

PROCEEDINGS

Darwin Harbour Technical Workshops: Current knowledge and future needs

Hosted by the Darwin Harbour Advisory Committee

Northern Territory University, Darwin, Northern Territory.

February 2003.

DISCLAIMER

The views expressed in this document represent those of individuals who attended Darwin Harbour Technical Workshops. These workshops were undertaken as a component of a public consultation program undertaken by the Darwin Harbour Advisory Committee for the purposes of the development of a Plan of Management for Darwin Harbour and its catchment. Comments in this document do not necessarily represent the views of the Darwin Harbour Advisory Committee.

SUMMARY

The Darwin Harbour Advisory Committee is a community based reference group established by Government in late 2002 to oversee the development and subsequent implementation of a Plan of Management for Darwin Harbour and its catchment. The committee comprises NT community and government representatives involved in the planning and management of the coastal and marine environment.

The Plan of Management for Darwin Harbour and its catchment will provide strategic direction and advice on the management of water and land-based activities that affect the range of values and uses of the harbour and its catchment. The Plan will inform decision-making processes and will incorporate a number of goals, strategies and actions to manage the use of the harbour and catchment. Measures will also include prioritised monitoring and research requirements to inform the ongoing management of this important resource.

A map detailing the Darwin Harbour Plan of Management area can be found at the following web site: www.ipe.nt.gov.au/divisions/dhac/index.html. For the purposes of the Darwin Harbour Plan of Management, the Harbour includes the waters and catchments bound by an imaginary line between Charles and Gunn Points. This includes the water of Darwin Harbour itself, (including Shoal Bay) as well as the catchments of the Howard River, Blackmore River and Elizabeth River, Buffalo Creek, Pioneer Creek, King Creek, Ludmilla Creek and Rapid Creek.

In February 2003, the Darwin Harbour Advisory Committee hosted a series of public consultation events to allow public input into the development of a Plan of Management for Darwin Harbour. The first of these events were the Darwin Harbour Public Presentations, held on the 11th (full day), 19th (morning only) and 26th (morning only) of February. These comprised presentations by scientists, government and industry representatives detailing current knowledge and understanding of the environments of the Darwin Harbour Plan of Management area, potential impacts and issues affecting those environments, future development and the recreational and cultural values of the region.

Three technical workshops followed each of the public presentation sessions at Northern Territory University on 12th (full day), 19th (afternoon only) and 26th (afternoon only) February 2003. These technical workshops discussed the issues of concern for the marine and estuarine environments (Workshop 1) and the terrestrial and freshwater environments (Workshop 2) of Darwin Harbour and its catchment. Workshop 3 discussed the values and uses of Darwin Harbour and its catchment and recommendations to protect or address these values and uses.

These proceedings outline the outcomes of the technical workshops, as summarised from notes taken by nominated scribes and facilitators. The comments provided in these proceedings are those of workshop participants and do not necessarily reflect the opinions of the Darwin Harbour Advisory Committee.

These proceedings are publicly available through the Darwin Harbour Advisory Committee or via the Department of Infrastructure, Planning and Environment website (www.ipe.nt.gov.au).

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WORKSHOP 1: MARINE AND ESTUARINE ENVIRONMENTS OF DARWIN HARBOUR

Introduction

On Wednesday 12th February 2003, the Darwin Harbour Advisory Committee hosted a full day workshop at Northern Territory University to discuss the issues of concern for the marine and estuarine environments of the Darwin Harbour Plan of Management area. Invited participants in the workshop comprised scientists, Darwin Harbour Advisory Committee members, Darwin Harbour Working Group members as well as representatives from key industry, commerce and community groups.

Objectives of the workshop

- To identify the major issues of concern for the marine and estuarine environments of the Darwin Harbour Plan of Management area;
- To identify generally what we need to know to assess the impact of these issues;
- To discuss the research and monitoring requirements to assess impacts and to improve our understanding of the harbour environments.

Participants

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Scott Bainbridge	Australian Institute of Marine Science
Julie Bennett	Department of Infrastructure, Planning and Environment
Anthony Bougher	URS Australia
Steve Caldwell	Department of Infrastructure, Planning and Environment
Julian Caley	Australian Institute of Marine Science
Caroline Camilleri	Environmental Research Institute of the Supervising Scientist
Ray Chatto	Department of Infrastructure, Planning and Environment
Helen Cribb	Department of Business, Industry and Resource Development
Peter Dostine	Department of Infrastructure, Planning and Environment
Brendan Dowd	Darwin City Council/ Darwin Harbour Advisory Committee
Julia Fortune	Department of Infrastructure, Planning and Environment
Samantha Fox	Department of Infrastructure, Planning and Environment
Belinda Glasby	Museum and Art Gallery of the Northern Territory
Simon Goodhand	Department of Infrastructure, Planning and Environment
Roland Griffin	Department of Business, Industry and Resource Development/ Darwin Harbour Working Group
Sue Jackson	The Marine and Coastal Community Network/ Darwin Harbour Advisory Committee
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Armando Padovan	Department of Infrastructure, Planning and Environment
Bill Panton	Department of Infrastructure, Planning and Environment
David Parry	Northern Territory University
Barry Russell	Museum and Art Gallery of the Northern Territory/ Darwin Harbour Working Group
Tony Scherer	Palmerston City Council
Neil Smit	Department of Infrastructure, Planning and Environment/ Darwin Harbour Working Group
Ray Taylor	Save Darwin Harbour Group
Frank Tirendi	Australian Institute of Marine Science/ Darwin Harbour Advisory Committee
Simon Townsend	Department of Infrastructure, Planning and Environment/ Darwin Harbour Working Group
Janice Warren	Department of Infrastructure, Planning and Environment/ Darwin Harbour Working Group
Scott Whiting	Biomarine International
David Williams	Department of Infrastructure, Planning and Environment
Eric Wolanski	Australian Institute of Marine Science

Process outline

Participants were divided into six focus groups which each contained scientists, stakeholders and advisory committee or working group members. Each group contained a facilitator (preselected and briefed about proceedings) and a scribe to record discussions.

Groups were asked to address the following questions:

1. What are the current major management issues that affect the marine and estuarine environments of Darwin Harbour Plan of Management area?
2. What is the relative and current importance of the identified issues?
3. For each of the nominated issues, what should we know about the marine and estuarine environments in order to assess the impacts of the issue and who should contribute to providing this information?
4. For each of the monitoring streams (water quality and hydrodynamics, benthos/seagrasses/corals, mangrove ecosystems, fish and fisheries and other vertebrates) what we need to know before any monitoring is undertaken; what indicators should be monitored; what research should be undertaken; and what are the opportunities for collaboration and financial partnerships?

For Questions 1 and 3, focus groups were prearranged to ensure that various viewpoints were expressed in each group. For Question 2, individuals were asked to vote on the importance of issues.

Section 1. Current management issues for the marine and estuarine environments of the Darwin Harbour Plan of Management area

The workshop identified the following management issues for the marine and estuarine environments:

- Aquaculture
- Climate change
- Coastal erosion
- Data management (including data quality)
- Fishing and harvesting practices
- Habitat degradation and loss, and impacts on biodiversity
- Introduced flora, fauna and pathogens
- Modification of catchment hydrology
- Modification of harbour hydrodynamics and sediment transport dynamics
- Pollution (including atmospheric pollution, debris and waste management)
- Vessel disturbance

Section 2. Importance of management issues for the marine and estuarine environments of the Darwin Harbour Plan of Management area

Issues were ranked as follows:

Issue	Score	%
Habitat degradation and loss, and impacts on biodiversity	73	23.7
Pollution	57	18.5
Data management	47	15.3
Fishing and harvesting practices	37	12.0
Modification of harbour hydrodynamics and sediment transport dynamics	35	11.4
Introduced flora, fauna and pathogens	24	7.8
Modification of catchment hydrology	21	6.8
Aquaculture	9	2.9
Climate change	2	0.6
Coastal erosion	2	0.6
Vessel disturbance	1	0.3
TOTAL	308	100

The importance of each issue was discussed, with the following points raised:

Habitat degradation and loss, and impacts on biodiversity

- Critical habitats need to be identified, mapped and better understood.
- Draining of swamps to reduce mosquito populations leads to loss of habitat.
- Reclamation of mangroves is loss of habitat and also leads to degradation around margins of reclamation.
- Identification and protection of areas for conservation and maintenance of biodiversity are important.
- Biodiversity is a poorly understood term.
- Urban development and agriculture cause loss of habitat.
- Key species need to be monitored to allow planning and management.

