national centre for tropical wetland research

Australian Government

Land & Water Australia

Natural Heritage Trust

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An Australian Government Initiative

LWA/NHT Project DET18

Australia's tropical rivers – an integrated data assessment and analysis

Milestone Report 2

Progress report for sub-projects 1 (Inventory & mapping) and 3 (Ecosystem services framework)

February 2005

Contents

Project summary

Sustainable management of Australia's tropical rivers and wetlands requires an integrated information base for assessment of their ecological character (including benchmarking their status) and the development of policy, especially for environmental flows and potential uses of water. This project is establishing an information base for assessing status and change of Land and Water Australia's tropical rivers study area, and, using the information base, is undertaking several case studies of ecological risk assessments of major pressures for various focus catchments.

The information base is being built on consultation, analysis of existing information, and, in the future, will include specific investigations to provide further data. It is anticipated that the final integrated information base will be used as a reference for assessing change to the river/wetland habitats and their species, and the ecosystem services they provide. As reference conditions for assessing change and environmental flows cannot be provided for all localities or species, it is expected that surrogates will be determined and responses to key pressures assessed through structured and quantitative frameworks and linked with the provision of ecosystem services. These analyses will extend analyses being done through other initiatives in tropical Australia.

Project details

Project Reference Number: DET18

Project Title: Australia's tropical rivers – an integrated data assessment and analysis.

Contracted Research Organisation: Environmental Research Institute of the Supervising Scientist (ERISS) on behalf of the National Centre for Tropical Wetland Research (NCTWR).

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Project duration: July 2004 – June 2006.

Milestone number: 2

Due date: 28 February 2005

Project objectives

The project will provide an information base for determining and applying management priorities and land use practices of relevance to stakeholders, including local and indigenous people, private sectors and governmental agents. Specific objectives are to:

1. undertake a multiple-scale inventory of the habitats and biota of the rivers and wetlands of tropical Australia, where necessary developing and/or ensuring consistency with other suitable typologies based on hydrological and landform features;
2. undertake risk assessments of the major pressures on the habitats and biota of the rivers and wetlands of selected focus catchments in tropical Australia; and
3. provide a framework for analysis of the ecosystem services (e.g. provision of water for multiple uses), provided by the habitats and biota of the rivers and wetlands of northern Australia.

These objectives each relate to one of the three sub-projects that make up the Tropical Rivers Project:

Sub-project 1 – Inventory of the biological, chemical and physical features of aquatic ecosystems;

Sub-project 2 – Assessment of the major pressures on aquatic ecosystems; and

Sub-project 3 – Development of a framework for the analysis of ecosystem services provided by aquatic ecosystems.

Milestone 2 and Achievement Criteria

This Milestone Report (Report 2) represents a Summary Progress Report for:

Sub-project 1 – Report on progress towards multiple-scale maps of aquatic ecosystems; typology of aquatic habitats; and a description and database of information on biological, chemical and physical features of aquatic habitats; and

Sub-project 3 – Report on progress towards a framework and an initial database for analysing ecosystem services provided by aquatic ecosystems.

Below we have summarised our progress to date for Sub-projects 1 and 3 as well the key consultation and communication activities since the project's commencement. Additionally, any administrative, human resource and technical issues are identified, and their consequences on the project and milestone schedules discussed. More detailed information for the two Sub-projects is provided in Attachment 1.

The Achievement Criterion for Milestone 2 is the receipt and acceptance of this report by Land and Water Australia.

Progress for Sub-project 1

Inventory of the biological, chemical and physical features of aquatic ecosystems

Description

The major purpose of this project is to undertake a multiple-scale inventory of the habitats and biota of the rivers, floodplains and estuaries within Land & Water Australia's program area for the Tropical Rivers funding program. The project will integrate information from the previous Land & Water Australia data collation project and additional published sources to make an initial assessment of the diversity, status and ecological value of aquatic ecosystems across the region. This will be undertaken using the multiple-scale model for inventory supported by the Ramsar Wetlands Convention and being applied in the Alligators Rivers Region. The core data will cover information necessary for describing the biological, chemical and physical character of an aquatic ecosystem.

Status

Sub-project 1 commenced in July 2004 and a detailed work plan was submitted to Land & Water Australia in November 2004 (representing part of Milestone Report 1; see Attachment 2). A summary is provided in table 1 of progress against the key activities scheduled between the project's commencement and February 2005 (ie. 8 month period).

Table 1 Summary of progress for key activities for Sub-project 1 (Inventory and mapping).

Activity	Progress/status
Data and metadata standards	Data being compiled at continental and catchment scale is maintained through a geographic coordinate system (according to the Geocentric Datum of Australia; GDA94). Data being compiled at focus catchment scale is maintained through a projected coordinate system, with the data for the individual catchments being projected into the relevant MGA grid zone. Metadata for databases / datasets is being progressively created / updated as required to ANZLIC-2 standard.
Design database	Data are created, edited, analysed, modeled & maintained in an ArcGIS Geodatabase environment. A hierarchical approach has been applied to the creation and management of spatial data for this project. Datasets have initially been collated within specific themes (eg infrastructure) at certain scales (eg continental or catchment).
Identify focus catchments	The following focus catchments were selected, although there may be some adjustment of the final selection of Qld rivers: *Inventory/biodiversity:* Roper R (NT), Staaten R (Qld), Nicholson R (Qld) *Pressure:* Fitzroy R (WA), Daly R (NT), Leichhardt R (Qld), Flinders R (Qld), Mitchell R (Qld)
Compile existing GIS datasets at 2.5M and 250K	Since project commencement, existing datasets representing infrastructure, topography, geology, landforms, climate, hydrology, and waterbodies have been compiled at both the continental (1:2 million) and catchment (1:250,000) scale. Continental scale vegetation data has been compiled, whilst land tenure information has been compiled at catchment scale.
Identify and collate additional reach attributes	National faunal (eg AUSRIVAS, OZCAM, BirdsAtlas) and floral databases (eg HERBRECS) are being progressively accessed and data extracted to identify the distribution of specific species at catchment and focus catchment scale. Additionally, new spatial datasets are being created for hydrological and geomorphological attributes. Attachment 1 provides details of progress for each attribute.
Develop typology	A typology to be applied to northern rivers is close to being developed and agreed. Currently, the typology will represent a merging of two existing schemes, that proposed by Erskine et al (2005) and the other developed by Gardiner & Brennan (2004). This recognises key features of rivers of the Top End and nortn-western rivers as well as those of the south-eastern Gulf of Carpentaria region. The typology will also be compatible with that developed for the Murray Dariling basin. Attachment 1 provides further details.
Field sampling	Due to the later than expected commencement of the project (see *Variations to future milestones*), no field sampling was undertaken in late 2004. However, targeted field sampling activities are planned for 2005 and possibly 2006.
Initial consultation and ongoing awareness	See *Comunications achievements*.

Progress for Sub-project 3

Development of a framework for the analysis of ecosystem services provided by aquatic ecosystems

Description

Based on analyses undertaken through the Millennium Ecosystem Assessment and other published sources this project aims to provide an outline of a framework for evaluating ecosystems services provided by aquatic ecosystems. The framework will entail identification of key services for different habitats (based on the habitat typology) and a description of the methods that can be used for evaluating these at the same scales as used in the analyses given above. The majority of work for this project is being undertaken by six Masters students from Wageningen University, The Netherlands.

Status

Sub-project 3 commenced in July 2004 and a detailed work plan was submitted to Land & Water Australia in November 2004 (representing part of Milestone Report 1; see Attachment 2). A summary is provided in table 2 of progress against the key activities scheduled between the project's commencement and February 2005 (ie. 8 month period).

Variations to future milestones

Although the project contract was signed in late April 2004, existing commitments prevented commencement of the work until July 2004. Consequently, a request was recently sent to Land & Water Australia (E-mail message to Penny Cook, 16 February) to vary the Milestone reporting dates. The proposed revised schedule is set out table 3.

Human resource issues

The key human resource issue during the reporting period has been the recent departure (as of 24 February 2005) from ***eriss*** of the project's Principal Investigator, Dr Max Finlayson, to the International Water Management Institute (IWMI). We are in the process of formally securing an appropriate allocation of Dr Finlayson's time in his new role to continue his input to key technical aspects of the project (eg. inventory structure, vegetation mapping, attendance at stakeholder workshop and other key fora). We will inform Land & Water Australia of the final details of this agreement. With regards to the Principal Investigator role, internal discussions about a replacement are still in progress. We will inform Land & Water Australia as soon as possible of the discussion outcomes and associated proposal for a new Principal Investigator.

Maria Bellio has also recently left ***eriss***. Maria was the theme leader for the waterbird component of Sub-project 1. As is evident in Attachment 1, much of the work for this component has been completed, although there are still several data sources to access. Whilst the additional effort required to do this task can likely be sourced from elsewhere within ***eriss***, we are also considering the option of sub-contracting Maria. Again, we will inform Land & Water Australia of the final details of any such agreement.

Renee Bartolo, the new Communications Officer at ***eriss***, has assumed the coordination role for communication of, and consultation for, the project. Renee's appointment has seen rapid progress on the development of a formal communications strategy for the project as outlined below (and in Attachment 3).

Table 2 Summary of progress for key activities for Sub-project 3 (Ecosystem services framework).

Activity	Progress/status
Undertake Search for Exisiting Information (Broad Search) to establish baseline for study areas.	The project was divided into 6 components, reflecting the key steps of the ecosystem services framework: 1. Function analysis and ecological valuation; 2. Social-cultural valuation; 3. Economic valuation; 4. Policy and institutional aspects; 5. Stakeholder Interests and Trade-offs; and 6. Management and planning implications. The Mary River and Daly River catchments were selected as the study areas. As much relevant existing data as possible was gathered in the first 4 months of the project. Data were accessed through literature/library searches, particularly at *eriss*, Charles Darwin University and CSIRO, and Internet searching for publications, stakeholder contacts and other information.
Interviews and Consultations	Many stakeholders were contacted ranging from private businesses, business lobby groups, environment groups, land councils and traditional land owners, research institutions, and local, Territory and Commowealth government. Face-to-face interviews with stakeholders were arranged in Darwin, Katherine, Jabiru, the Mary River region, The Daly River region and in Kunbarllanjnja community. Stakeholders were found to be generally forthcoming with information and frequently provided reports and supplementary information.
Catchment/site visits	Following the initial task of collating existing information, the research students spent the majority of their time in or around the study areas.
Communications	Formal communications activities in Australia included two seminars and an ABC National Radio interview. Additionally, presentations were given at the University of Wageninen, The Netherlands, the November 2004 project workshop, in Darwin and at the 3rd IUCN World Conservation Congress, in Bangkok.
Data analysis/interpretation and report preparation	A resource library of information in hardcopy has been constructed and an effort to produce this in digital format is also progressing. Associated with this, a themed database for future students/ researchers to be able to use is also growing. Current analysis of information includes transcribing and coding of interview material and analysis and assessment of Federal and Territory policy and management documents.

Communications achievements

A formal communications strategy has been developed with the following specific aims:

- To identify and engage relevant stakeholders in the Tropical Rivers Project;
- To communicate effectively with identified Tropical Rivers Project stakeholders for the duration of the project;
- To ensure Tropical Rivers Project outputs are communicated in an appropriate form to stakeholders and the wider community;

Table 3 Proposed revised schedule for Milestone reporting.

Milestone	Original date	Proposed date
1. Detailed workplan for Sub-projects 1 and 3 for Year 1	31 May 2004	31 May 2004
2. (a) Progress report for Sub-projects 1 and 3	31 December 2004	28 February 2005
(b) Detailed work plan for Sub-project 2	31 December 2004	31 March 2005
3. (a) Progress report for Sub-projects 1 and 2	30 April 2005	30 June 2005
(b) Final draft report for Sub-project 3	30 April 2005	30 June 2005
4. (a) Final report for Sub-project 3	1 July 2005	31 July 2005
(b) Financial Report, 2004-05	30 September 2005	30 September 2005
5. (a) Final report for Sub-project 1	31 December 2005	31 January 2006
(b) Progress report for Sub-project 2	31 December 2005	31 January 2006
(c) Financial Report, 2005-06	31 March 2006	31 March 2006
6. (a) Final report for Sub-project 2	1 July 2006	31 July 2006
(b) Final Financial Report	31 October 2006	31 October 2006

- To ensure all communication aspects are reported in accordance with Land & Water Australia Milestones; and
- To build awareness of the Tropical Rivers Project among the scientific and general community.

A comprehensive process of stakeholder identification has been undertaken and the resultant list and consultation activities has been developed into an interactive stakeholder map.

Since project commencement, the major communications and consultation activity has been the stakeholder workshop in Darwin, 12 November 2004. The workshop was well attended by stakeholders representing government, indigenous, industry and research interests. Nineteen presentations were delivered, providing stakeholders with a summary of the TRP and funding cycles, and an update on the progress of the Sub-projects. These presentations played an important role in providing the stimulus for open discussions on many aspects of the TRP. Summary information on the project, including the stakeholder workshop is placed and regularly updated on the NCTWR web site (www.nctwr.org.au). To date, approximately 150 consultations with stakeholders have been held at various locations across the north, including specific visits to the southern and northern Gulf of Carpentaria regions in Queensland, and Perth and Broome in Western Australia. Darwin has also been a focus of numerous consultations, including efforts to link with other groups conducting relevant research in the region. Finally, a project update newletter has been prepared and will be distributed to stakeholders and available from the web site in early March (Attachment 4). Further details of the communications strategy and associated communications activities are provided in Attachment 3.

Summary

Progress on the project, *Australia's tropical rivers – an integrated data assessment and analysis*, is on-track. Sub-project 1, *Inventory of the biological, chemical and physical features of aquatic ecosystems*, is well underway, with a large amount of existing data for catchment/river biophysical attributes having already been compiled and mapped at various

scales. Data for most attributes are still being sourced and the associated spatial datasets and GIS will be further developed over the next 10 months, with the attention moving progressively towards the focus catchments. It is promising that a key component of the project, the development of a suitable typology for northern rivers, is now close to being resolved.

Sub-project 3, *Development of a framework for the analysis of ecosystem services provided by aquatic ecosystems*, is approaching completion. The six Masters students from the University of Wageninen completed their field work in the Top End region in late 2004, and are currently finalising their theses, each of which address a specific component of the ecosystem services framework. A final task for this project is to ensure the successful integration of the individual theses into one report for Land & Water Australia.

A communications strategy has been developed and numerous formal communication and consultation activities have taken place. The key activity was the stakeholder workshop in Darwin in November 2004, at which there were approximately 80 attendees. Stakeholder consultations have taken place at various locations across the north and have captured all major groups of stakeholders, including other groups conducting related research in the region. Consultations and formal communications activities (eg. project newsletter, conference attendance, web page updates) will continue to occur and be recorded.

