



Science Strategy for the Peel-Harvey Estuary

Summary Document
and
Peel Harvey Catchment Council Response

May 2011



The original report is to be referenced as:

Peel-Harvey Catchment Council (2010) Science Strategy for the Peel-Harvey Estuary, A report by the Centre for Fish and Fisheries Research, Murdoch University, Murdoch, Western Australia.

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Peel-Harvey Catchment Council (2011) Science Strategy for the Peel-Harvey Estuary, Summary Document and Peel Harvey Catchment Council Response

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Disclaimer

This summary document should be read in context with the full 'Science Strategy for the Peel-Harvey Estuary' which is attached to this summary document or can be viewed at www.peel-harvey.org.au.

The authors have prepared the full report in accordance with the usual care and thoroughness of the Centre for Fish and Fisheries Research (CFFR) for the use by the Peel-Harvey Catchment Council (PHCC) and only those third parties who have been authorised in writing by the CFFR to rely on the report. It is based on generally accepted practices and standards at the time it was prepared. No other warranty, expressed or implied, is made as to the professional advice included in this report. It is prepared in accordance with the scope of work and for the purpose required by the PHCC. The methodology adopted and sources of information used by the authors are outlined in this report. The authors have made no independent verification of this information beyond the agreed scope of works, and they assume no responsibility for any inaccuracies or omissions. No indications were found during our investigations that information contained in this report as provided to the authors was false. This report was prepared between October 2009 and July 2010, and is based on the information reviewed at the time of preparation. The authors disclaim any responsibility for changes that may have occurred after this time.

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Peel Harvey Catchment Council
PO Box 3450
Mandurah East WA 6210
www.peel-harvey.org.au

Foreword

The Science Strategy for the Peel-Harvey Estuary has been prepared for the Peel Harvey Catchment Council by the Centre for Fish and Fisheries Research at Murdoch University to report to the community and decision makers on the current state of the Estuary, and importantly, to inform actions required firstly to recover and then to maintain the quality of the estuarine system.

The Peel-Harvey Estuary and surrounding Peel Yalgorup Ramsar Site are internationally significant assets of economic, environmental and cultural importance, with attendant legal responsibilities. Economically the Estuary has been valued as contributing over \$3 billion to the value of houses, over \$600 million annually in boating and \$147 million annually to tourism [URS 2008]. We have not even begun to understand the value of these areas.

Alarming, the health of the Estuary has continued to deteriorate since at least the early 2000s. This Strategy confirms a decline in species abundance and biodiversity. River prawn and cobbler populations have practically disappeared and without adequate management, the crab stocks and some fish species will become, and, in some instances, have already become, overfished. Macroalgae growth is perceived to be increasing within the Estuary. The Murray and Harvey Rivers regularly experience toxic algal blooms resulting in fish kills and health concerns for people who come into contact with the water. The lower Serpentine is described as 'biologically dead'.

The Estuary and lower rivers already receive twice the amounts of nutrient pollution than the ecosystem can naturally assimilate. The population of the catchment is set to treble with the proposed creation of an additional 185,900 new residences over the next two decades. This will put enormous pressure on our already stressed waterways.

The opening of the Dawesville Channel in 1994 succeeded in its aim to remove the toxic and macro algal blooms that dominated the Estuary in the 1980s and through to the early 1990s. It did this by creating a saline environment, which improved aesthetic values and subsequently got rid of odorous wracks of rotting macroalgae, thereby responding to the political imperative.

However, the Catchment wide actions required to solve the issues causing the pollution of the Estuary have not been implemented at the scale required. Only recently has urban development been found to be deleterious, not beneficial as was originally thought. Once the Estuary looked clean, the pressure and political will to fix the problem diminished. A whole of Government approach to land use planning and the management of estuaries and waterways is required that truly recognises the unique values of the Peel region, and it needs to be done now.

Jan Star, AM
Chairman, PHCC



Murdoch Uni researchers sampling fish by seine net in the shallows of the Peel Harvey Estuary. Photo P. Coulson

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Executive Summary

This report, “Science Strategy for the Peel-Harvey Estuary”, has been commissioned by the Peel-Harvey Catchment Council (PHCC) and prepared by the authors [Peter Rogers, Norm Hall and Fiona Valesini] on their behalf. The strategy developed is about a new beginning, a fresh start towards dealing with ongoing but emerging risks for managing the ecosystem health of the Peel-Harvey Estuary. This report focuses on the ecosystem health of the estuary but, like any estuarine system, the inter-relationships between the surrounding catchment and drainage systems, including the rivers and streams and adjoining nearshore marine waters, are inherently inter-twined and thus cannot easily be separated.

Like many estuaries in Western Australia, the Peel-Harvey is changing principally due to the pressures of catchment development, increasing human populations, increasing freshwater extraction, changing water use and drying climate. The predicted effects of climate change, i.e. rising sea levels, shifting temperatures, intensification of storm events and reduced freshwater inflows, will continue to impact on the estuarine ecosystem, influenced strongly by nutrient flow from the catchment and changing interface with the marine environment.

The work of Professor Ernest Hodgkin and others in the 1980s and 1990s and ultimately the building of the Dawesville Channel in 1994 were pivotal in recovering the quality of the estuarine waters in the Peel-Harvey and therefore the values of the system at that time.

Since the building of the channel, development and population growth in the catchment and usage of the estuary has expanded as the economy and population of Western Australia has continued to grow. Today, Mandurah and the surrounds of the Peel-Harvey Estuary, as one of the State’s prime assets, continues to be a destination of considerable attraction, with the population resident in its catchment expected to double in the next ten or so years.

That is about four times the level of activity and population that existed at the time the channel was built.

Evidence is provided suggesting that the quality of the Peel-Harvey Estuary ecosystem is again declining and this is expected to become an issue of political import as ongoing population growth, intensity of catchment use and longer term climate change exert their impacts on the Peel-Harvey Estuary, the catchment and its adjacent riverine and nearshore marine waters.

This report attempts to re-define and provide an appropriate science strategy that monitors long term, ecosystem health for the estuary. It also provides a pathway for the building of predictive capacity to allow managers to cope with changing and different scenarios linked to drivers of ecological change including population growth, development and climate change. Where possible, every attempt should be made to build on existing monitoring strategies and evaluation tools assisted by model development.

In writing this report, issues of governance for the management of estuarine health, reporting and accountability are raised and discussed along with many suggestions for change. This report does not pretend it knows all the answers, nor has it covered every piece of research or issue relevant to the future management of these waters.

Like many complex and often called “wicked problems,” there is no immediate quick fix or solution. The community itself has to be a necessary part of the problem identification and its solution. Community empowerment in the facilitation of ongoing adaption of science and corrective actions ensures that values of the Peel-Harvey system and its assets meet their changing expectations over time.

This science strategy has been built around a philosophy of good information, supported by monitoring and science, as the platform for effective decision making through informing the community and enlisting their support in determining priorities for management action.

Fourteen recommendations are proposed, some of which have broader application to the management of all estuaries in Western Australia. These

recommendations have been built around issues of monitoring and science; development of models and indices; and community, governance and science partnerships.