Pollution

- Pollution refers to changes in water quality from baseline natural levels.
- Pollution is “a misplaced resource”.
- Pollution may arise from many sources – urban development, industrial development, agriculture, horticulture, aquaculture etc.
- Sediment is included as a pollutant, with turbidity as an indirect measure. Sediment also has the ability to bind other contaminants.
- Pollution includes both point source (sewage, oil, aquaculture discharge) and diffuse (stormwater, fertilisers, pesticides, heavy metals) pollution.
- Pollution includes atmospheric deposition of ash and particulates from fires, which may have impacts on water quality.
- Atmospheric pollutants (through industrial air emissions etc) may also impact upon water quality through precipitation (eg acid rain).
- Litter and debris (deliberate dumping of rubbish) are important forms of pollution.
- Land fills and dump sites need better management as they act as sources of pollution.
- Stormwater management is an issue of concern.
- Sewage treatment is an issue of concern. Treatment needs to be appropriate and baseline data is required to determine what is acceptable.
- Produce spillage upon ship loading can contribute to pollution.
- Chemicals used for insect management may have impacts other environments (eg mangroves).
- There needs to be quantification of sources of pollution.
- There needs to be research into pollution thresholds and the extent of pollution that leads to adverse change. Also into the level of change that is unacceptable (which depends upon perspective).
- Incremental impacts and effects occur over time, and are often not recognised.

Data management

- A coordinated approach to data management is required to determine what has been done (baseline data) and what needs to be done (gap analysis for future research).
- There is a lack of communication and integration within government, as well as external to government.

- Integrated management is important.

Fishing and harvesting practices

- More baseline data is required to fully understand the importance of this issue.
- The sustainability of fisheries should also be considered.

Modification of harbour hydrodynamics and sediment transport dynamics

- Better tools for hydrodynamics and sediment transport need to be developed to allow prediction/understanding of impacts.
- This category includes dredging and the introduction of solid structures (such as wharves and jetties).

Introduced flora, fauna and pathogens

- This category refers to “non indigenous species”.
- There is a delineation between pest species and introduced species as not all introduced species are threatening or reach “pest” status.

Modification of catchment hydrology

- Land use impacts upon catchment hydrology.
- Dams, weirs etc also impact upon catchment hydrology.

Aquaculture

- This category represents an emerging issue, which is separate from fishing as it occurs in different areas, with different impacts. Pollution is a potential impact.

Climate change

- This category includes the impacts of sea-level rise, temperature change and changes to rainfall distribution.
- Require good baseline data to determine what changes are occurring.
- The problem is very broad and perhaps beyond the scope of the Plan of Management. But the issue may have impacts within the harbour area which need to be managed, or at least recognised.

Coastal erosion

- This category includes natural coastal erosion as well as human induced erosion.
- This is related to hydrodynamics.
- Geomorphology of an area effects erosion rates.

Vessel disturbance

- Shipping/boating disturbance may not be a big issue, but if the impact of waves and wash are also taken into consideration, then the issue has broader potential impacts.
- This category includes the effects on marine life of boat strike, wave action and bottom disturbance.
- Impacts are not only upon mammals and reptiles, but also upon systems such as reefs.
- This category includes both shipping as a commercial activity and recreational boating.

Other

- Public awareness and education is important.
- Access to the environment by the public is also an issue. People, vehicles and domestic pets may cause environmental impacts.
- Integrated and coordinated management is important. Various agencies and bodies must undertake coordinated management and research.
- Planning for future development needs to assess the ecological impacts in the short term and long term. It needs to incorporate design elements to minimise these impacts.
- Approval processes need to assess impacts upon environment as a whole.
- Ongoing management is required to ensure that long term issues are addressed in the short term.
- Political pressure often interferes with management processes, with vested interests overriding best management.

Section 3. Knowledge requirements for addressing issues identified and parties who can contribute to providing knowledge and management

3a. Issue: Habitat degradation and loss, and impacts on biodiversity

Knowledge requirements

The following knowledge requirements were identified to address habitat degradation and loss, and impacts on biodiversity:

- Baseline studies of the harbour to map habitats and to determine biodiversity value of the habitats, community structure, significant species and dependence of species on habitat.
- Identification and mapping of critical habitats, including supra-littoral swamps and reefs.
- Quantification of current sources of threat and impacts.
- Understanding the ecological processes in habitats to determine how they will be affected by disturbances.

- Development of predictive tools for assessing impacts of developments on habitats and biota.
- Ongoing monitoring of biota for disturbance.
- Determination and monitoring of keystone species (ecologically important/totemic species).
- Determination of areas for protection (zoning).
- Development of thresholds of disturbance/impact to trigger management responses.

Contributing organisations

The following organisations and contributions were identified:

- An independent body is required which can coordinate and integrate data and information from all sources. This group would need to develop a vision, have dedicated resources, an administrative structure, access across government departments and be able to implement actions. Perhaps there could be an ongoing role for the Darwin Harbour Advisory Committee.
- NT Government
 - Department of Business, Industry and Resource Development - data from research and monitoring, tools for management.
 - Department of Infrastructure, Planning and Environment –data from research and monitoring, tools for management and quantification of sources.
- CRC for Sustainable Development of Tropical Savannas
- Northern Territory University
- Commonwealth Scientific and Industrial Research Organisation

3b. Issue: Pollution

General discussion

General discussion of pollution as an issue highlighted the following points:

- Sources of pollution include sewage; stormwater (urban, industrial, rural); general dumping of debris and litter; port related activities and ship maintenance (TBT, paints, rubbish, accidental spillage, ballast water etc); atmospheric deposition; dredging; reclamation; aquaculture; recreational boating.
- Impacts are often unknown and may be more prevalent in the wet season (stormwater). There may be impacts to biota, water quality (eg turbidity, nutrients, acidity, oil) and on aesthetic values.

Knowledge requirements

The following knowledge requirements were identified to address pollution:

- Collection of baseline data on water quality, pollutant loads, pollutant concentrations, biota. This will include collection of historic data through monitoring species such as corals which accumulate metals over time, as well as collation of monitoring datasets.
- Determination of the source of pollutants, points of discharge, pollutant loads and concentrations and the management controls already in place (eg litter traps). Sources may be point and non-point. Sources may also be within the harbour (eg. oil spills from vessels, dredging, disturbance of mangrove sediments) or external to it (non-point sources such as catchment runoff, which discharges to the harbour as a point source, but is managed as a diffuse source in the catchment and point sources such as wastewater effluent discharge).
- Determination of the fate of the pollutants (in sediment, water, biota), which requires improved understanding of the processes that determine that fate (requiring research into hydrology, catchment runoff, pollutant characterisation) and the impact on biota (assessed through biological indicators and bioaccumulators). This will enable prediction of impacts and appropriate siting of monitoring locations. There is also a need to determine appropriate biological indicators for monitoring.
- Determination of the appropriate types and locations of management measures based on information on fates, loads, impacts etc (such as determining location of litter traps, determining water quality objectives, thresholds for sediment and biota concentrations of pollutants etc).
- Understanding of the current legislative and regulatory framework.
- Understanding of lessons learned through case studies in Australia and overseas.