Listing of Attachments

Attachment 1	*Detailed progress report for Sub-projects 1 and 3*.
Attachment 2	*Detailed work plans for Sub-projects 1 and 3*.
Attachment 3	*Detailed progress report for communication and consultation*
Attachment 4	*Tropical Rivers Project Newsletter March 2005*

Attachment 1 Detailed progress report for Sub-projects 1 and 3

Detailed Progress Report for Sub-project 1

Inventory of the biological, chemical and physical features of aquatic ecosystems

Project description and objectives

The major purpose of this project is to undertake a multiple-scale inventory of the habitats and biota of the rivers, floodplains and estuaries of northern Australia within Land & Water Australia's geographic scope for the Tropical Rivers funding program (figure 1). The project will integrate information from the previous data collation project and additional published sources to make an initial assessment of the diversity, status and ecological value of aquatic ecosystems across the region. This will be undertaken using the multiple-scale model for inventory supported by the Ramsar Wetlands Convention and being applied in the Alligators Rivers Region. The core data will cover information necessary for describing the biological, chemical and physical character of an aquatic ecosystem.

The inventory data will be used to illustrate known areas of biodiversity importance and gaps in information. The data will be linked to a river/wetland typology, which will provide a framework for predicting the possible occurrence of specific biota and habitats within previously unsurveyed areas. The inventory will provide information for policy and management implementation at multiple-scales (eg. regional, catchment, or individual habitat). This will be possible through the use of GIS data layers and presentation of information at appropriate scales.

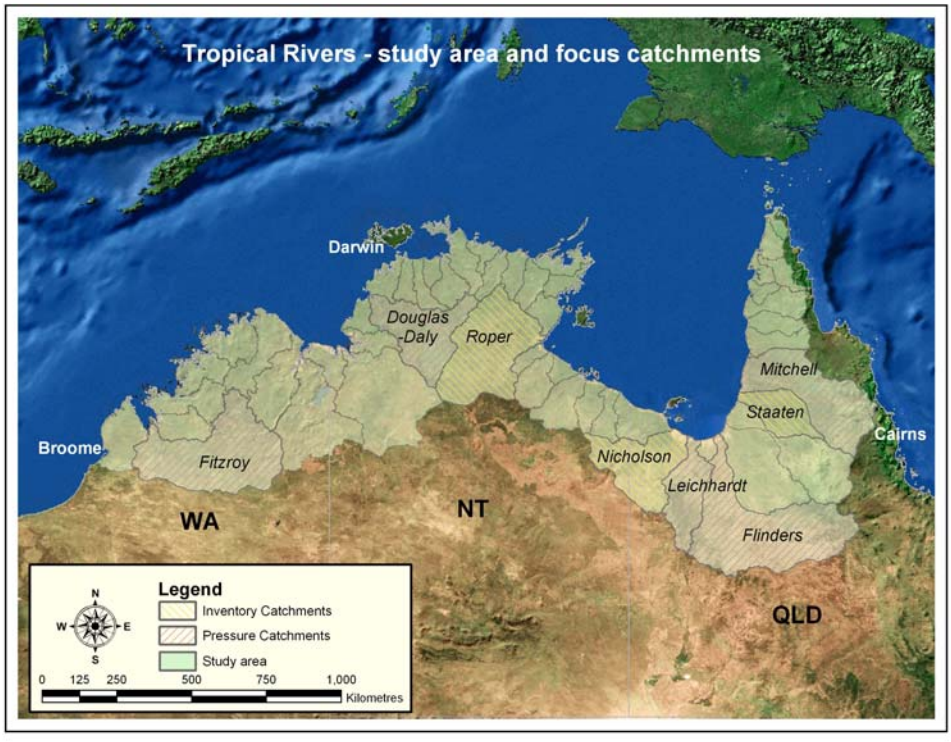

Figure 1 Australia's tropical river catchments within the study area.

Data collection/collation

Progress on the data collection and mapping of the selected biophysical attributes of the northern rivers is detailed below. It is evident that progress has varied across the attributes, which is a reflection of the existing project commitments to date of the various team members leading the data collation exercise.

Geomorphology

Selection and development of river typology

Various methodologies/schemes/typologies have been used to describe the geomorphology of the rivers and catchments in the tropical parts of Northern Australia. As part of the CSIRO Land Research Series, land systems and geomorphology have been described for some of the tropical rivers, including:

- Daly River, NT (Speck et al 1965)
- Adelaide, Mary and Alligator Rivers, NT (Story et al 1969, 1976)
- Leichhardt, Flinders, Norman & Gilbert Rivers QLD (Twidale 1966).

The information is of a general nature, with broad land systems and/or geomorphic region classifications.

More recently, general work has been undertaken on the Roper River (Faulks 2001) and the Daly River (Faulks 1998a, b) catchments. This work has included discussion of the geomorphology of the catchments based on the CSIRO Land Research Series reports, Soil survey mapping and other sources. These reports also have maps (1:250,000) showing landform regions and also stream orders.

A geomorphic study called a "Geomorphic Assessment of River Series: Gulf Basin & Mitchell Catchment" (GAR) is being undertaken for many of the Queensland Rivers that debouche into the Gulf of Carpentaria. A comprehensive geomorphic reach classification has been completed for the Flinders, Leichhardt, Gilbert, Nicholson, & Mitchell River catchments (Brennan & Gardiner 2004). The report also states that additional river catchments to be completed in 2004-2005 include the Norman, Staaten, Settlement and Morning Inlet river catchments. These geomorphic river reach assessments contain extensive work on each of the river catchments and were compiled from aerial photographs at a range of scales. Geomorphic reach maps of the rivers have been produced however the scale is not immediately apparent.

It is important to propose a useful and user friendly scheme (typology) that can be readily applied, at minimal expense across the study area. It is also very important to make use of the existing data sets that have been used to describe the reach characteristics of the study rivers. The scale of any such scheme is important as too small a scale is often too broad for a meaningful classification and too large a scale my not be practical to complete. For this reason, the reach scale (ten's to hundreds of km's) is considered the most appropriate. Erskine et al (2005), have suggested a river reach typology that can be used to classify the many rivers of the tropical rivers study area. This typology initially had eight main river reach types (table 1), and, for the purposes of this project, is currently being expanded to incorporate the recent work of Brennan & Gardiner (2004). The GAR scheme is also a reach classification but is needlessly complicated by sedimentological and locational descriptors that increase the reach types. It is anticipated that the final form of the typology will be agreed by the end of March, at which time it can be incorporated into the GIS. Finally, it is noteworthy that, as suggested by DEH (Bruce Gray), the typology will be compatible with that developed for the Murray Darling basin, which focuses on erosional, transport and depositional sections.

Table 1 Summary of river typologies proposed to be merged for the development of a typology for northern rivers.

	Erskine et al 2005 Typology	QLD Geomorphic Assessment of River Series (GAR)	Comments
1	**Resistant Bedrock Channels**	Upper Headwater	These are a location only, not channel morphology. Hence they are not a river type and are an illogical inclusion.
	Upland bedrock channels	Headwater	
	Deep Bedrock Gorgres	Gorge (low sinuosity)	There is no difference because sinuosity is defined as the ratio of river length to valley length. Hence all gorges have a sinuosity of essentially one because the valley length is the same as the river length.
		Gorge (high sinuosity)	The mechansm by which the channel is influenced is by vertical and lateral confinement and hence conf inement is a more accurate term, which is just so happens, is also used by aquatic ecologists.
2	**Bedrock-Confined Rivers**	Bedrock Controlled, Sand	
		Bedrock Controlled, Sand/Gravel	
		Bedrock Controlled, Gravel	
		Floodplain Pockets	It is illogical to start to define rivers by floodplains. River characteristics only should be used.
3	**Avulsive Rivers**	These are totally ignored by GAR and should not be.	
4	**Meandering Sand-Bed Rivers**	Planfrom Controlled Meandering	There is a need to expand our 'forested meandering sand-bed streams'.
		Continuous Meandering, Fine-Grained	
		Continuous Meandering, Sand	
		Continuous Meandering, Gravel	
5	**Island- and Ridge-Anabranching Sand-Bed Rivers**	Continuous Anabranching	
		Planform controlled Ananbranching	
		Continuous Low sinuosity, Multi-Channel Sand Belt	
6	**Co-Existent Mud-Braided and Anabranching Rivers**	Continuous Anastomosing	
		Planfrom controlled Anastomosing	

Table 1 (cont.)

	Erskine et al 2005 Typology	QLD Geomorphic Assessment of River Series (GAR)	Comments
7	**Extensive Freshwater Wetlands and Billabongs**	Continuous Anabranching Swamp Belt	Where do Billabongs fit in GAR
		Discontinuous Channel - Chain of Ponds	Not aware of existance in Tropics
		Discontinuous Channel Valley Fill (possibly here)	
8	**Tidal not covered in Erskine et al 2005 typology**	Continuous Channel Tidal	
		Discontinuous Channel - Tidal Delta	
	Others not in Erskine et al 2005	Continuous Low Sinuosity, Fine Grained	Essentially talking about straight rivers
		Continuous Low Sinuosity, Sand	perhaps need new type in Erskine et al typology
		Continuous Low Sinuosity Gravel	No difference apart from particle size.
		Continuous Low Sinuosity Bedrock	
		Discontinuous Floodout	Usually associated with Gullies
		Discontinuous Reverse Floodout	Erskine et al 2005 typology doesn't include these features
		Planfrom Controlled Wandering &	Not sure that these exist in the Australian tropics
		Continuous Wandering sand.	Erskine (1992) has discussed southern examples
		Planfrom Controlled Low Sinuosity	
		Discontinuous Sand Bed	
		Dam and weir influence	This not a natural geomorph reach type and is incompatible with a geomorphic approach to reach classification

References

Brennan S & Gardiner E 2004. *Geomorphic Assessment of River Series: Gulf Basin & Mitchell Catchment (Draft Only March 2004)*, Natural Resources and Mines, Queensland Government.

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Water quality

Most state/regional water quality data are held in large and fairly unwieldy databases. Currently data can be obtained in the form of simple spreadsheets but layouts are not directly compatible with most of the software that is normally used to explore, validate, summarise and/or analyse data. Accordingly it has proven difficult to properly assess the usefulness of existing data.

For example, the Queensland Dept. of Natural Resources and Mines HYDSYS database holds the most readily accessible and extensive Queensland datasets and these are a crucial source of information for this project. Spreadsheets imported from this database are structured such that data obtained using various optional sample handling procedures are stored in separate rows even when they are taken at precisely the same time and place as other samples. Consequently, the number of rows associated with any individual sampling event can vary randomly from 1 to 6, and the number of replicate values contained within these rows can range from 0 to 4. Many existing data exploration tools require a fixed or predictable number of replicates and most rapid methods only work well if each row is representative of a single unique point in time and space. For instance, because the number of replicates varies

randomly, appropriate weightings must be applied to each individual data-point before it is possible to calculate even simple summary statistics such as means. Some packages allow this to be done but it is usually a very tedious and time consuming process.

To date this component of the Tropical Rivers study has focused on alleviating these problems by developing software capable of automatically consolidating, reformatting and summarising the data. This has been done in MS-Excel by using a combination of linked calculation sheets, visual basic modules and macros. The resulting workbook has been successfully tested using HYDSYS data obtained from the Gilbert, Norman, Staaten and Mitchell River catchments in the Gulf of Carpentaria. When first imported, these data, which comprise historical water quality records from 74 gauging stations, were merged to create a 9000 row by 65 column spreadsheet containing numerous suspect values and a very large number of blank cells. The calculation sheet successfully consolidated these into 3600 rows of validated data. Quite sophisticated exploratory analyses that would previously have taken weeks are now being carried out in a matter of hours.

It may be necessary to alter collation routines in order to accommodate data from sources other than HYDSYS, but since the data analysis algorithms have now been written, that should be a relatively simple exercise (provided that data can be obtained in a simple structured electronic format, as is usually the case).

The Excel workbook has the following structure and functions:

SHEET 1

- This is a merged version of the original spreadsheets obtained from QDNRM.

SHEET 2

- This is a write-protected formula sheet displaying consolidated data formatted as a standard excel list with one row per case and one column per variable (gives full MS-access database compatibility).
- New variables have been added to keep track of the number and type of replicate samples merged into each row.
- Means are shown for cases where values are derived from replicates.
- Cases where the range of replicate values is unacceptably high (criteria vary between parameters) are highlighted.
- Values that fall outside the expected range for each parameter and/or incorrect data types are also detected and flagged

SHEET 3

- This is a working sheet that allows the user to employ any combination of manual selection, excel auto-filter, excel data filter or access database query to display any desired subset of the data contained in sheet 2.
- Short cut keys allow current selections to be locked or unlocked so that subsequent selections can be appended if desired in order to build up subsets based on very complex criteria if desired.

SHEET 4

- This is a write-protected formula sheet that calculates summary statistics for the data selected in sheet 3.

- Interactive plots can be added as desired (i.e. the plots change automatically as data is selected or deselected).
- Any standard summary statistics can be added as needed.
- Summaries currently comprise mean, standard deviation, median, selected percentiles, inter-quartile range, number of cases, number of blanks and number of values.
- The statistics on this sheet are volatile (i.e. they change whenever a different subset of data is selected in sheet 3) but a shortcut key allows a permanent record to be automatically transferred to sheet 5 whenever desired.

SHEET 5

- This is a transposed sheet (rows = variables, columns = statistics) that accumulates a permanent record of any summary statistics considered to be useful, in a format that produces printouts that fit comfortably on A4 pages.
- This sheet stores a record of the filter conditions that were active at the time of the data transfer.

The development of this workbook will now allow faster and more accurate analysis of the very large and unwieldly datasets that are available in the region, most of which have never been analysed before.

Hydrology

Data

Long-term streamflow characteristics, such as mean annual/monthly runoff and, in particular, inter-annual variation, are important flow variables as they have been shown to be linked to stream biota. Therefore, it is recommended that these characteristics are established for various streams within the tropical rivers region (Bruce Gray pers comm. 2004). To conduct this analysis, gauging stations with at least 30 years of streamflow data were identified throughout the region. Of the 633 stations that have operated or are still currently operating in the region, there were 132 stations with a period of record greater than 30 years (http://www.bom.gov.au/hydro/wrsc). For these gauging stations located throughout Queensland and Western Australia, mean annual and mean monthly runoff and coefficient of variation data were obtained from the agency websites - DNRM (http://www.nrm.qld.gov.au/watershed/precomp/nf_tsi/div_ix.htm) and DoE(WA) (http://portal.environment.wa.gov.au/portal/page?_pageid=55,205140&_dad=portal&_schema=PORTAL) respectively. Mean annual and mean monthly runoff and coefficient of variation data for the long-term stations located throughout the NT were obtained from DIPE via email. These data indicated that many of the stations had significant periods of missing flow data. For example, table 2 shows that of the 60 stations in WA and Qld with periods of record greater than 30 y, only 34 stations actually had 30 y of streamflow data. Data has yet to be analysed for NT.