The strategy for the Peel-Harvey Estuary is estimated to cost about \$14 million in today's costs over a 10 year period. An aligned strategy, which extends to a range of key estuaries in the south-west, has the potential to generate substantial cost-efficiencies as part of a broader program, having similar benefits for the maintenance and improvement of estuarine ecosystem health.

One of the keys to managing the future lies with the better integration of science and its delivery across the silos of government, the tertiary institutions and the community. Fundamental to this is the proposed appointment of a senior scientist with the PHCC to be the integrator, the coordinator of science and the community's independent science champion to deliver effective collaboration, implementation and outcomes for estuarine ecosystem health.

The challenge is to match science with investment and the gradual evolution of capacity, knowledge and solutions within an adaptive management decision-making pathway that is directly linked to transparent performance measurement and reporting. The pathway must be supported by continuous improvement in modeling and decision support tools that assimilates monitoring data, science and knowledge required to

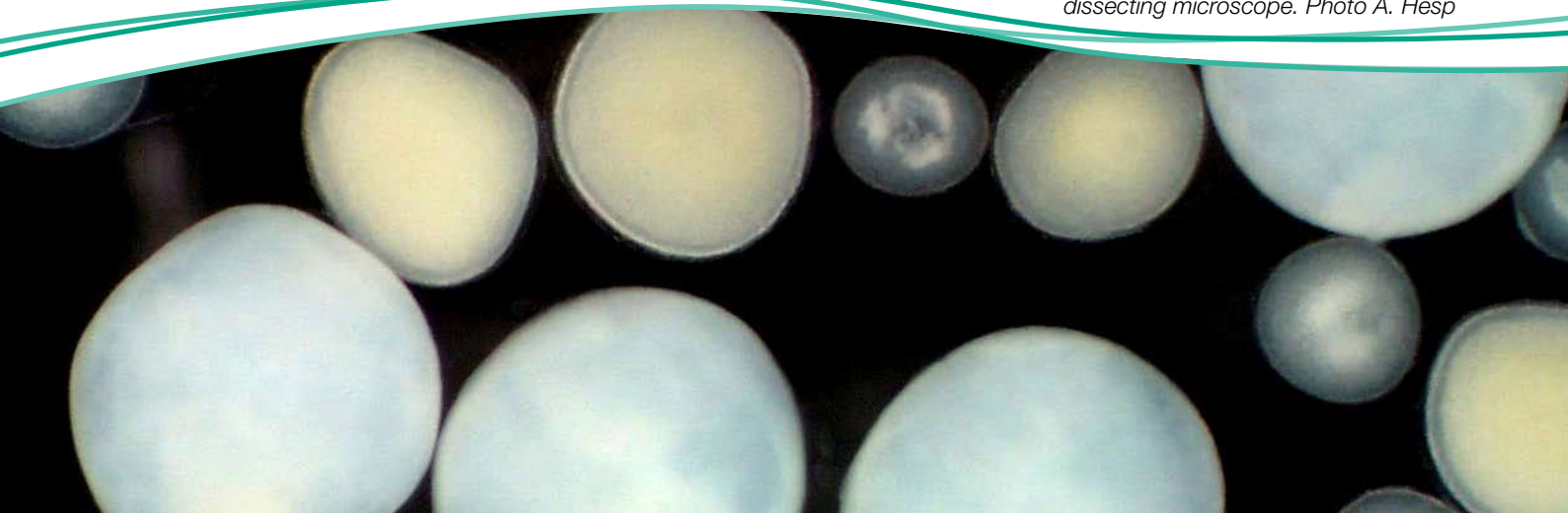
meet management needs. The development of models which integrate data and information within a systems-based framework provide the means for creating effective science-based decision-making tools for the future management of all estuaries in south-western Australia. This will provide a holistic and consistent approach for all estuaries.

One of the main recommendations of the report focuses on better governance supported by legislation. The authors believe there is considerable merit in the newly announced Chief Scientist's working group examining the need for the community to have a greater understanding of ecosystem health in all estuaries in south-western Australia and to determine action required for improving management of those systems. Should this not proceed, the option of a committee enquiry is recommended.

The challenge for the PHCC and others having an interest in this report, is to consider the merits of the case, the arguments presented and build on the proposals through debate and new knowledge. The science strategy should thus be considered as a platform for nurturing the future health of the Peel-Harvey Estuary and for extending those approaches relevant to other estuarine systems.

There are far too many assets at risk, both natural and man-made, to simply ignore the messages in this report. The proposed science strategy provides a practical pathway to moving forward.

Eggs of a spawning female Tarwhine, as viewed under a dissecting microscope. Photo A. Hesp



Recommendations

The following is a summary of the findings of the report, drawing upon the information presented in the full report and the collective experience of the authors and numerous contributors. The recommendations presented are unlikely to be the final word on either the science strategy or the actions required for its delivery due to the multifaceted complexity of the issues and the numerous parties involved and affected.

The recommendations are accompanied by contextual comments by the authors to allow the reader to more effectively interpret the Science Strategy. The themes focus on an understanding of the basic science and monitoring required for the Peel-Harvey catchment, rivers and particularly the estuary, through the development of indices and models, and enabled by improving the partnership between the community, government and science providers.

The recommendations are followed by a response from the Peel Harvey Catchment Council.

“... water quality and environmental problems remain in the rivers and over time have continued to get worse. The lower reaches of the Serpentine River, as an effective ecosystem, could now be described as biologically dead and perhaps not possible to save, and there are indications that the health of the lower reaches of both the Murray and Harvey Rivers are in a parlous biological state.” [PHCC, 2010]

Issues of monitoring and science

Recommendation 1

The ongoing successful management of the Peel-Harvey Estuary, including satisfying Ramsar obligations, needs to be built on funding, support for monitoring and the coordination of reporting by the PHCC on the following elements:

- i. The Water Quality Improvement Plan (EPA, 2008).
- ii. Total nutrient loads flowing into the estuary, ideally for phosphorous, nitrogen and organic carbon.
- iii. Analysis, performance measurement, reporting and adaption of the strategies employed to reduce nutrient flows into the estuary.
- iv. Key biotic components, including:
 - a. Submerged macrophyte (macroalgae and seagrass) and littoral and fringing vegetation cover, composition and biomass throughout the estuary (3 yearly intervals);
 - b. Macrophyte wrack cover, composition and biomass throughout the estuary as a proxy for year-to-year variation in macroalgae and seagrass production;
 - c. The species composition and proxies for biomass of fish and benthic invertebrate communities (including crabs and prawns) throughout the estuary and its adjacent nearshore marine waters (3 yearly intervals);
 - d. Water bird species counts throughout the estuary (3 yearly intervals).
 - e. Spatial coverage of other habitat types, such as shallow mudflats, throughout the estuary (every 3 years);
 - f. The composition of the phytoplankton communities at nominated sites throughout the estuary (2 weekly);
 - g. The growth and reproductive biology of key fish and crustacean species (10 yearly intervals);
 - h. Collection of data relevant to human health issues (annually as available).
- v. Nutrient and non-nutrient contaminant loads in estuarine sediments.

