuals, in Western Australia include North West Cape, Barrow Island, Muiron Islands, and the Montebello Islands (Prince, 1994).

Most of these areas are well away from pearl farms. However, others are closer, such as the Montebello Islands. Turtles are known to occasionally become entangled in the ropes of craypots on the west coast of Western Australia, and it is possible that they also become entangled in lines on pearl farms. Section 5.1.4 recommends monitoring to determine the level of interaction of protected species with pearl farms.

Saltwater crocodiles in the Kimberley are the protected species most likely to have routine interactions with pearl farms. Crocodiles are territorial, and are most common in inshore mangrove areas. The crocodiles pose a danger to people on the pearl farms, so the presence of crocodiles in the area would be of concern.

In recent years a substantial tourism industry has developed in the Ninagloo Marine Park off the west side of North West Cape where whale sharks regularly congregate in March and April. Tourists are drawn to the area to view and swim with the whale sharks. Aside from this area, whale sharks rarely seen (Allen, 1997) and are well away from areas of pearl farm locations.

4.3 What is known of the impacts of organic matter from the long lines on the benthic community, and how does this attract other fauna?

On the farms the seeded pearl oysters are cleaned of naturally occurring fouling organisms every 3-5 weeks. The cleaning was described in detail by Enzer (1998). Pearl shells are considered by the industry to grow more healthily and produce better pearls when fouling is minimised.

During the cleaning process the lines are removed from the water and one crew member manually cleans the lines and floats. Panels are placed into a machine and cleaned with high pressure seawater. No chemicals are used in the process. When the panels emerge from the machine, encrusting organisms on the shells are removed by hand and the panels, floats and lines returned to the water. Even after cleaning there is still material adhering to the shell; this helps prevent the settlement of barnacles. Juvenile shells that originated from the hatchery are cleaned in basically the same manner, although they are treated more gently. In both cases, the time that the animals are out of the water is kept to as short a period as possible.

During cleaning a stream of discoloured seawater leaves the vessel. On calm days this can be seen for up to 200 m before it merges into the background. On windy days, or when a strong current is running, the stream is visible for much shorter distances. As the water is disposed over the side it attracts considerable numbers of small fish that feed on the discarded material as it settles through the water column.

Material removed from the shell is largely algae, with a variety of other organisms such as sponges, molluscs, crustaceans, polychaetes and ascidians. Due to the regularity of the cleaning regime relatively few barnacles were seen. The great majority of the material breaks down very rapidly. Shell material from molluscs, barnacles, etc., settles to the bottom. The amount of calcareous material removed from oyster shells during cleaning varies considerable both spatially and temporally, but is never large. The lines are worked on site, so the material returned to the sea is widely dispersed over the farm. In addition, material disperses further as it settles to the bottom in 15 to 30 m of water. It is very unlikely that there is any accumulation of material on the bottom.

Staff of the Western Australian Museum recently conducted a survey of garden bottom habitat on a long running pearl farm in Beagle Bay but could find no evidence of measurable damage to the habitat (WAM 1997).

Many companies rotate the location of their longlines every five years or so to 'rest' the bottom in a manner similar to the agricultural practice of leaving a portion of a farm fallow on a periodic basis. While there is strong evidence for the utility of this practice in agriculture, there is only anecdotal support for it on pearl farms. It is simply one of the industry practices that has developed over time without having been scientifically analysed. The practice is not universal, and some sites have been in continuous use for a decade or more. The garden bottom habitat surveyed by the Museum was one of those which has been in continuous use for a prolonged period.

There is no detailed information available on the amount of material being removed, the taxonomic composition of the material cleaned, its fate when returned to the water, possible buildup on the bottom, and the species such as fish which are attracted to the stream of material entering the water from the cleaning process. A study of this aspect is recommended in Section 5.1.

To examine the possibility of material from the pearl oysters accumulating in the lease area and modifying the biota present, Prince (1999) compared two sites in operating pearl farms in the Montebello Islands with three control sites outside the lease areas. While Prince qualified her findings by stating that the sites were not identical, she concluded "there were no statistically significant differences between lease and control sites in the total diversity and abundance of the fauna, or the diversity and abundance of any individual taxon".

Taylor et al. (1996) examined the effects of fouling animals on the growth of *Pinctada maxima* near the island of Bacan, Maluku Utara, Indonesia. Pearl oysters were held in panels of 10 individuals and were cleaned in differing periods of 2, 4, 8, and 16 weeks. Panels cleaned after 2 weeks had 0.00 to 2.11 grams dry weight of fouling organisms, while those cleaned after 16 weeks had 97.57 grams dry weight. Fouling organisms included barnacles, bivalves and polychaetes.

4.4 What is the impact of the holding sites on the habitat?

Once pearl oysters have been collected, cleaned, and placed in tagged panels they are stored on the sea floor in holding sites until needed for seeding. The sites are marked with surface buoys so they can be relocated. The bottoms in the area must be sufficiently hard that the panels do not sink into the mud. A minor amount of damage is caused to organisms growing on the bottom, but these are not sensitive areas; environmentally sensitive areas such as coral reefs do not occur in the areas where fishing for pearl oysters occurs.

To investigate the effects of the holding sites, Enzer (1998) sampled a 300 m transect on a holding site off Eighty Mile Beach. One panel was found leaning against a coral (Turbinaria), but the coral was not damaged. The rope between panels went through several sea fans and alongside some sponges, causing minor damage, but no problems of significance were seen. After the panels have been dropped down from the surface, divers place them individually into proper position on the seafloor so the pearl oysters can feed. The divers also make sure the rope and panels are not caught on corals, etc., because chafing on hard surfaces would cut the oysters free or break the rope when it is being pulled up to a boat on retrieval.

4.5 What is the benefit to the environment and pearl production of untreated sewage compared to sewage treated with chemicals?

Grey water includes water from the toilets on board boats and from the domestic sinks. The only unusual feature of the use of boats by the pearling industry is that those on farms may be moored in the same area for prolonged periods of time with a small crew of eight to 10 people on board at one farm, and up to 30 or 35 during peak periods of about two weeks on some farms. This creates a potential for the accumulation of wastes in a small area.

Similar problems occur in the Abrolhos Islands where fishers occupy shore stations on a limited number of islands and use the sea for removal of untreated wastes. There is an average of about six island residents for each of the 158 boats in the Abrolhos fleet. Approximately 1,000 people live on 22 islands during the three and a half months of the season.

As in most of the marine areas of Western Australia, the waters surrounding the Abrolhos have very low nutrient concentrations. During late autumn and winter, storms tear macroalgae off the bottom. These are washed into the lagoons, where breakdown and remineralization increase nutrient concentrations. The nutrient regime in the Abrolhos is finely balanced. Concern has been expressed that grey water in the Abrolhos may be adding nutrients to the system, and that over time the increased nutrient availability would alter the ecosystem.

To examine this, Marine Science Associates and Environmental Contracting Services (1998) examined nutrient concentrations (inorganic nitrate, organic nitrate, ortho-phosphate, and organic phosphate) near Rat Island. The Rat Island area houses approximately 80-100

people. The survey was conducted in mid-May, at the height of the western rock lobster season, and a time when the season had been operational for two months. Some small elevation of nutrients was found immediately adjacent to domestic outfalls at Rat Island, but did not reach nearby reefs.

The evidence available suggests that it is unlikely that untreated grey water from pearl farms will create environmental hazards. Chemically treating grey water before it is released into the sea will itself create issues such as the toxicity to marine organisms of the chemicals used to treat the waste. EPA approval would be required for a comparative study of the value of chemically treating wastes rather than simply releasing it at present. Such a study is not justified by the present low level of environmental risk.

4.6 What is the risk of introducing exotic organisms?

There has been considerable press in recent years over the dangers of introducing exotic organisms into the Australian marine environment. The introduction of the Pacific seastar (*Asterias amurensis*) and the European shore crab (*Carcinus maenus*) into southeastern Australia have heightened awareness of the possibility of species being introduced into Australian waters and causing catastrophic consequences. The *Herpesvirus* which caused widespread pilchard deaths is thought to have been a recent introduction. Most of these species have been introduced into temperate waters, but there are a number of organisms which have invaded the tropics. Most prominent among these is the black striped mussel, *Mytilopsis sallei*, which was introduced into three small boat harbours in Darwin. The species was successfully eradicated; the first time an eradication program has been successful in the marine environment (Willan et al., 2000).

The marine fauna and flora of Western Australia can be divided into three biogeographic zones (Wilson and Gillett, 1971; Wells, 1980; Wilson and Allen, 1987):

- a tropical north coast, from North West Cape across northern Australia to the southern portion of the Great Barrier Reef. This is part of the vast Indo-Pacific biogeographic region which includes waters from the east coast of Africa to Hawaii;
- a temperate south coast, from Cape Leeuwin to southern Queensland; and
- the west coast overlap zone between Cape Leeuwin and North West Cape, where the proportions of tropical and temperate species vary with latitude.

In addition, a small component of the biota is endemic to Western Australia. For example, about 10% of the shallow water marine molluscs occur only in Western Australia. These species are concentrated on the west coast of the State (Wells, 1980; 1997).

The north coast of Australia can be divided into two regions: east of Cape York, Queensland (the old Solanderian region) and to the west of Cape York (the Damperian region). While the two regions were initially considered to be biogeographically separate, they are now considered to be a single Tropical Australian Province (Wilson and Allen, 1987). There are

no known major distributional barriers on the north coast of the continent west of Cape York; species tend to be widely distributed over the entire region if the necessary habitat is present. As the pearl industry operates entirely within a single biogeographical region, it is unlikely to introduce exotic species into the region.

However, industry is concerned about the potential introduction of harmful species into the environment in which the industry is operating. The lack of distributional borders within the Indo-West Pacific means that the most species capable of living on the northern coast of Australia have already naturally colonised the area. Species which are likely to be introduced are from other biogeographic regions. While the taxonomy of the black striped mussel, *Mytilopsis sallei,* is a matter of discussion, the species may have originated in the Caribbean Sea. The specific habitat requirements of the species allowed it to be eradicated. Other species introduced along the north coast of Western Australia include barnacles, which have invaded harbours such as Dampier and Port Hedland, but which have not caused problems. The Australian Quarantine and Information Service (AQIS) have developed guidelines for control of pests arriving in ballast water of ships. To date these controls have not been extended to small vessels. The key to the issue is to preventing the arrival of introduced species. Once they have colonised the north coast there is little that can be done in most instances to prevent their arrival.