Table 2 Long-term gauging stations in the tropical rivers region

	No. of gauging stations	
State	**PoR > 30 y**	**30 y flow data**
Queensland	34	25
Western Australia	26	9

The Fitzroy and Flinders catchments have the most long-term gauging stations in the tropical rivers region of WA and Qld respectively. Figure 2 shows that there is a general consistency of long-term flow characteristics across each catchment, particularly for the Fitzroy catchment (ie similar interannual variability between stations). Furthermore, the variability of annual flow data within the Fitzroy catchment is lower than that of the Flinders catchment. This is an expected trend given the higher average annual rainfall and runoff over the Fitzroy catchment than the Flinders catchment.

Further work

- Complete the analysis of long-term flow characteristics for the remainder of the tropical rivers region (ie NT).
- Construct mean annual runoff and coefficient of variation graphs for the various streams across the region, particularly within the focus catchments, and compare these data to other streams in Australia and overseas.
- Use these data to construct gridded contour maps for the tropical rivers region to illustrate the spatial variation of annual runoff and interannual variability.

Vegetation

Sources of data

Numerous data sources have been accessed to date to identify relevant aquatic, riparian and mangrove species. These include:

i. Australian Nature Conservation Agency (1996). *A directory of important wetlands in Australia*. Second Edition. ANCA, Canberra.

ii. Perry, R.A. & M. Lazarides (1964). Vegetation of the Leichhardt-Gilbert area. In: *General report on lands of the Leichhardt-Gilbert area, Queensland, 1953-54*, pp. 152-191.

iii. Sattler, P.S. & R.D. Williams (1999). *The conservation status of Queensland's bioregional ecosystems*. EPA, Brisbane.

iv. Stephens, K.M. & R.M. Dowling (2002) *Wetland plants of Queensland*. CSIRO, Collingwood.

v. Story, R. (1970). Vegetation of the Mitchell-Normanby area. In: *Lands of the Mitchell-Normanby area, Queensland*, pp. 75-88. CSIRO, Melbourne.

vi. Thurgate, M. (1994). *Natural Assessment of the Gulf Plains Biogeographic Region*. JCU, Townsville.

Identification of species

A total of 267 plant species with have been identified in a preliminary literature search of publications and reports dealing with the rivers that flow into the Gulf of Carpentaria in Queensland. Of this total, 29 are identified as obligate riparian species; 126 as facultative riparian species; 84 as freshwater aquatic species; and 28 as mangrove species. Definitions for these groupings are as follows:

- ***obligate riparian species***: plants that occur exclusively in the riparian zones associated with creeks, rivers, lakes or lagoons.
- ***facultative riparian species*:** plants that occur in the riparian zone, but are more common in other habitats.

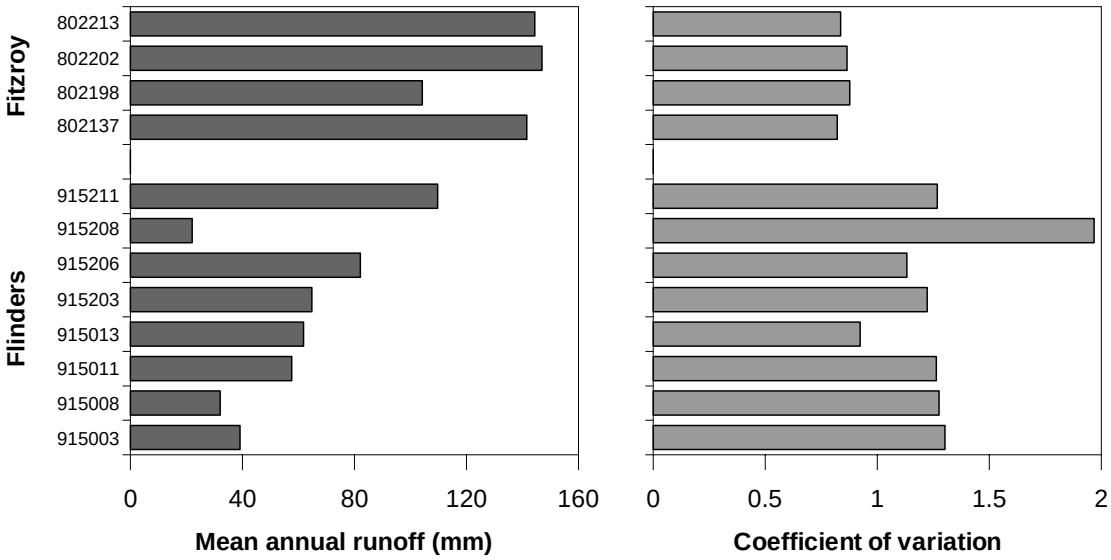

Figure 2 Mean annual runoff (Left) and inter-annual variability of runoff (Right) of the streams within the Fitzroy and Flinders catchment areas.

- ***freshwater aquatic species***: plants that occur in freshwater systems, in either moving or free-standing water, and spend most of their life cycle in water, but does include species that can withstand periodic drying.
- ***mangrove species***: species that occur in saltwater or brackish water environments, fringing rivers, estuarine areas and coastal areas.

The next phase with the Queensland species is to retrieve distribution data from the Qld Herbarium database, HERBRECS, and create spatial layers for the species groupings. A similar process will follow for the Northern Territory and Western Australian data. For mangrove distribution, the 1:250K topographic mangrove layer for northern Queensland and the Northern Territory generated by Qld Department of Primary Industries and Fisheries (DPI & F) has been sourced.

Invertebrates

Consultations

A number of government agency staff and other specialists from the Commonwealth, states and Territory have so far been consulted in developing this inventory project. Information has kindly been forthcoming from: Bruce Gray, Cameron Slatyer & Alice Wells (DEH), Peter Dostine (NT DIPE), Andrew Storey (UWA) and Diane Conrick (QLD NRM).

Framework to meet the study objectives

This study aims to:

- compile a multiple-scale inventory of aquatic invertebrates of the rivers and wetlands of tropical Australia, using a spatially-related database
- on the basis of invertebrate data, make an initial assessment of the diversity, status and ecological value of aquatic ecosystems across the region, identifying areas of biodiversity importance and gaps in information.

Aquatic macroinvertebrates are ideal candidates for multi-scalar study, the inventory and assessment model being applied in the broader TR Project. In particular:

- Macroinvertebrates have inherent and traditional virtues for use in monitoring and assessment of environmental quality.
- National protocols and guidelines are available that provide for broad-scale (catchment or regional, relatively coarse) river health assessments to more detailed, site-specific assessments, with respective increase in taxonomic resolution and quantification.

The broad-scale and site-specific approaches to study are summarised below.

Broad-scale assessment using AusRivAS

AusRivAS is a national, standardised approach to biological monitoring and assessment of stream health using macroinvertebrate communities, and has been developed under Australia's National River Health Program. Predictive models have been developed by State and Territory agencies of macroinvertebrate community composition expected at a site in the absence of human-related disturbance. Assessment of stream 'health' may then be made based upon an Observed/Expected taxa number ratio. Because AusRivAS models are based upon family-level, presence-absence data (only) they are regarded as a relatively coarse, broad-scale screening tool (for 'rapid assessment').

Potential developments for tropical rivers using the AusRivAS database and samples

eriss has acquired from ERIN the AUSRIVAS data base for tropical rivers. These data have been entered into the spatially-related database being used for the TRP. One application of the data that will be investigated, is to seek a (multivariate) classification across the tropical rivers region, which could potentially lead to improved precision and resolution of AusRivAS models. (Currently models have been developed for separate states and territory.) The success of this analysis will depend upon whether or not ecological gradients are sufficient amongst streams to distinguish distinct classification groups (noting that at family-level, the macroinvertebrate communities of north Australian streams are very similar (eg Kay et al 1999)). Different protocols have been used by the different state and territory agencies in acquiring AusRivAS data sets, which might also confound the analysis (ie creating artefacts whereby classification groups are distinguishable by sampling and processing method rather than ecological separation).

AusRivAS samples may also be used to identify animals to lower levels of taxonomic resolution and determine habitat requirements. This is underway elsewhere in Australia (see below). Such work has the potential to lead to models and techniques capable of detecting more subtle impacts, or improved conservation assessments. However, additional work in this area will not be possible within the scope of the present study. (It is worth noting, nevertheless, that one NT AusRivAS model is based upon genus-level information.)

Assessments at specific sites and/or for conservation & biodiversity importance

Stronger inference and greater sensitivity to disturbance become more important requirements as investigations move from larger scales to specific sites (eg point sources), or wherever subtle impacts must be detected. Typically, conservation and biodiversity studies are also applied at site-specific scales. Collectively, these types of investigation often require more detailed and quantitative information, for example, relative abundance and/or species-level data.

Sources of species-level data from tropical rivers

Tropical streams for which species-level data are available include: Sites within Ord and Pentecost Rivers (WA), and sites within Keep, Daly, Finniss, Adelaide & Mary river systems, Darwin Harbour streams, South Alligator R and Magela Ck (East Alligator R) (NT).

There are other sources of species-level data which are planned to be acquired and geo-referenced under the present study, thus:

- NHT study by Dr Phil Suter (Latrobe Uni): using AusRivAS samples, derive species' 'habitat profiles' for EPTO taxa (improved monitoring and assessment) eg ABRS grant to Dr Phil Suter, Latrobe University
- Cameron Slatyer (DEH, Natural Environment Assessment Section) - Australian Heritage Assessment Tool. So far, complete records for:
    - Freshwater molluscs (mainly Australian Museum, ~14,000 records biased towards SE Aust)
    - Odonata (ANIC, all state museums except NTAGM)
    - Adephaga families of diving beetles (mainly SA Museum, ~10,000 records, good continental coverage)
    - Rotifers (4000 records, continental but biased towards the SE).
- Global Biodiversity Information Facililty (www.GBIF.org) holds ANIC's digital invertebrate collection
- OZCAM (Online Zoological Collections of Australian Museums). This is an online distributed network of databases that contain information about the faunal collections held in Australian museums and other institutions such as CSIRO (http://www.ozcam.gov.au/index.php).

Invertebrates of conservation interest in tropical rivers

Aquatic insects

Aquatic insects are typically widely dispersed across tropical rivers though many have distinct habitat preferences. A number of species have restricted distributions, eg some mayflies (*Tillyardophlebia dostinei*, Genus P sp. AV3, *Platybaetis gagadjuensis*), caddisflies (Dipseudopsidae, *Hyalopsyche*), damselflies (*Nososticta*) and naucorid bugs (*Aphelocheirus*) (P Dostine, pers. comm.).

Crustaceans

A diversity of isopods, shrimps and freshwater crabs occur in stone country seeps and springs, and groundwater ecosystems, of WA and the NT. The Kakadu-Arnhem sandstone massif and outliers, in particular, are a national 'hotspot' for crustacean biodiversity, eg the endemic shrimp family Kakaducarididae (*Leptopalaemon gagadjui*, *L.* nov. sp., *Kakaducaris glabra*, *K.* nov. sp.). Stygofauna have not been studied in great detail, though Cutta Cutta caves, south-east of Katherine harbours the endemic shrimps, *Parisia ungius* and *P. gracilis.*

Other issues

- Unless new data are acquired (unlikely in the timeframe of this project), focal catchments can not be studied in any greater detail than other catchments.
- Estuarine invertebrates have not yet been considered. Moreover, there are unlikely to be more than 'a handful' of estuaries for which data are available.

Fish

Sources of Spatial Data on Freshwater Fish

Two main sources of data are published survey data and museum records. The primary museum database is OZCAM Australian Museum national fauna database, with contributions provided by the the major state museums. OZCAM has given valuable spatial data on species even though it is in its relative infancy (compilation began 30/06/2003).

Published survey data comes in a variety of forms. Refereed journal articles have been the most easily accessed. Technical reports are equally common but have been more difficult to access, mainly due to the limited numbers printed. Thus, you often have to go to the original authors to get these. Given that many are years old and the authors have moved on, this has taken some time. However, we believe we have obtained all the large scale surveys that exist in technical reports. Other reports with limited data may still be missing, but these are of lesser value.

In the Kimberley, the Fitzroy River has been well surveyed recently (70 sites), and the King Edward River is currently under survey. Other rivers such as the Prince Regent, Mitchell and Drysdale were surveyed in the 1970's and the lower Ord has been surveyed more recently. Site locations are obtained for most of these surveys. In the NT, most work has focused on the Alligator Rivers area and is summarised in Bishop et al (2001). Other river systems such as the Victoria, Roper and Limmen Bight systems were surveyed in the 1970's. In the Gulf of Carpentaria catchments, the Queensland Department of Primary Industries annually samples seven sites in each of the Gregory and Mitchell rivers, with the latter also being the subject of several surveys over recent years, making it the best known fish fauna in Queensland. Most of the major river systems in the Gulf of Carpentaria (eg, Gilbert, Norman, Staaten, Flinders and Leichhardt) have never been surveyed or had only minor surveys. The information from the Gulf catchments has been reviewed and is among the best collated to date. A large proportion of the data from Cape York comes from the CYPLUS surveys conducted 1992-1993. Additional smaller-scale studies have been conducted near the top of the Cape. A summary of surveys conducted in the western-draining rivers of Cape York has recently appeared in a recent textbook by Pusey et al (2004). This list was obtained from the senior of that text, with whom we have been cooperating considerably.

Most published sources of data for freshwater fish in the study area have been obtained. Other sources of information such as surveys conducted as part of environmental monitoring associated with mining ventures have not yet been obtained, but these have very limited geographic scope and utility to the project. The locations of survey sites from the information obtained has been added to the GIS database. Thus, a good picture of where data gaps are has been compiled and an analysis of patterns apparent from the existing information has begun.

References

Bishop KA, Allen SA, Pollard DA & Cook MG 2001. *Ecological studies on the freshwater fishes of the Alligator Rivers Region, Northern Territory: Autecology*. Supervising Scientist Report 145, Supervising Scientist, Darwin.

Pusey BJ, Kennard M & Arthington A 2004. *Freshwater Fishes of North East Australia.* CSIRO Publishing. Australia.

Amphibians

Sources of Data

The only source of spatial data accessed to date is OZCAM. This source of spatial data was flagged in the Australian Tropical Rivers Data Audit as being one of the few data sets relating to fauna occurrences in the project area (NGIS Australia 2004).