Contributing organisations

The following organisations and contributions were identified:

- A Darwin Harbour Management Authority should be established to oversee coordination and integration.
- Federal Government
 - Department of Defence - monitoring data collected for licences, pollutant quantification data.
- NT Government
 - Department of Infrastructure, Planning and Environment –coordination and overview, as well as providing data from research and monitoring and quantification of sources.
 - Office of Environment and Heritage - monitoring data collected for licences, pollutant quantification data.
 - Power Water –licence monitoring data, pollutant quantification data.
- Local Government – monitoring data collected for licences, pollutant quantification data, particularly in relation to stormwater.
 - Coomalie Community Government Council
 - Cox Peninsula Community Government Council
 - Darwin City Council
 - Litchfield Shire Council
 - Palmerston City Council

- Industry –National Pollutant Inventory data and data obtained from licence based monitoring.
 - Darwin Port Corporation and Marina Authorities
 - Community
 - Greening Australia – National data.
 - Waterwatch – Water quality data.
 - CRC for Sustainable Development of Tropical Savannas
 - National Centre for Tropical Wetland Research
 - Northern Territory University
 - Centre for Tropical Wetlands Management
 - Postgraduate students
 - Researchers
 - Australian Institute of Marine Science
 - Commonwealth Scientific and Industrial Research Organisation
 - Centre for Research on Introduced Marine Pests
 - Indigenous groups
 - CRC for Coastal Zone, Estuarine and Waterway Management
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3c. Issue: Data management

Knowledge requirements

The following knowledge requirements were identified to address data management:

- Determination of frameworks existing for data management.
- Collection of metadata – what kind of data is there, who ‘owns’ it, what quality is the data, where was the data collected?
- Development of guidelines for the collection of data – standardisation of methodology to ensure data quality, standardised analysis, standard nomenclature, spatial presentation of data.
- Determination of type of data required for management and understanding.
- Determination of the data gaps.
- Collection of data to fill the knowledge gaps.

Contributing organisations

The following organisations and contributions were identified:

- A lead agency or consultant may have a role in developing a data management system. Organisations who require data or have data would then pay this lead agency/consultant to manage data. Data licencing agreements would determine the use and availability of the data, with key data being available to the public (eg mapping). Metadata only may be available for other data sources which are more sensitive or incomplete. This will enable strategic collection of data and reduction in overlapping data collection. This agency may also process unpublished data, analyse results and direct research.

- Researchers who undertake studies requiring a permit are required through that permit to provide research data to the databank.
- Organisations requiring data could pay for that data, thus funding the data coordination agency.

Data contributors:

- Federal Government
 - Bureau of Meteorology
 - Department of Defence
 - Geoscience Australia
- NT Government
 - Department of Business, Industry and Resource Development
 - Department of Infrastructure, Planning and Environment
 - Museum and Art Gallery of the Northern Territory
 - Office of Environment and Heritage
 - Power Water
- Local Government
 - Coomalie Community Government Council
 - Cox Peninsula Community Government Council
 - Darwin City Council
 - Litchfield Shire Council
 - Palmerston City Council
- Industry
- Darwin Port Corporation and Marina Authorities
- Community
 - Amateur Fishing Association of the Northern Territory
- CRC for Sustainable Development of Tropical Savannas
- Northern Territory University
- Environmental consultants
- Australian Institute of Marine Science
- Commonwealth Scientific and Industrial Research Organisation

3d. Issue: Fishing and harvesting practices

Knowledge requirements

The following knowledge requirements were identified to address fishing and harvesting practices:

- Fisheries resource assessments.
- Determination of demography/population biology of key harbour species.
- Creel surveys – quantification of fishing effort, species caught, size, post release survival.
- Determination of life cycle stage requirements – feeding grounds, nursery grounds, ontogenetic migration and habitat requirements.
- Identification of critical habitats.
- Understanding of spawning aggregation requirements.

- Understanding of indigenous requirements and use of indigenous knowledge.
- Assessment of lessons learned from other case studies.
- Quantification of harvesting of fauna by indigenous groups.

Contributing organisations

The following organisations and contributions were identified:

- Federal Government
 - Agriculture, Fisheries and Forestry– case studies.
 - Environment Australia – case studies.
- NT Government
 - Department of Business, Industry and Resource Development – lead agency, creel surveys, fisheries resource assessments, demography, life cycle requirements, critical habitats, spawning aggregations etc.
 - Department of Infrastructure, Planning and Environment – research.
 - Museum and Art Gallery of the Northern Territory - demography, life cycle requirements, critical habitats, spawning aggregations etc.
- Community
 - Amateur Fishing Association of the Northern Territory - creel surveys, public education, tagging data, post release survival.
 - Northern Territory Seafood Council
- Northern Territory University - demography, life cycle requirements, critical habitats, spawning aggregations etc.
- Australian Institute of Marine Science - demography, life cycle requirements, critical habitats, spawning aggregations etc.
- Northern Land Council – indigenous use, knowledge and harvesting.

3e. Issue: Modification of harbour hydrodynamics and sediment transport dynamics

Knowledge requirements

The following knowledge requirements were identified to address modification of harbour hydrodynamics and sediment transport dynamics:

- Baseline and ongoing bathymetric data, particularly in the upper part of the arms. Three-dimensional coordinates (x, y, z) are required for the entire harbour to the high tide mark.
- Knowledge of sediment distribution, type and substrate through a grided survey with approximately 100m resolution. In certain areas such as capes, headlands, reefs, intertidal zones, etc resolution would need to be much finer. Also need to know about particle size, density, layering, fall velocity, sheer velocity.
- Knowledge of land use changes and the resulting changes in sediment fluxes and flows.

- Understanding of processes and dynamics during different weather patterns – flood, drought etc.
- Knowledge of current processes and tides – strength and direction of currents, tide heights, boundary currents.
- Knowledge of physical wave height.
- Measurement of fine sediment loads and dynamics and sand loads and dynamics.
- Modelling of the Shoal Bay area is required also, with two separate models for the main Darwin Harbour area and Shoal Bay.

Contributing organisations

The following organisations and contributions were identified:

- Federal Government
 - Department of Defence
 - NT Government
 - Department of Infrastructure, Planning and Environment – lead agency, research and monitoring.
 - Darwin Port Corporation and Marina Authorities – bathymetry.
 - Australian Institute of Marine Science – research.
 - Environmental consultants – bathymetry and research.
-

3f. Issue: Introduced flora, fauna and pathogens

Knowledge requirements

The following knowledge requirements were identified to address introduced flora, fauna and pathogens:

- Baseline knowledge of ecosystem processes and health and of the indigenous fauna, flora and pathogens. This includes environmental risk assessment (available habitats, seasonal information, disturbance etc).
- Determination of transport vectors for introduction.
- Knowledge of predisposition of non-indigenous species to persistence in the environment (population biology of potential introductions).
- Assessment of lessons learned in other regions and case studies.
- Bio-regional risk assessment.
- Implementation of a monitoring system to identify introductions when they occur.

Contributing organisations

The following organisations and contributions were identified:

- Federal Government
 - Agriculture, Fisheries and Forestry– case studies.
 - Australian Quarantine and Inspection Service – transport vectors, predisposition to persistence, bioregional risk assessment.
 - Environment Australia – case studies.

- NT Government
 - Department of Business, Industry and Resource Development – lead agency, predisposition to persistence, baseline knowledge, transport vectors, bioregional risk assessment, monitoring system.
 - Department of Infrastructure, Planning and Environment – baseline knowledge, bioregional risk assessment.
 - Museum and Art Gallery of the Northern Territory - baseline knowledge.
 - Northern Territory University – baseline knowledge, predisposition to persistence.
 - Australian Institute of Marine Science - baseline knowledge, predisposition to persistence.
 - Commonwealth Scientific and Industrial Research Organisation
 - Centre for Research on Introduced Marine Pests – case studies, predisposition to persistence, transport vectors.
 - Darwin Port Corporation and Marina Authorities – monitoring system, transport vectors, legislation and enforcement.
 - Community - monitoring system.
-

3g. Issue: Modification of catchment hydrology

Knowledge requirements

The following knowledge requirements were identified to address modification of catchment hydrology:

- Collection of rainfall distribution data.
 - Development of a catchment runoff model that incorporates land use and vegetation changes to determine impacts of developments. This can be used as a design tool to ensure that developments are not detrimental.
 - Understanding of vegetation changes and land use changes in the catchment.
 - Understanding of processes during cyclonic conditions.
 - Knowledge of groundwater quality and quantity and impacts of land use and vegetation.
 - Definition of acceptable water quality standards for catchment runoff entering the harbour. These standards need to be based on scientific data and indicator species.
-

Section 4. Research and monitoring requirements to address identified issues

4a. Hydrodynamics and water quality

Knowledge requirements prior to monitoring:

- Quantification of data and information - What data and information already exists. Where? Quality? In what form?
- The reasons for monitoring:

- For generic, broad scale reporting (eg State of the Environment) for decision support
- To monitor a specific site or issue (e.g. point source discharge monitoring) to detect change
- To collect data to better understand ecological processes to support better decision making.