Blue Manna Crab collected from the shallow waters of Peel Harvey Estuary. Photo P Coulson



Author Comment

Chapters 5 and 6 in particular provide considerable comment on elements around monitoring and reporting relevant to this recommendation.

Appendix 1 provides a snapshot but comprehensive view of existing monitoring programs under the WQIP and other management and research projects, those proposed by the PHCC in their Monitoring and Evaluation Guide for the PYRS (Hale, 2008) and those proposed by this report. The comparative difference between each of these identifies the existing monitoring gaps that are required to be filled to place ecosystem health measurement and future prediction on a solid platform.

Proposed measurement of the key biotic components is intentionally structured to enable the identification of their longer term trends in response to shifts in estuarine conditions. Without regular assessment, longer term trends are difficult to interpret and separate from year to year variance.

All of this data is relevant to compiling and reporting the proposed indices of estuarine health, as well as the coupled model.

The core elements for an effective estuarine health monitoring and evaluation program must include physical as well as some biological components. The key monitoring elements are listed in order of priority in the above recommendation.

As outlined in the comments for recommendation 8, in the absence of a single reporting body covering all elements of ecosystem and management performance reporting impacting on the Peel-Harvey system, it is suggested that the PHCC performs this function.

PHCC Response

Adequate funding to support monitoring and reporting is essential. The current reliance by the DoW on grant funding for basic water quality monitoring is neither sustainable nor practical. With ongoing, adequate funding and support it would be fitting for the PHCC to undertake an integrative long-term role in partnership with relevant agencies, research institutions and community groups. The design and implementation of a monitoring and reporting and communications framework for the Catchment is identified as a 'core enabler' project within the PHCC, 2011 'Catchment condition and priorities report'. The suggested list of monitoring priorities may need to evolve over time.



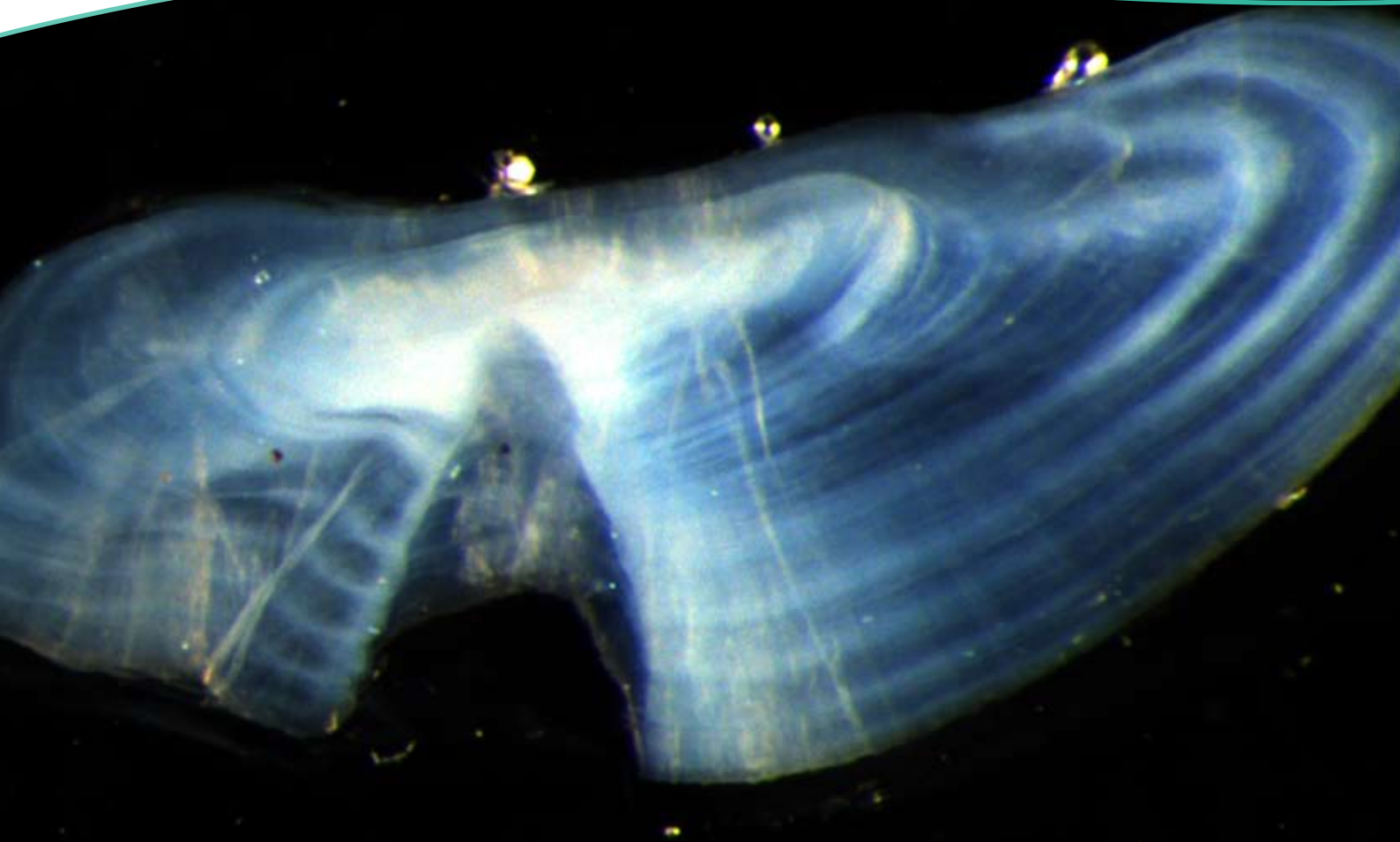
Typical fish fauna in the shallows of the Peel-Harvey Estuary, showing Small-toothed Flounder, Blue Weed Whiting and juvenile Six-lined Trumpeter.

Recommendation 2

That the PHCC be sufficiently funded to enable the ongoing appointment of a Senior Scientist to deliver the following outcomes:

- i. The integration of science across the University, Government and broader community sectors and facilitation and co-ordination of a science strategy that addresses current and future risks for the Peel-Harvey Estuary, its catchment and its adjacent riverine and marine waters.
- ii. Provides, with the co-operation of the Western Australian science community and advice from government agencies, reporting on the current and projected status of the ecosystem health of the Peel-Harvey Estuary and its adjacent riverine and nearshore marine waters, and on the performance of catchment management strategies.
- iii. Helps establish priorities for research in the Peel-Harvey Estuary, its adjacent riverine and marine waters and its catchment.
- iv. Facilitates community liaison and communication on the outcomes of research relevant to the objectives of the PHCC.
- v. Facilitates co-investment and funding for monitoring, research and model development and evaluation.
- vi. Maximises the opportunity to build science capacity in the region using PhD programs, relationships with the university sector relevant to estuarine, catchment, riverine and nearshore marine adaptive research (including restoration), and Commonwealth and State funding programs.