Limitations of the OZCAM database include:

- Digitizing the data is being funded by the individual museums as resources allow. Adding data is a continual process and may not necessarily be complete at the time of our data extraction.
- There is no systematic or consistent method of specimen collection by museums. Collections are obviously restricted by issues of access to areas and may take place much more comprehensively in certain catchments compared to others. For example, there are still extensive areas of land in the Northern Territory that have not been surveyed in the Wet season.
    - Related to this issue is the discovery of new species for which spatial data has not yet been collected. To date, there are 6 species for which no spatial information exists, either in the OZCAM database nor any other sources searched so far.

Northern Territory Frogs Database is another source of information investigated for use in this study. However, the information on frog distributions is largely descriptive rather than spatial, and only a few spatial records exist. Nevertheless, this database will be an important source of information for mapping the distribution of cane toads (*Bufo marinus*) as they move closer to Darwin.

Other sources of spatial data for which access is currently being sought include:

- Northern Territory – Parks and Wildlife Commission of the Northern Territory Database
- Queensland – Queensland Parks and Wildlife Service WildNet database
- Preliminary research suggests that spatial data for Western Australian amphibians is held entirely by the Museum, and this data is available on OZCAM
- Contact with expert herpetologists in WA and QLD is also being made for further relevant information.

Identification of species

To date, spatial data for 60 frog species listed as occurring in the study area have been collected. In addition, there are a number of species whose distributions are on the border of the study area and these are being investigated to determine whether they should be included in the project. The spatial data have been converted to digital format, and mapping will commence shortly.

Reptiles

Sources of Spatial Data

Two databases have so far been identified as providing quality spatial data:

- OZCAM Australian Museum national fauna database, with contributions provided by the the major state museums; and

- Parks and Wildlife Commission of the Northern Territory database. (http://www.nt.gov.au/ipe/pwcnt/index.cfm?attributes.fuseaction=open_page&page_id=262). This is a flora, fauna and vegetation database but as yet access permission has not been obtained.

OZCAM is the only database so far accessed and has given valuable spatial data on species, but as it is in its relative infancy (compilation began 30/06/2003), large data gaps occur and some species have not been recorded in certain catchments. This problem is certain to improve with time as more data is collected and entered. The number of records pertaining to each species within the project area is given in table 3 along with total number of records in the database. Extracting the geographical coordinates of the sample locations enabled the distribution of the different species to be mapped across the project area, and integrated with other datasets using ArcGIS software. An example of the distribution of the genus *Emydura* is shown in figure 3.

Other Data

Literature searches have been conducted and an information bank is steadily growing. Yearly crocodile population data has been obtained from Parks Australia North for the rivers in Kakadu and data is being sought for the other river systems within the TRP area.

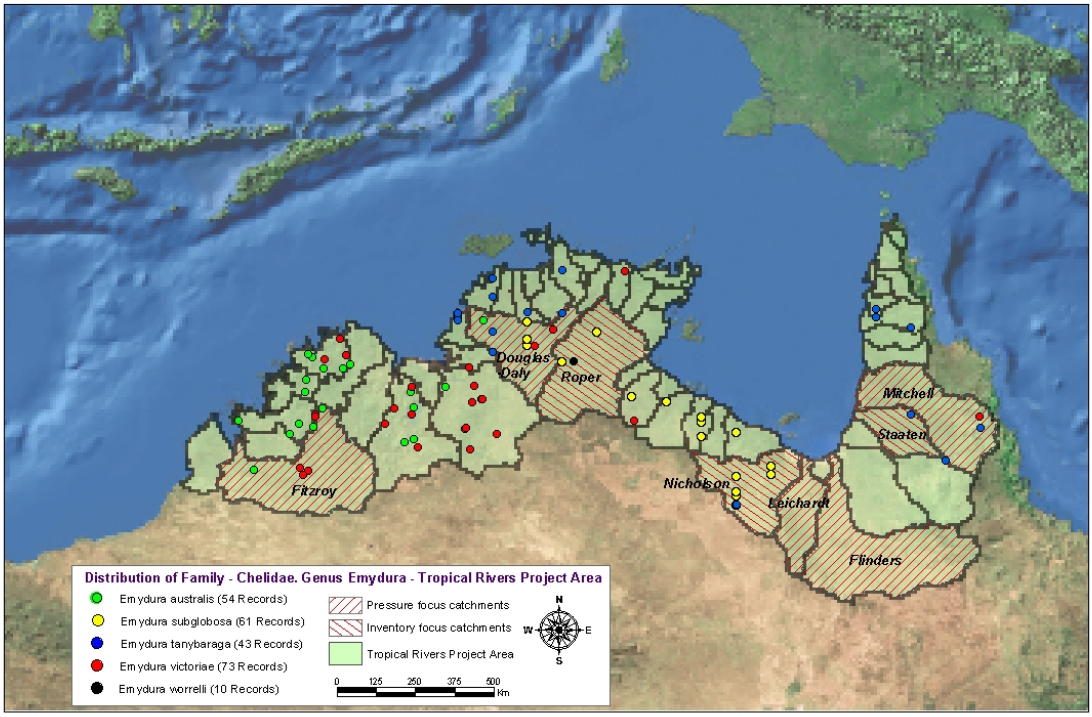

Figure 3 Distribution of Genus *Emydura* as recorded in OZCAM Database (January 2005).

Table 3 Aquatic and Semi-Aquatic Reptiles List for Tropical Rivers Project.

Family	Species	Common Name	OZCAM records	
			Within study area	Total
Crocodylidae	*Crocodylus johnstoni*	Freshwater Crocodile	59	63
	Crocodylus porosus	Esturine Crocodile	51	87
Carettochelydidae	*Carettochelys insculpta*	Pig Nose Turtle	12	12
Chelidae	*Chelodina canni*		22	57
	Chelodina rugosa	Northern Snake Necked Turtle	100	129
	Chelodina novaeguineae		6	10
	Chelodina kuchlingi	Kuchling`s Long neck Turtle	1	1
	Chelodina burrungandjii		10	10
	Elseya dentata	Northern Snapping Turtle	116	167
	Elseya lavarackorum		14	14
	Elseya latisternum	Saw Shelled Turtle	64	184
	Emydura australis	North West Red Faced turtle	54	54
	Emydura subglobosa		61	67
	Emydura tanybaraga		43	83
	Emydura victoriae	Northern red Faced Turtle	73	73
	Emydura worrelli		10	10
Varanidae	*Varanus indicus*	Mangrove Monitor	10	35
	Varanus mertensi	Merten`s Water Monitor	93	108
	Varanus mitchelli	Mitchell`s Water Monitor	75	76
	Varanus panoptes	Yellow Spotted monitor	70	113
	Varanus semiremex		8	17
Achrochordidae	*Acrochordus arafurae*	Arafura File Snake	91	94
	Acrochordus granulatus	Little File Snake	9	35
Boidae	*Liasis fuscus*	Water Python	70	95
Colubridae	*Cerberus rynchops*	Bockadam	52	101
	Enhydris polylepis	Macleay`s Water Snake	65	69
	Fordonia leucobalia	White Bellied Mangrove Snake	95	146
	Myron richardsonii	Richardson`s Mangrove Snake	5	40
	Stegonotus cucullatus	Slaty Grey Snake	41	53
	Tropidonophis mairii	Keelback of Freshwater Snake	233	635
		Total	**1613**	**2638**

Selection of Species

Thirty species of reptile have been selected for inclusion in the Tropical Rivers study to date (table 3). These consist of 2 crocodilidae, 1 carettochelydidae, 13 chelidae, 2 achrochordidae, 1 boidae, 6 colubridae and 5 varanidae. The definition of what constitutes a “semi-aquatic” species, and therefore what should be included or excluded from this study is an area of on-going discussion, and feedback is welcome. Crocodiles, turtles, filesnakes and the colubrid snakes are easily identifiable as aquatic or semi-aquatic. The water python (*Liasis fuscus*) is the only python included in the study. Of the goannas, *Varanus mertensi* and *V. Mitchelli* are described as being aquatic (Cogger 2000) and show morphological adaptions to aquatic life

(e.g., laterally compressed tail; nostrils and eyes positioned high on head) (Shine 1986). The mangrove monitors *V. indicus* and *V. semiremex* have been included because of habitat preference and aquatic species form part of their diet e.g fish and crabs. Although *Varanus panoptes* has been variously described as being ground dwelling (Cogger 2000) or terrestrial (Shine 1986), it is usually observed in riparian habitats and takes 32% of its ingested biomass from aquatic habitats. Martin (1990) describes diving behaviour in *V.panoptes* from a small creek near Nabarlek and his interpretation of this event is that the goanna was searching for food in the creek. For these reasons, *V.panoptes* has been included in this study but further clarification may be necessary. It should be noted that the list of species included in this study (table 3) is not exhaustive, and any suggestions are welcome.

References

Cogger HG 2000. *Reptiles and amphibians of Australia*. Reed Books Australia Pty Ltd Melbourne.

Martin, K. 1990. A note on diving behaviour in the Northern Sand Goanna *Varanus panoptes*. *Northern Territory Naturalist 12*, 28-29.

Shine R 1986. Food habits, habitats and reproductive biology of four sympatric species of varanid lizard in tropical Australia. *Herpetologica*, 42(3), 1986, 346-360.

Birds

Sources of Spatial Data

Two databases have so far been identified as providing quality spatial data for the area of study:

The data base of the ***first "Atlas of Australian Birds"*** (Blakers et al 1984*)*

This data base includes distribution and breeding maps for 650 bird species, including information about bird distribution since the time of European settlement. This atlas ran for five years (1997-1981). It was based on a 1° grid-search, and where possible atlasers provide information by surveying 10' grids. Three thousand atlasers took part in the project, producing 2.7 million records (sightings), for a total of 716 birds species, and 812 1° grids surveyed.

The data base of the ***"The New Atlas of Australian Birds"*** (Barrett et al 2003).

This atlas ran for four years (1998-2002), and included 279,000 surveys, for a total of 750 bird species recorded. This atlas represents the largest continent-wide survey of birds in the world. Surveys were based on species presence rather than counts of individuals. It was based on a 1° grid-search, and where possible atlasers provide information by surveying 10' grids. Four survey methods were employed in order to collect bird lists at a range of scales:

- 2-ha searches for 20 minutes
- area searches for at least 20 minutes within 500 m of a central point
- area searches for at least 20 minutes within 5 km of a central point
- incidental searches, no time or area limits, usually one-off sightings of rare or unexpected species.

The data base of the "*The New Atlas of Australian Birds*" included information from seven sources (table 4).

Table 4 Data sources used by The New Atlas of Australian Birds (Barrett et al 2003).

Source	Total Record Forms
Atlas Record Form	335253
Nest Record Scheme	31
Literature	130
Parks & Wildlife Commission NT	17406
QLD Parks & Wildlife Service	2
Bird Info	3903
Birds on Farms	328

Other sources of data not accessed at the moment include:

- the Australian Wader Study Group database
- the database associated with the Technical Report: *Chatto R in prep. The distribution and status of waterbirds around the coast and coastal wetlands of the Northern Territory*. This database is the property of PWCNT and will be available once the report is published.

Knowledge from experts and general public

There is also a great amount of knowledge in terms of waterbird distribution that is not published and is part of the personal knowledge of many bird-watchers and scientists who have yet to publish their data, and people from the general public who have lived within the study area. In order to access this information we hope that at the stage of the review of this inventory more data will be integrated and gaps identified.

Bioregions

Seventeen of Australia's 85 major bioregions are included in the study area (table 5).

Table 5 IBRA (Interim Biogeographic Regionalisation for Australia) region and codes represented by study area.

Biogeogrpahic region	IBRA code	Biogeogrpahic region	IBRA code
Dampierland	DL	Pine Creek	PCK
Central Kimberley	CK	Arnhem Plateau	ARP
Northern Kimberley	NK	Arnhem Coast	ARC
Victoria Bonaparte	VB	Central Arnhem	CA
Ord-Victoria Plains	OVP	Gulf Coastal	GUC
Sturt Plateau	STU	Gulf Plains	GUP
Gulf Fall and Uplands	GFU	Cape York Peninsula	CYP
Daly Basin	DAB	Einasleigh Uplands	EIU
Darwin Coastal	DAC		

Selection of Families

In accordance with the Convention on Wetlands (www.ramsar.org) waterbirds are broadly defined as 'birds ecologically dependent on wetlands' and include traditionally recognized groups of birds known as wildfowl, waterfowl and shorebirds. Table 6 lists the seventeen families of waterbirds accepted under the Ramsar definition and included in the Asia-Pacific Migratory Waterbird Strategy (2001-2005) and found in the study area.

This project will consider all species, of both inland and coastal wetlands, included in the taxonomic groups in table 6. This includes shorebirds (waders) that are defined according to the species listings in Lane (1987) and Watkins (1993). In addition to these groups there are other species that are dependent on wetlands, such as the kingfishers and passerines. Although these birds would benefit from efforts undertaken to conserve waterbirds, they are not the focus of this project. Table 6 lists the number of records pertaining the study area of this project and extracted from "*The New Atlas of Australian Birds*", and figure 4 demonstrates an associated map output for the Anatidae Family

Guilds and status

In order to undertake the risk assessment component of the project, the 126 species of birds belonging to the seventeen families of waterbirds, were grouped in five feeding guilds:

- TIP – terrestrial invertebrates, such as insects, and/or terrestrial plants, including bulbs and rhizomes
- AIP – aquatic invertebrates and/or plant material
- AI – mainly animal material, small aquatic invertebrates, such as insects
- FAA – mainly fish or small aquatic animals such as crustacean, insects and frogs
- SBA – mainly animals in coastal saline or brackish water.

Table 6 Waterbirds families considered in the project and found in the study area.