5 RECOMMENDED STUDIES

The environmental effects of the pearling industry are small. This is particularly true when one considers that the total value of the industry is in the order of $ 250 million per year and it is Australia's largest aquaculture industry in terms of value. The following studies are recommended to further document and assess the environmental impacts of the pearling industry:

- monitoring of farms to determine if there are any longterm impacts;
- material cleaned from oysters after capture; and
- survival of oysters removed from the bottom.

In addition, the following study is recommended to assist the industry in understanding the biological basis for their success and to develop techniques which might enhance the industry:

- environmental characteristics required for successful pearl farming.

5.1 Monitoring of farms to determine if there are any long-term impacts

One of the key environmental concerns about the pearling industry is whether or not there are longterm environmental impacts. All of the available evidence suggests the environmental impacts are in fact low. However, a study should be undertaken to document whether this is in fact the case and to determine the actual level of the environmental impacts of the industry. The study would have four components:

- quantification and identification of material cleaned from oysters on lease sites;
- assess build up of material cleaned from oysters on lease sites;
- disposal of grey water from vessels and shore camps; and
- monitor interactions with protected fauna.

The first three of these would be examined using two to three farms chosen to represent the range of conditions occurring in the industry. The last would be undertaken by all farms.

5.1.1 Quantification and identification of material cleaned from oysters on lease sites

The ERA workshop identified the following knowledge gap: What is known of the impacts of organic matter from the cleaned oysters on the benthic community? The available information on this is summarized in section 4.3. However, the information is limited. A study needs to be undertaken to determine the amount and type of material which is being cleaned from the shells and returned to the water. The study would incorporate seasonality of cleaning and the different geographical areas in which the fishery operates. For example, one study site could be in the Kimberley and one in the Pilbara.

5.1.2 Build up of material cleaned from oysters on lease sites

At the same time the study would determine whether there is a build up of material under on the long line sites. This is important in determining optimal usage of the farm leases. Many companies rotate the location of their longlines every five years or so to 'rest' the bottom in a manner similar to the agricultural practice of leaving a portion of a farm fallow on a periodic basis. While there is strong evidence for the utility of this practice in agriculture, there is only anecdotal support for it on pearl farms. It is simply one of the industry practices which has developed over time without having been scientifically analysed. The practice is not universal, and some sites have been in continuous use for a decade or more.

5.1.3 Disposal of grey water from vessels and shore camps

Vessels are used to house staff working on some of the farm leases. These boats may continuously house up to 30 or more people and appear to be kept on the same station or at nearby localities. Toilet wastes and kitchen wastes are disposed of overboard without treatment. This is the normal treatment process used on small vessels and is not unique to the pearling industry. The only difference is the fact that the vessels remain on station for prolonged periods. Given the high degree of water movement in the Kimberley, particularly on spring tides, this is not considered to be a major problem as water movement should rapidly distribute and dilute the wastes. However, it is an issue which is consistently raised.

A short-term examination of the practice could determine whether or not there is an issue to consider further. A small scale bacteriological sampling programme should be undertaken around a vessel in the Kimberley with high staff numbers on neap tides when water movement is minimal. Under these conditions faecal coliform bacterial concentrations would be maximal.

The same procedure should be undertaken at one location in the Pilbara where tidal ranges are much lower.

5.1.4 Interactions with protected fauna

As indicated in Section 4.2, the pearl farms are in general located well away from breeding areas of protected species of marine fauna. However, there are few actual data on the interactions between pearl farms and protected fauna. Staff of the pearl farms are on the water frequently during the routine maintenance of the equipment and cleaning of the pearl oysters. It would be very easy to establish a formal system of simply recording the presence of protected fauna on the leases, and any nearby breeding areas of protected species.

5.2 Material cleaned from oysters after capture

After the pearl oysters have been collected, fouling organisms are cleaned off the shell surface by a combination of mechanical scraping of the shell surface with a knife followed by washing with high pressure seawater. No chemicals are used in the procedure. The material removed is discharged back into the sea, but consists entirely of natural materials that originated in the ocean. As the boat is constantly moving during shell cleaning, the material is rapidly dissipated in the open ocean without detrimental environmental effect. A sample of material scraped from 90 shells weighed 7 kg. Using this to provide a first order estimate, a boat catching 1,500 pearl oysters in a day would return approximately 120 kg of material to the sea (Enzer, 1998). Joll (pers. comm.) estimated that on heavy potato bottom, a total of 30 to 50 kg of material is returned back to the sea on each dive. If 8 to 10 dives are made in a day, this would cause 240 to 500 kg of material to be returned to the ocean. The returned material would be dispersed over a wide area and would not be concentrated in a single location.

A variety of organisms are removed from the pearl shells. These include attached animals such as sponges, ascidians, bryozoans, hydroids, barnacles (few were seen), sedentary polychaetes, and molluscs. Little algal material is attached, particularly in deeper water. The presence of attached organisms and natural crevices in the shells provide areas in which mud collects. Mobile species also occur on the shells, primarily crustaceans, holothurians, brittle stars, errant polychaetes, and molluscs.

Few data are available on the amount and nature of material cleaned from the pearl oysters after capture. As the material consists of fouling organisms which grow naturally in the area and they are dispersed widely when the shells are being cleaned, there will be little environmental effect. However, a relatively simple one off study should be undertaken to determine how much material is being discarded and the composition of the discards.

5.3 Survival of oysters removed from the bottom

A quota of 572,000 pearl oysters can be collected in the wild each year for use in pearl culture. The animals are individually removed from the bottom by a diver, and placed in a mesh bag until the end of the dive. Immediately after each dive the animals are measured, and individuals between 12 and 16 cm in shell length are retained. Undersize and oversize animals are thrown back into the water.

There is a strong pressure for divers to select animals of the correct size; they are paid on the basis of the number of animals of the correct size collected. Time is wasted in collecting and measuring undersize and oversize individuals for which the diver is not paid; the animals are returned to the ocean. There is a steep learning curve. New divers quickly learn to recognise the appropriate size ranges underwater. Relatively few undersize or oversize animals are collected after a new diver's first few days. However, there are no estimates of the number of animals of incorrect size are collected – the only data available are for the number retained by the divers.

Fisheries management practices are based on an implicit assumption that animals thrown back into the water survive, but there is no data to evaluate this assumption. It may well be that the great majority survive, but we simply do not know. The length of survivorship is also important. Given the long lifespan of pearl oysters, it is essential that returned animals survive for years, not simply for the first few days or weeks after being returned to the water.

When veligers pearl oysters metamorphose and settle to the bottom as juveniles they settle into cracks and crevices in the rocks where they are relatively protected from predators. Byssal threads rapidly develop to attach the young pearl oyster to the bottom. Once attached, the pearl oyster lives in the same position for the remainder of its life.

When the animal is removed from the bottom by a diver and returned to the water, it clearly will not land in the same place. Because of the heavy shells, which protect the oysters and mean that they sink rapidly, losses of pearl oysters through predation in the water column are

probably low. However, to survive in the long term, the pearl oyster must land in a suitable area.

Those which land on sand are at risk of being smothered by sand as it shifts. As the habitat on the pearling grounds is relatively uniform, this may happen to a relatively small proportion of the pearl oysters. It is not known whether the animals can develop a new byssal attachment to adhere to the bottom. Even if they do, the animal will almost certainly be in a more exposed position than it would have originally occupied.

Few species of potential predators would be capable of successfully attacking a pearl oyster of nearly 12 cm long. However, rays are known to remove abalone from reef top platforms in the Perth metropolitan area and are probably capable of attacking a pearl oyster of the same size. Sharks would also be able to attack the animals. Returned animals would probably be subjected to increased predation.

Returned pearl oysters would probably also be subjected to increased losses through physical disturbance, particularly during storms. As they are not attached, the animals would be rolled about the bottom during storms and could be killed by striking hard objects. Such mortalities would be sporadic, occurring primarily during strong storms, such as cyclones. As wave energy decreases sharply with increasing bottom depth, such mortalities are likely to be depth dependent (i.e. less mortality with greater depths).

Thus there are three probable causes for increased mortality of pearl oysters returned to the sea:

- being returned to an unsuitable habitat;
- increased predation; and
- losses during storms.

There are two reasons for reaching a tentative conclusion that there is no effect of increased mortality on natural pearl oyster populations:

While no direct data are available on the magnitude of these losses, the industry has been operating at a level of removing approximately 572,000 animals annually for a number of years. Catch per unit effort data are closely monitored by Fisheries WA, and there has been no apparent decline in the availability of pearl oysters, except in Zone 1 where the total allowable catch was reduced by 50% in 2001. If increased mortalities were having an adverse effect, it should show up in the catch per unit effort data.

Joll (1996) demonstrated that only 24% of the culture sized pearl oysters are removed from the environment during fishing on potato bottoms and only 31% on garden bottoms. These data did not include animals returned to the water. However, animals returned comprise only a small proportion of the number of animals collected by divers. There is a substantial proportion of the population which is unaffected by the fishing operations.

A simple, one-off study could be undertaken in conjunction with the study of material cleaned from the oysters after capture. This would provide information on the numbers of oversize and undersize pearl oysters collected during the season, and the potential effects on populations of *Pinctada maxima.*

5.4 Environmental characteristics required for successful pearl farming

The pearl industry has been developed by a series of companies. While there is a considerable degree of overlap between the companies, each has developed its own methods of operations and farming is conducted over a wide range of the coastline of northern Australia. A fairly simple monitoring strategy could be established on all farms which would monitor physical, chemical and biological conditions on the farms. Data obtained would improve understanding of the requirements for successful pearl farming, and would lead to improved profitability of the industry.

Examples of such monitoring programmes would include:

- measurement of phytoplankton densities and types in the water as they are food for the pearl oysters;
- monitoring of temperatures as extreme temperatures stress the animals and the animals should be left alone at this stage;
- monitoring of water quality; and
- monitoring for diseases.

While such monitoring programmes are basically intended to increase production, they can provide substantial background information if problems develop in the future.

6 RELEVANCE OF INFORMATION TO OTHER INDUSTRIES

The present study specifically examines the environmental effects of the *Pinctada maxima* pearl fishery. However, some of the findings of the present study could be used in other pearl industries and in the abalone fisheries in Western Australia. Relevant areas of information are discussed below.

