Northern Territory Government

DEPARTMENT OF
NATURAL RESOURCES, ENVIRONMENT, THE ARTS AND SPORT

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Scoping Paper:

A Finer Scale Vegetation Map for the Northern Territory

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PREFACE

Context

A working group was formed in 2006 to determine the requirements for and possible approaches to the production of a finer scale map of Northern Territory vegetation communities. This report summarises the information developed by the working group. It is essentially a scoping report and was produced in conjunction with NTNRM RIS2005/121. It will be largely superseded by the final business plan/work plan developed at the end of RIS2007/167.

Summary

The Northern Territory occupies approximately 18% of Australia and covers a large range of environments and climatic regimes. Native vegetation defines the character of most of this landscape.

The only presently available NT wide standardised vegetation mapping is derived from the 1:1 million scale vegetation map completed in 1990. This earlier mapping has been updated with more recent mapping of most of the closed forest types in the NT (NVIS ver 3 present and Pre-european dataset). The vast majority of NT vegetation communities still remain mapped at a broad scale (1:1K).

The current NT wide mapping, while useful for providing an overall ecological perspective of the NT, is inappropriate for regional or catchment level planning issues presently emerging with the increased development and modification of the NT environment.

A workshop was held in March 2007 to scope the need for more detailed vegetation mapping than currently available It was attended by a number of agencies and non-government organisations including Qld Herbarium, DPIFM, the Australian Defence Department, Greening Australia NT, Charles Darwin University, private consultants, as well as various branches of NRETA itself.

Participants all agreed that finer scale mapping is needed and that the rationale for such a system needs to be clearly presented to potential funding bodies. In addition participants thought that any finer scale mapping system/program that is developed should aim to:

- Have the capacity to be updated with new information.
- Maintain IBRA bioregion uniformity by mapping whole bioregions at a time.
- Keep relationships between land and vegetation mapping units close (ecosystem rather than pure vegetation mapping).
- Be an adaptive system that enables even finer scale mapping to be conducted in the future.
- Provide for engagement of Indigenous Land holders.

A scale of 1:100,000 was deemed the most appropriate and practicable scale at the workshop.

On consideration of patterning within the vegetation types in the NT and current NRM needs, the simplest and quickest approach for future mapping would be:

Task 1 1:100,000 mapping of the broader patterned vegetation in the Top End. Retain current 100k mapping of MVF, melaleuca, mangrove etc
Task 2 Separate mapping of important, discrete vegetation types such as wetlands, paleo drainage channels, and riparian vegetation in the Arid region (100k-50k ?).
Task 3 Separate mapping of seasonally inundated floodplains of Top End coastal (100k-50k scale).

Indicative costings to complete Task 1 are in the order of $3-5 million

The report is divided into five sections

Section 1 Background material.
Section 2 Possible Approaches with indicative costings.
Section 3 Funding sources.
Section 4 Current Initiatives and projects which complement a mapping program.
Section 5 Protocols, mapping standards, procedures etc. (to be developed prior to any mapping).

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SECTION 1

Background:

1.0 Introduction / Overview

Native vegetation has been argued to provide the best single source of information on variation in environment and resource potential, because vegetation is the surficial integration of the ecosystem and its history. Small scale (1:200,000 or smaller) vegetation mapping has long been a much practised and much justified activity in most parts of the globe. (Dickinson & Kirkpatrick 1986).

The Northern Territory occupies approximately 18% of Australia and covers a large range of environments and climatic regimes. Native vegetation defines the character of most of this landscape. The environments range from the wet/dry tropics in the north to semi-arid and arid regions of central Australia. The patterning within the vegetation generally becomes broader as it progresses from north to south, particularly from the 18^0 southward.

In comparison to other States and Territories, the Top End of the NT still has large areas of un-cleared native vegetation, which although not pristine, could be regarded as relatively intact and un-fragmented. With some caveats, the current state of NT vegetation can be regarded as pre-european/pre-settlement, or as near to it, as can be practicably or sensibly ascertained. However in some areas, particularly in more arid regions, the native vegetation has been significantly altered

In addition, the NT differs in tenure from most of Australia in that over half of the land area and ~80% of the coastline is currently under Aboriginal freehold title or control.