Taxonomic Family	English Name	Records in study area
Podicipedidae	Grebes	1830
Phalacrocoracidae	Cormorants	3960
Pelecanidae	Pelicans	1115
Ardeidae	Herons, Egrets and Bitterns	12263
Ciconiidae	Storks	1240
Threskiornithidae	Ibises and Spoonbills	5145
Anatidae	Swans, Geese and Ducks	8702
Anseranatidae	Magpie Goose	945
Gruidae	Cranes	1684
Rallidae	Rails, Crakes, Swamphens and Coots	2031
Jacanidae	Jacanas	1105
Haematopodidae	Oystercatchers	634
Recurvirostridae	Stilts and Avocet	1231
Glareolidae	Pratincoles	753
Chradriidae	Plovers	6263
Scolopacidae	Turnstones, Curlews, Sandpipers and Snipes	7185
Laridae	Gulls, Terns and Skimmers	4849

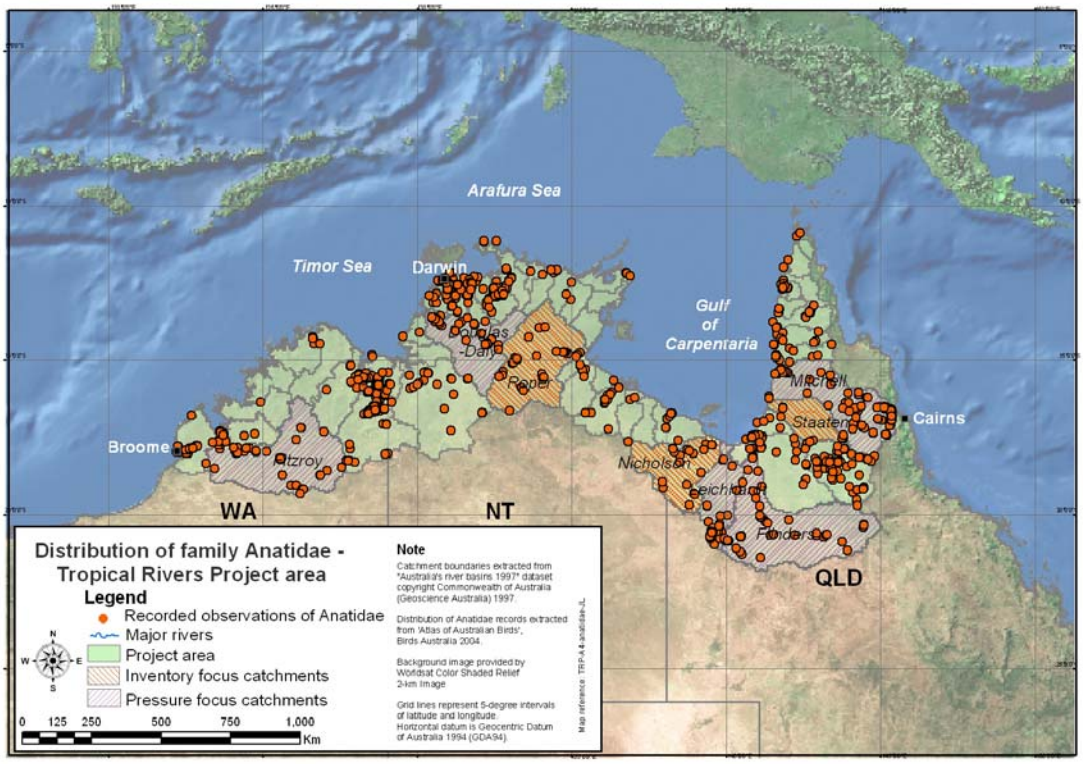

Figure 4 Distribution of Anatidae Families from "*The New Atlas of Australian Birds*" .

Finally, Appendix A lists each species of birds considered in the inventory, in which state they occur and if listed under the JAMBA (Japan-Australia Migratory Bird Agreement) and CAMBA (China-Australia Migratory Bird Agreement) agreements.

References

Barrett G, Silcocks A, Barry S, Cunningham R & Poulter R 2003. The New Atlas of Australian Birds. Royal Australasian Ornithologists Union. Melbourne – Australia.

Lane BA (1987). Shorebirds in Australia. Nelson Publisher

Watkins D (1993). A National Plan for Shorebirds Conservation in Australia. RAOU Report no.90. August 1993, Melbourne.

GIS and mapping

Data collation

The identification, collection and collation of key spatial datasets is continuing as described above, with the focus increasingly shifting to the collection, and generation of data for use at the focus catchment scale. Access to several datasets produced by state and federal agencies has been granted, with ongoing negotiations for additional data. Since the commencement of the project, datasets representing infrastructure, topography, geology, landforms, climate, hydrology, and waterbodies have been compiled at both the continental (1:2 million) and catchment (1:250,000) scale. Continental scale vegetation data has been compiled, whilst land tenure information has been compiled at catchment scale. National faunal (eg AusRivas, OZCAM, BirdsAtlas) and floral databases are being progressively accessed and data

extracted to identify the distribution of specific species at catchment and focus catchment scale.

Copies of data layers have been supplied to team members to enable them to compile and produce maps for their respective themes.

Data management and structure

A hierarchical approach has been applied to the creation and management of spatial data for this project. Datasets have initially been collated within specific themes (eg infrastructure) at certain scales (eg continental or catchment) (figure 5). Data is maintained in ArcGIS Geodatabase format, with data at continental and catchment scale being maintained in a geographic coordinate system (GDA94). Data being compiled at focus catchment scale data is maintained through a projected coordinate system (with the data for the individual catchments being projected into the relevant MGA grid zone). Data collation and management is being coordinated by GIS centres in Darwin and Townsville, with each centre being responsible for the management and collection of specific data themes.

The spatial data and structure is regularly backed up onto DVD, with copies of the data maintained offsite as an added security measure. Finally, metadata for databases / datasets is being progressively created / updated as required to ANZLIC-2 standard.

Modelling and Analysis

Samples of a range of digital elevation models have been trialed to determine their suitability for developing a geomorphic typology of streams. Faunal databases have been interrogated to identify the spatial distribution of a range of aquatic species, and the results progressively integrated with existing data.

Issues

The development of the geomorphic stream typology has been delayed in part by the absence of a suitable dataset which could be used to delineate drainage features and classes across the study area. This is planned to be addressed by the acquisition of the 1-second digital elevation model (1” DEM) for northern Australia (produced by the Defence Imagery and Geospatial Organisation (DIGO)) by the Department of Environment and Heritage, which will in turn make this data available to the project.

Planned activities

Data acquisition and integration is planned to continue for some months to come, as additional datasets and sources become available, particularly at the focus catchment scale. At a catchment scale, attention will focus on the compilation of vegetation data, and the generation of a geomorphic typology using the 1” DEM and a lower resolution DEM such as the 3” DEM. Specific theme-based acquisitions (particularly for the focus catchments) are planned to continue, from both existing databases and from field-based observations.

Communication and consultation

The relevant activities are described in the separate report at Attachment 3 of the overall Milestone Report.

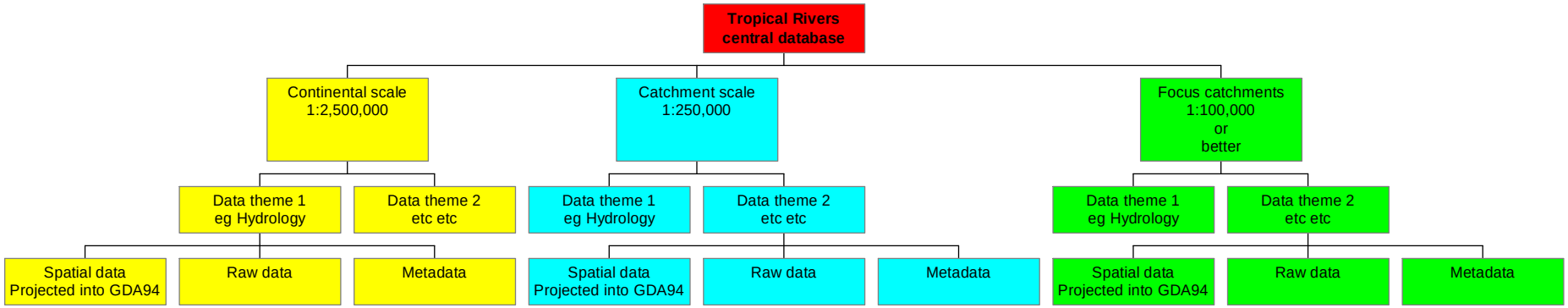

Figure 5 Directory structure for Tropical Rivers Project.

Sub-project 3 - Development of a framework for the analysis of ecosystem services provided by aquatic ecosystems

Project description and objectives

Based on analyses undertaken through the Millennium Ecosystem Assessment (MEA) and other published sources this project aims to provide an outline of a framework for evaluating ecosystems services provided by aquatic ecosystems. The framework will entail identification of key services for different habitats (based on the habitat typology) and a description of the methods that can be used for evaluating these at the same scales as used in the analyses given above. The framework development will be led by Dr Dolf de Groot, an expert on evaluation of ecosystem services from the Netherlands, and linked to the UN supported MEA. The framework will also contribute to the Ramsar Scientific and Technical Review Panel (STRP) task 1.4.iii; a report on Guidelines for evaluating the values, functions, goods and services provided by wetlands.

Specifically, the objectives of the research are to:

- Identify relevent stakeholders to consult with about current and potential benefits of wetlands in the Daly and Mary River catchments
- Determine the current and potential uses/benefits of the regions' wetlands from dialogue with relevent stakeholders
- Analyse and assess sourced Federal and Territory policy documents and management plans relevent to the use of aquatic systems in the Northern Territory
- Develop an understanding of the range of benefits currently obtained from wetlands in the selected regions and categorise them as ecological, economical and/or sociocultural values
- Recommend sound methods for the development of wetlands management and policy that seek to maximise potential human wellbeing as well as preserving the environment for the equal benefit of future generations.

Where available, data on the value and extent of particular services will be included. The latter is likely to rely on a small number of published analyses of specific habitats and reports from or about industry sectors. Initial consultation will be used to identify the services with further detailed consultation and research being necessary at some stage in the future.

The majority of work for this project is being undertaken by six Masters students from Wageningen University, The Netherlands. The project is being supervised by Dr Dolf de Groot (The Netherlands) and Dr Max Finlayson (Australia). Each of the research students has been focusing on a separate component of the highly integrated framework. The six components of the research and framework are:

- Function analysis and ecological valuation
- Social-cultural valuation
- Economic valuation
- Policy and institutional aspects
- Stakeholder Interests and Trade-offs

- Management and planning implications.

The research methodology is dominated by the search and review of literature (policy, management documents and other research materials), and interviews with both individuals and stakeholder representatives from the community, government, industry and research organizations.

The majority of the data was collected between July and November 2004 when the Masters students undertook fieldwork within the study areas; the Mary and Daly River catchments in the Northern Territory. The student researchers have since returned to their university in The Netherlands and are in the process of collating and analysing their data. The current state of the framework, a work in progress, is shown below (figure 6).

Data collection/collation

The data collected to develop the framework and analyse ecosystem services provided by the Daly and Mary Rivers was obtained in various forms. These include policy and management documents as well as recorded interview material.

The student researchers were given initial direction in seeking out relevant stakeholders by Dr Max Finlayson and Emma Woodward (through knowledge gained through her PhD research). Further primary information was initially gained through discussion with Dr Peter Bayliss and other ***eriss*** staff, as well as through the stakeholder list held and compiled by the National Centre for Tropical Wetland Research.

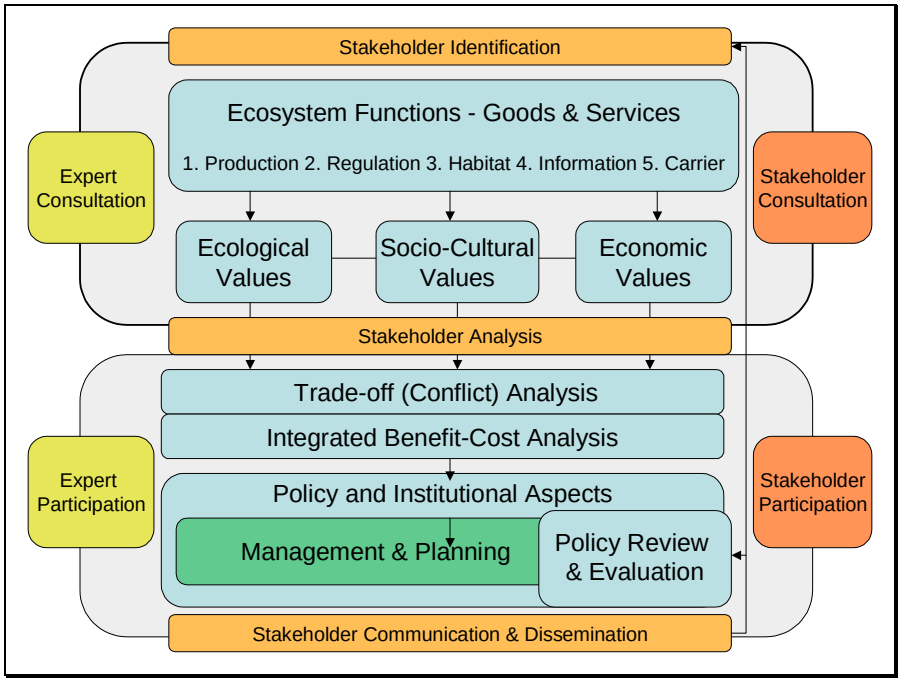

Figure 6 Framework for the analysis of ecosystem services.

Other useful stakeholder contacts were sought through:

- Organisational, institutionsal, business and Territory Government websites (DBIRD, DIPE, AAPA)
- Minutes of the Daly Advisory Committee meetings and Hansard records; identified people involved in the process, witnesses and spokespeople and sought their contact details through websites or departments
- Accessed the policy review documents for various policies that had contact details. Tried to seek specific persons within departments using the general enquires email
- Contacting the stakeholder in charge of ecosystem function development, organization or management within relevent government agencies or industry councils
- The "Snowball" effect; interviewees would recommend other potential interviewees
- Backward effect; "people who communicate the information recommend us to talk to people at the source of the info"
- By attending the Darwin Royal Show and speaking with stall holders
- Contacting people involved in the main reports for the Daly and Mary catchments.

Most stakeholders were contacted initially be email or telephone. If they were emailed cold, the research student told the recipient who they were, why they were contacting the person (usually to arrange an interview) and a description of the type of information they would like to collect. They also attached an information sheet that further detailed the research.

Those who were initially called were asked if they would like further information, and were then sent the information sheet via email or fax.

In some instances repeat emails and phone calls were made in an attempt to engage stakeholders and overall there was a high response rate. They found the majority of stakeholder groups to be very helpful, particularly considering their often very limited capacity (in time and resources) to do so. Opportunities were also created by staff within the Territory Government's research farms and mining division for the student researchers to obtain some "practical" fieldwork experiences which led to a greater understanding of the organisation, business and even the function itself.

The research students were taken on several field trips/tours by stakeholders, for instance to visit a mine, to learn about sacred sites and also to visit pastoral properties.

Face-to-face interviews were arranged in Darwin, Katherine, Jabiru, the Mary River region, The Daly River region and in Kunbarllanjnja community. Interviews were held at the interviewee's workplace or home and took on average between 45 mins and 1.5 hours to complete. Stakeholders were found to be generally forthcoming with information and frequently provided reports and supplementary information.

Some interviewees expressed a strong desire to have access to the report at the conclusion of the research, whilst some wished to check the content of the report in the draft phase (NT Buffalo Industry Council). The names of these stakeholders have been recorded and the relevent information will be forwarded in due course. In other interviews the research student offered the interviewee access to the report, if interested, on completion of the draft. This would give stakeholders an opportunity to comment before the report is finalised.