6.1 Universal features of boats and the operation of shore camps

As these features are universal, the present findings are readily transferable to other aquaculture activities where boat based operations or shore camps are established in remote areas.

6.2 Industry effects

6.2.1 Other pearl fisheries

Most of the information on the effects specifically related to the pearl fishery can be transferred to other species of *Pinctada,* if they are cultured in the same way. This is particularly true of *P. margaritifera,* which is now being raised commercially in Western Australia. The *P. margaritifera* industry is based on hatchery reared animals. Operators have the ability to take 300 animals in the first year from the wild to act as broodstock, then 100 animals annually. Growout occurs on panels in a similar way to *P. maxima.*

One operator in Shark Bay is rearing *Pinctada albina*. The operator is allowed to take 50,000 wild animals annually and grow them out. The sustainability of this catch level is beyond the scope of the present report. Other companies have licences to take animals for broodstock, but this is not presently being done. Issues of growing the animals in panels would be similar to *P. maxima.*

Pteria penguin is in the same family as *Pinctada,* and the basic biology is similar. A key feature of *P. penguin* is that the species lives on soft corals, etc. rather than on hard bottoms as in *Pinctada.* At present the fishery for *P. penguin* is small. Operators have a licence to take 300 animals for broodstock, but also are able to take unlimited numbers of wild caught spat. The animals are grown in panels or subsurface cages. Environmental issues of growing *P. penguin* in panels would be similar to *P. maxima,* but cages are a different method. We have anecdotal information that some years ago one operator used netting to protect the oysters, which were growing on lines. This resulted in a number of fish being inadvertently caught in the net.

6.2.2 Abalone fisheries

Three commercial species of abalone in Western Australia: *Haliotis laevigata, H. roei* and *H. conicopora.* Most interest in aquaculture centres around *H. laevigata* on the south coast. There is a lesser degree of interest in culturing *H. roei* and *H. scalaris* on the west coast.

There are significant differences in the biology of abalone and pearl oysters. These differences mean that there are no similarities between the wild caught abalone fisheries and farming of wild caught pearl oysters.

Abalone aquaculture will be based on hatchery reared animals. Abalone hatcheries are subject to the regulations similar to those for *P. maxima.* There are also regulations on the transfer of broodstock between zones, though the zones are different for abalone. However, even though the hatchery regulations are similar, methods of grow out of abalone differ from those of pearl oysters.

In particular, abalone feed on algae, and in a culture situation must be fed. This raises issues of where food sources can be obtained, the fate of uneaten food, etc, which do not occur in pearls.

There are three ways of undertaking grow out of hatchery reared abalone:

- raceways on shore;
- restocking natural areas and allowing populations to then regenerate naturally; and
- using cultivation devices (such as containers) in the sea in which the animals live.

All of these cultivation methods are very different to pearl oysters, and raise different environmental issues. The information presented in the present report for *P. maxima* is of little relevance to the aquaculture of abalone.

7 ACKNOWLEDGEMENTS

The report was written by Dr Fred Wells who is pleased to acknowledge the considerable help received from Dr Peter Jernakoff and Sarah Brown of International Risk Consultants, Dan Machin of Fisheries Western Australia, and Doug Cochrane of CALM during the preparation of this report.

8 LIMITATIONS OF REPORT

Enzer Marine Environmental Consulting has prepared this report for the use of International Risk Consultants and the Pearl Producers Association in accordance with generally accepted consulting practice. No other warranty, expressed or implied, is made as to the professional advice included in this report. This report has not been produced for use by parties other than the client, the owner and their respective consulting advisers. It may not contain sufficient information for purposes of other parties or for other uses.

Whilst to the best of our knowledge information contained in this report is accurate at the date of issue, environmental conditions can change over time. This should be borne in mind if the report is used after a protracted delay.

9 LITERATURE CITED

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Appendix 6
Task 4: EMS gap analysis

Pearl Producers Association Inc.

EMS Gap Analysis

DATE: 26 JUNE 2002

PROJECT: J01-032

DOC NO.:E-REP-01-032-004 REV 1

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1	Includes FRDC comments	Sarah Brown	Peter Jernakoff	Peter Jernakoff	26 June 2002

Contents

ABBREVIATIONS

EMS	Environmental Management System
GST	Goods and Services Tax
IRCE	IRC Environment
ISO	International Organisation for Standardisation
PPA	Pearl Producers Association Inc.
SMART	Specific, Measurable, Achievable, Results orientated, Time-based

EXECUTIVE SUMMARY

The Pearl Producers Association Inc. (PPA) requested that IRC Environment (IRCE) conduct a gap analysis of the industry's existing environmental management system (EMS).

The PPA's proactive environmental stance and ability to integrate environmental issues into their business indicate that Western Australian *Pinctada maxima* pearlers are industry leaders in the area of environmental stewardship of fisheries resources from both a national and international perspective. One of the PPA's goals is to have the industry's environmental achievements and activities recognised by an objective, transparent and internationally recognised method. The PPA sees achieving and demonstrating compliance to the Standard ISO 14001 [1] as a solution to this requirement.

Achieving ISO 14001 certification may translate into benefits to the industry such as:

- Effectively communicating 'best in class' fisheries management;
- Being viewed by industry as taking another initiative to 'raise the bar' in environmental management;
- Enhancing stakeholder credibility; and
- Assistance with entering new export markets.

From available EMS documentation and responses to a questionnaire, IRCE personnel found that a number of gaps exist in meeting the requirements of ISO 14001 [1]. Examples of such gaps relate to key components of an EMS including the:

- Environmental policy (the policy is a statement by an organisation of its intentions and principles in relation to its overall environmental performance which provides a framework for action and for the setting of its environmental objectives and targets);
- Environmental aspects (aspects are the elements of a company's activities, products or services that can interact with the environment); and
- Environmental objectives and targets (an objective is the overall environmental goal, arising from the environmental policy, that an organisation sets itself to achieve, and which is quantified where practicable and a target is the detailed performance requirement, quantified where practicable, that arises from the environmental objectives and that needs to be set and met in order to achieve those objectives).

The gaps were significant enough to prevent pearling companies from achieving the requirements of the Standard at the present time (and therefore certification to ISO 14001). It is commendable however, that 100% of PPA member companies who responded to an EMS questionnaire had already begun to formalise their environmental management through the development of systems. These companies are yet to fully implement their EMS systems.

This document has two main purposes:

- It provides a summary of the gap analysis outcomes; and
- It suggests options on how to proceed towards meeting the requirements of the ISO 14001 Standard [1] in key areas of an EMS.

1 INTRODUCTION

IRC Environment (IRCE) was commissioned by the Pearl Producers Association Inc. (PPA) to conduct a gap analysis of the PPA 's existing environmental management system (EMS). This activity commenced 30th July 2001 with preparations for the gap analysis and continued to the 1st August 2001 with a review of available EMS documentation.

The PPA's proactive environmental stance and ability to integrate environmental issues into their business indicate that Western Australian *Pinctada maxima* pearlers are industry leaders in the area of environmental stewardship of fisheries resources from both a national and international perspective. One of the PPA 's goals is to have the industry's environmental achievements and activities recognised by an objective, transparent and internationally recognised method. The PPA sees achieving and demonstrating compliance to the Standard ISO 14001 [1] as a solution to this requirement.

This document has two main purposes:

- It provides a summary of the gap analysis outcomes; and
- It suggests options on how to proceed towards meeting the requirements of the ISO 14001 Standard [1] in key areas of an EMS.

2 AIM

The purpose of the EMS gap analysis is to identify gaps that would need to be addressed in current pearling industry procedures in order to develop a PPA Environmental Code of Practice in line with the requirements of an EMS (such as ISO 14001) [1].

3 METHOD

The gap analysis was conducted using the standards on environmental auditing for EMSs, ISO14010 [2] and 14011 [3] for guidance.

Site visits to farms at Bynoe Harbour, Kuri Bay and Talbot Bay provided an opportunity to interview farm personnel and to review environmental management related documentation. Interviews were held with David Mills (Paspaley Pearls) and Brett McCallum (PPA) during the gap analysis, to ensure that relevant EMS documentation was being interpreted correctly by IRCE personnel and to ensure that all available EMS documentation could be accessed.

PPA member companies were invited to take part in the EMS gap analysis via a questionnaire. Three areas of a typical management system were selected to form the basis of the questionnaire, as they are the building blocks to an effective EMS:

- Environmental policy;
- Environmental aspects; and
- Environmental objectives and targets.

Key questions were included in the questionnaire to determine the existence of an EMS. Specific clauses of the Standard ISO 14001 [1] were provided against which companies were compared. Not all clauses of the Standard were listed in the questionnaire, rather those areas which would give an indication of whether the fundamentals of an EMS existed.

The complete questionnaire is provided in Attachment I.

3.1 PPA Member companies

The following list of PPA Member companies was invited to take part in the EMS gap analysis via the questionnaire (refer to Attachment 1). The PPA was also included in the review.

- Arrow Pearl Co. Pty. Ltd.
- Australian Sea Pearls Pty. Ltd
- Blue Seas Pearling Company.
- Broome Pearls Pty. Ltd.
- Cossack Pearls.
- Cygnet Bay Pearls.
- Dampier Pearls Pty Ltd.
- Exmouth Pearls.
- Hamaguchi Pearls.
- Maxima Pearling Co. Pty Ltd.
- Morgan & Co.
- Nor West Pearls.
- Paspaley Pearling Co.
- Pearls Pty Ltd.
- Roebuck Pearl Producers.

Of those invited, the following companies took part in the review:

- Australian Sea Pearls Pty. Ltd.
- Broome Pearls Pty. Ltd.
- Cygnet Bay Pearls.
- Exmouth Pearls.
- Hamaguchi Pearls.
- Paspaley Pearling Co.

- Pearls Pty Ltd.
- Morgan & Co.
- Roebuck Pearl Producers.

The results of the questionnaire are presented in sections 4 and 5.

4 GAP ANALYSIS SUMMARY

This section provides a summary of the gap analysis outcomes. These outcomes are assumed to apply to all of the industry members (not just to the companies that responded to the questionnaire). However this is a large assumption and the PPA may wish to consider this assumption in any decisions that it makes regarding the findings of this report. The outcomes are used as a basis for recommendations as to how to proceed towards developing an EMS Code of Practice (based on the requirements of ISO 14001 [1]).