Indicators for monitoring:

- A risk analysis of threats should be undertaken.
- Traditional water quality parameters (dissolved oxygen, temperature, nitrogen, phosphorous, carbon, physical parameters).
- Bio-indicators, supported by eco-toxicological information.

Research to be undertaken:

- New sampling methods need to be identified eg time integrated indicator such as bio-indicator organisms.
- An overall model for the health of Darwin Harbour.
- Research into the underlying processes in the harbour, through development of numerical and conceptual models.
- Development of new tools and application of new technologies.

Potential collaborators and financial partnerships:

A proportion of capital works should be allocated to support monitoring and information collection to contribute to better management.

- Federal government
 - Australian Research Council
 - National Heritage Trust
- NT Government
 - Department of Infrastructure, Planning and Environment
- Darwin Port Corporation
- Industry
- Community
 - Amateur Fishing Association of the Northern Territory

4b. Benthos/seagrasses/corals

Knowledge requirements prior to monitoring:

- Historical data collection and management arrangements.
- Baseline information (flora and fauna).
- Spatial distribution of species and boundaries.

- Characterisation and identification of habitats.
- Species composition of habitats, key species and bio-indicators.
- Water quality and other environmental parameters.
- Ecological processes.
- Identification of sources of threat/potential disturbance.

Indicators for monitoring and research requirements:

- Water quality parameters (nutrients, flow, quantity, hydrocarbons, oil, fertilisers, heavy metals, chlorophyll, organics).
- Community assemblages.
- Comparison of impacted sites to control sites to detect changes.
- Identification of the health of the communities.
- Trophic structure and interaction.
- Ephyte levels (indicator of nutrients).
- Research on algae is required.

Potential collaborators and financial partnerships:

- Federal government
 - Australian Customs Service
 - Australian Quarantine and Inspection Service
- NT Government
 - Department of Business, Industry and Resource Development
 - Department of Infrastructure, Planning and Environment
 - Museum and Art Gallery of the Northern Territory
- Northern Territory University
- Darwin Port Corporation
- Industry
- Australian Marine Science Association
- Australian Institute of Marine Science

4c. Mangrove ecosystems

Knowledge requirements prior to monitoring:

- Species composition and distribution across the entire harbour at a sufficient scale
- Processes for the maintenance of mangal ecosystems – hydrological, ecological processes, responses to disturbance and recovery.
- Quantification of threats to the system.
- Collation of existing information and data to determine data gaps and to direct strategic research towards threats and gaps.

Indicators for monitoring:

- Condition.

- Canopy cover.
- Structure.
- Basal area.
- Invertebrate diversity and abundance.
- Sedimentation.
- Bioaccumulation.
- Heavy metals.
- Productivity.

Research to be undertaken:

- Need to broaden the range of sites in the harbour to quantify variability, adequately assess impacts and to cover Shoal Bay.
- Identify indicator species, thresholds for species tolerance for nutrients etc.
- A robust model to predict impacts of proposed developments.
- Research to determine the best indicators for monitoring.
- Impacts of speed boats on mangal.
- Linkages between mangal and other habitats.
- Identification of key indicator species.
- Model of sediment transport to predict impact of development.
- Baseline information on heavy metals in flora and fauna.
- Role of crab burrows in mangal.
- Identification of key areas for protection.

Potential collaborators and financial partnerships:

- NT Government
 - Department of Business, Industry and Resource Development
 - Department of Infrastructure, Planning and Environment
 - Museum and Art Gallery of the Northern Territory
- Northern Territory University
- Cooperative Research Centres
- Industry
- Australian Institute of Marine Science
- Environmental Research Institute of the Supervising Scientist
- Community
 - Amateur Fishing Association of the Northern Territory
- Tourism Industry

4d. Fish and fisheries

Knowledge requirements prior to monitoring:

- Understanding of fish species biology and population dynamics.
- Knowledge of the behaviour of fish and anglers.

- Data on trophic relationships – diet and habitat requirements throughout lifecycles.
- Broadscale standardised monitoring program.
- Impacts of recreational fishing - size of the harvest, the size and age of harvested fish and data and on the survival of released fish.
- Information on the by-catch of recreational fishing, particularly sharks and catfish.
- Habitat mapping to gain an understanding of the relationships between fish and different habitat types such as reefs, mangroves, mudflats etc depending on age, sex or other factors.
- Impacts and requirements of indigenous harvesting.
- Role of artificial reefs in the Darwin Harbour fishery.

Indicators for monitoring:

- Size and age structure data.
- Relative abundance.
- Catch and effort.
- Angler satisfaction.
- Estimates of post-release mortality of the key indicator species e.g. barramundi, snapper, bream.

Research to be undertaken:

- Identification and assessment of nursery and juvenile habitats and protection of these sites.
- Identification and protection of spawning aggregation sites.
- Surveys to monitor and assess the impacts of various resource user groups. Groups that could potentially be targeted include charters, beach seiners, Amateur Fishing Association of the Northern Territory members, the aquarium fishery and coastal line (commercial) fishery.
- Dietary analysis of the catch to determine trophic relationships.
- Research into fish life-cycles to determine the habitat requirements.
- Shell middens may be able to provide baseline data on the size/age distribution of fish populations prior to European settlement.
- Fish species which have conservation or endangered status need to be separately identified and monitored.
- Monitoring of fish tissues for elevated levels of pollutants and the potential effects of fish consumption on human health.
- Monitoring of fish populations for the impacts of transitory events such as dredging (impacts are usually localised) or cyclones.

Potential collaborators and financial partnerships:

Management of the fisheries resource may be improved by licensing recreational fishers, charter boat operators etc and obtaining data from logbooks, surveys etc.

- NT Government
 - Department of Business, Industry and Resource Development
 - Department of Infrastructure, Planning and Environment

- Museum and Art Gallery of the Northern Territory
 - Community
 - Amateur Fishing Association of the Northern Territory
 - Northern Territory Seafood Council
 - Industry
 - Darwin Port Corporation
 - Commercial and aquarium fisheries
 - Northern Territory University
 - Australian Institute of Marine Science
 - Indigenous communities
-

4e. Other vertebrates (birds, mammals, reptiles)

Knowledge requirements prior to monitoring:

- Species diversity in the harbour.
- Identification of critical habitats for species.
- Seasonal distribution of species.
- Regional, national and international importance of the species (conservation status, iconic species).
- Migration and movement of species.

Indicators for monitoring:

- Monitoring of key indicator species and/or iconic species.
- Long term monitoring and event based monitoring.
- Population structure and dynamics (eg nesting, population abundance, size, distribution).
- Resource needs within and external to the harbour.
- Sublethal stress (eg heavy metals, heat stress).
- Lethal stress (eg stranding, boat strikes).
- Community structure and dynamics.
- Habitat indicators.
- Behaviour patterns.

Research to be undertaken:

- Relative importance of different resources to different species and communities (critical habitats).
- Social significance of species.
- Diet.
- Migration patterns and requirements.
- Impacts of certain types of disturbance (eg shipping).
- Stranding database should be developed.
- “Harbour watch” program could be developed to monitor whales etc.
- Investigate opportunities for public education programs (eg Casuarina Beach).

- Assess other programs in other regions to define monitoring indicators.
- Traditional harvesting pressures.
- Further research on mangrove snakes required.
- Investigate tourism opportunities to assist in funding of research and monitoring.
- Behaviour of animals and the impacts of disturbance.

Potential collaborators and financial partnerships:

Should capitalise on iconic species to gain support and funding.

- Federal Government
 - Environment Australia
 - National Oceans Office
- NT Government
- Local Government
- Industry and local businesses
- Community
 - Birds Australia
 - Conservation Groups
 - EarthWatch
 - Foundations
 - Non Government Organisations
 - Volunteer Research Groups
- Tourism industry
- Northern Territory University
- Australian Institute of Marine Science
- Indigenous communities

Other issues

In general discussion, several points were raised which were carried forward to subsequent workshops. These included:

- Need for integrated management to aid development assessment and decision making.
- Interference of political/vested interests in best management.
- Need for public education and development of agreed environmental values.
- Recognition of cultural issues.