*Otolith (ear bone) from a 6yr old Six-lined Trumpeter. The rings on fish otoliths are counted to determine their age.
Photo L.Veale*



Author Comment

A significant component and a driving success factor for the ultimate delivery and construction of the Dawesville Channel in 1994 was the work of Professor Ernest Hodgkin. This scientist was an eminent leader who facilitated the co-ordination and delivery of the collaborative science required across the University and Government sectors necessary to provide the Government and Ministers of the day, the case and confidence to proceed with the Dawesville solution.

The value of this independent science leadership facilitated at the time through the EPA was pivotal.

With population growth, the solutions of the 1990s are becoming less relevant (refer Chapter 4).

A great deal of new science is required to manage future risks for the environmental and ecosystem health of the estuary, rivers and nearshore marine waters. Population and associated development growth along with climate change are significant drivers for changing the condition of these aquatic systems.

Collaborative partnerships with the University sector through co-investment, research partnerships, post-graduate research training, joint monitoring programs and collaborations that facilitate learning from other overseas estuarine and riverine restoration programs, can only be to the benefit of the PHCC and its charter. Such partnerships potentially have the capacity to reduce research costs to State Government as the immediate funder. Building science capacity facilitates new knowledge and creation of new solutions. It makes business sense.

Coordination of planning, priority setting for science, attraction of funds and the management, delivery and communication of outcomes to stakeholders is the key to cost effective delivery of the relevant science and information.

A scientist charged with the responsibility for leading the delivery of such a research program needs to be able to provide independent science-focussed advice, free of

government agency directive but capable of providing leadership within the field. The employment of a senior scientist within the PHCC could fulfil such a role and effectively be the voice of the community science champion. In other jurisdictions, a similar role has been provided by the University sector.

PHCC Response

The appointment of a Senior Scientist, or a senior person who understands science and has a sound science background, would be a great benefit and is supported. The PHCC is actively seeking support to fund this position as a high priority or 'core enabler' project, as described within the PHCC, 2011 'Catchment condition and priorities report'. The suggested expansion to marine waters is outside the traditional hydrological catchment area and may need to be a long term aim. There is a need to interpret and make usable, in an adaptive management framework, ongoing research in the catchment here and elsewhere.



*Eagle Ray caught in the shallows of the Peel Harvey Estuary
Photo P. Coulson.*

Recommendation 3

New investment in science will be required over a number of years for capacity to be developed to enable reliable prediction of the future status of the estuary. The type and accuracy of data required for quantitative modelling will depend on the questions asked, accuracy required, timing and level of risk acceptable for interpretation. Over time, knowledge and data needs to accumulate towards meeting the objective of evolving longer-term modelling and management requirements. Areas in which knowledge gaps have been identified, and thus which require new research, include the following:

- i. Development of a quantitative food-web to enable an understanding of the trophic pathways for bird and fish populations in the estuary;
- ii. The adoption of remote-sensing technologies to allow mapping of the spatial coverage of submerged macrophytes, accumulations of macrophyte wrack along the shores, littoral and fringing vegetation and shallow mudflats;
- iii. Basic but accurate bathymetry that provides data to build a hydrodynamic and sediment transport model for the estuary, capable of defining future impacts of changing water fluxes from river flows, changes in sea level, storm surges and wind conditions;
- iv. The role of sediments, particularly monosulphidic black ooze (MBOs), in the de-oxygenation of water and the entrapment and release of nutrients;
- v. Estimation of nutrient and sediment fluxes within the estuary, through production of a biogeochemical model based on the hydrologic

and sediment transport model that is linked to ocean interchanges and entrance channel modification;

- vi. Detailed sedimentology throughout the estuary, including in coastal waters and land near the estuary entrance, to facilitate more accurate predictive models of longer term climatic change on the estuary and its foreshores. Its basic form should allow scenario testing for assessing various engineering solutions for adaptive management, and be able to cope with various and changing assumptions around climate change predictions;
- vii. Research surveys of recreational fishing be undertaken at least at five-yearly intervals, and that the potential of using fixed video cameras at jetties, shore locations and boat ramps, such as the Department of Fisheries is testing in other locations, should be considered for use in monitoring recreational fishing effort in the Peel-Harvey Estuary in the intervening years.
- viii. Development of multi-metric biotic indices (e.g. from fish or benthic invertebrate characteristics) for quantifying year-to-year changes in estuarine health condition;
- ix. A pre-feasibility study involving an expert panel that identifies the contribution to estuarine nutrient loads by various land uses in the catchment, in order to ascertain the practicality of introducing a pricing or taxing arrangement that requires or enables funds to be applied to the future management of the estuary and its associated riverine and nearshore marine waterways.



Author Comment

In developing this report, a number of identified gaps in science have emerged in writing Chapters 4 - 6 which need to be investigated. These are summarised in section 4.6. Undoubtedly as model development for the Peel-Harvey Estuary occurs, other gaps will emerge as information is found to be either not available or incomplete.

Those data requirements listed may have different time priorities around their development depending on the management issues requiring assessment and the overall state of model development. This is an issue that requires co-ordination and management by the PHCC in conjunction with the Senior Scientist appointment.

Judicious management of research proposals through PhD research scholarships and University sponsored research will assist through applications to existing granting bodies and co-investment to reduce costs.

One significant issue requiring priority consideration is that relating to (ix) above and section 5.9 covering new funding options. This has major relevance to broadening the case for new funding approaches for addressing management needs and supporting science for Western Australia's estuaries and its waterways, including adjacent nearshore marine areas.

Murdoch University researchers sampling fish by seine net in the shallows of the Peel Harvey Estuary. Photo P. Coulson

PHCC Response

New investment in contemporary science is supported and the priorities identified are necessary to provide the information needed to understand the system. While the Peel-Harvey Estuary may be one of the most researched estuaries in Australia, there are many gaps in knowledge, and research is not consistent, nor easily available in practical formats to decision makers, researchers or the community. Research needs to be carefully targeted to ensure that it informs adaptive management processes and where possible coordinated in partnership with universities, agencies and the community.

The issue of taxing or levies should be treated separately and judiciously. However, it is clear that without a significant commitment to funds for the protection of the Estuary, the actions required to recover the system cannot be implemented at the scale required. The State Government may need to recognise that the introduction of a 'Healthy Catchment Levy' for the region or similar [cf. Metropolitan Region Improvement Tax], is inevitable for the recovery of the Peel-Harvey system and the sooner it is introduced, the sooner recovery can begin.