Table 1 Land-Use in NT circa 2005

Dominant Land-Use	% NT *	Status	Modifying Agent
Agricultural / Horticultural	0.06	cleared	Land use
Roads/Urban	0.36	cleared	Land use
Conservation & native vegetation (includes Aboriginal land)	53.7	relatively intact	Fire regimes and grazing (feral)
Pastoral	45.9	relatively intact	Fire and grazing (feral and domestic)
* Land use categories based on NT LUMP project 2005			

The management of this vegetation affects sustainable primary production, soils, salinity, water yield and quality, wildlife, and other natural resource management issues. The NT has the opportunity to get baseline data and manage these vegetation resources prior to major changes or modification of this environment.

More detailed vegetation information can be used to address:

- monitoring and reporting natural resource condition and trends at a range of scales
- targeting investment in high priority natural resource management issues
- supporting development of natural resource management regional and industry strategies
- environmental reporting and environmental management systems
- developing planning and risk assessment
- modelling vegetation processes that affect the natural resource base and support programs aimed at addressing issues such as biodiversity conservation, salinity, water quality and soil loss, and
- meeting legislation obligations
- pest and weed control, and
- fire management
- implement trading schemes (water, carbon)
- impacts of climate change: provide a baseline to measure against: benchmark/sentinel sites or communities and/or to prevent the situation of over allocation of resources.

1.1 Aim

The objective is to develop a framework, and ultimately a strategic re-mapping program for vegetation of the NT. This is being driven by the increasing need for more detailed mapping at management scales such as 1:25 000 to 1:100 000. A nominal scale of 1:100,000 is deemed appropriate and practicable but does not preclude other scales.

There is also scope to bring together, within this strategic framework:

- existing data and expertise (local, state and national)
- collaboration between a number of agencies (NTG, Inter-State, NGO's, Education, Private etc)
- outcomes to address the NRETA strategic plan
- outcomes to address a number of the INRM targets
- current and past NTG and Commonwealth funded projects and initiatives such as the definitive vegetation types, vegetation condition indicators, national standards for vegetation survey and mapping etc.
- NRETA corporate database storage issues: one standardised site database as per historical times
- etc

In terms of future mapping, a clear purpose and consistent approach, at appropriate scales, for delineation and/or definition of the vegetation resource is required. There is also a strong need to develop an integrated approach that places the vegetation in to a context of overall landscape functioning.

Future mapping should address management needs and tasks will entail spatial mapping, reports and descriptive information as well as interpreted products.

In the short term, in order to bring the NT in line with other jurisdictions, and in respect that population and land use pressures for most of the NT will remain for the next few years of an extensive, rather than intensive nature, a general rapid mapping technique of vegetation is required (e.g. rather than a long term mapping project that delivers small areas at a time). In the long term the expertise developed to produce the larger area mapping should be retained for finer scale mapping (e.g. < 100,000 scale) of priority areas in the future.

A working group has been established to progress the initiative.

1.2 Impetus: Vegetation mapping work shop and Key Outcomes:

A workshop was held in March 2007 to scope the need for a more detailed vegetation map than is currently available (Appendix 1 and web link: http://www.nt.gov.au/nreta/natres/natveg/seminar/vegmapping.html). It was attended by a number of agencies and non-government organisations including Qld Herbarium, DPIFM, the Australian Defence Department, Greening Australia NT, Charles Darwin University, private consultants, as well as various branches of NRETA itself.

Participants all agreed that finer scale mapping is needed and that the rationale for such a system needs to be clearly presented to potential funding bodies. In addition participants thought that any finer scale mapping program developed should:

- Have the capacity to be updated with new information.
- Maintain IBRA bioregion uniformity by mapping whole bioregions at a time.
- Keep relationships between land and vegetation mapping units close.
- Be an adaptive system that enables even finer scale mapping to be conducted in the future.
- Provide for engagement of Indigenous Land holders (via Land Councils).

A scale of 1:100,000 was deemed the most appropriate and practicable scale.

It was agreed that a finer scale mapping proposal should be developed and would proceed via a number of technical working groups.

Stage 1) Develop a finer scale mapping criteria paper (this document)
Peter Brocklehurst, Bruce Wilson, Mike Clark, Ben Sparrow

Stage 2) Establish a finer scale mapping working group
Based on the mapping criteria paper, establish a Working Group of interested workshop participants.
Mike Clark, Peter Brocklehurst & Bruce Wilson.