WORKSHOP 2: TERRESTRIAL AND FRESHWATER ENVIRONMENTS OF THE DARWIN HARBOUR CATCHMENT

Introduction

On Wednesday 19th February 2003, the Darwin Harbour Advisory Committee hosted a half day workshop at Northern Territory University to discuss the issues of concern for the freshwater and terrestrial environments of Darwin Harbour catchment. Invited participants in the workshop comprised scientists, Darwin Harbour Advisory Committee members, Darwin Harbour Working Group members as well as representatives from key industry, commerce and community groups.

Objectives of the workshop

- To identify the major issues of concern for the terrestrial and freshwater environments of the Darwin Harbour Plan of Management area;
- To identify generally what we need to know to assess the impact of these issues.

Participants

<u>Name</u>	<u>Organisation</u>
John Bailey	Darwin Harbour Advisory Committee
Del Batton	Department of Infrastructure, Planning and Environment/ Darwin Harbour Working Group
Julie Bennett	Department of Infrastructure, Planning and Environment
Kirsten Blair	Environment Centre of the Northern Territory/ Darwin Harbour Advisory Committee
Steve Caldwell	Department of Infrastructure, Planning and Environment
Caroline Camilleri	Environmental Research Institute of the Supervising Scientist
Peter Dostine	Department of Infrastructure, Planning and Environment
Brendan Dowd	Darwin City Council/ Darwin Harbour Advisory Committee
Julia Fortune	Department of Infrastructure, Planning and Environment
Samantha Fox	Department of Infrastructure, Planning and Environment
Simon Goodhand	Department of Infrastructure, Planning and Environment
Roland Griffin	Department of Business, Industry and Resource Development/ Darwin Harbour Working Group
Trevor Haig	Department of Infrastructure, Planning and Environment
Sally Jacka	Land for Wildlife, Litchfield Shire Council
Bob Karfs	Department of Infrastructure, Planning and Environment
Sally Kent	Northern Territory University
Ian Lancaster	Department of Infrastructure, Planning and Environment
Geraldine Lee	Department of Infrastructure, Planning and Environment
Mike Letnic	Department of Infrastructure, Planning and Environment
Christine Long	Department of Infrastructure, Planning and Environment
Andria Marshall	Department of Business, Industry and Resource Development
Mark Meekan	Australian Institute of Marine Science
Armando Padovan	Department of Infrastructure, Planning and Environment

Bob Pidgeon	Environmental Research Institute of Supervising Scientist
Steve Pople	Department of Infrastructure, Planning and Environment
Owen Price	Department of Infrastructure, Planning and Environment/ Darwin Harbour Working Group
Donna Rayner	Northern Territory University
Barry Russell	Museum and Art Gallery of the Northern Territory/ Darwin Harbour Working Group
Tony Scherer	Palmerston City Council
Ray Taylor	Save Darwin Harbour Group
Simon Townsend	Department of Infrastructure, Planning and Environment/ Darwin Harbour Working Group
Penny Wurm	Tropical Savannas CRC - Northern Territory University/ Darwin Harbour Working Group

Process outline

Participants were divided into four focus groups which each contained scientists, stakeholders and advisory committee or working group members. Each group contained a facilitator (preselected and briefed about proceedings) and a scribe to record discussions.

Groups were asked to address the following questions:

1. What are the current major management issues that affect the terrestrial and freshwater environments of the Darwin Harbour Plan of Management area?
2. What is the relative and current importance of the identified issues?
3. For each of the nominated issues, what should we know about the terrestrial and freshwater environments in order to assess the impacts of the issue and who should contribute to providing this information?

Section 1. Current major catchment issues that affect the freshwater and terrestrial environments of the Darwin Harbour Plan of Management area

The workshop identified the following management issues for the terrestrial and freshwater environments:

- Climate change
- Data management
- Groundwater extraction
- Habitat degradation and impacts on biodiversity
- Harvesting of native flora and fauna
- Impacts of recreational and stock access
- Introduced flora and fauna
- Modification of catchment hydrology and river geomorphology
- Pollution (including litter)

Section 2. Importance of management issues for the freshwater and terrestrial environments of the Darwin Harbour Plan of Management area

Issues were ranked as follows:

Issue	Score	%
Habitat degradation and impacts on biodiversity	64	27.5
Modification of catchment hydrology and river geomorphology	52	22.3
Pollution (including litter)	31	13.3
Introduced flora and fauna	30	12.9
Data management	20	8.6
Impacts of recreational and stock access	15	6.4
Groundwater extraction	12	5.2
Harvesting of native flora and fauna	7	3.0
Climate change	2	0.9
TOTAL	233	100

Section 3. Knowledge requirements for addressing issues identified and parties who can contribute to providing knowledge and management

3a. Issue: Pollution

General discussion

General discussion of pollution as an issue identified the following types and sources of pollution:

- Stormwater.
- Sewerage from licensed overflows.
- Horticulture derived pollutants including sediments, herbicides/pesticides and fertilisers.
- Extractive industry derived pollutants including sediments and hydrocarbons.
- Industry derived pollutants including nitrogen, and phosphorus, metals and hydrocarbons.
- Urban derived pollutants including sediment, nutrients, metals, hydrocarbons and swimming pool discharges.
- Aquaculture/feedlot (e.g. cattle feedlots and crocodile farms) derived pollutants primarily nutrients.
- Litter.

Knowledge requirements

The following knowledge requirements and actions were identified to address pollution:

- Establishment of baseline and control (unimpacted locations such as Bynoe Harbour) sites for monitoring pollutant loads in waterways.
- Establishment of a biological-monitoring program to assess the impact of fluctuating pollutant concentrations on the biota. This program needs to be established in concert with a pollutant-monitoring program.
- Research to establish response protocols for chemical spills, “data-spikes” detected by monitoring and fish/bird kills.
- Research to minimise the effects of pollutants.
- Development of a system of centralised/coordinated data management between agencies.
- Development of a public education program aimed at improving water quality.
- Adequate resourcing to undertake the above mentioned activities.
- Clear delegation of responsibility for monitoring, regulation and spill response.

Contributing organisations

The following organisations and contributions were identified:

- A coordinated regulatory body to oversee catchment activities that affect water-quality in the catchment.
- Federal Government
- Northern Territory Government
- Local Government
 - Coomalie Community Government Council
 - Cox Peninsula Community Government Council
 - Darwin City Council
 - Litchfield Shire Council
 - Palmerston City Council
- Non-government organisations
- Northern Territory University
- Community
- Industry

3b. Issue: Habitat degradation and loss, and impacts on biodiversity

Knowledge requirements

The following knowledge requirements and actions were identified to address habitat degradation and loss, and impacts on biodiversity:

- Identification of critical habitats that need protection.
- Identification of threatening processes to fauna.
- Research to establish ecological thresholds for clearing eg how large do corridors and fragments need to be to protect diversity.
- Research to establish if the diversity of fragment's biota is related to the proximity of other fragments.
- Research to improve the understanding of movements (seasonal/daily) by animal species between habitats, particularly rainforest to woodland.
- Information on biota, their distribution and associations with habitat types.
- Mapping of habitats.
- An inventory of wetlands.
- Inventories of riparian flora and fauna.
- Understanding of the effects of fire regimes on the biota.
- Research to determine ideal geographic configurations of corridors and fragments (landscape design) to facilitate biodiversity.
- Research into methods used to rehabilitate land used for extractive industries.
- Research to establish the importance of groundwater flows on fauna, particularly the impacts of groundwater extraction on wetland biota.

Contributing organisations

The following organisations were recognised as being able to contribute:

- NT Government
 - Department of Infrastructure, Planning and Environment
 - Department of Business, Industry and Resource Development
- Environmental Research Institute of the Supervising Scientist
- Northern Territory University
- CRC for Sustainable Development of Tropical Savannas
- Extractive industry and horticulture associations

3c. Issue: Modification of catchment hydrology and river geomorphology

Knowledge requirements

The following knowledge requirements and actions were identified to address modification of catchment hydrology and river geomorphology:

- Collation of existing data-sets and assessment of anecdotal evidence; identification of gaps in the data-set; collection of additional data.
- Collection of baseline data for ground water and surface water - increase in the frequency and extent of existing monitoring programs is required. Collection of baseline data on the surface water flows of smaller creeks.
- Inventory of land and water systems needs to be undertaken. In particular mapping is required at a smaller scale than currently exists. Smaller scale mapping will allow changes in conditions to be identified more reliably.