The different groups/stakeholders that were approached and consulted included:

- Government; DIPE; various departments, DBIRD; various departments (Buffalo Research Farm, Daly Research Farm), Aboriginal Areas Protection Authority, Northern Territory Tourism Commission
- Academic and Research Institutions; eriss, CSIRO, CDU (various departments and individual researchers including KCTWM)
- Fishing related; AFANT, Northern Territory Seafood Council (NTSC), government departments, members of the community, NT Museum
- Pastoral; pastoral land board, pastoralists, government departments, research farms;
- Mining; Government related department
- Aboriginal interests; health related (sunrise etc), land management (ranger groups and coordinators), representatives (NLC), ANKAAA and art centres
- Tourism; tour operators, government department.

Data analysis and interpretation

The biggest task and initial focus for the researchers on return to The Netherlands was to determine the most effective method of organizing the large amounts of resources and hours of interviews collected in the field. A resource library of information in hardcopy has been constructed and an effort to produce this in digital format is also progressing. A themed database for future students/researchers to be able to use is also growing.

There is an intention to expand an online database which was commenced before the students returned to The Netherlands, however, there are several issues to resolve before this is further progressed. The difficult task is to sift through all data (including interviews) and determine what is firstly, relevant data and secondly, what is 'good' data - that can be verified.

Current analysis of information includes transcribing and coding of interview material and analysis and assessment of Federal and Territory policy and management documents.

Report preparation

The initial format of documentation of the results of this sub-project will be in the format of 6 Masters theses which are due to be completed by March/April 2005. A summary of these combined works will be condensed into a report for submission to Land & Water Australia in June 2005.

Communication and presentation of research

Australia

- October 2004 ***eriss*** Darwin (with invitation to external stakeholders) presentation of preliminary results.
- November 12 2004 Presentation to NT stakeholders at Tropical Rivers Program workshop (Charles Darwin University) .
- ABC National Radio Interview conducted with student researchers, Katherine, NT.

The Netherlands

- Article published in Wageningen University Newspaper on Tropical Rivers Research Project and the experiences of the students. Available online; http://www.wb-online.nl/index.php?/krant/artikel.php?id=388 (in Dutch).
- Presentation to the Environmental System Analysis Department, Wageningen University.

Bangkok

- Conference Presentation of Poster by Bas Verschuuren at the 3rd IUCN World Conservation Congress within the workshop entitled "Estimating and Realising the Value of Ecosystem Services". An invitation has been extended to present the research again to a group of specialists working on a publication for Wetlands International.

Issues and constraints

In the early stages, research was hindered by the inability to obtain permission to access chosen study areas. One permit application to the Northern Land Council for access to a community in Arnhem Land is still pending (after submission in July 2004). Similarly we were dissuaded from incorporating Kakadu National Park as a study area because of difficulties dealing with protocols, written or "unwritten", associated with doing research in the Park. Due to these complications, the study areas were changed during the first week the student researchers arrived in Australia. This decision also caused the researchers to tap into new sources of literature and revise their research proposals.

The student researchers believe they would have benefited from increased supervision in the early stages of their research.

Due to the method by which the research is being undertaken, that is 6 researchers individually accomplishing a section of the research/framework and then integrating their findings, deadlines are particulary important as the completion of the research project can only progress as fast as the slowest contributor. While this is a common issue in collaborative research projects, it is a problem exacerbated by the highly integrated nature of the research project ("..individual timeframe pressures are a barrier to a more integrated product at the moment." This is mainly due to the individual thesis requirements upheld by their university).

The time allocated to transcribing the interviews into digital format was underestimated, and subsequently some information is currently not easily available for use.

Because the researchers have returned to their university in The Netherlands, they are unable to easily access stakeholders for followup interviews and clarification of statements made in previous interviews in Australia. Since the researchers have begun data collation and analysis they have also identified gaps in their data and questions they haven't addressed, which may have been possible to fill if they had written up the research in the study area (Australia).

Another challenge lies in identifying the best way to include the views of the many stakeholders interviewed in the process, first in the context of an academic thesis, and second ensuring this information is not lost in its conversion to a synthesis report for LWA.

Schedule

The student researchers will continue to work on their individual theses, maintaining close contact with ***eriss*** throughout this stage. Draft manuscripts are due by the end of March 2005,

with the final versions to be condensed into a report for LWA in July 2005. A decision has not been finalised as to who will write this report. It may be a joint effort between ***eriss*** staff and the student researchers from Wageningen University.

Appendix A Detailed list of bird species considered in the inventory

	Listing				
Family Group and species	**JAMBA[1]**	**CAMBA[1]**	**NT**	**WA**	**QLD**
***Anatidae*: Geese, Swans, Ducks**					
Plumed Whistling-Duck			X	X	X
Wandering Whistling-Duck			X	X	X
Spotted Whistling Duck					X
Radjah Shelduck			X	X	X
Green Pygmy-goose			X	X	X
Pacific Black Duck			X	X	X
Grey Teal			X	X	X
Pink-eared Duck			X	X	X
Hardhead			X	X	X
Anseranatidae					
Magpie Goose			X	X	X
***Podicipedidae*: Grebes**					
Australasian Grebe			X	X	X
***Anhingidae*: Darters**					
Darter			X	X	X
***Phalacrocoracidae*: Cormorants**					
Little Pied Cormorant			X	X	X
Pied Cormorant			X	X	X
Little Black Cormorant			X	X	X
Great Cormorant			X	X	X
***Pelecanidae*: Pelicans**					
Australian Pelican			X	X	X
***Ardeidae:* Herons, Egrets, Bitterns**					
White-faced Heron			X	X	X
Little Egret			X	X	X
Eastern Reef Egret			X	X	X
White-necked Heron			X	X	X
Great-billed Heron			X	X	X
Pied Heron			X	X	X
Great Egret	X	X	X	X	X
Intermediate Egret			X	X	X
Cattle Egret	X	X	X	X	X
Striated Heron			X	X	X
Nankeen Night Heron			X	X	X
Little Bittern			X	X	X
Black Bittern			X	X	X
***Plataleidae*: Ibises, Spoonbills**					
Glossy Ibis		X	X	X	X
Australian White-Ibis			X	X	X

Appendix A (cont.)

	Listing				
Family Group and species	**JAMBA[1]**	**CAMBA[1]**	**NT**	**WA**	**QLD**
Straw-necked Ibis			X	X	X
Royal Spoonbill			X	X	X
Yellow-billed Spoonbill			X	X	X
***Ciconidae*: Storks**					
Black-necked stork			X	X	X
***Gruidae*: Cranes**					
Sarus Crane	X	X	X		X
Brolga			X	X	X
***Rallidae*: Rails, Crakes, Swamphens, Coots**					
Red-necked Crake					X
Buff-banded Rail			X	X	X
Bush-hen			X		X
Baillon's Crake			X	X	
Australian Spotted Crake				X	X
Spotless Crake				X	X
White-browed Crake			X	X	X
Chestnut Rail			X	X	
Purple Swamphen			X	X	X
Dusky Moorhen			X		X
Black-tailed Native hen			X	X	
Eurasian Coot			X	X	X
***Scolopacidae*: Turnstones, Curlews, Sandpipers, Snipes**					
Latham's Snipe		X			X
Swinhoe's Snipe			X	X	X
Black-tailed Godwit	X	X	X	X	X
Bar-tailed Godwit	X	X	X	X	X
Little Curlew	X	X	X	X	X
Whimbrel	X	X	X	X	X
Eastern Curlew	X	X	X	X	X
Common Redshank			X	X	
Marsh Sandpiper	X	X	X	X	X
Common Greenshank	X	X	X	X	X
Wood Sandpiper	X	X	X	X	X
Terek Sandpiper	X	X	X	X	X
Common Sandpiper	X	X	X	X	X
Grey-tailed Tattler			X	X	X
Wandering Tattler	X	X			X
Ruddy Turnstone	X	X	X	X	X
Asian Dowitcher		X	X	X	X
Great Knot	X	X	X	X	X
Red Knot	X	X	X	X	X
Sanderling	X	X	X	X	X

Appendix A (cont.)

	Listing				
Family Group and species	**JAMBA[1]**	**CAMBA[1]**	**NT**	**WA**	**QLD**
Red-necked Stint	X	X	X	X	X
Long-toed Stint			X	X	
Pectoral Sandpiper			X	X	X
Sharp-tailed Sandpiper	X	X	X	X	X
Curlew Sandpiper	X	X	X	X	X
Broad-billed Sandpiper		X	X	X	X
Ruff			X	X	
***Jacanidae*: Jacanas**					
Comb-crested Jacana			X	X	X
***Haematopodidae*: Oystercatchers**					
Pied Oystercatcher			X	X	X
Sooty Oystercatcher			X	X	X
***Recurvirostridae*: Stilts, Avocets**					
Black-winged Stilt			X	X	X
Red-necked Avocet			X	X	X
***Charadridae*: Plovers, Dotterels**					
Pacific Golden Plover			X	X	X
Grey Plover	X	X	X	X	X
Red-capped Plover			X	X	X
Lesser-Sand Plover	X	X	X	X	X
Greater-Sand Plover	X	X	X	X	X
Oriantal Plover			X	X	X
Black-fronted Dotterel			X	X	X
Red-kneed Dotterel			X	X	X
Masked Lapwing			X	X	X
***Glareolidae*: Pratincoles, Coursers**					
Oriental Pratincole	X	X	X	X	X
Australian Pratincole			X	X	X
***Laridae*: Gulls, Terns**					
Silver Gull			X	X	X
Gull-billed Tern			X	X	X
Caspian Tern			X	X	X
Lesser Crested Tern			X	X	X
Crested Tern			X	X	X
Roseate Tern			X	X	X
Black-naped Tern				X	X
Common Tern			X	X	X
Little Tern			X	X	X
Bridled Tern			X	X	X
Sooty Tern			X	X	X
Whiskered Tern			X	X	X
White-winged Black Tern			X	X	X
Common Noddy			X		X
Black Noddy			X		X

[1] JAMBA: Japan-Australia Migratory Bird Agreement; CAMBA: China-Australia Migratory Bird Agreement.

Attachment 2 Detailed work plans for Sub-projects 1 and 3

National Rivers Consortium (Tropical Rivers)

Australia's tropical rivers – an integrated data assessment and analysis

Detailed Work Plan for Sub-Project 1

Inventory of the biological, chemical and physical features of aquatic ecosystems

Duration

2 person equivalents at each of ERISS and ACTFR for 18 months each (Years 1 and 2)

Description

Undertake a multiple-scale inventory of the habitats and biota of the rivers, floodplains and estuaries of northern Australia using information from the previous data collation project and published sources to make an initial assessment of the diversity, status and ecological value of aquatic ecosystems across the region. This will be undertaken using the multiple-scale model for inventory supported by the Ramsar Wetlands Convention and being applied in the Alligators Rivers Region and in parts of Asia where a landscape-scale approach to wetland inventory and assessment is underway. This approach is based on 1) remotely sensed imagery for mapping at different scales (e.g. biogeographical, catchment and site scales), 2) core and interlinked data sets for each scale (e.g. covering biodiversity, water quality and quantity), and 3) a suitable habitat typology.

Consultation with and engagement of local people, including indigenous people, will be required to supplement the information held by agencies and researchers. Associated with the development of this proposal discussions have been held with the Centre for Indigenous Natural Cultural Resource Management at Charles Darwin University to seek complementary funding for compatible projects on tropical rivers and wetlands. If successful these funds would add to the work already underway in the Alligator Rivers Region to incorporate appropriate indigenous knowledge into existing river and wetland programs.).

The inventory data will be used to illustrate known areas of biodiversity importance and gaps in information. The typologies provide a framework for predicting the possible occurrence of specific biota and habitats within previously unsurveyed areas, but cannot be used as substitutes for further such surveys as the biogeographical information for many aquatic species is simply not available.

The inventory information will provide information for policy and management implementation at multiple-scales, e.g. regional, catchment, or individual habitat. This will be possible through the use of GIS data layers and presentation of information at appropriate scales.

Responsibilities

The data collation and analysis and multi-scalar mapping using remote sensing will be led by ERISS. Ground-truthing and surveys will be led by ACTFR and linked to the development of priorities from the initial mapping and data analyses. Consultation and interaction through the NCTWR Advisory Committee will be led by ERISS and ACTFR.

Work Plan & Schedule

The project tasks and associated task leads and timeframes are detailed below.

1. Applying layers - existing datasets

1.1 Access & review existing datasets (topographic, biophysical, infrastructure, etc) and compile data at continental (1:2.5M), catchment (1:250K) and focal catchment (1:50K – 1:100K) scales. Lowry & Alewijnse

1.2 Establish standards for projects ie. datums and projections to be used at different scales – ONGOING through life of project. Lowry

1.3 Design directory and geodatabase structure Lowry

1.4 Map 1:2,500,000 across northern Australia Lowry & Alewijnse

1.5 Map 1:250,000 across northern Australia:

Compilation, reinterpreatation, as necessary, and integration of existing base map layers. Base layers to include: infrastructure (roads, railways), drainage, tenure, vegetation (especially riparian), hydrology, geology, landuse, elevation (including possible acquisition of 1" DEM for northern Australia) Lowry & Alewijnse

1.6 Source, collate and synthesise additional material for river reach attributes and provide to GIS team. Creation & integration of new layers where they do not exist at a suitable scale eg. geomorphology; hydrology information (see Task 1.6) Lowry & Alewijnse

THEME LEADERS

ATTRIBUTE	*ERISS*	*ACTFR*
GIS	Lowry	(Alewijnse)
Geomorphology	Saynor	-
Water Quality	(Humphrey)	Butler
Hydrology	Molliere	(Davis)
Vegetation	(Finlayson)	Dowe
Birds	Bellio	-
Fish	(Pidgeon)	Burrows
Invertebrates	Humphrey	(Burrows)
Reptiles & Amphibians	G. Fox/Nou	-

Note: *Each lead person is to collate and assess the extent of information available for their taxa group across the northern rivers (covering meta-data and spatial extent of data coverage) and provide a description (review) of the taxa (species occurrences and locations, assemblages and or populations, key or significant species, ecological interactions and connectivity, eg, migration) and its status (if possible to conclude). The goal is to identify data and describe the riverine habitat and its condition (based on each major taxa group, etc) and outline the extent of data. Ecological conceptualisations of key processes based on expert approaches may also be used to develop indices and descriptors.*

1.7 Evaluation of datasets (how useful or meaningful they are at nominated scale), creation / updating of metadata for datasets (ongoing through life of project) and supply of datasets to JCU. Lowry

2 Skeletal typology

2.1 Determine typology to be used for ecological characterisation and inventory of rivers. River reaches to be based on 'skeletal attributes' from existing methods/sources. eg Erskine method (geomorphology) with possible amendments (hydrology and biology). Finlayson & Lukacs

2.2 Trial mapping of skeletal typology at 1:250k (whole of region) and 1:50k (focus catchments). Revise as necessary to provide functional typology for GIS. Lowry & Alewijnse

2.3 Identify focal catchments: Finlayson & Lukacs

Pressure catchments – eg. Fitzroy, Douglas-Daly, McArthur, Leichhardt, Flinders, Mitchell or Gilbert

Inventory catchments – eg. Roper, Nicholson, Staaten, or Embley, and another in W.A

2.4 Undertake mapping of skeletal typology across study area and in focal catchments. Provide in GIS format. Evans, Saynor, Lukacs and Finlayson

3 Applying typology extrapolations to GIS [last 6 months]

3.1 Theme leaders to utilise expert opinion through appropriate mechanisms (eg expert panels, workshops) to enable codification of river reaches not attributed by existing datasets.