From available EMS documentation, interviews and information received via the questionnaire, IRCE personnel found that a number of gaps exist in meeting the requirements of ISO 14001 [1].

Table 4.1 summarises where the main gaps lie in relation to compliance of the pearling industry against ISO 14001 [1]. It is acknowledged that individual companies may be advanced in their development of management systems and others less so. The aim of Table 4.1 is to see where the industry (as a whole) is at present in relation to the development, implementation and compliance of systems designed to manage environmental issues.

Table 4.1: Summary of Gap Analysis Findings

Typical Environmental Management System Element	Documentation Exists[1]	Fully Implemented System	ISO 14001 Compliant
Policy	Yes	No	No
Identification of Aspects	No	No	No
Objectives and targets	No	No	No

[1] *The industry was given a 'yes' if at least 80% of companies that responded replied 'yes'.*

The gap analysis indicated that the gaps were significant enough to prevent pearling companies from achieving at the present time compliance to the Standard (Table 4.1). *Although the gap analysis indicated significant gaps in what the PPA members currently have in place compared to what is required to achieve compliance to ISO 14001* [1]*, the majority of what is required appears to be associated with developing a system that documents the PPA 's current activities*.

5 ISO 14001

This section refers to specific clauses of the Standard ISO 14001 [1] and provides an interpretation of those clauses against which the PPA Members were assessed. Not all clauses of the Standard have been listed in this report, rather those areas which IRCE recommend that the PPA member companies focus on initially.

IRCE provide extracts of the relevant text contained in the Standard ISO 14001 [1] in italics. We then comment as to what is required by the Standard. The questions from the questionnaire which relate to the three key components of an EMS are also included together with the number of positive responses

5.1 Environmental Policy

5.1.1 ISO 14001 requirements

Top management shall define the organisation's environmental policy and ensure that it … includes a commitment to continual improvement and prevention of pollution …[and]… provides the framework for setting and reviewing environmental objectives and targets. …[and].. is communicated to all employees.

5.1.2 IRC Environment Comment

To ensure consistent understanding of the policy, it is suggested that companies' top management defines and approves a documented environmental policy, which should include the following:

- A commitment to continuous improvement;
- A commitment to the prevention of pollution;
- A commitment to comply with relevant environmental legislation and regulations;
- A commitment to comply with other requirements to which a company subscribes; and
- Provide a framework for the setting and reviewing of environmental objectives and targets.

The policy must be:

- Documented, implemented and maintained;
- Signed by the senior manager;
- Appropriate to the nature, scale and environmental impacts of a company's activities, products and services;
- Communicated to all employees; and
- Available to the public.

Whilst senior management may have a clear understanding of the environmental policy, it is recommended that consideration be given as to how this policy can be communicated so that all employees have the same understanding as senior management.

5.1.3 Questions

Policy Characteristics	# of Positive Responses
Does your company have an environmental policy statement?	7/9
Does the policy statement include:	
• A commitment to continuous improvement.	3/9
• A commitment to the prevention of pollution.	3/9
• A commitment to comply with relevant environmental legislation and regulations.	3/9
• A commitment to comply with other requirements to which your company subscribes.	3/9
• Provide a framework for the setting and reviewing of environmental objectives and targets.	3/9

Requirement	# of Positive Responses
Is the policy:	
• Documented, implemented **and** maintained.	3/9
• Signed by the senior manager.	3/9
• Communicated to **all** employees.	3/9
• Available to the public.	3/9

5.2 Environmental aspects

5.2.1 ISO 14001 requirements

The organisation shall establish and maintain (a) procedure(s) to identify the environmental aspects of its activities … in order to determine those which have or can have significant impacts on the environment. The organisation shall ensure that the aspects related to these significant impacts are considered in setting its environmental objectives. The organisation shall keep this information up–to–date.

5.2.2 IRC Environment Comment

- This element requires three distinct stages: a) identify aspects, b) determine and register those with significance and c) keep register up-to-date. The guidance offered in Annex A.4.2.1 to the Standard is: "The aim should be to consider **all** environmental aspects of the organisation as a basis for establishing the [EMS]."
- The process for identification and evaluation of environmental aspects should clearly demonstrate that **all** aspects with the potential for significant impact have been considered. Examples for a pearling company might be: fishing activities, waste management at sea, factory processing, refuelling, etc. The results of the risk analysis should be documented.
- Indirect aspects should be considered, where relevant, for example, suppliers, contractors, clients, use of natural resources, and neighbours.
- All operations, activities, products and services executed by a company, including purchase and disposal, should be reflected in the initial aspects identification.
- Identifying environmental aspects and determining which of them are significant is not a once-only activity. Knowledge about the impacts on the environment is growing – consequently, priorities may change. Environmental aspects and impacts should also be analysed in the event of changes or innovation of activities, products and services.
- Even the most environmentally benign organisation should be able to identify which of its aspects is relatively the most significant and use this as a basis for the EMS. It is, therefore, not possible for an organisation to have no significant aspects.

The Standard requires that the environmental aspects register be kept up-to-date and complete. In order to keep the register up-to-date and to identify and add new environmental effects to the register consistently, the Standard requires a procedure to identify the aspects that can be influenced/controlled related to a company's activities and services and to determine those aspects that can have a significant environmental impact under normal, special and abnormal conditions. It is recommended that companies develop an EMS manual and include such a method for identification and evaluation of environmental aspects. This method would provide background as to how issues were included in the register as well as their determination of significance.

5.2.3 Questions

Requirement	# of Positive Responses
Does your company have a list of their activities, products and services?	3/9
Has your company identified their environmental aspects?	3/9
Has your company:	
• Developed a list of significant aspects.	3/9
• Developed a list of activities which may result in significant impact to the environment.	3/9
• Identified indirect aspects, for example those generated by suppliers, contractors, clients, use of natural resources, neighbours.	3/9

5.3 Objectives and targets

5.3.1 ISO 14001 requirements

The organisation shall establish and maintain documented environmental objectives and targets, at each relevant function and level within the organisation.

When establishing and reviewing its objectives, an organisation shall consider the legal and other requirements, its significant environmental aspects, its technological options and its financial, operational and business requirements, and the views of interested parties.

The objectives and targets shall be consistent with the environmental policy, including the commitment to prevention of pollution.

5.3.2 IRC Environment Comment

Once significant aspects have been established, the next step is to prioritise the way continual improvement of those aspects is addressed through the setting of objectives and targets.

The objectives and targets chosen should be based on a sequence of activities which begin by identifying aspects establishing criteria which helped to determine which aspects are significant. Objectives and targets are based upon significant aspects; thus laying the foundation for continual improvement. It is, however, not essential that each significant aspect has an objective set provided that it is addressed by other means such as operational control.

Objectives may be intended to cover longer-term considerations. Objectives should be supported by targets, which give evidence of incremental change in a relevant and realistic timeframe.

There may be one or more of the following types of objectives:

- improvement of environmental performance;
- improvement of environmental control; and
- improvement of knowledge and information (in order to feed the first two types on the longer term).

Ideally, targets should be SMART: Specific, Measurable, Achievable, Result oriented, Time-bound.

It is recommended that companies develop objectives and targets as a means of managing their significant aspects. The method by which objectives and targets are developed and tracked should be described in a company's EMS manual.

5.3.3 Questions

Requirement	# of Positive Responses
Does your company set the following types of objectives:	
• Improvement of environmental performance.	3/9
• Improvement of environmental control.	3/9
• Improvement of knowledge and information (in order to feed the first two types for the longer term).	3/9

6 EMS DEVELOPMENT AND IMPLEMENTATION

6.1 EMS Manual outline

IRCE recommend that PPA member companies consider the best means to demonstrate to an external body that **systems** exist, that they are in place and working. One method is to document the way in which a company currently manages and intends to continue to manage environmental issues associated with their business activities. IRCE suggest that the companies develop an EMS manual based on the requirements of ISO 14001 [1] that is structured to allow for future integration of management systems such as safety and quality. The EMS documentation could be Intranet based. We therefore suggest that the EMS manual be the main document with electronic links to supporting documentation such as EMS records, forms, audit reports etc.

The key factors which IRCE consider important are that the system should ensure that:

- the management of environment is efficient, effective and continually improving;
- improved performance can be monitored; and
- management of environment is transparent to regulators.

6.2 Certification to ISO 14001

It is recommended that the PPA conduct a cost/benefit exercise to determine whether ISO 14001 [1] certification is a worthwhile investment in terms of cost and effort of achieving certification and the benefits that certification might deliver. Achieving ISO 14001 [1] certification may translate into benefits to the industry such as:

- effectively communicating 'best in class' fisheries management;
- being viewed by industry as taking another initiative to ‘raise the bar’ in environmental management;
- enhancing stakeholder credibility; and
- assistance with entering new export markets.

6.3 Environmental Code of Practice

The PPA intends to develop an Environmental Code of Practice. The PPA will encourage all pearlers to adopt this Code as a statement of the industry’s commitment to ecologically sustainable development. The outcome for pearlers should be to continue to:

- operate in an environmentally responsible manner; and
- be known as an industry that is environmentally benign, producing a high quality product with minimal adverse effect on the environment.

It is recommended that the Code of Practice include a requirement to 'Develop, implement and maintain an environmental management system". It is further recommended that practical guidance be available to assist companies in meeting this requirement.

7 CONCLUSION

In order to progress towards fulfilling the requirements of an environmental management system, the PPA has several options:

- Develop an Environmental Code of Practice which includes a requirement to "develop, implement and maintain an environmental management system";
- Develop practical guidance to assist companies in developing an EMS; and
- Develop a template for PPA Members to develop their own EMS manual and allow companies to choose whether to certify their EMS to ISO 14001 [1].

8 REFERENCES

[1] Standards Australia/Standards New Zealand. 1996. Australian/New Zealand Standard AS/NZS ISO 14001: 1996 Environmental Management Systems – Specification with Guidance for Use.

[2] Standards Australia/Standards New Zealand. 1996. Australian/New Zealand Standard AS/NZS ISO 14010: 1996 Guidelines for Environmental Auditing – General Principles.

[3] Standards Australia/Standards New Zealand. 1996. Australian/New Zealand Standard AS/NZS ISO 14011: 1996 Guidelines for Environmental Auditing – Auditing Procedures – Auditing of Environmental Management Systems.