Peel-Harvey Estuary

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“It seems that natural predators for these mosquito species do not exist or have any significant effect on their larvae in the Peel-Harvey Estuary. The increasing abundance of mosquito larvae in the wetlands is also reported to be an indicator of declining health of water quality and the wetlands”.
[PHCC, 2010]

Development of models and indices

*Filtering water samples for plankton.
Photo T. Linke*

Recommendation 4

That the PHCC:

- i. Note that work is funded by the Western Australian Marine Science Institution (WAMSI) and currently progressing to develop a set of qualitative models for supporting the future development of quantitative ecosystem models that will provide decision support tools for the management of the ecosystem health of the Peel-Harvey Estuary;
- ii. Note that the funding of a modelling workshop to define the type of quantitative model required to meet future management needs of the Peel-Harvey Estuary has been approved by WAMSI. The work on both this and the above initiative is planned to be completed by early 2011 (refer to section 6.1).
- iii. Endorse the merits of the proposed strategy for development of the ecosystem health indices and predictive models as described in Chapter 6.
- iv. Subject to the outcomes of (ii) above, advocate for the priority funding of the development of a coupled hydrodynamic, biogeochemical and ecological model, which can be used as a risk-based decision tool by providing predictions of estuarine physical and ecological status arising from current and future population and climate change scenarios. This model should also account for spatial and seasonal shifts in the physico-chemical characteristics of the Peel-Harvey Estuary, as required. The key to building this model is its construction in modular form that allows each component to be built independently and integrated as needed, or as resources allow. The construction of this model could be undertaken by a range of agencies, with the correct governance arrangements. The ownership, coordination and integration of such a tool by the PHCC will be a key driver for its successful completion and utilisation.

Author Comment

The Western Australian Marine Science Institution, as part of its marine science program into sustainable marine ecosystems (node 4), is developing methods and generating information needed to assist with the management of fisheries and marine ecosystems of WA. This work is being co-ordinated by the Department of Fisheries Research Division at Hillarys.

As referred to in Chapter 6, this research, built around qualitative and quantitative modelling, will aim to define the key relationships for ecosystem assessment and model design and build requirements for the Peel-Harvey Estuary.

The PHCC has agreed to actively participate in the WAMSI modelling workshop and is encouraging all interested parties to support ongoing work in this area in the spirit of furthering development of partnership arrangements.

Reports resulting from these workshops will directly assist the PHCC in its future planning for development of diagnostic tools for predicting the future status of the Peel-Harvey Estuary and model design and build scoping requirements.

It is planned both reports will be available for the PHCC by early 2011.

Without appropriate quantitative model development, any scope for predicting future risks and impacts of catchment development, population growth and climate change scenarios on the status of the estuary will be extremely limited. Chapter 6 provides a pathway for progression of model development, which is dependent upon the successful appointment of a senior scientist to manage collaboration across a range of institutions. The outcomes of the WAMSI funded projects will continue to refine the work that is required.

Investment in the development of a completed hydrodynamic, biogeochemical and ecological model that can be used as a risk based decision tool for planning and assessment of different development and climate change scenarios, is considered an essential need. How it is developed and integrated as a co-ordinated, across government/university science evaluation tool, will be crucial to its ongoing utility and effectiveness.

The rate of the model's development and its modular construction, which will allow different agencies to independently build and use various components of the tool, will be a significant challenge and require effective co-ordination, integration and commitment across agencies. There is also the opportunity, as outlined in Chapter 6, to modify or directly use off-the-shelf models to facilitate early development and to build on modelling work already completed.

Such a model will require continual updating as the monitoring information and inputs alter over time (possibly decadal) and the types of management questions change both in terms of scale and complexity. The model would also need to be sufficiently flexible to eventually cope with changing assumptions around forecasts on the impacts of climate change, changes in freshwater flows and requirements for different engineering and/or restoration options.

Whilst a number of agencies could assume responsibility, it is proposed that the PHCC should be the lead organisation for facilitating the model's development, coordinating integration and ensuring its relevance and understanding as an evaluation tool that is linked to reporting and meeting community expectations for the ongoing management of the estuary. The Senior Scientist appointment as outlined in recommendation 2 could assume the integration and coordination role.

PHCC Response

The PHCC acknowledges the proactive work of WAMSI to develop modelling to assist in understanding the flow of water and nutrients from the catchments to the Estuary, impacts of this on the Estuary, and effectiveness of adaptive management measures.

Following the workshop held in October 2010, the PHCC received WAMSI's draft report and provided feedback confirming that the PHCC is happy with the scope of recommendations and recognises that the creation of a structure capable of delivering the continuity of model development will enable better use of science in adaptive management. However, the effective delivery of recommendation 4 [referring to the proposed structure] requires a body with resilience in the face of political and economic change to ensure continuity of modelling, and presentation of results to the community.

The PHCC endorses the ownership, coordination, integration and advocacy of such tools and acknowledges that it will be a key driver for its successful completion and utilisation. The PHCC would like to take on this role, but will need to build capacity to enable it to not only manage the process in partnership with science providers but also to ensure that the modelling and index results are provided to the community (see Recommendations 1 & 2 of the Science Strategy).

Recommendation 5

Independent of the coupled model referred to above, it is plausible to fund, at lower cost, the development of estuarine health indices, including identification of their main environmental drivers, and provide the resultant information in forms that (i) are easily understood and accessed by the community and (ii) are appropriate for rigorous surveys of ecosystem status. Such an approach could be used to provide a comparative assessment of the ecosystem health of key south-western Australian estuaries over a time series. However, compared to the coupled model, its predictive capacity is limited.

Author Comment

The case for effective reporting of estuarine health as a tool for improving community and government feedback on the status of the estuaries has been substantially raised throughout this report.

Section 5.1.1 and 6.3 specifically cover the opportunity to develop a statistically based estuarine health index. Murdoch University has the capacity to develop such an index relevant to measuring year-to-year variation in defined biotic assemblage metrics. Work on the development of such an index has progressed for the Swan-Canning Estuary within a current PhD research program. This work could be extended to other estuaries with sufficient funding.

PHCC Response

The development of estuarine health indices and reporting of these to the community is supported as a first step towards detailed reporting of estuarine health. The PHCC intends working with tertiary institutions to review the selection of indices used for estuarine health report cards across the globe. This will allow for the PHCC and partners to more comprehensively track ecosystem health into the future and provide good methods for communicating results to the wider public. Metrics comprising such indices need to be carefully selected to ensure that they not only provide the relevant measures of estuarine health, but that they relate to community values of the estuarine system, or clearly provide the link for relevance to community values. This will be done in partnership with relevant stakeholders, particularly the Department of Water, who undertake some estuary monitoring and has prepared a report card for the estuary.

A state wide set of report cards adopted by relevant agencies/groups will enable cross comparisons of estuaries which is supported. Alignment with the National Estuarine Environmental Assessment Framework should also be explored.

“During the last five or so years, ..., some of the biological indicators of estuarine health point potentially to a gradual reversal of ecological conditions back towards the status of the Estuary that existed immediately prior to the construction of the [Dawesville] Channel”.
[PHCC, 2010]

Community, governance and science partnerships

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Recommendation 6

Management of estuaries needs to be adaptive and have an effective governance and accountability framework that engages a partnership between the community and governments in understanding not only the future risks for estuaries, their catchments and adjacent riverine and nearshore marine waters, but also in the mitigation strategies to effectively manage complex natural resource issues. The community must be empowered through effective reporting and engagement to bring overall management performance to account, politically and through legislation.