3.2 Assess estuarine information sources and link with inland layers Eliot

4 Sampling regimes for focal catchments [3 months, late dry 2005]

4.1 Collate existing layers, create new layers and integrate these at scale appropriate for focal catchments.

4.2 Assess existing information and confirm sampling parameters and regimes for focal catchments.

4.3 Undertake verification sampling and record information in designated datasets and add to data layers used in GIS. Lukacs/Burrows/Davis

5 Consultation

5.1 Establish contact with agencies, boards and representative panels in WA, Qld & NT to introduce the project and seek collaboration and support, and access to information. Finlayson & Lukacs

5.2 Establish schedule and purpose for continued consultation, including ongoing exchange of information, collaboration and reporting and demonstrating initial analyses and outcomes. Finlayson & Lukacs

6 Reporting

6.1 Individuals provide initial detailed work plan for data collection, analyses, sampling (as necessary) and reporting. van Dam

6.2 Coordinated final report first draft,including final versions of hard copy maps, posters, reports, illustrations (NB – maps etc would be produced during the earlier phases; these are the final versions) van Dam, Finlayson and Lukacs

Timeline for tasks

Task	2004 – 05												2005 - 06					
	July	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.1 – Access & review data for GIS																		
1.2 – Data standards GIS																		
1.3 – Design databases																		
1.4 – Compile GIS datasets 2.5M																		
1.5 – Compile GIS datasets 250k																		
1.6 – Identify reach attributes																		
1.7 - Metadata																		
2.1 – Develop typology																		
2.2 – Trial skeletal typology																		
2.3 – Identify focal catchments																		
2.4 – Apply skeletal typology																		
3.1 – Codify typology																		
3.2 - Estuary																		
4.1 - Data review																		
4.2 – Collate focal & inventory catchment data																		
4.3 – Field sampling																		
5.1 – Initial consultation																		
5.2 – Ongoing awareness						✲												✲
6.1 – Theme leader plans																		
6.2 - Reporting																		

✲ Workshops

National Rivers Consortium (Tropical Rivers)

Australia's tropical rivers – an integrated data assessment and analysis

Detailed Work Plan for Sub-Project 3

Development of a framework for the analysis of ecosystem services provided by aquatic ecosystems

Duration

12 months; student project based at *eriss* (Year 1).

Description

Based on analyses undertaken through the Millennium Ecosystem Assessment and other published sources provide an outline of a framework for evaluating ecosystems services provided by aquatic ecosystems. The framework will entail identification of key services for different habitats (based on the habitat typology) and a description of the methods that can be used for evaluating these at the same scales as used in the analyses given above. The framework development will be led by Dr (Ru)dolf de Groot, an expert on evaluation of ecosystem services from the Netherlands, and linked to the UN supported Millennium Ecosystem Assessment (MEA).

Where available data on the value and extent of particular services will be included. The latter is likely to rely on a small number of published analyses of specific habitats and reports from or about industry sectors. Initial consultation will be used to identify the services with further detailed consultation and research being necessary at some stage in the future.

Responsibilities

eriss will support six students from the University of Wageningen, The Netherlands, and linked with various international initiatives.

Work Plan & Schedule

The project tasks and timeframes are detailed below.

1. Pre Student arrival

1.1 Identify focal catchments

1.2 Arrange introductory materials and region-specific "induction" information for student researchers

1.3 Coordinate arrangement of accommodation, transport, visas, stipends, computer access and other logistical support including permit applications

2. Inductions

2.1 Arrange OH&S inductions for researchers

2.2 Assist researchers in seeking contacts for key stakeholders, databases and other information sources

3. Researchers- Undertake Search for Exisiting Information (Broad Search)

3.1 Literature searchers; eriss library, csiro, Charles Darwin University

3.2 Internet searching for publications, stakeholder contacts and information

3.3 Compile library of relevant information (digitial and hardcopy)

3.4 Identify gaps in readily available literature and seek out grey literature/internal and unpublished reports

4. Establish baseline Information

4.1 For the Mary and Daly identify the catchment boundaries and parameters for research

4.2 Seek catchment specific information; land use, land tenure, and the key stakeholders for each region

5. Interviews and Consultations

5.1 Compile a list of stakeholders and their contact details

5.2 Compile research information sheet for stakeholders

5.3 Establish contact with key stakeholders and notify them of the TRP and Poject 3

5.4 Arrange interviews/Conduct interviews

5.5 Develop and maintain a database of stakeholder consultations and related information including any transcriptions and digital recordings.

6. Catchment/site visits

6.1 Daly

6.2 Katherine

6.3 West Arnhem (Gunbalanya)

7. Communications

7.1 Present project outline to eriss staff

7.2 Present research outline at Gunbalanya Open Day

7.3 Engage media for communication possibilities (ABD Rural Radio Katherine and Freelance Journalist)

7.4 Compile an eriss note

7.5 Poster construction

7.6 Present research to CDU TRP Workshop 12th November

8. Report Writing

8.1 Student these' write-up

8.2 Compilation of synthesis/report

Timeline for tasks

Task	2003-04				2004-05											
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
1.1																
1.2																
1.3																
2.1																
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8.2																

Attachment 3 Detailed communication and consultation progress report

Detailed communication and consultation progress report

Communications strategy

A communications strategy has been specifically developed for the TRP. The objectives of the communications strategy are:

1. To identify and engage relevant stakeholders in the Tropical Rivers Project;
2. To communicate effectively with identified Tropical Rivers Project stakeholders for the duration of the project;
3. To ensure Tropical Rivers Project outputs are communicated in an appropriate form to stakeholders and the wider community;
4. To ensure all communication aspects are reported in accordance with Land & Water Australia milestones; and
5. To build awareness of the Tropical Rivers Project among the scientific and general community.

This strategy is dynamic and will be up-dated and reviewed regularly. Both internal and external communications are outlined. A working communications plan is currently being produced to further progress communication activities. Table 1 provides a list of communication and consultation activities achieved to date.

The communications strategy also presents mechanisms by which relevant stakeholders in the TRP have been identified and engaged. The broad categories of stakeholders identified for the Tropical Rivers Project are:

- Government
- Non Government Organisations
- Industry (mining, pastoral, farming, fishing, buffalo, tourism)
- Land Owners
- Indigenous people (eg. Traditional Owners) and organisations (eg. Land Councils);
- Research Organisations
- Users of Tropical Rivers.

The major stakeholders for the TRP were identified through the consultation process and grouped under the above-mentioned broad categories. An interactive stakeholder mpa is currently being developed. This will identify stakeholders at various levels and will include a ‘live’ link to an Access database containing all communications and consultation activities. Engagement and consultation of identified stakeholders requires a range of methods. The methods, which were adopted in this communication strategy, are:

- Telephone
- Email
- Facsimile
- Interview- face to face interview with stakeholder
- Meetings
- Presentations/Forums/Workshops
- Information sheets.

Table 1 Description of TRP communication and consultation activities undertaken to date or in progress.

Type of communication	Date	Outcome
Stakeholder-consultations	June 04 – present	To date 150 consultations with stakeholders have taken place. The consultation details are stored in a consultation record, which includes contact details, response and follow-up requirements.
Stakeholder- forum invitations	Prior to 12/11/ 2004	Over 100 people invited to workshop Sent either through electronic or mail out an invitation to the Tropical River Forum that included a detailed project description
General public- media release	11/11/04	National Centre for Topical Wetland Research Media Release: " Australia's Tropical Rivers" Promotes the Forum and the TRP
General public- media	14/11/2004	Tropical wetlands under threat, conference told A conference at Charles Darwin University has heard that many of Australia's tropical wetlands are under threat and have to be protected. http://www.abc.net.au/news/newsitems/200411/s1243051.htm
General public- media	14/11/2004	**702 ABC SYDNEY Radio News - 11:00 AM** A conference in the Northern Territory has heard that many river systems and wetlands across tropical Australia are no longer pristine. Grab(s) of George Lucaks (ph.sp.), Researcher, explaining the need to tackle the issue of rehabilitation.
General public- media	14/11/2004	**720 ABC PERTH Radio News - 07:45 AM** The river and wetlands systems across tropical Australia are in grave danger. Grab(s) of George Lukacs, Centre for Tropical Freshwater Research who says we really need to tackle the issue of rehabilitation.
Internal communications- SSD-Newsbrief	2004	In 10 editions of the SSD internal Newsbrief, 6 articles on the TRP appeared.
General public- media release	27/01/05	DEH – Supervising Scientist Division Media Release: "Status of Top End Wetlands and Rivers" Promotes World wetlands Day 2005 and the TRP.
Stakeholder – communications-newsletter	Planned release for early March 05	A TRP Newsletter is under development. The newsletter provides stakeholders with a summary of the workshop held on 12/11/04, announces the next workshop and details TRP representation at upcoming events. This will distributed by both electronic and mail out mechanisms to stakeholders listed according to the consultation record.
Stakeholder – communications – project scope document	Planned release for early April	The objective of this document is to communicate the scope of the Tropical Rivers Project (TRP) to all stakeholders and interested parties in the context of the allocated resources available for the project. The TRP team are unable to undertake work outside of the scope outlined in this document. The scope has been produced from the detailed work plans developed for each of the three sub-projects.

Project Steering Committee

The NCTWR Advisory Committee has agreed to act as the Steering Committee for this project, providing ongoing advice to the project team on project progress, direction and communication activities at approximately six monthly intervals. In addition, several other relevant individuals have accepted roles on the Steering Committee. The membership of the Committee is provided in table 2. The Committee has convened once, on 25 August 2004, primarily to agree on, and discuss its role for the project. The next meeting of the Steering Committee is scheduled for March/April 2005.

Project workshop

The first Tropical Rivers Project (TRP) Workshop took place on 12 November 2004 at Charles Darwin University. The workshop was well attended by stakeholders representing government, indigenous, industry and research interests. Nineteen presentations were delivered, providing stakeholders with a summary of the TRP and funding cycles, and an update on the progress of the sub-projects. These presentations played an important role in providing the stimulus for open discussions on many aspects of the TRP.

Key presentations were delivered on:

- **The National Water Initiative (NWI).** Basic elements of the NWI IGA and the Australian Water Fund were presented.
- **The Australian Tropical Rivers Group (ATRG).** The role of this group of experienced scientists is to work in partnership with all stakeholders to discuss and plan management of Australian tropical rivers.
- **The Land and Water Australia (LWA) Australian Tropical Rivers Program.** The four research themes of the program were presented.
- **Sub-projects and their progress to date.**

Open discussions during the workshop, highlighted some key issues that need to be addressed. The following points are a summary of these key issues:

- **Data availability.** Access to information is an issue with products and outputs.
- **Data supply and long-term management of information.** In the first instance, published material will be uploaded to the TRP website.
- **Consultation and communications.** Communications need to continue and expand in various ways.
- **Natural Resource Management (NRM) and regional engagement.** It is a priority that managers are involved in NRM on the ground and the question is how the TRP links to them.
- **Social and economic aspects of the TRP.** Concern has been raised within stakeholder groups that the social and economic aspects my not be addressed specifically enough within the TRP.

After the workshop, feedback on the TRP was received from a number of stakeholders. The relevant project members addressed this feedback and requests for further information were met. The feedback addressed and incorporated into the communications strategy included: a photo library which includes photos of habitat and biota; engaging indigenous stakeholders in the Daly and Roper Rivers catchments; inclusion of TRP articles in the NRM facilitator

Table 2 Membership of the Tropical Rivers Project Steering Committee

Name	Position	Organisation
Theo Hooy (Chair)	Assistant Secretary, Coasts & Water	DEH
Michelle Handley	National Wetlands Policy Officer	World Wide Fund for Nature
Simon Townsend	Water Monitoring Branch, Natural Resource Management Division	Department of Infrastructure, Planning & Environment
Margaret Card	Regional Director	Qld EPA
Steve Vellacott	Manager, Environment Strategy	Nabalco Pty Ltd
Clair O'Brien	MRLG member, pastoralist	-
Fiona Fraser	Wetlands Officer	Northern Land Council
Alexander Stubbs		
Vern Veitch	Deputy Chairman	Sunfish Qld
Ilse Kiessling	Oceans Liaison Officer	National Oceans Office
Susan Worley	Regional Manager, North West	Water and Rivers Commission
Samantha Fox	NRM Regional Facilitator, Northern Territory	DEH
Claire Taylor	NRM Regional Facilitator, Kimberly	DEH

newsletter; and targeting communications materials appropriately to our various audiences. Requests for information were predominantly related to provision of the maps of the project area and details relating to the sub-projects scope. As a result a project scope document is being developed and is near completion that summarises the sub-project details.

Other activities

World Wetlands Day 2005

World Wetlands Day was celebrated on 2 February 2005. A media brief focussing on wetlands in northern Australia was released making mention of the TRP and its importance. The excerpt relating to the TRP reads:

> *"The Environmental Research Institute of the Supervising Scientist (**eriss**) in Darwin, part of the Australian Government's Department of the Environment and Heritage, is a key partner in the Land and Water Australia funded Tropical Rivers Project. The aim of this project is to produce an information base containing an integrated inventory, risk assessment and ecosystem services framework for some of our Top End rivers."*

The following is a list of media appearances:

- **Max Finlayson interview on TopFM with Daryl Manzies.** Tuesday 25th January, "Status of Top End Wetlands and World Wetlands Day 2005 Darwin event promotion"
- **Maria Bellio interview on ABC Radio Darwin with Leon Compton.** Wednesday 2nd February, "Waterbirds of the Top End and World Wetlands Day 2005 Darwin event promotion"
- **Maria Bellio and Tida Nou in NT News.** Wednesday 2nd February, "Wild Wetlands of Amazing Creatures".