ATTACHMENTS

Attachment 1:
EMS Gap Analysis Questionnaire

Key Questions to Determine the Existence of an EMS

Specific clauses of the standard ISO 14001 are provided against which your company will be compared. Not all clauses of the standard have been listed in this questionnaire, rather those areas which will give an indication of whether the fundamentals of an EMS exist.

Instructions

Extracts of the relevant text contained in the standard ISO 14001 is given below in italics. You are then asked a series of questions to determine if your company meets the requirements of the standard. Definitions may need to be referred to on page 5 before answering each question.

1 Environmental Policy

1.1 ISO 14001 requirements

Top management shall define the organisation's environmental policy and ensure that it … includes a commitment to continual improvement and prevention of pollution …[and]… provides the framework for setting and reviewing environmental objectives and targets. …[and].. is communicated to all employees.

1.2 Questions

Q1. Does your company have an environmental policy statement? Yes☐

No☐

If yes, please answer questions 2 and 3.

If no, please go to question 4.

Q2. Does the policy statement include:

Policy Characteristics	Yes/No
A commitment to continuous improvement.	
A commitment to the prevention of pollution.	
A commitment to comply with relevant environmental legislation and regulations.	
A commitment to comply with other requirements to which your company subscribes.	
Provide a framework for the setting and reviewing of environmental objectives and targets.	

Q3. Is the policy:

Requirement	Yes/No
Documented, implemented **and** maintained.	
Signed by the senior manager.	
Communicated to **all** employees.	
Available to the public.	

2 Environmental Aspects

2.1 ISO 14001 requirements

The organisation shall establish and maintain (a) procedure(s) to identify the environmental aspects of its activities … in order to determine those which have or can have significant impacts on the environment. The organisation shall ensure that the aspects related to these significant impacts are considered in setting its environmental objectives. The organisation shall keep this information up–to–date.

2.2 Questions

Q4. Does your company have a list of their activities, products and services? Yes☐

No☐

If yes, please answer question 5.

If no, please go to question 7.

Q5. Has your company identified their environmental aspects? Yes☐

No☐

If yes, please answer question 6.

If no, please go to question 7.

Q6. Has your company:

Requirement	Yes/No
Developed a list of significant aspects.	
Developed a list of activities which may result in significant impact to the environment.	
Identified indirect aspects, for example those generated by suppliers, contractors, clients, use of natural resources, neighbours.	

3 Objectives and Targets

3.1 ISO 14001 requirements

The organisation shall establish and maintain documented environmental objectives and targets, at each relevant function and level within the organisation.

When establishing and reviewing its objectives, an organisation shall consider the legal and other requirements, its significant environmental aspects, its technological options and its financial, operational and business requirements, and the views of interested parties.

The objectives and targets shall be consistent with the environmental policy, including the commitment to prevention of pollution.

3.2 Questions

Once significant aspects have been established, the next step is to prioritise the way continual improvement of those aspects is addressed through the setting of objectives and targets.

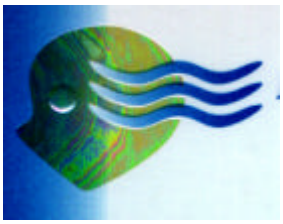
Q7. Does your company set the following types of objectives:

Requirement	Yes/No
Improvement of environmental performance.	
Improvement of environmental control.	
Improvement of knowledge and information (in order to feed the first two types for the longer term).	

Definitions as per ISO 14001

Environmental aspect	Element of an organisation's activities, products or services that can interact with the environment.
Environmental impact	Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services.
Environmental management system	That part of the overall management system which includes organisational structure, planning activities, responsibilities, practices, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy.
Environmental objective	Overall environmental goal, arising from the environmental policy, that an organisation sets itself to achieve, and which is quantified where practicable.
Environmental policy	Statement by the organisation of its intentions and principles in relation to its overall environmental performance which provides a framework for action and for the setting of its environmental objectives and targets.
Environmental target	Detailed performance requirement, quantified where practicable, applicable to the organisation or parts thereof, that arises from the environmental objectives and that needs to be set and met in order to achieve those objectives.
Significant environmental aspect	An environmental aspect, which has or can have a significant environmental impact.

Appendix 7
PPA environmental code of practice



PEARL PRODUCERS ASSOCIATION

ENVIRONMENTAL CODE OF PRACTICE/CONDUCT

Introduction

Australian South Sea pearls are the most highly regarded in the jewellery industry worldwide and companies operating in the Western Australian pearling industry from Exmouth Gulf to the Kimberley/NT border have an enviable record for producing the highest quality product. The Western Australian pearling industry is one of the largest and most successful fishing and aquaculture industry in Australia. The industry is based on the pearl oyster *Pinctada maxima*, a bivalve mollusc species.

Production is based on a mix of the collection of pearl oysters from the wild and oysters produced in land based hatcheries. Oysters are seeded with a nucleus for the start of the pearl culture process and then placed on a long line system on sea based grow -out farms to produce the pearls to commercial sizes.

The total numbers of pearl oysters that can be caught in the wild and produced in hatcheries is limited through a quota system applied within the industry. Department of Fisheries Western Australia is the primary regulatory agency for the pearling industry and maintains individual quotas on each licensed operator.

The Need for an Environmental Code of Practice/Conduct

Australian South Sea pearls are synonymous with an image of 'rare, natural and from a pristine environment' – resulting in the ability to command premium prices. With a well managed fishery, clean environment and freedom from many of the major diseases experienced in the northern hemisphere, Western Australian pearlers have a strong competitive marketing advantage.

Clean water and natural variation in nutrients means strong growing oysters and high quality pearls. Hence, environmental protection is a major priority for the industry, as it relies on the provision of clean waters for its livelihood.

The only sound approach to the ongoing management of the Western Australian pearling industry is through maintaining the integrity of the environment so as to enable the industry to be sustainable.

The peak industry body, the Pearl Producers Association (PPA), is striving to maintain the industry's image through the commitment to implementing industry practices based on ecologically sustainable development principles. Recognition of the need for pearling to play a major role in ongoing protection of the waters of Western Australia has led to the development of this Environmental Code of Practice/Conduct.

What is a Code of Practice/Conduct?

A Code of Practice/Conduct provides a voluntary set of guidelines for the carrying out of a specific activity. For the pearling industry the document specifically aims to:

- Provide realistic objectives;
- Be flexible and relevant to the Western Australian pearling industry;
- Provide a mechanism for environmental self regulation;
- Be practical and focus on outcomes;
- Provide options for environmental management
- Recognises that only the financial success of a pearling operation can ensure the provision of adequate resources to manage environmental issues

The Environmental Code of Practice/Conduct evolved out of a consultation process involving representatives from industry, government, environmental interest groups, recreational fishers, Aboriginal groups and other stakeholders with a commitment to the sustainable management of Western Australia's aquatic environment.

This Code is voluntary, except in so far as parts of the Code may have been given, or may give, binding legal effect by means of legislation. No penalties can be directly imposed on a pearling company for failing to follow advice in this Code.

The Code does not remove the legal requirements that pearling companies have under their environmental authority and associated conditions.

The PPA members have prepared and endorsed this Code to provide minimum generic standards for environmental performance. The PPA will encourage all pearlers to adopt this Code as a statement of the industry's commitment to ecologically sustainable development. The outcome for pearlers should be to continue to:

- operate in an environmentally responsible manner; and
- be known as an industry that is environmentally benign, producing a high quality product with little adverse effect on the environment.

The preparation and distribution of this Code is one of the many steps in a strategy promoting responsible environmental practices within the pearling industry. The guiding principles outlined in the Code will provide specific sectors of the industry with a framework in which they can develop their own individual Environmental Code of Practice and Management Systems, with a focus on ecological and economic sustainability for their particular site or operation.

This Code is designed to interface with two key industry Codes of Practice:

- Code of Conduct for Responsible Fisheries developed by the Food and Agriculture Organisation; and
- Australian Aquaculture Code of Conduct developed by the Primary Industries and Resources South Australia.

Ecologically Sustainable Development

The concept of Ecologically Sustainable Development has evolved from the World Commission on Environment and Development's report, *Our Common Future* (1987). It can be generally defined as conserving and enhancing the community's resources such that, our total quality of life, both now and in the future, is secured.

The Environmental Code of Practice for The Pearling industry supports the principles of Ecologically Sustainable Development and the Precautionary Principle.

Consistent with the three operational interpretations of the Precautionary Principle (Young 1993), it is suggested that as confidence with an activity increases, a transition must be made to require only the use of best available technology when this does not entail excessive cost.

The management practices set out in this Code of Practice provide a responsible approach to environmental management while ensuring that pearling industry activities will continue to be economically viable.

Underlying philosophy for the Code of Practice

Management of the Pearling Industry recognises that protection of the environment is a requirement of all businesses to ensure long term benefit to all stakeholders. The pearling industry is committed to the development and operation of an environmentally sustainable pearling industry.

The following principles are adopted to maintain ecological and economic sustainability for the pearling industry:

- Ecologically sustainable development (ESD);
- Economic viability;
- Long term protection of the environment to ensure availability of suitable sites for pearling operations;
- Compliance with and implementation of necessary systems to support legislative requirements and the industry Code of Practice/Conduct;
- Resource sharing and consideration of the other users of the environment; and
- Research and development to support the achievement of the above five priorities.

These principles provide the industry with the mechanism to implement the Code of Practice.

The Code

Industry will work in conjunction with government and other stakeholders to ensure that the pearling industry is managed sustainably (ecologically and economically) and that the pearling industry's considerable social, economic and environmental advantages are achieved. This will be accomplished through five guiding principles for environmental best practice.

For the pearling industry to be ecologically and economically sustainable, pearlers will:

1. Protect the environment.
2. Comply with regulations.
3. Respect the rights and safety of others.
4. Treat aquatic animals responsibly.
5. Promote the safety of seafood and other aquatic foods for human consumption.

1. To protect the environment pearlers will:

- Encourage the development and operations of pearling at a rate in accordance with ecologically sustainable principles.
- Support natural resources management that provides improved outcomes for sustainable resource use through effective co-operation between government agencies, the pearling industry and the wider community.
- Promote industry training and education opportunities in environmental awareness, clean production methods and best pearling practices.
- Recognise the importance of good farm site selection, system design and infrastructure to minimise ecosystem changes.
- Monitor and regularly review farm management practices to minimise ecological impact.
- Minimise and, where practicable, eliminate the use of chemicals.
- Adopt farm design and farm management practices that encourage integration, recycling and reuse of effluents.
- Provide for disposal or / and processing of wastes to minimise the risk of ecological damage.
- Continue to work in association with governments to develop appropriate protocols regarding the translocation of live pearl products within and between states.
- Develop, implement and maintain an environmental management system in line with the guidelines of this code.
- Support the maintenance of precise records regarding the transfer or translocation of stock between pearling operational areas.