Stage 3) Develop a finer scale mapping proposal
Develop a specific finer scale mapping proposal and a strategy to implement the proposal (e.g. assess funding /collaborative opportunities; collate and assess existing map data; promote and market to Northern Territory and Australian Governments etc).
Who – Working Group

This document addresses Stage 1. The final mapping proposal will be repackaged into ‘policy’ speak and be much reduced in size.

1.3 Issues to be considered

Issues that need to be addressed prior to any mapping program:

- Requirements for finer scale mapping, what scale, extent etc.
- What type of mapping: Need to decide what is to be mapped, what will the map units look like, what will the vegetation descriptions, what purposes will the data be used for.
- Physiognomic/structural vegetation mapping theme as per current vegetation map with hard lines imposed on a continuum. Vegetation types only.
- Ecosystem or ecological vegetation communities: an environmental base for the mapping. Does this occur at out-set during interpretation or can it be imposed on a vegetation theme layer at a later date.
- Currency of mapping and update frequency.
- An appropriate and practical mapping methodology. Different approaches might be required in different areas (e.g. arid versus tropical regions).
- National Standards.

- Any work to adhere to current national standards for vegetation survey and mapping and follow the NT Guidelines for Vegetation Survey and Mapping where appropriate.
- Linkages to national programs if and where relevant.
- Database storage and data dissemination issues.
- What resources are available (data), who does the work (who and where) and how can it be funded.

1.4 Long Term Goals: Expectations

The aim is to work towards generating a whole of NT theme layer for vegetation which would be a key component of an integrated NRM database consisting of multiple layers.

- To help with future monitoring frameworks.
- To provide linkages to other vegetation related projects and NRM activities.
- Completing, maintaining and updating a state-wide vegetation map and classification in collaboration with other State and National agencies and organizations
- Developing the most appropriate vegetation products for conservation planning and natural resources management within the state

1.5 Guiding Principles of any mapping group/program

This is a reiteration of the original reason the vegetation mapping group was established in 1986. The principal roles of any scientific program, in this instance vegetation mapping, should include:

- Developing and maintaining a standardized vegetation classification system for the NT.
- Developing best methods of vegetation assessment including sampling, analyzing, reporting, and mapping vegetation at multiple scales.
- Training resource professionals on these techniques and coordinating with other agencies and organizations to ensure a state wide, standardized approach toward collecting, reporting, and interpreting vegetation data.
- Developing best practices for using these data for long-range conservation and management of natural landscapes in the Territory.
- Conducting integrated vegetation assessments throughout the Territory.
- Archiving and distributing quality vegetation data to all who need it.
- Coordinating with other State, federal, and local agencies and organizations involved in vegetation assessment

2.0 Background and Current Situation:

2.1 Available Scales and Mapping

The only presently available, NT wide, standardised vegetation mapping is derived from the 1:1 million scale vegetation map completed in 1990. This earlier mapping has been updated with more recent mapping of most of the closed forest types in the NT (NVIS ver 3 present and Pre-european dataset). Large areas of the NT still remain mapped at a 1:1million scale.

A very limited suite of finer scale vegetation mapping is available (~ 8% of NT) for localised areas and these are associated with specific conservation areas, zones of development or specific vegetation community types.
Land unit and land system mapping also contains vegetation information, however the boundaries are primarily topographic and each map unit often contains more than one vegetation type. This mapping is also largely at broad scales when considering the whole NT.

All other States and Territories have mapping at finer scales than the NT. Current NT mapping projects are generally reactive rather than pro-active, resulting in mapping in a piecemeal manner with no overall strategic vision for the whole NT.

Table 2 NT Vegetation Mapping circa 2007

Scale	Area km2	% NT Coverage	Significance	Datasets
≤ 1:50 000	7 662	0.6	Local*	Various maps
1:100, 000-1:250,000	100 898	7.5	Regional*	Various maps
1:1 000 000	1 346 200	100	national	NT 1:1m pre-european vegetation map
1:100,000-1:1 000,000 mixed scale	1 346 200	100	national/regional	NVIS ver 3.1 pre-european vegetation map NVIS ver 3.1 present vegetation map
* Only ~ 8% of NT mapped at regional or local scales				

Table 3 State & Territory Mapping (current and past)