The North Australian Remote Sensing and GIS Conference (NARGIS), 4-7 July 2005 in Darwin

A TRP exhibition booth has been submitted for NARGIS. Collation of materials for the booth will begin in April. This is a good opportunity to showcase the TRP to our local stakeholders.

www.nargis05.cdu.edu.au

International Rivers Symposium, 6-9 September 2005 in Brisbane

The possibility of having an exhibition booth at this event needs to be investigated. Papers on the TRP will be submitted to the symposium in relation to the session themes on "living with floodplain rivers", "rivers as corridors for wildlife", and "environmental flows for rivers and estuaries".

www.riverfestival.com.au/symposium

Australian Society for Fish Biology Conference, 14-15 July 2005 in Darwin

The prospect of the Supervising Scientist Division having an exhibition booth at the two-day conference is being investigated. This will enable the TRP to be showcased. TRP team members who are working on sub-project components relevant to this conference will be encouraged to submit papers or posters to this event. Abstracts for papers close on 30th May 2005.

http://www.territorylive.com/asfb2005/

Attachment 4 Tropical Rivers Project Newsletter March 2005

TROPICAL RIVERS PROJECT NEWSLETTER

March 2005

Australia's tropical rivers – an integrated data assessment and analysis

CONTENTS

For comment or suggestions on this newsletter, please contact:

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Ngarradj (Swift Creek), NT

Tropical Rivers Project

Sustainable management of Australia's tropical rivers and wetlands requires an integrated information base for assessment of their ecological character (including benchmarking their status) and the development of policy, especially for environmental flows and potential uses of water. An information base will be established for assessing change, undertaking ecological risk assessments of major pressures, supporting local and indigenous management, and strengthening holistic approaches for managing tropical rivers/wetlands.

The information base will be built on consultation, analysis of existing information, and specific investigations to provide further data as a reference for assessing change to the river/wetland habitats and their species, and the ecosystem services they provide. As reference conditions for assessing change and environmental flows cannot be provided for all localities or species, surrogates will be determined and responses to key pressures assessed through structured and quantitative frameworks and linked with the provision of ecosystem services. These analyses will extend analyses being done through other initiatives in tropical Australia.

national centre for tropical wetland research

Australian Government

Land & Water Australia

Natural Heritage Trust

Helping Communities Helping Australia

An Australian Government Initiative

The first Tropical Rivers Project (TRP) Workshop took place on 12th November 2004 at Charles Darwin University. The workshop was well attended by stakeholders representing government, indigenous and research interests. Nineteen presentations were delivered, providing stakeholders with a summary of the TRP and funding cycles, and an update on the progress of the sub-projects. These presentations played an important role in providing the stimulus for open discussions on many aspects of the TRP.

Max Finlayson fielding questions from the audience

Key presentations were delivered on:

- The National Water Initiative (NWI). Basic elements of the NWI IGA and the Australian Water Fund were presented.
- The Australian Tropical Rivers Group (ATRG). The role of this group of experienced scientists is to work in partnership with all stakeholders to discuss and plan management of Australian tropical rivers.
- The Land and Water Australia (LWA) Australian Tropical Rivers Program. The four research themes of the program were presented.
- Sub-projects and their progress to date.

Open discussions during the workshop, highlighted some key issues that need to be addressed. The following points are a summary of the key issues discussed:

Discussions continued during tea breaks

- **Data availability:** Concern was raised in regards to the accessibility of data generated by the TRP with particular reference to spatial data. An argument was presented that the public funds the project, therefore the data and information should be made available to the public. It was suggested that there is no access to core data as there are many issues associated with making the data freely available. However, images will probably be accessible as will the ability to print out maps from selected GIS layers. It was clarified that data will be available through the data custodian subject to licence

agreements. The repository for data is likely to be with ERIN-DEH.

Access to information is an issue with products and outputs.

Stuart Blanch – WWF

- **Data supply and long-term management of information:** Questions were raised in relation to: how are datasets going to be housed?; How will we be able to supply data to stakeholders such as conservation groups?; what are we going to do to ensure information is secure?; who will have ownership?; and where will the data be located in 10-15 years?

  This issue will be discussed with Brendan Edgar (LWA). In the first instance, published material will be uploaded to the TRP website.

- **Consultation and communications:** It was expressed that there is a need to communicate the science of the TRP to the general public. ***eriss*** and the NCTWR are currently responsible for co-ordinating communications. However, the question was asked: How do we co-ordinate communications across the entire LWA Tropical Rivers Program? Brendan Edgar representing LWA responded by stating that the communications strategy will be attached to the project plan, but they still not have determined how to co-ordinate communications across the LWA funding program. It was also suggested that the outlines of the TRP have to established and communicated. This is currently being addressed by developing a project scope document to distribute to stakeholders and other interested people.

  Communications need to continue and expand in various ways.

- **Natural Resource Management (NRM) and regional engagement:** It was stated that it is a priority that managers are involved in NRM on the ground and the question is how the TRP links to them especially to resource targets for the state or territory government agencies. Questions centred on the link include: What is the process linking the TRP, NRM and resource targets and how do we validate these processes?; and is the TRP going to use national indicators in citing resource targets? Feedback received to date indicates that stakeholders hope that the outputs of the TRP are not another audit product with no assistance with regional investment. Some of these NRM groups are data deficient at this point in time so are working closely with other agencies to identify gaps in data.

George Lukacs – James Cook University

- **Social and economic aspects of the TRP:** Concern was raised specifically that within stakeholder groups the thought was that the social and economic aspects might not be addressed specifically enough within the TRP.

Acknowledgements

A big thanks to the workshop organisers (Claire Watts, Ann Thompson and Carolyn Lord in particular). Their organisational skills made for a smooth running event.

Thankyou to all the TRP staff and presenters for their time and effort, which was greatly appreciated by all participants. The TRP team would also like to acknowledge the support of Land and Water Australia, Natural Heritage Trust 2 and the Department of the Environment and Heritage. Finally, but not lastly, we would like to thank those participants that provided us with feedback. The feedback we received was detailed and highly relevant. We have taken all issues raised on board and addressed all requests for further information.

Upcoming TRP Workshop Announcement

The next TRP workshop will be held in either Brisbane or Townsville. The two options are:

1. Brisbane: To be held in conjunction with the International River*symposium* in September; or
2. Townsville: A stand-alone workshop.

Stay tuned for further information…

TRP Representation at Upcoming Events

The North Australian Remote Sensing and GIS Conference (NARGIS)

4th-7th July 2005 in Darwin

NARGIS 05 attempts to provide a forum, which will bring together people from a range of disciples that, will come under the umbrella of the spatial sciences in Northern Australia. The theme of the conference aims to review **what has gone before, discuss current research and applications, and to come up with a set of future directions** for the spatial sciences in Northern Australia, allowing people to share ideas and understand the different applications.

John Lowry will be presenting a paper titled “Integration of data for inventory and assessment of Australia’s northern rivers”.

Dene Moliere will be presenting a paper titled “A GIS analysis of stream lag-times in Northern Australia”.

A TRP exhibition booth has been submitted for NARGIS. Collation of materials for the booth will begin in April. This is a good opportunity to showcase the TRP to our local stakeholders.

www.nargis05.cdu.edu.au

International River*symposium*

6th-9th September 2005 in Brisbane

River*symposium* 2005 will focus on some of the pressing issues important to water and food security such as transboundary catchment conflicts and resolutions, water scarcity and urban and rural tensions over sharing water resources. Institutional and legal arrangements for river management will be featured along with work on rivers as corridors. Discussions will continue on living with floodplain rivers, maintaining and restoring native fish populations, polluted rivers and predicting and planning for climate change.

The possibility of having an exhibition booth at this event is being investigated. Papers on the TRP will be submitted to the symposium in relation to the session themes on "living with floodplain rivers", "rivers as corridors for wildlife", and "environmental flows for rivers and estuaries".

www.riverfestival.com.au/symposium

The Australian Society for Fish Biology Worshop and Conference 2005
11th-15th July 2005 in Darwin

The Australian Society for Fish Biology has hosted a national workshop series since the early 1980's. The 2005 Workshop will explore 'Monitoring Fish Stocks and Aquatic Ecosystems'; a topic of great importance across Australia. The 2005 workshop will review the following sub-themes:

- Monitoring commercial, recreational, and indigenous fisheries.
- Fisheries independent monitoring approaches.
- Ecosystem-based approaches to monitoring aquatic resources.
- What works best and what doesn't.

Relevant components of the TRP will be exhibited at a Supervising Scientist ehibtion booth.

http://www.territorylive.com/asfb2005/home.htm

Update on TRP sub-projects

Sub-project 1: Inventory of the biological, chemical and physical features of aquatic ecosystems

Progress on data collection for selected biophysical attributes has varied across the attributes due to the existing project commitments of team members. Further details for specific attributes are listed in the table below.

Attribute	**Activities**
Geomorphology	The final form of the typology will be determined by the end of March 2005 at which time it can be incorporated into the GIS. The typology will be compatible with that developed for the Murray Darling Basin, which focuses on erosional, transport and depositional sections.
Water quality	Software has been developed in MS-Excel that automatically consolidates, reformats and summarises data from the various databases held by the different agencies. This has been successfully tested for HYDSYS data from the Gilbert, Norman, Staaten and Mitchell River catchments in the Gulf of Carpentaria. The development of the software allows faster and more accurate analysis of datasets that are available for the region.
Hydrology	Long-term stream flow characteristics, such as mean annual/monthly runoff and, in particular, inter-annual variation, are important flow variables as they have been shown to be linked to stream biota. The approach taken here is to establish these characteristics for various streams within the tropical rivers region. To conduct this analysis, gauging stations with at least 30 years of stream flow data were identified throughout the region. For these gauging stations located throughout the Northern Territory, Queensland and Western Australia, mean annual and mean monthly runoff and coefficient of variation data were obtained from the various agencies. The data has been analysed for Queensland and Western Australia, with the Northern territory analysis yet to be completed. Further work will include: • Complete the analysis of long-term flow characteristics for the Northern Territory. • Construct mean annual runoff and coefficient of variation graphs for the various streams across the region, particularly within the focus catchments, and compare these data to other streams in Australia and overseas. • Use these data to construct grided contour maps for the tropical rivers region to illustrate the spatial variation of annual runoff and interannual variability.
Vegetation	Numerous data sources have been accessed to date to identify relevant aquatic, riparian and mangrove species. A total of 267 plant species with have been identified in a preliminary literature search of publications and reports dealing with the rivers that flow into the Gulf of Carpentaria in Queensland. The next phase with the Queensland species is to retrieve distribution data from the Qld Herbarium database, HERBRECS, and create spatial layers for the species groupings. A similar process will follow for the Northern Territory and Western Australian data. For mangrove distribution, the 1:250K topographic mangrove layer for northern Queensland and the Northern Territory generated by Qld Department of Primary Industries and Fisheries (DPI & F) has been sourced.

Invertebrates	A number of government agency staff and other specialists from the Commonwealth, states and Territory have so far been consulted in developing this inventory project. The AUSRIVAS data have been entered into the spatially related database being used for the TRP. One application of the data that will be investigated is to seek a (multivariate) classification across the tropical rivers region. Tropical streams for which species-level data are available include: Sites within Ord and Pentecost Rivers (WA), and sites within Keep, Daly, Finniss, Adelaide & Mary river systems, Darwin Harbour streams, South Alligator R and Magela Ck (East Alligator R) (NT). There are other sources of species-level data, which are planned to be acquired and geo-referenced. Invertebrates of conservation interest in tropical rivers are being investigated. Other issues for consideration are: • Unless new data are acquired (unlikely in the timeframe of this project), focal catchments cannot be studied in any greater detail than other catchments. • Estuarine invertebrates have not yet been considered. Moreover, there are unlikely to be more than 'a handful' of estuaries for which data are available.
Fish	Most published sources of data for freshwater fish in the study area have been obtained. Other sources of information such as surveys conducted as part of environmental monitoring associated with mining ventures have not yet been obtained, but these have very limited geographic scope and utility to the project. The locations of survey sites from the information obtained have been added to the GIS database. Thus, a good picture of where data gaps are has been compiled and an analysis of patterns apparent from the existing information has begun.
Amphibians	To date, spatial data for 60 frog species listed as occurring in the study area have been collected. In addition, there are a number of species whose distributions are on the border of the study area and these are being investigated to determine whether they should be included in the project. The spatial data have been converted to digital format, and mapping will commence shortly.
Reptiles	Thirty species of reptile have been selected for inclusion in the Tropical Rivers study to date. These consist of 2 crocodilidae, 1 carettochelydidae, 13 chelidae, 2 achrochordidae, 1 boidae, 6 colubridae and 5 varanidae. The definition of what constitutes a "semi-aquatic" species, and therefore what should be included or excluded from this study is an area of on-going discussion, and feedback is welcome.
Birds	Seventeen families of waterbirds accepted under the Ramsar definition and included in the Asia-Pacific Migratory Waterbird Strategy (2001-2005) and found in the study area. This project will consider all species, of both inland and coastal wetlands, included in the 17 taxonomic groups. In order to undertake the risk assessment component of the project, the 126 species of birds belonging to the seventeen families of waterbirds, were grouped in five feeding guilds.

GIS & Mapping	A hierarchical approach has been applied to the creation and management of spatial data for this project. Data acquisition and integration is planned to continue for some months to come, as additional datasets and sources become available, particularly at the focus catchment scale. At a catchment scale, attention will focus on the compilation of vegetation data, and the generation of a geomorphic typology using the 1" DEM and a lower resolution DEM such as the 3" DEM. Specific theme-based acquisitions (particularly for the focus catchments) are planned to continue, from both existing databases and from field-based observations.

Sub-project 3: Development of a framework for the analysis of ecosystem services provided by aquatic ecosystems

The data collection component of this project has been completed. The initial format of documentation of the results of this sub-project will be in the format of 6 Masters theses which are due to be completed by March/April 2005. A summary of these combined works will be condensed into a report for submission to Land & Water Australia in June 2005.

Communication and presentation of the research has been undertaken in various fora in both Australia and The Netherlands. In addition a presentation of the work was conducted at a conference in Bangkok: Conference Presentation of Poster by Bas Verschuuren at the 3rd IUCN World Conservation Congress within the workshop entitled "Estimating and Realising the Value of Ecosystem Services". An invitation has been extended to present the research again to a group of specialists working on a publication for Wetlands International.

Linkages with other LWA Tropical Rivers Program projects

The TRP undertaken by the NCTWR has linkages with other LWA mini call projects. One such project is *"Ecosystem processes in tropical rivers: conceptual models and future R & D"*. The project is lead by Dr M Douglas (Charles Darwin University); Prof S Bunn (Griffith University); and Prof P Davies (University of Western Australia) and involves a consortium of researchers from 12 agencies. This project focuses on ecosystem processes in tropical rivers.

Rick van Dam and Peter Bayliss are part of the consortium and attended a meeting with the ecosystem processes project team. The aim of the meeting was to identify activities for future research to improve our understanding of ecosystem processes in Australian tropical rivers. The research that has been proposed will compliment the work being undertaken by the NCTWR led project on inventory and risk assessment.