- Development of catchment models to simulate ecological processes and to understand the effects of catchment modifications such as clearing on stream flow – eg the development of models describing how land-use affects streams and modelling of the links between land, water and the biota.
- Development of a predictive spatial model that allows for the assessment of development impacts on catchment hydrology.
- Development of a mechanism for private sector drillers to keep records of rock types and water depths.

Contributing organisations

The following organisations and contributions were recognised:

- A peak coordination body to stimulate, coordinate and integrate the research and data should be established.
- NT Government
 - Department of Infrastructure, Planning and Environment - mapping of surface waters and groundwater, measurement of stream flows, mapping of land systems, establishment of a wetland inventory and baseline monitoring.
 - Department of Business, Industry and Resource Development - through geological mapping.
- Northern Territory University - studies of the impacts of changes in water levels on the biota, importance of environmental flows, modelling, wetlands mapping and biota inventories.
- Commonwealth Scientific and Industrial Research Organisation - studies on the dependence of fauna on environmental flows and modelling of hydrology.
- Environmental Research Institute of the Supervising Scientist -wetlands mapping and biota inventories.
- CRC for Sustainable Development of Tropical Savannas - wetlands mapping and biota inventories, education and public education and baseline monitoring.

3d. Issue: Introduced flora and fauna

Knowledge requirements

The following knowledge requirements and actions were identified to address introduced flora and fauna:

- Determining which species or life-forms (eg aquatic plants) constitute possible threats, particularly tropical species.
- Determining the vectors for each species or life-form through which they are likely to be introduced.
- Conducting baseline monitoring and inventories, so that the presence and impact of introduced species can be assessed.
- Research into the impacts of weed establishment on native fauna.

- Assessments of the risk of biological invasion posed by different organisms and vectors (risk analyses).
- Forums to discuss and share knowledge, establish baseline data and identify knowledge gaps.
- Development of monitoring and public education programs.
- Development of response strategies and plans.
- Allocation of resources to monitoring, education and management not just on individual management plans;

Contributing organisations

The following organisations and contributions were recognised:

- Federal Government - for the occurrence of introduced species on their estates.
- NT Government
 - Department of Infrastructure, Planning and Environment - for weeds and terrestrial fauna.
 - Department of Business, Industry and Resource Development - for fish and invertebrates.
- Local Government
 - Coomalie Community Government Council
 - Cox Peninsula Community Government Council
 - Darwin City Council
 - Litchfield Shire Council
 - Palmerston City Council
- Northern Territory University
- Community
 - Landcare
 - Coastcare
 - Waterwatch

Other issues

In general discussion, several points were raised which were carried forward the subsequent workshops. These included:

- Drainage, erosion and sediment.
- Coordination of knowledge and responsibility across the catchment.

WORKSHOP 3: SOCIAL AND ECONOMIC CONTEXT FOR DARWIN HARBOUR AND ITS CATCHMENT

Introduction

On Wednesday 26th February 2003, the Darwin Harbour Advisory Committee hosted a half day workshop at Northern Territory University to discuss the social, economic and environmental values of Darwin Harbour Plan of Management area. Invited participants in the workshop comprised scientists, Darwin Harbour Advisory Committee members, Darwin Harbour Working Group members as well as representatives from key industry, commerce and community groups.

Objectives of the workshop

- To identify the values and uses of Darwin Harbour Plan of Management area.
- To discuss how the Plan of Management can protect and address these values and uses.

Participants

<u>Name</u>	<u>Organisation</u>
Bob Adams	Department of Business, Industry and Resource Development
Graham Bailey	Department of Infrastructure, Planning and Environment
John Bailey	Darwin Harbour Advisory Committee
Del Batton	Department of Infrastructure, Planning and Environment/ Darwin Harbour Working Group
Chris Bell	NT Chamber of Commerce and Industry
Kirsten Blair	Environment Centre of the Northern Territory/ Darwin Harbour Advisory Committee
Steve Caldwell	Department of Infrastructure, Planning and Environment
Caroline Camilleri	Environmental Research Institute of the Supervising Scientist
Matt Coffey	Planning Action Network
Phil Cross	Department of Infrastructure, Planning and Environment/ Darwin Harbour Working Group
Duncan Dean	Save Darwin Harbour Group
Tony Desouza	
Ric Fallu	Department of Business, Industry and Resource Development
Julia Fortune	Department of Infrastructure, Planning and Environment
Craig Foster	Marine Harvest
Samantha Fox	Department of Infrastructure, Planning and Environment
Ken Grattan	Department of Infrastructure, Planning and Environment
Roland Griffin	Department of Business, Industry and Resource Development/ Darwin Harbour Working Group
Sally Jacka	Land for Wildlife, Litchfield Shire Council
Bob Karfs	Department of Infrastructure, Planning and Environment
Graham Kirby	Department of Business, Industry and Resource Development/

	Darwin Harbour Working Group
Geraldine Lee	Department of Infrastructure, Planning and Environment
Mike Letnic	Department of Infrastructure, Planning and Environment
Andria Marshall	Department of Business, Industry and Resource Development
Lesley Mearns	Aboriginal Areas Protection Authority
Mark Meekan	Australian Institute of Marine Science
David Mills	Paspaley Pearls
Patrick O'Leary	Northern Land Council / Darwin Harbour Advisory Committee
Bill Panton	Department of Infrastructure, Planning and Environment
Owen Price	Department of Infrastructure, Planning and Environment/ Darwin Harbour Working Group
Barry Russell	Museum and Art Gallery of the Northern Territory/ Darwin Harbour Working Group
Jim Smith	Marine Harvest
Ray Taylor	Save Darwin Harbour Group
Rob Wesley Smith	Planning Action Network
Penny Wurm	Tropical Savannas CRC - Northern Territory University/ Darwin Harbour Working Group
Chris Young	Perkins Shipping Pty Ltd/ Darwin Harbour Advisory Committee

Process outline

Participants were divided into four focus groups which each contained scientists, stakeholders and advisory committee or working group members. Each group contained a facilitator (preselected and briefed about proceedings) and a scribe to record discussions.

Groups were asked to address the following questions:

1. What are the current major values and uses of the Darwin Harbour Plan of Management area that you would like to protect or address?
2. How can the Plan of Management protect and address these values and uses?

Section 1. Current major values and uses of the Darwin Harbour Plan of Management area

The workshop identified the following values and uses of the Darwin Harbour Plan of Management area:

Environmental

- Freshwater, estuarine and marine water quality/quantity.
- Ground water quality/quantity.
- Air quality.
- Ecological health and biodiversity.
- Flora, fauna and habitats of conservation significance and cultural/social significance.
- Ecosystem function and processes.

- Indigenous environmental values.

Economic

- Economically and ecologically sustainable industry and agriculture (including uses such as general industrial development; commercial development; tourism; shipping/port activities; fishing; aquaculture; extractive industries/mining; agriculture/horticulture/forestry; research and development; defence and communication; water extraction/harvesting; indigenous uses and harvesting).
- Viable communities and cities.
- Sustainable indigenous communities.
- Individual economic wellbeing and opportunities.

Social/Cultural

- Aesthetics.
- Indigenous and cultural heritage.
- Spiritual values.
- Historic values.
- Lifestyle and recreation (including fishing, boating, walking, cycling, hunting etc).
- Human health.
- Community capacity for participation.
- Public awareness and education.
- Access to the environment.
- Legislation that supports a vision and values for the environment.
- Coordinated and integrated monitoring, planning and management.

Section 2. Recommendations for the Darwin Harbour Plan of Management

The following recommendations were provided by participants, to protect and address the values and uses of the Darwin Harbour Plan of Management area. These recommendations are provided verbatim, as written by participants and are unedited. No recommendations have been omitted.