2. To comply with the regulations pearlers will:

- Support practical and cost effective industry strategies to ensure that relevant environmental performance standards are monitored and met.
- Promote appropriate incentives for responsible environmental performance and advocate sanctions for non-compliance.
- Promote effective consultative mechanisms with governments, the community and other users.
- Expand self-management and co-regulation to include industry-based codes of practice/conduct that specifically address environmental issues.

3. To respect the rights and safety of others pearlers will:

- Recognise the needs of other users of the waterways and promote methods to minimise user conflict.
- Encourage consultation with the community and other users of the waterways to enable legitimate concerns and issues to be raised and solutions proposed. Recognise that the use of public resources confers responsibility on all users.
- Advocate that the farm sites and infrastructure be kept clean and tidy and noise impacts minimized.
- Promote goodwill in the local community and provide where practicable for farm visits and other opportunities for education and tourism.
- Recognise and promote the community benefit from monitoring and reporting on the state of the aquatic environment used for pearling.
- Advocate the installation of appropriate navigational markers and other measures to prevent incidents.

4. To treat aquatic animals responsibly pearlers will:

Seek the development of expertise in health management and ecological sustainability within the pearling industry.

- Promote the maintenance of efficient and sustainable stocking densities.
- Address the physical and biological requirements of the *Pinctada maxima*.
- Encourage the installation of anti-predator devices designed to manage predators without deliberately injuring them.
- Seek methods to transfer and harvest pearl oysters which reduce stress.
- Endorse the use of responsible discard methods.
- Support the development of appropriate contingency plans to deal with unplanned releases of aquaculture species / stock, or the spread of diseases, parasites and other pathogens.
- Encourage the immediate reporting of any mass mortalities of oyster stocks or other environmental problems to the relevant agencies and the containment of diseased or infected stock.
- Identify responsibilities for environmental monitoring proportionate to possible environmental risk and benefits.

- Provide guidelines on reporting and analysis of findings, taking into account the costs and benefits of such monitoring.
- Promote the correct disposal of dead stock in a manner that will not render the likelihood of any disease or pathogen being released into natural waterways.
- Encourage research and development programs that are funded and supported jointly by industry and governments to expand knowledge and understanding of pearling operations and their environmental interactions.

5. To promote the safety of seafood and other aquatic foods for human consumption pearlers will:

- Support the maintenance, and expansion where necessary, of chemical residue testing and other quality assurance programs.
- Endorse compliance with the requirements of the National Food Hygiene Standards.
- Encourage the continued adoption of internationally recognised food quality standards.
- Highlight the sensitivity of the waterways to pollution and its resultant effects on the quality and safety of seafood.
- Support the maintenance of precise records regarding the transfer of products destined for human consumption between all links in the distribution and marketing chain.
- Support the use of accurate product labelling.

Appropriate Management Practices

Appropriate Management Practices have been determined using Best Practice Environmental Management.

The Best Practice Environmental Management of an activity is the management of the activity to achieve an ongoing minimisation of the activity's environmental harm through cost-effective measures assessed against the measures currently used nationally and internationally for the activity (EPA 1994).

In deciding the Best Practice Environmental Management of an activity, regard must be had to the following measures:

- Strategic planning by the company carrying out, or proposing to carry out, the activity;
- Administrative systems put into effect by the company;
- Public consultation carried out by the company;
- Product and process design; and
- Waste prevention, treatment and disposal.

Site Selection

Site selection and evaluation must ensure that the proposed site will be capable of operating in an economically viable and environmentally responsible manner and in accordance with this Code of Practice.

In evaluating potential pearl farm sites, managers must identify the features of the site and its environment. Evaluations must take into account the objectives and the likely environmental risks of the proposed operation.

The following list although not exhaustive, identifies the major issues that must be considered, utilising appropriate expertise, when evaluating a potential pearl farm site.

- Environmental value of the site and the region;
- The potential impacts of the development on environmental values and biodiversity;
- Access to marine or estuarine waters;
- Water quality and tidal hydrology;
- Capacity of the receiving environment to dilute and assimilate the discharge waters;
- Existing flora and fauna, both on and surrounding the site;
- Freshwater influences;
- Neighbouring land uses;
- Existing water users;
- The proximity of Marine Parks, Fish Habitat Areas, Erosion Prone Areas, Coastal Control Districts, National Parks, Ramsar sites, Recreational Area Management Areas and World Heritage Property; and
- Regulatory requirements of the development, site and region.

Farm Design and Planning

The planning stage of any pearl farm (new or expanding), is crucial not only for financial success, but also as an opportunity to design the development in a way which will not cause undue influences on the environment.

New pearl farms and any expansion of existing farms must be designed and planned in accordance with the checklist below to minimise the risk of harm to the environment.

- The planning and design of proposed pearl farms must incorporate the following, utilising appropriate expertise;
- Identification of features of the farm and its environment which are important aspects of ecological value;
- Farms must be designed to create access to tidal waterways that will maximise the advection and dispersion of discharge waters and minimise impacts to tidal hydraulics, while recognising the need to minimise disturbance and potential impacts to marine vegetation;

- Farm size must be limited according legislative requirements;
- Farm design must minimise disturbance to mangrove communities or other tidally influenced zones;
- Areas of significant vegetation must be preserved, wherever and whenever possible, provided that the economic and productive efficiencies of the operation are not compromised; and
- The final design must ensure that the proposed farm will operate in an environmentally sustainable manner and in accordance with other sections of this Code of Practice.

Construction

Correct construction of the farm is likely to lead to increased profitability through savings in maintenance and unexpected construction failures.

Pearl farms must be constructed in such a way as to minimise the risk of harm to surrounding areas.

Stocking Densities

Stocking densities of pearl farms will vary between and within farms. The stocking density of farms will contribute significantly to production efficiency, profitability and nutrients within the area of the farm. Stocking densities must be planned and managed to optimise production, minimise the pressure placed on water quality within the area and minimise associated wastes.

Water Exchange

The level of water exchange on pearl farms varies depending on climate, phytoplankton levels, shell densities and management techniques. Pearl farmers must plan to optimise the water exchange rates in accordance with other appropriate complimentary management techniques.

Noise

Pearl farm noise sources are principally vessel movements and seaplanes. The majority of pearl farms are constructed in areas where there are no human sensitive locations. In some instances, pearl farms are constructed near other environmentally sensitive marine or land areas where noise emissions may need to be managed.

In managing noise emissions from a pearl farm, where that noise creates or is likely to create an issue at a sensitive place at sensitive times, pearl farm operators must incorporate appropriate noise reduction techniques. This may include incorporating at the planning stage, maximum distances between noise sources and sensitive places.

Environmental Contingency Plans

Due to the difference in management techniques and site variability in the Australian pearling industry, the development of an industry contingency plan is not possible.

Each pearl farm location must develop in consultation with administering authorities, a satisfactory, site specific environmental contingency plan.

Contingency plans are needed to provide management actions in the event of environmental breaches occurring.

As an example an environmental contingency plan may take into account the following:

- There may be contamination of pearl farm site water in excess of normal management expectations
- Management techniques must be reviewed in the area specific to the contamination;
- Specific procedures must be implemented until the breach is resolved and normal operating procedures are restored;
- Monitoring of water quality must be more frequent than normal should a contingency plan be initiated;
- On the implementation of a contingency plan, the Administering Authority must be notified as soon as practicable by the management of the operation.

Fauna Interaction Management

A range of fauna have the potential to impact on/be impacted by pearl farming operations. The management of fauna interaction will vary considerably depending on the region. The appropriate management of fauna interaction is likely to increase profitability and minimise the potential environmental impacts to fauna species.

Fauna interaction management techniques must be planned and implemented to minimise impacts to native fauna species while protecting the economic viability of the pearl farm.

Disease Management

Disease and health management requires a holistic management approach inclusive of, water quality management, hygiene and post seeding/harvest health.

The pearl farming industry must develop plans to ensure that, in the event of a disease outbreak, the threat of disease spread within a farm and spread from a farm is minimised. Disease management under this plan must be in accordance with any Pearl Health Management Guidelines adopted by the pearling industry and the Department of Fisheries WA.

Pearl farm managers must implement an appropriate disease management strategy in accordance with the Pearl Health Management Guidelines. Compliance with these guidelines will benefit farmers through providing a set of standard procedures in the event of a disease outbreak and subsequently minimising losses from disease and by contributing to the long term sustainability of the industry.

General Domestic and Vessel Wastes

This waste stream is generally minor in its nature and is limited to land base waste such domestic garbage, treated sewage and support vessel waste. The pearling industry must reduce as practicable the amount of wastes generated from support activities.

Training

Training employees is a vital part of ensuring that an organisation maintains a suitable level of compliance with this Code of Practice. Staff must be aware of the requirements of the Code of Practice, in varying levels of detail, depending on their duties.

Training programs must contain common elements such as familiarisation with the company environmental policy, the Code of Practice, commitment to waste prevention and raw materials conservation. Employees must be encouraged to suggest new ideas that are in line with compliance with the Code of Practice.

Environmental Monitoring

An environmental monitoring program may be required by administering authorities as a condition of license, to quantify the extent and nature of any environmental changes attributable to a pearl farming operation. The environmental monitoring program must aim to differentiate such environmental changes from naturally occurring environmental fluctuations.

Where an environmental monitoring program is not provided for in licence conditions, pearl farmers must implement an appropriate environmental monitoring program to quantify changes in the receiving environment attributable to the pearl farming operation.

The design of appropriate monitoring programs must consider the following:

- **Environmental Authority**

Frequently a licence or other authority will include specific monitoring requirements in its conditions. The conditions might address issues such as frequency, techniques and performance indicators, and must be included in the final monitoring program.

- **Cost Effectiveness**

A monitoring program must aim to be cost effective. The level of change to be detected needs to be balanced against the costs associated with monitoring and the environmental values of the receiving environment.

- **Performance Indicators**

It is not possible to recommend a uniform set of performance indicators for the entire industry due to the high variability in receiving environments. ANZECC (1992) advises that individual acceptable water quality parameters must be determined on a site specific basis.