Author Comment

The management of estuaries and their catchments fall within the context of 'wicked' problems, that is they are difficult to define, have many interdependences, often no clear solutions, involve changing behaviours and are characterised by chronic policy failure (refer 5.8). By their nature they are not easily resolved and require effective engagement of the community through multiple agencies with different roles and responsibilities. Solutions have to be adaptive assisted through effective reporting with clear accountabilities.

A successful policy mix must include measurement of performance and reporting to be understood by the community and, as necessary, application of mitigation strategies supported by science within an adaptive management cycle (refer 7.2). The empowerment of the community comes from knowledge, the recognition of arising problems and their willingness to engage with decision makers including political action.

PHCC Response

The actions required to protect the Estuary [and rivers] have been well described for up to 20 years, yet there continues to be a general reluctance to implement and resource the necessary policy, research and practical measures [PHCC, 2011]. Responsibility for protection and management of the Estuary [and Catchment] is poorly defined across numerous organisations and many documents. Statutory responsibilities are held by a number of agencies, each required to balance the health of the Estuary with many other competing objectives [PHCC, 2011].

This lack of action, continuous shift in political commitment [reflected in shifting and diminishing funding and support] is reflected in the disempowerment of communities who are frustrated and discouraged by the regular alteration of agency responsibilities, changes to funding and programs, lack of openness, objectivity, consultation and action.

Design and implementation of a Peel-Harvey Catchment Governance Framework is identified as a core enabler within the PHCC Condition and Priorities report, 2011, as well as a Regional Priority [PDC, 2010].

Recognition of the resources needed to provide appropriate frameworks and adaptive management is imperative and the PHCC, already recognised as the peak environmental group in the Peel-Harvey, with a demonstrated record of delivery, is the logical choice (URS, 2008).

Recommendation 7

To facilitate an understanding of the effectiveness of existing management programs for reducing nutrient loadings into the Peel-Harvey Estuary, the Auditor General should be requested, via the Environmental Protection Authority (EPA), to undertake a performance audit of the progress of actions proposed by that agency under its Water Quality Improvement Plan (November 2008). This review would effectively establish a benchmark for future audits and reporting. One of the audit outcomes needs to determine a cost effective means of agency performance reporting on a regular basis, including the prospect of ongoing audits every five years.

Author Comment

Much of the success of mitigation strategies aimed at reducing nutrient impacts on the estuary depend on the success of the EPA actions of best management practice and recommended actions for implementation of the Water Quality Improvement Plan.

Without an audit of funding/performance of current programs under these actions, it is not possible to assess levels of compliance or improvements in delivery of actions into the future. Without some measure of performance audit noting multiple agencies are involved, there is a real risk priorities could shift with no apparent accountabilities in performance reporting.

One approach could be to encourage the Office of the Auditor General to provide an initial impetus for ongoing regular performance measurement and reporting which falls within their audit scope across government. Guidance on future audit approaches would also assist in clarifying how best to undertake future assessments.

Estuary cobbler collected from the shallows of the Peel Harvey Estuary. Photo B. Farmer



Photo: Bryn Farmer

PHCC Response

The EPA and the Australian Government finalised the Peel-Harvey Water Quality Improvement Plan [WQIP] in December 2008. In March 2010 the Office of the EPA [OEPA] sought agreement from the Department of Water [DoW] to accept the responsibility for the implementation of the WQIP as they considered that ongoing coordination was more closely aligned with the DoW's responsibilities. No funding was provided to enable implementation. However, the OEPA advised that there would be a role for the EPA in the formal review of the WQIP within 10 years of its implementation.

The DoW works in close collaboration with the PHCC to assist in implementing the WQIP and are in discussions to formalise an agreement for the PHCC to deliver the WQIP on behalf of the DoW [on behalf of the EPA]. Some components of the WQIP are being implemented by various agencies, but not necessarily under the umbrella of the WQIP. For example, the Department of Agriculture are responsible for the Fertiliser Action Plan; Department of Water are undertaking monitoring and delivering the 'Waterways Health Program' and 'Urban Water Management'.

The PHCC applied for and has been funded through the Royalties for Regions grant process, to prepare a framework for the WQIP, as its current form is awkward in its presentation of non-site specific recommendations. The framework will provide clarity of the recommendations as well as identify responsibilities and strategies for implementation. This will be done with relevant agencies and stakeholders. Without such a framework an audit of the WQIP would be virtually impossible.

The PHCC are also implementing WQIP projects such as preparation of subcatchment plans and infrastructure such as stormwater retrofits and construction of biofilters [to reduce the nutrient loads going into the Estuary and rivers]. This again demonstrates that core responsibilities of State Government are not adequately funded and implementation is reliant on grants sourced in conjunction with and delivered by community groups. Therefore, an auditing framework is supported but an audit at this stage may be premature in the light of a proposed revision of the WQIP by DoW.



Murdoch University researchers sampling fish by seine net in the shallows of the Peel Harvey Estuary. Photo P. Coulson

Recommendation 8

That the PHCC work with the Minister for Water and the Minister for Environment to seek:

- i. the establishment of a new reporting framework to require Natural Resource Management (NRM) agencies, Local Government and relevant authorities to report to a single agency charged with providing annually a report on the ecosystem health status of the Peel-Harvey Estuary. This agency would also be responsible for describing the current and predicted impacts on the estuary and its catchment from climate change and anthropogenic activities, and separately on the progress and success of mitigation strategies to reduce risks to the health of this ecosystem.
- ii. the immediate development of an interim reporting format for assessing the ecosystem health status of the Peel-Harvey Estuary within the context of south-western Australia, covering at least the Swan-Canning Estuary, the Leschenault Estuary, the Vasse region, Hardy Inlet, Wilson Inlet and Oyster Harbour.
- iii. the requirement, by legislation, of relevant Government agencies to report to a single agency on the performance of their functions and programs relevant to the ongoing management of the Peel-Harvey Estuary, its catchment and its adjacent riverine and nearshore marine waterways. Importantly, this should include as relevant, programs such as the Water Quality Improvement Plan (EPA, 2008) and the Monitoring Requirements for the Peel-Yalgourup Ramsar Site (Hale, 2008).

Author Comment

The lack of transparency and understanding by the community on the status of the Peel-Harvey Estuary and other important estuaries in Western Australia continues to be problematic. Without regular science based assessment and reporting within an agreed format on the current and future predicted health status of Western Australia's estuaries, it is difficult for government, politicians and the community to understand current and future risks to the health of the Peel-Harvey system from impacts of population growth, increasing freshwater extraction, climate change and regional development, as well as changing estuary usage and modification.

Some of the necessary information appears to be already collected, but in multiple agencies. There needs to be a clear focus on reporting that is easily understood by the community and government, with underlying detail for managers and scientists.

The process for development of an agreed reporting format will, by necessity, need to be iterative, based firstly on an interim format that is progressed through a cycle linking science and monitoring with reporting, performance measurement and adaptive management changes. Together, these should facilitate an ongoing review and improvement process with community engagement and empowerment in decision making. The adaptive decision making pathway outlined in Figure 4, Chapter 7, provides a suitable schematic for such a process.