Overarching management

- There needs to be an independent body/board to manage the harbour, to integrate legislation, monitoring and research in the region and which has the legislative teeth to make decisions that are in the best interests of the community and the harbour itself. This body would be involved in amending current legislation to ensure zoning and land use plans reflect community values and vision, and would also have a role in determining the appropriate development of the harbour. The board would be comprised of a broad range of people and would include representatives from community, government, industry, tourism etc.
- Formation of a Darwin Harbour and Catchment Board of Management to include representative stakeholders. Community must have the opportunity for consultation and board of management must be independent of current political environment.

- A Management Advisory Group should be set up for permanent management. This body should be at “arms length” from both the Ministerial Cabinet and Government departmental structures. By instigation of this Management Advisory Group, Darwin Harbour will become more akin to structures used in every other state. The advantages of a Management Advisory Group will be the ability to submit for greater funding than that attainable by NT government alone. All environmental management plans should be the responsibility of the group and not self regulated.
- Due to the huge responsibility on Ministers and their advisers in coming to the right decision on major issues (such as a gas plant and industry versus tourism industry in Darwin Harbour), there needs to be a Board of Management with legislated powers to ensure maximum understanding of the projects under consideration and effective decision making processes. This Board will be strongly guided by the Cost Benefit Analysis Process and there will be strong penalties for defaulters.
- Need an overview advisory/management board to look comprehensively at issues so that decision-making (ministerial/government) is consistent with this. If not, certain sanctions, which are legislated, to survive individual ministers and governments. This board might commission research etc, at least note areas of need. Especially quantify values of harbour assets, cost benefit analysis of proposals.
- Establish a management board to oversee the harbour and Plan of Management (accountable/transparent).
- Whole of harbour, holistic, integrated approach to management, no incremental planning.
- Bottom up rather than top down management.
- Integrated catchment management approach.
- The Plan of Management needs to have a philosophical approach to the endeavour or the whole effort.
- Must plan for the long term and take the whole of the harbour catchment into account, especially accounting for the potential cumulative impacts of multiple proposals.
- Administrative framework – apolitical, independent of government, similar to development consent authority, needs to coordinate with Environment Australia.
- Investigate funding opportunities for a management board.
- Realistic resourcing to match commitments.
- Develop a pathway for ensuring that discussion results in some actions.
- Government resolve to maintain function and role of DHAC, must lead to action and maintenance of values.
- A priority list of existing environmental damage and sources (eg sewage pollution).
- Comprehensive risk assessment for Darwin Harbour and catchment.
- Identify all management issues. For each, determine management strategy, responsible body, desired outcomes/limits etc and specified timeframe.
- Establish a transparent system for key actions for implementation of the plan with appropriate targets, timeliness and triggers so the community can see what action will be taken, by whom and when. Similar to Federal EPBC set which compels certain actions by the minister under law.

- Set KPI's for management actions to measure performance of Plan of Management and actions. Focus on identifying outcomes.
- Ensure KPI's in place.
- Need to develop clear implementation mechanisms to ensure the planning and management apparatus can deliver, when reconciling competing uses.
- Plan of Management should establish total protection areas, permitted development with defined outcomes, open development areas (including reclamation).
- Develop a range of strategic/monitoring plans under the Plan of Management (eg Water Quality Management Plan, Wetlands, Management of significant areas/parks within the catchment boundary, wastewater strategies etc).
- Need to develop a stormwater management plan, sewage management plan, best practice guidelines for developments, aquatic pest management plan, oil spill management plan, protection of areas to maintain biodiversity, etc.
- Zoning of areas – “multi-use”, “conservation significance” and “cultural significance”.
- Decide on environmental outcomes for areas rather than targeted industries.
- The Plan needs to balance protection of the harbour with the need to also allow continued growth of Darwin. Given Darwin is located largely within the harbour catchment, there must be recognition that some loss of values will occur. It is unavoidable and even options to increase tourism will have that effect.
- Decide on environmental outcomes for areas rather than targeted industries.

Legislation

- Ensure appropriate review of existing policy and legislation and where necessary creating new policy and legislation to ensure the planning framework can deliver against the aims of the plan.
- Review of planning process regarding option of approvals based on defined outcomes (eg water quality) for development. Outcomes need to be assessed re:impacts on the harbour. Could use other jurisdictions environmental measures.
- Address/review the options for integrated planning within the Darwin Harbour Plan of Management area. Put its recommendations into NT Policy. It is important that this also covers local government's role.
- Enforce existing legislation.
- Provision of frameworks for regulation and enforcement.
- Advocate enforceable legislation on land clearing and weed control.
- Incentives for land holders to take care of native habitats on their land.
- Legislation, not guidelines, should be the outcomes of this process.
- Must include a regulatory framework including legislative power to ensure the plan is implemented and enforceable.
- New policy to implement the recommendations. Should cover local government as well as NT government.
- Legislation to reduce environmental impacts/pollution, especially with respect to water pollution and catchment use.
- All elected people should be bipartisan when it comes to protection of our environment.

Vision and values

- The Plan of Management should include a vision statement for the Harbour, which will capture the core values of the harbour, to be maintained and managed sustainably. The plan, future processes, supporting legislation etc will be the mechanisms by which the vision is to be achieved.
- The harbour values and uses are underpinned by natural resources (biota, substrates, water and air) and human resources (cultural, economic and social) which will need to be managed/sustained through time. The management will be supported by legislation, ongoing decision making processes, data, information and analysis and guidelines such as the plan.
- Need to develop a vision for Darwin Harbour and values in consultation with the community. These then become the basis for management.
- Identify values.
- Identify /create a unique/special Darwin Harbour identity/character/vision/profile.
- Promote a vision of Darwin as a sustainable city.
- Establish a set of base parameters of Darwin Harbour health, use, value and seek agreement in how these might be improved/maintained.
- Agreed defined management goals – general and for specific values and uses.
- Must prioritise community needs/values over short term profits.
- Need to clarify how the community rates competing values (eg 1997 Darwin Harbour Survey update).
- Need a landholder survey to find out what the people of Darwin Harbour catchment really want. Not just want the money makers and politicians want.

Development

- Cost Benefit Analysis – For any major development, where there are alternative industries or options to the prospective project, it is imperative that the government ensures the economic, social, cultural and political costs and benefits are carefully weighed. This should incorporate in-depth community consultation and be as transparent a process as possible so that the community ownership of the process is also assured. Due to the expensive nature of such an exercise, governments rarely choose to follow a comprehensive cost benefit analysis process. However, such a process is imperative to ensure future sustainability and maximisation of outcomes is achieved. Industry should contribute.
- Comprehensive risk assessment/socio-economic of developments.
- The plan must have specific recognition's of the incremental nature of the impacts of development (there is no crisis point to trigger action until it is too late) and that there are economic costs associated with development if the environmental or social structure is impacted. Strategies to address these must be developed.
- Establish a framework to guide future continued development of the region.
- Provide clear guidelines for appropriate developments.
- Provide proponents with information on appropriate sites and associated restrictions.
- Recognise that best practices, as required by existing legislation will reduce potential impacts of any activity on the harbour.
- Identify controls of discharges etc necessary to minimise impacts on all identified values.

- Environmental legislation for development (best practice management).
- Tough penalties need to be inflicted upon breaches.
- Need environmental assessment officers.
- Enforcement of auditing processes and EMS' for industry operators – statutory.
- All Environmental Management Plans, Development Permit Conditions, Clearing Permits Conditions need to be audited and tough penalties (including restrictions on further development/clearing) need to be enforced.
- Ensure that appropriate developments under consideration are evaluated according to scientific rigour, not bias or perceptions. Encourage appropriate development.
- Keep the door open for developments in the future that are in line with management goals for the harbour and surrounds.
- The plan should have a major focus of facilitating or guiding the development of urban, rural and industrial infrastructure that will inevitably occur in the harbour and in the hinterland and catchment area. The protection of the harbour values should take account of the fact that this plan is being developed only because the harbour is impacted upon by the adjacent human occupation. If this were not the case then we may as well do a Plan of Management for Bynoe Harbour or the Victoria River mouth. The human occupation and development will continue and will not be stifled by a Plan of Management for the harbour and the plan should be cognisant of this fact. Too narrow focus on ecological issues will provide a plan that will fail at the first difficult economic development hurdle.
- Recognise that we need a plan for the harbour because people live here.
- I believe a line should be drawn down the middle of the Elizabeth River. The eastern side of the line is for development and the western side is conserved for future generations. All mangroves should be protected on the western side and there should be a buffer area above the mangroves. As many mangroves as possible should be conserved on the eastern side of the line.
- No industry on Middle Arm – tourist type business only on Middle Arm.
- Since the harbour boundaries include towards the Adelaide River, I strongly advocate a landuse study of whole of Koolpinyah, with a view to best usage of that land for Darwin's future planning. This would necessitate being prepared to resume Koolpinyah Station, on reasonable terms. The use of this land (eg for industrial/oil/port/venue) can save Darwin Harbour and tourism and conservation.
- Investigate options for increasing tourism.