- **Natural Variability**

It is important to have a clear understanding of both acceptable levels of environmental change and levels of natural variability, to ensure that the monitoring program can determine environmental impacts as required by the administering authority. A monitoring program must be designed with a stated hypothesis and address this with collection of data regarding appropriate parameters at an adequate temporal and spatial frequency.

- **Monitoring Frequency**

The frequency of data collection needs to take into account the magnitude and time scale of potential impacts. Environmental impacts within a pearl farming operation are most likely to be from natural variations or introduced pests and diseases. Potentially influenced communities are likely to respond slowly and changes will occur gradually.

In this regard, monitoring frequency can be less frequent than if potential impacts and associated responses were both quick and extreme.

- **Control Sites**

The inclusion of control sites is required to detect any widespread natural influences that are unrelated to the pearling operation but nevertheless may result in significant changes to communities and/or variables being measured.

- **Baseline Data**

It will be important for the monitoring program to incorporate a baseline data collection phase to provide a set of background data to assess natural variability and the spatial and temporal scale at which monitoring would be most appropriate. Administering Authorities could use this information to determine a threshold for the cost effective, detectable level of change in a monitoring program.

- **Sampling Techniques**

Sampling techniques and monitoring of environmental parameters must be in accordance with appropriate and recognised scientific methodology. Specifically the techniques utilised when taking environmental water samples must be in accordance with the most recent edition of the *Water quality sampling manual* published or endorsed by the Administering Authority.

Environmental Complaints

Complaints in regard to environmental issues of pearl farms may take two forms:

1. Receipt of a formal complaint from Administering Authorities; and
2. Receipt of a written complaint from a third party.

Complaints will be recognised by the pearling industry under this Code of Practice on the basis that the complaint:

- is in a formal or written manner;
- notes the specific incident;
- notes the specific concern or potential impact of the alleged incident;
- notes the place of the alleged incident; and
- notes the date and time of the alleged incident.

On receipt of a complaint made in the appropriate form, the pearling company will notify the Administering Authority in writing as soon as practicable of the complaint and will implement an internal investigation. Such an investigation will include, a review of the relevant environmental records, communications with the responsible employee(s) and any other actions the pearling management deems as necessary.

The Administering Authority will be informed in writing of the outcome of the investigation within thirty days of completion of the investigation.

In the event that any single incident is substantiated by the investigation, the pearling company must undertake a review of operating procedures to ensure that the incident is not repeated. If the incident identified is a continuing breach, the contingency plans must be implemented.

Environmental Records and Auditing

Under this Code of Practice, pearling companies must undertake to keep all records required to provide a substantial base of information for the collation of environmental data relevant to the aquaculture operation. Such records must include:

- Time and date of monitoring activities;
- Laboratory water quality results in line with monitoring requirements;
  - original analysis report;
  - collated data;
- In situ water quality measurement results in line with monitoring requirements;
- Rainfall records and records of major rain events and visual observations of surrounding waterways;
- Correspondence with relevant Administering Authorities, interest groups and community organisations;
- Written complaints received by the company;
- A copy of relevant licenses and approvals;
- Environmental Audit and Review reports and annual returns; and
- Names and addresses of consultants and contractors engaged in environmental matters.

Under this Code of Practice, pearl farmers should conduct an annual review of their environmental records and management systems. The review shall comprise an internal review to confirm that the proposed actions are appropriate.

Site Rehabilitation

This Code of Practice provides for the rehabilitation of pearl farm sites on termination of pearl farming activities.

Where a pearl farmer chooses to terminate the operation of a pearl farm and not continue with a similar use, the pearl farm site must be rehabilitated in accordance with any requirements set by an Administering Authority or alternatively, to the extent that no further impacts to the environment result from the development site.

Code of Practice Review

The PPA on a 3 yearly basis shall review this Code of Practice. New technology must be incorporated where appropriate, based on its efficiency and effectiveness to minimise the environmental impacts of pearl farming.

Contact

To find out more about the Code or learn about sustainable pearling practices contact:

Pearl Producers Association
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Appendix 8
PPA environmental management system guidelines

Pearl Producers Association

PPA Environmental Management System Guidelines

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Contents

ABBREVIATIONS

DFWA	Department of Fisheries Western Australia
EMS	Environmental Management Strategy
ISO	International Organisation for Standardisation
IRC	International Risk Consultants
PPA	Pearl Producers Association

1 ENVIRONMENAL MANAGEMENT FRAMEWORK

The Pearl Producers Association (PPA) is committed to working towards the achievement of sustainable development by prompting appropriate resource conservation, environmental management and environmental protection practices as an integral part of industry operations.

The PPA endorses an environmental management framework broadly based on the following:

- Commitment and environment policy;
- Planning;
- Implementation and operation;
- Measurement and evaluation; and
- Management review and improvement.

An environmental management system (EMS) is the systematic methodology an industry or company adopts to achieve its environmental policy objectives. Environmental management systems should be integrated into the overall business management process at all levels. Environmental management systems include the setting of goals and objectives, organisational resources and responsibilities, plans and procedures, monitoring, audit and review processes for ensuring effective environmental protection.

Section 2 of this document provides the pearling industry with an introduction to assist with the development of an EMS. The recommendations in this section are designed to encourage compliance to ISO 14001.

Table 2.1 provides pearling companies with practical operational guidelines for environmental management. These guidelines represent good industry practice for specific industry land and water based activities. They may be used directly to guide a company's operations or as the basis for development of an EMS.

These guidelines should apply equally to company staff and contractors. Relevant contracts should acknowledge company environmental requirements. Environmental performance may influence choice of contractors.

2 ELEMENTS OF AN ENVIRONMENTAL MANAGEMENT SYSTEM

2.1 Overview

The overriding goal of an EMS should be to control, manage risks associated with and reduce the impact of operations on the environment. Effective documentation of a company's EMS is important. EMSs are defined to enable regulatory requirements to be met and to demonstrate systematically how this is achieved.

The development of an EMS and methodology for environmental management will depend upon the nature, size, maturity and culture of a company. Typically, environmental management systems should address the following elements:

- Commitments and Policy.
- Planning.
  - Environmental aspects;
  - Legal and other requirements;
  - Objectives and targets; and
  - Environmental management programmes.
- Implementation and Operation.
  - Structure and responsibility;
  - Training, awareness and competence;
  - Communication;
  - Environmental management system documentation;
  - Document control;
  - Operational control; and
  - Emergency preparedness and response.
- Measurement and Evaluation.
  - Monitoring and measurement;
  - Non-conformance and corrective and preventive action;
  - Records; and
  - Environmental management system audit.
- Management Review and Improvement.

2.2 Commitment and Policy

A company's EMS should be an integral part of day to day business, with management leadership and commitment in the form of defining guiding principles and environmental policy, and line management and employee ownership of the programs, plans and procedures for implementing and achieving policy objectives.

Environmental impact/risk assessment and minimisation is an essential element of overall environmental management. It should be an ongoing process throughout the life cycle of all exploration and production operations: -

- Planning and design
- Construction and commissioning
- Operations and maintenance
- Decommissioning

In the planning phase, the process may involve:

- Establishing knowledge and understanding of the existing natural, cultural and social environment, and identification of its particular values and sensitivities (e.g. shipwrecks, commercial fishing grounds, biologically-rich areas such as coral reefs, mangroves or wetlands, Aboriginal heritage sites, endangered flora or fauna, etc.);
- Identifying and addressing environmental research needs;
- Identifying the source of impact on the environment from the project (eg. Physical disturbance, discharges, emissions);
- Evaluating the effects and significance (consequence, likelihood) of impacts on the environment; and
- Identification and implementation of measures to control and monitor environmental impacts.

In both the construction and the commissioning, and operations and maintenance phase, the process may involve continuous reassessment of environmental impact and risk by: -

- Monitoring sources of impact, and identifying and addressing any unforseen adverse environmental changes;
- Monitoring effects on the environment and identifying and addressing any unforseen adverse environmental changes; and
- Maintaining and improving knowledge and understanding of the existing environment, values and sensitivities.

2.3 Planning

Setting measurable objectives and targets is an important element of an EMS. Environmental objectives and targets should be included in overall business performance measures for which line managers are responsible each year. The data elements may be numeric (eg. Waste reduction targets or non-compliance incidents), but they do not have to be. It can be just as easy and meaningful to measure milestones (eg. successful completion of a pollution control project or an environmental training program).

The setting of meaningful objectives and targets is a difficult process and the data elements used will vary greatly between companies, depending on a range of factors including the types of environmental issues face, the level of risk involved and the environmental benefits which can be accrued. Measurement tools should also be selected with a focus on customer satisfaction (which is often a good indicator of risk and benefits as well). Customer groups

may include employees, product buyers/customers, other land/resource users, shareholders, regulatory authorities and community interest groups.

While data elements themselves will vary widely depending on the type of activity and the degree of environmental effect, there are common principles for which data elements may be identified: -

- Measures of resource conservation such as: -
  - Own fuel use reduction programs (eg. machinery efficiency)
- Measures of pollution prevention such as: -
  - Wastewater treatment efficiency indicators or wastewater treatment program/project milestone
  - Environment monitoring indicators or programs
  - Chemical use reduction percentages/volumes or programs
  - Waste reduction and recycling programs
  - Air emissions reduction programs
  - Spill prevention programs
- Measures of regulatory compliance such as: -
  - Number of licence breaches
  - Number of oil spills
  - Number of infringement notices, penalties and/or complaints
- Measures of environmental management capacity such as: -
- Environmental training programs
- Environmental information/documentation programs
- Monitoring systems and programs
- Audit coverage and audit ratings (i.e. How good were the findings?)
- Recognition awards
- Oil spill response programs
- Environmental accounting/ data collecting programs

Having identified data elements for setting objectives and targets, it is essential to capture and analyse data to monitor and evaluate performance (refer to section 2.3.2).

Operations may involve multiple values and objectives. Operations sited in or near closely settled areas or environmentally valued or sensitive locations can create public interest and concern. It is that they can be addressed constructively and effectively. Appropriate community consultation is often an essential component of Government approval processes. Community consultation means informing and being informed by the community, but keeping the decision-making with the responsible authorities.