Legislative obligation for reporting to a single community/government body would improve accountability and transparency and provide the opportunity for community empowerment.

In the absence of such a body/partnership, the PHCC could provide such a function.

There is a case, noting the emerging risks for the Peel-Harvey Estuary, its catchment and rivers, for early progression of this pathway as a pilot for, eventually, a state-wide program for the management of estuarine health in the face of ongoing population growth, development and climate change. That is, the learnings from the pilot study in the Peel-Harvey system could be easily modified and extended to other south-western Australian estuaries. Whilst this has relevance for those estuaries, those in the north-west of W.A. have a different set of dynamics, drivers and threats.



PHCC Response

- I *The PHCC supports the development of catchment governance, starting with a reporting framework and agrees that State NRM agencies and local government should be required to report annually to the EPA, who in turn, devolves the production of the report cards to the PHCC. Perhaps the South-east Queensland Healthy Waterways Partnership is a good model to consider. Reporting should be shared with community and appropriate decision makers/land managers/stakeholders.*

- II *An interim reporting format is supported that could result in the Peel-Harvey being used as a pilot for a future State wide system. The PHCC will actively pursue funding opportunities as there is no current capacity to deliver this, however we are working with tertiary institutions to explore relevant models already being used as well as working closely with the Department of Water. This will all be used as research and background information for an effective reporting format.*

*Laboratory activity at Murdoch University.
Photo Office of Corporate Communications and Public Relations, Murdoch University*

Recommendation 9

The objectives of the PHCC should change to reflect stewardship responsibilities not only for the catchment, but also for the ongoing ecosystem health of the Peel-Harvey Estuary and its waterways, including its adjacent riverine and nearshore marine areas.

Author Comment

The objectives of the PHCC, as the name suggests, focus on the catchment. The trend from other jurisdictions is for integration of management responsibilities to extend from the catchment and rivers to the estuary and adjoining marine waters. This needs to be considered by the PHCC explicitly in its charter and organisational structure.

PHCC Response

The estuarine waterway is the visible endpoint of caring for the Catchment. Implications of inappropriate actions throughout the entire terrestrial system including the ocean interface must be considered. Inclusion of stewardship for the Estuary needs to have consideration of the current and proposed role of the Peel Inlet Advisory Council [PIAC], which is supported by the DoW through their Waterways Health Program. The overarching objective of the PHCC is to protect the Estuary and rivers, through effective catchment management and the PHCC would be supportive of a modification to its constitutional objectives, dependant on analysis of PIAC's current and future roles and responsibilities.

The inclusion of the marine environment has enormous implications and needs to be considered in context and over the longer term. While appreciating the inherent links with the nearshore marine areas, the priorities of the PHCC are the catchment, estuary and Ramsar assets of the Peel-Harvey until capacity allows consideration of extending to the marine environment.

Recommendation 10

That the PHCC is sufficiently funded so that its core responsibilities can be undertaken without continually detracting from its role caused by the requirement to seek funds from various sources to ensure its ongoing operations.

Author Comment

A significant degree of effort is exerted annually by the PHCC staff and Board members in raising sufficient funding through granting bodies and government sources to maintain operational currency.

This activity detracts from the core functions and effectiveness of the Council.

Security in funding would make the Council and its staff more effective in its role and enable better delivery of programs under its purview.

For this to occur requires a wider examination of governance arrangements (refer recommendations 2, 8, 11 and 12).

PHCC Response

Sufficient funding is crucial if the system is to be recovered. It is absurd that e.g. the Swan River Trust receive approximately \$17 million a year while the Peel-Harvey, the largest estuarine System in Western Australia, protected under several international treaties and recognised as contributing billions to the economy has no funding for an overarching body - with community groups and agencies having to rely on small amounts of grant funding. With sufficient funding, and a quality administrative centre [ie Peel Waterways Institute] with sufficient facilities for PHCC staff and partners, the PHCC would be able to focus on its core business and to strengthen partnerships to deliver outcomes.

The PHCC is preparing a business plan with the support of the Peel Development Commission to help to reduce its vulnerability. There is also a need for the State (and Commonwealth) to recognise Peel as an NRM region so that it can decide on its own priorities and have some recognised status with the State. The Council is actively working with partners to help deliver outcomes that are consistent with their own strategic plans and delivered at regional and landscape scales, but at an opportunistic level, not according to its own priorities.



Recommendation 11

That the Departments of Water and Environment and Conservation, in consultation with the State's NRM regions, catchment councils and EPA, explore the principles outlined in the Swan and Canning Rivers Management Act 2006 to determine how a similar but more general Act (or modification of the Waterways Conservation Act 1976) could be modelled to provide legislation relevant to the management of the State's other key estuaries and their catchments.

Author Comment

The Swan and Canning Rivers Management Act 2006 passed by government in September of that year provides arguably the most coherent legislation for the protection of a Western Australian estuarine system.

The new legislation supports the "Healthy Rivers Action Plan" for the Swan-Canning Estuary (Swan River Trust, 2008) by:

- *"Providing a statutory basis for water quality targets;*
- *Establishes a whole-of-government approach for river management including Ministerial approval of management programs;*
- *Establishes the Swan Canning River park;*
- *Providing a statutory basis for partnerships agreements and;*
- *Enabling the use of River Protection Notices as a mechanism to address activities affecting water quality".*

The provisions of Part 4 Division 2-4 of that Act provides for strengthened governance around the "River Protection Strategy", defining accountabilities for performance and those responsible for management arrangements, and may inclusively specify reporting and compliance requirements. The Act also binds Chief Executive officers and their respective Ministers under 33 separate Western Australian Acts (refer schedule

5), subject to defined consultative and agreement procedures in the delivery of the River Protection Strategy or management program.

Differences arising from disputes in content of the strategy or management program between Ministers are to be resolved by the Governor; that is, in effect, Cabinet.

Another important component of the legislation is for the Trust to monitor and report on compliance to the Minister on the extent to which targets are met and on the ongoing operation and effectiveness of the strategic documents.

It is not clear from the legislation whether non-performances in reporting or delivery of programs by the accountable agencies, in accordance with the "approved" strategic documents, are made "public" beyond presumably their reporting under Section 66. Arguably non-performance in delivery and reporting should occur (refer Section 66(4)) and be transparent to the community.

The power to issue a River Protection Notice was also seen as an essential element in the legislation.

Whilst performance under the Swan and Canning Rivers Management Act 2006 is yet to be fully assessed, the principles adopted appear sensible and ought to be incorporated in the Waterways Conservation Act of 1976.

Whether a similar 'Trust' body needs to be created for other estuaries in order to provide clearer lines of accountability, improved governance and financial responsibility is not considered, but is an issue requiring exploration.

The Waterways Conservation Act 1976 (as amended) provides many of the powers reflected in the Swan and Canning Rivers Management Act 2006, but does not have the same level of accountabilities.