Research and monitoring

- Mapping of habitats to identify critical area for protection (eg representative areas program).
- Map harbour bottoms etc.
- Mapping of habitats in the harbour (eg extent of coral reefs and seagrass).
- Baseline data/information on environments of harbour and catchment.
- Baseline information collection re species diversity and driving ecological processes.
- Development of long term baselines. One of the major problems with detecting change is that there is nothing to measure impacts of development against. This can be done using new technologies (eg coral coring).
- Continuous research and monitoring of native flora and fauna species and habitats.

- Research and monitoring programs (on-going) to improve understanding of the harbour ecosystems and to detect changes.
- Monitoring of whole of environment in terms of maintaining health and biodiversity.
- Long term monitoring program for ecosystem health.
- Establish formalised monitoring program of key indicators in harbour with regular reporting mechanism.
- Identify and implement comprehensive and ecologically relevant early warning detection system – both freshwater and marine.
- Formalise parameters that should/can be regularly monitored by all researchers.
- Environmental auditing against measurable standards for State of the Environment Reporting – applicable to developments.
- Ongoing monitoring role and reporting back to public (State of the Environment).
- Monitoring and reporting to the public.
- Development of a Darwin Harbour and catchment status report.
- Respond to identified knowledge gaps and fill them (eg 3D predictive models). But need to be prioritised.
- The harbour in particular is important and there is a need for continuing research to address the uncertainties/unknowns that still exist.
- Identify gaps in scientific knowledge and recommend these areas be addressed.
- Identify existing knowledge gaps; recommend research and monitoring priorities; information/knowledge management to make available information for scientific/technical/management purposes; administrative/legislative framework to protect; monitoring and feedback (State of the Environment report).
- State existing water quality programs and enhancement measures and promote further measures and public education.
- Set standards for acceptable water quality and discharges.
- Research acceptable impacts and levels.
- Research to more clearly establish “threshold” levels for pollution – ie what is acceptable?
- Research needs to focus on what are critical thresholds that should not be breached.
- Point source monitoring of discharges should be incorporated into a long term monitoring program.
- Monitoring and reporting needs to be addressed independently by the polluter and through a coordinated body on a harbour-wide scale.
- Continued coordinated research needs to become a priority.
- Support/promote the aquatic/marine pest program work in deterring marine pests. List pest species of premier concern/threat to harbour ecosystems so they can be identified and reported by public.
- Gain funding for PhD/Masters research through corporate sponsorship.

Participation and communication

- Greater encouragement and incentives for community participation in environmental management.

- Encourage community involvement in environmental monitoring and therefore education (eg Waterwatch).
- Community involvement and education (private and public industry).
- Seek consultation with diverse user and ethnic groups ie indigenous, Greek, Vietnamese etc.
- Establish specific strategies for inclusion of aboriginal community in access to jobs, planning process and other relevant aspects of harbour management.
- Improve minority group consultation, especially Larrakia and ethnic groups.
- Support indigenous communities and their participation in management.
- Minority group representation and input. Better means of these groups being able to contribute.
- Provision of an effective ongoing community consultation forum/advisory group.
- Development of an interactive website for public awareness and education.
- Regular and comprehensive reporting and interaction with the public is necessary.
- Public education is important. Keep the public informed on what is planned for their harbour.
- Education of the public on the values for the harbour and its unique features.
- Development of an interactive website for public awareness and education.
- Public awareness and communication/consultation sessions needed with an education program.
- Capacity building and community education.
- Freedom of Information – wastewater discharge licences should be available.
- Better communication between government departments, non-government organisations and landholders.

Data management and coordination

- Foster information exchange and collaboration towards whole of catchment/harbour management.
- Provide data management facilities for Darwin Harbour.
- Establish centralised or coordinated data management (holistic, scientific).
- Centralise baseline data collection and make available.
- Data collected by different studies carried out about the Darwin Harbour by government department's needs to be collated and widely distributed.
- There must be a central database and a group of people to maintain it.
- Data management and coordination. Single group/agency/person to collect information in one central/accessible location.
- Coordinated database detailing available data and links and/or contacts to other systems – issue of commercial in-confidence/legal aspects would need to be addressed.
- Program to infill data gaps.
- Provision of a mechanism for the flow of relevant information on environmental impacts and management options to minimise or avoid (eg codes of conduct, guidelines).
- Ensure data is accessible to all eg environmental assessment by companies, if proposals go ahead or not, pool the data.

- Create a workable data management and coordination system – user pays (eg pay to access and input data). A Board of Management to ultimately oversee its operation.
- Coordination of monitoring and data requires a GIS based system to map monitoring sites, licenced discharges, points of discharge/threat, data trends etc.

Environmental

- Maintain environmental integrity of Darwin Harbour.
- Habitat protection is required, not just mangroves.
- Once the environment is destroyed it is lost forever.
- Recognise that Darwin Harbour is one of many features of environmental significance in the Darwin Region.

Fishing

- Recreational fishing - there is little quantification of effort, catch and targets. This represents a major potential threat to the integrity of the ecosystem, but is largely unmeasured.
- Marine reserves are required as refuges from fishing and as breeding stock reservoirs.
- Registration of recreational fishing boats/vessels.
- Fishing permits – Recreational fishing (particularly in some areas).

Aquaculture

- Aquaculture is present and contributing to the creation of wealth.
- Aquaculture if managed appropriately is sustainable.
- Promote industries that are in the environment not on it.
- Aquaculture relies on high water quality and therefore monitors critical parameters.

Social and cultural values

- Social and cultural – raise the profile of these values and facilitate community access.
- Maintain the importance of the harbour recreational values.
- Too much emphasis on economic values and not enough on social and lifestyle values. Don't forget the people who live here.
- Lifestyle and recreation - identify the various uses and state existing areas where varying uses are suited and identify areas that are better suited for complementing uses – ie sailing and sunset watching, skiing and jet-skiing.
- Lifestyle and recreation is difficult to maintain without sufficient education, meaningful employment, health and recreation infrastructure as presently available.
- Maintain and create foreshore areas (public open space) for public use (multiple uses) ie foreshore defence land.
- Preservation of aesthetics such as retaining the appearance of the harbour.

- Recommend to enhance the quality of infrastructure with which to appreciate Darwin Harbour aesthetics.
 - Provision of public infrastructure appropriate to enhancing the benefits/enjoyment of Darwin Harbour by people in Darwin.
 - Respecting indigenous cultural heritage and rights, such as sacred sites and their food resource.
 - Historical or geographic entity can be obliterated by progress or development (eg Sydney metropolitan area).
 - Retain undeveloped part of western half of harbour in pristine condition – this will enhance aesthetics, indigenous and cultural heritage and historic value.
 - Safety – full mobile phone coverage for the harbour.
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Feedback

Feedback regarding the final workshop was collected by means of a Comment Sheet, which was distributed to all participants.

Respondents indicated that the day had generally been well organised and that there was adequate time to discuss values, uses and recommendations. While some respondents were happy with the workshop representation, others felt that the workshop participants were primarily government, academics and environmental lobby groups, with inadequate community representation.

One participant felt the questions were unclear and confusing, while another commented that the open format of the second question gave the opportunity to provide their thoughts in an unrestricted manner.

Several participants stated that they enjoyed the workshops in general and were looking forward to providing further input into the Plan of Management for Darwin Harbour in the future.