The type, timing and extent of community consultation programs will vary widely between companies, depending on the level of public interest in a particular operation and the

company's assessment of it's needs (remembering that a good consultation program can accrue many benefits including reducing some of the uncertainties in approvals processes and reducing delays resulting from widespread community opposition). The aims of a community consultation programme may include:

- Providing factual accurate information about an operation and it's likely environmental impacts where there is a genuine requirement or request for such information;
- Identifying and gaining an understanding of community values, concerns and interests;
- Demonstrating that the community's views are being taken into account during planning and operational phases;
- Instilling within the community a level of confidence that operations will be environmentally responsible (and not exclusively driven by economic considerations); and
- Assessing and improving community acceptance of pearling operations.

The community consultation process generally involves:

- Identification of target stakeholder groups such as:
  - Fisherman and fishing organizations;
  - Tourist organisations;
  - Natural resource managers;
  - Conservation and environmental groups;
  - Aboriginal groups;
  - Media;
  - Local authorities; and
  - Local community groups (eg. Maritime history, divers, beach protection).
- Ensuring access is made available to all concerned parties wishing to be involved
- Information delivery strategies such as:
  - Media releases and advertisements;
  - Newsletters, brochures;
  - Displays;
  - Site visits; and
  - Environment al impacts assessments and other study reports.
- Information gathering strategies such as: -
  - Written submissions;
  - Questionaries, surveys;
  - Interviews;
  - Media monitoring; and
  - Research and studies.
- Interaction strategies such as:

  - Meetings (individual, small groups);
  - Workshops, seminars;
  - Formation of advisory committees; and
  - Telephone contact service.
- Feedback strategies:
  - Ongoing information delivery; and
  - Measurement of success of process.

2.3.1 Implementation and Operation

Organisational resources (personnel and financial) form the foundation of any environmental management program. Depending on the size of the company, human resources may include dedicated environmental professionals or environmental responsibilities may be fully incorporated into the job roles of exploration, engineering, production and legal personnel. In all companies, the ongoing education of all employees to promote a greater awareness of their responsibilities to assist in environmental protection should be an objective of the company.

As with other areas of job responsibility, suitable qualification, information and training are essential to allow employees to satisfactorily carry out their responsibilities. Information and training may range from general environmental awareness to job-specific procedures such as operation of pollution control equipment or effluent monitoring procedures.

2.3.2 Measurement and evaluation

Comprehensive environmental accounting systems and recording procedures are required once objectives and targets have been set to enable performance monitoring and evaluation to be undertaken. Establishment of these systems and procedures can be a major task in itself. The types of systems and procedures required may include:

- Inventory and tracking systems for fuel and chemicals used and waste generation through to disposal;
- Licence condition monitoring systems and data recording and reporting procedures;
- Environmental costing systems (to identify environmental projects costs and potential savings); and
- Logging and progress tracking of all environmental management recommendations (eg. via memos, audits, monthly reports, incident reports, etc.)

The type and detail of data collected must be sufficient to enable satisfactory measurement of performance. For example, sampling twice per year at the point where a continuous effluent leaves a site may give minimal control over the process, making it impossible to identify and prevent or correct excedance on a timely basis.

2.3.3 Review and improvement

Environmental auditing is a management tool comprising a systematic, documented, periodic and objective evaluation of how well a company is complying with it's environmental policy (including regulatory requirements) and safeguarding the environment in it's operations. Consequently, environmental auditing is an essential element of EMS as it provides a measure of the overall success of the system and enables identification of system failures and areas for improvement.

Environmental auditing should be a proactive internal management tool, allowing for the correction of deficiencies and minimisation of risk, as well as giving credit where it is due. Environmental auditing also provides a sound foundation for the demonstration of due diligence in terms of environmental management of a company's business.

The type, scope, method and frequency of environmental auditing will vary greatly between companies depending on the scale and nature of operations and the types of environmental issues faced. Essentially the environmental audit process involves:

- Setting audit objectives such as:
  - Verifying compliance; and
  - Identifying opportunities for waste reduction or other impact or risk reduction.
- Scoping the audit based on:
  - The greatest areas of potential environmental impact;
  - Recurrent environmental incidents;
  - Regulatory breaches; and
  - Significant issues such as waste management standards.
- Selecting audit team members:
  - Site and corporate personnel;
  - Consultants; and
  - Company management representatives.
- Planning the audit:
  - Logistics;
  - Background information;
  - Questionnaires; and
  - Protocols.
- Team training:
  - Audit techniques.
- Identifying and assessing the environmental management/control systems in place at the site
- Gathering audit evidence such as:

  - Visual observations;
  - Interview records;
  - Monitoring data;
  - Incident records;
  - Regulatory and management reports.
- Evaluating and reporting audit findings such as:
  - Management system changes;
  - Technical recommendations about equipment, processes or operating procedures; and
  - Environmental monitoring recommendations to address information gaps.
- Developing and implementing action plans (a site and management responsibility)
- Identifying and addressing relevant research priorities.

Table 2.1: Operational Guidelines for Environmental Management

Issue	Action
Environmental Impact Identification	An assessment of potential environmental impacts (this includes a risk assessment and environmental management planning) should be carried out. Include: • Identify (and map) the existing natural, cultural and social environment and its particular sensitivities (e.g. shipwrecks, coral reefs, seasonal values such as whale migration); • Identify potential impacts (disturbances, discharges, emissions, etc.); • Analyse the frequency, duration, nature and severity of environmental impacts likely to be caused by disturbances, discharges, emissions; • Identify risks and appropriate measures to minimise them; • Assess the significance of direct and indirect potential environmental impacts; and • Identify measures to prevent or control potential environmental impacts.
Chemical Management	A site management plan for chemicals should be prepared which takes into account the relevant regulatory requirements. The plan should include: • Provision of Material Safety Data Sheets (MSDSs) and handling procedures for chemicals; • Provision of ecotoxicity information for chemicals; • Provision of absorbent material and spill clean up equipment; • Provision of segregated and contained storage areas; and • Use of low impact chemicals (low toxicity, biodegradable, lowest concentration) as far as practicable.
Waste Management • Solid and Hazardous Waste	A site waste management plan should be prepared which takes into account the relevant regulatory requirements. The plan should include: • Collection of solid domestic waste for proper disposal to recycling or landfill facilities; • Segregation and safe storage and labelling of chemical packaging, lube oils, batteries, tyres, maintenance and other industrial wastes for proper disposal to recycling or landfill facilities; and

Issue	Action
	• Suitable drains and pits for the disposal of food wastes and sewage, ensuring they will not contaminate surface or ground water.
• Discharges to Sea • Oily Wastes • Air Emissions	• No waste to be disposed of overboard, except for comminuted sewage and food wastes is permitted. Oily wastes include incidental wastes. When managing these wastes considerations include: • Use clean-up materials that will be compatible with selected disposal options (i.e. in oil spill situations, natural absorbents are preferable for land disposal); and • Obtain the necessary approvals from regulatory authorities for waste disposal methods. Management of atmospheric emissions should aim to minimise and control avoidable releases and could include: • Regularly maintain equipment such as generators and compressors.
Emergency Response	An emergency response plan must be in place for environmental incidents including oil or chemical spill, fire, and fuel spill, covering all operations. Ensure that: • Emergency response plans are tested and reviewed at regular intervals; and • Operational personnel are appropriately informed of emergency procedures and trained to effectively implement them.
Spill Prevention	Facilities and procedures to prevent spills must be in place and include; • Contained storage areas for oil and chemicals; • Containment around oil and chemical use areas and equipment; and • Safe fuel transfer procedures.
Spill Contingency	The emergency response plan should include an oil spill response plan which includes: • Identification of the sources of risk, procedures to minimise risk and potential impacts; • Identification of internal and external emergency organisations, responsibilities and resources (human, equipment and materials) for oil spill response and call out details; and • Spill response and clean up strategies.

Issue	Action
Induction	An environmental and safety induction should be conducted with each employee prior to the commencement of work. Topics covered should include: • Regulatory requirements for operations; • Environmental considerations and special procedures to be used for environmental protection during all operations; and • Safety procedures with any particular regard to the safe use of vehicles and equipment.
Wildlife Protection	Special procedures may be required to protect wildlife and may include: • Spotting reports of endangered species; and • Specifying routes and/or operating procedures for access roads, machinery which minimise impact on wildlife.
Land Management	Land management issues which should be addressed include: • Soil erosion caused by wind or rain; • Soil compaction; • Land and water contamination; • Vegetation clearance; • Wildlife habitat disturbance; • Weed and vermin invasion; • Drainage alteration; • Disturbance to Aboriginal heritage sites; and • Visual impairment of the landscape. Sound land management is an important consideration during operations. Management considerations should include: • Use existing designated access roads, tracks, gates and avoid detours as far as practicable; • Avoid the creation of fire hazards (eg through the stockpiling of dead vegetation, use of equipment without mufflers or spark arresters, etc);

Issue	Action
	• Avoid disturbance of third party property; and • Identify and implement any special procedures such as cleaning of vehicles and equipment to prevent the introduction of weeds and pathogens.
Environmental Audit	At the end of harvest, an audit of environmental performance should be undertaken. The audit should include: • Compliance with company standards and procedures; • Compliance with regulatory requirements; • Compliance with landholder requirements; • Reporting of environmental incidents (e.g. unauthorised vegetation removal, erosion areas, loose rubbish, etc.); • Observations or reports of impacts on wildlife from operations (e.g. injury from boats, vehicles); • Logs of environmental matters which may have future significance (e.g. waste disposal sites, water supply sources, etc); • Identification of any remedial action on ongoing monitoring required; and • Identification of improved practices or procedures for future surveys.
Landholder and Community Consultation	Consult with other relevant land users and public interest groups such as landholders, Aboriginal communities, natural resource managers, conservation groups, tourism operators and other affected parties to: • Exchange information and facilitate good working relationships; • Promptly identify and address potential concerns and conflicts of interest; • Facilitate arrangements for the use and maintenance of infrastructure (e.g. water sources, roads, airstrips, fences, gates, etc); and • Meet regulatory requirements for consultation and notification, particularly of landholders.
Government Consultation and Regulatory requirements	Consult with government agencies as per operational approvals under the relevant legislation: • Consult with relevant Departments and local authorities; and • Consult with relevant authorities regarding the use and maintenance of infrastructure (e.g. water sources, roads,

Issue	Action
	airstrips).
Water Supply Management	Water supply management strategies should aim to: • Minimise the amount of water drawn from groundwater and surface water sources; • Ensure that appropriate water minimisation strategies are employed; and • Control or prevent groundwater draw down and saline water intrusion.