A case could be made for the PHCC to write to relevant Ministers seeking a review of existing legislation controlling management of the State's other estuaries and waterways towards having similar compliance requirements as that in place for the Swan and Canning Rivers.

Any findings from the announced appointment of a working group to examine "estuarine ecosystem health" and new requirements for legislative change should also form part of any legislative review (refer to recommendations 8 and 14).

*Large haul of Blowfish collected by Murdoch University researchers from the shallows of the Peel-Harvey Estuary.
Photo P.Coulson*

PHCC Response

The PHCC support the exploration of combining the advantages of a non-government, community-based organisation with some of the legislative components/controls of the Swan and Canning Rivers Management Act 2006.

A review of relevant legislation, including the Swan and Canning Rivers Management Act 2006, Waterways Conservation Act, and other relevant legislation, will be an important component when considering the design and implementation of a suitable legislative framework for Peel-Harvey Catchment Governance. This review should be collaborative.



Recommendation 12

It is necessary to secure long-term funding to underpin a monitoring program that measures and reports on the current and predicted ecosystem health of the Peel-Harvey Estuary. The PHCC should consider the science strategy and develop the business case for the adoption and funding (where necessary) of the ongoing and proposed new monitoring and research, as summarised in Appendix 1 in this report. This science strategy will require a long-term funding commitment of about \$14 million, in today's dollars, over a 10 year period.

Author Comment

This issue of long-term funding has arisen due to uncertainty and lack of long-term commitment by Government for the management of estuarine health. Without an effective monitoring program and performance reporting on the current and predicted status of the estuary, support for action programs to mitigate or reduce nutrient impacts as a consequence of population growth, associated development etc. remains problematic.

Tables 1-3 presented in Appendix 1 specify, in tabular form, a science strategy and estimated costs for the Peel-Harvey Estuary.

Indicative cost estimates have been provided based on, where practical, known comparative costs from other like projects and programs, drawing from a number of sources. These need to be refined and updated as new information becomes available and used as an ongoing 'tool' for progressing the Science Strategy for the Peel-Harvey Estuary, in order to retain currency over time.

The next steps for the PHCC are to progress a business case built around the Science Strategy and develop priorities for funding and timelines for delivery of its key components. One of the key issues will be strengthening the partnerships and accountabilities for performance with Government, science providers and the community. These are addressed throughout this report.

PHCC Response

The PHCC supports consistent, reliable and appropriate research, the analysis and reporting of which needs to be provided and presented in a way to ensure that it can be effectively used to inform decision making and adaptive management for the recovery of the Estuary and Rivers.

Implementation of the Science Strategy is a core enabler project identified in the Catchment Condition and Priorities report [PHCC 2011], with the appointment of a Senior Scientist to have responsibility for coordination and investment. The focus would initially be on the Estuary, then over the wider catchment, hence \$14 million may be an underestimation of the costs of delivering this.



Murdoch University grounds.
Photo Office of Corporate Communications and Public Relations, Murdoch University

Recommendation 13

The pathway to gaining security around future funding for monitoring, evaluation and reporting on the current and future predicted ecosystem health of the Peel-Harvey Estuary requires appropriate problem recognition, community support and political action.

Author Comment

Much of the success of the South-East Queensland Healthy Waterways Partnership and the European Union Water Framework Directive (refer Chapter 7) comes from community empowerment and a willingness to look beyond the catchment to the health of the estuary and adjacent riverine and marine waters. Adequacy for funding monitoring, evaluation and reporting on estuarine health by Governments will only occur through problem recognition and political lobbying. Unfortunately for the Peel-Harvey Estuary, political interest in its ecosystem health waned following the construction of the Dawesville Channel.

Ongoing population growth, intensification of development and freshwater extraction within the catchment and increasing use of the waterways will again threaten the ecosystem health of the estuary. There is evidence to suggest this is already the case (refer Chapter 3).

It is paradoxical that the loss of dolphins in the Swan-Canning Estuary has caused the Chief Scientist for Western Australia to report that these deaths are symptomatic of a larger problem, i.e. the ecosystem health of the estuary itself.

It is becoming more evident that there are growing risks for the ecosystem health of other estuaries in south-western Australia.

PHCC Response

The statement is acknowledged. The PHCC is actively working to raise awareness of the scope of issues and prompt action by delivering science outcomes to all levels of Government and implementing community awareness programs. The challenge of raising the awareness of the deterioration of the Estuary is greater now that it was in the late 80's and early 90's when it was impossible to ignore the algal blooms and associated odour. People who live near or recreate on the Rivers know things are not right but the Estuary looks clean and, while community understand there have been some changes [e.g. less fish and prawns], the majority don't understand the real state of the Estuary and the risks of not taking immediate action. The South East Queensland model is an excellent example of how adequate identification and communication of an issue can provide a catalyst for political action.

Recommendation 14

One possible pathway is for the community to seek a formal, independent, Government-lead inquiry, with appropriate terms of reference, that examines the current status of the State's significant estuaries with respect to their funding, legislative and governance arrangements and their programs for monitoring, evaluating and reporting ecosystem health status. The inquiry needs to take into account the current and future risks for these estuaries from the impacts of climate change, population growth, freshwater extraction and catchment development. The inquiry, as a minimum, ought to focus on the Swan-Canning Estuary, the Peel-Harvey Estuary, the Leschenault Estuary, the Vasse region, Hardy Inlet, Wilson Inlet and Oyster Harbour, and their relevant catchments.

Author Comment

The recently released report by the Chief Scientist Lyn Beazley on "Dolphin deaths in the Swan-Canning River Park and comments on the Bunbury inner waters, South West of Western Australia" has proposed a similar review to examine estuarine health (see recommendation 8 of that report). The above recommendation adds support and provides the basis for determining the "terms of reference" for a working group to be commissioned by the Minister for Environment, quoted below.

"The Minister to establish a working group with extensive experience of science and government policy. The group should report within six months and recommend initiatives that build on existing local expertise and science infrastructure in the field of marine mammal health and estuarine health. The working group should consider ways to achieve greater integration between government agencies, science institutions, industry and the community. Arrangements should ensure that the scientific activities are conducted

to an international standard and that there are clear reporting mechanisms of achieved outcomes."

The authors strongly endorse this recommendation and welcome Minister Faraghar's action to proceed with this recommendation.

The PHCC should consider the merits of a broader enquiry and, in the context of Lyn Beazley's report, seek support for the working group to consider the need for the community to have a greater understanding of ecosystem health in all estuaries in south-western Australia, and to determine action required for improving management of those systems. Should this not proceed, the option of a committee enquiry is recommended.


PHCC Response

It is recognised that Estuaries fall between the gaps of proper governance and these important community assets are deteriorating as a result of this. Action needs to be taken and while it would be preferred that an independent inquiry not be required, perhaps, if no meaningful action is taken, this should be pursued.

*Laboratory activity at Murdoch University.
Photo Office of Corporate Communications and Public Relations, Murdoch University*







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Peel Harvey Catchment Council
PO Box 3450
Mandurah East WA 6210
www.peel-harvey.org.au