State	Predominant Scale	Extent	Significance	Predominant Type	% of Australia	% of Population
TAS	25k	100%	local	Pure vegetation	~ 0.8	~ 2.6
VIC	25k	100%	local	ecosystems	~ 3	~ 24.6
ACT	≤ 50k	100%	local	Pure vegetation	~ 0.039	~ 1.7
QLD	100k-250k	90%	local/regional	ecosystems	~ 22.5	~ 18
NSW	≤ 250k	60%	Regional/local	ecosystems/ Pure vegetation	~10.4	~ 33
SA	≤ 250k	90%	Regional/local	Pure vegetation	~ 13	~ 8
WA	250k	100%	regional	Pure vegetation	~ 33	~ 9.6
NT	≤ 1000k	100%	National/regional	Pure vegetation	~ 17.5	~ 0.9

2.2 Current Gaps

The current NT wide mapping, while useful for providing an overall ecological perspective of the NT, is inappropriate for regional or catchment level planning issues, presently emerging with the increased development and modification of the NT environment. Also, increased development is expected on aboriginal lands if new Australian Government proposals are enacted (leasing of aboriginal lands).

Table 4 Scale Gaps in NT Vegetation Information at the **1:100,000 scale**

Data	Gap	Description
Spatial Extent Mapping*	~90%+ at 1:1m scale	Generally mapped or missing with current mapping: • Broad areas of forest and woodland in Top End and open-woodlands / grasslands in Arid regions. • Floodplain wetlands and to some degree riparian habitats in the Top End, wetlands and relict drainage lines in Arid regions • Sensitive or threatened Ecosystems, priority ecosystems etc It is envisaged that currently available 1:100,000 scale mapping of closed forests in the NT will be retained. These vegetation types were specifically mapped and could not be remapped to the same detail.
Vegetation Type	~60%+ inadequately undescribed	Approximately 30,000 vegetation sites have been assessed in NT for floristic, faunal or mapping purposes. From this and associated reports a preliminary list of benchmark vegetation types or Definitive Vegetation Types was compiled. 374 communities have been recognized so far for the NT with only ~100 currently mapped.
Currency of data	~90%+	Current mapping is of variable age, mostly old being of 1986-2004 lineage However how much 'significant' change has really occurred across all NT landscapes in the last 15 years? ↓
Vegetation Condition Information	~95%+	Assessment of vegetation condition lacking for most of NT. However some landscape or very local level projects underway. Rangelands monitoring projects, NATT , fire ecology etc
* Changes in extent (e.g. clearing) of native vegetation is currently undertaken for the Intensive Land use zones on a yearly basis and for the whole NT on a 2 yearly basis.		

Table 5 Perceived Gaps by NRM Project/Program

Component	**Target or indicator by Plan, Strategy or Organisation**					
	NT M&E strategy	**ESCAVI/NVIS /NFI (various AG)**	**NT NRM Plan**	**Parks Master Plan 2005**	**LWA interests**	**CERF Interests ?**
Current vegetation mapping -1:1million	n	n	A	A	no	no
Current vegetation mapping - NVIS ver2 2005	A	A	A	A	no	no
Refined vegetation mapping	n	G	G	G	NO	NO
Threatening processes	n	n	A	A descriptive	+	+
Condition assessment methods	G	G	G	G	+	+
Current vegetation condition	G	G	G	G	+	+
Benchmark vegetation types	G	G	n	n	+/-	+
Vegetation survey and mapping standards	n	A	A		no	+
G= seen as a gap or is required. **A**= presently available or used						

2.3 Ideal scales

A series of ideal mapping scales, for the purposes of NRM monitoring and evaluation, have been proposed by the Australian Government. Although some are impractical to implement in NT under current regimes, they provide some indication of desired scales and map currency.

Table 6 Nationally Recommended scales and currency of mapping

Type	Recommended Scale*	Significance	Currency	%NT
Wetlands, Riparian, Remnant, Priority veg types	1:25,000	local	12 months	10%
Agricultural Lands: ILZ	1:100,000 preferably 1:50,000	Local/regional	18 months	40%
Pastoral/Rangelands: ELZ	1:250,000 preferably 1:100,000	regional	18 months	50%
*NOTE: some of these scales are 'inspirational' in terms of practicality under current State & Territory programs				

2.4 NT Vegetation mapping

A number of agencies are currently involved in vegetation survey and/or mapping in the NT. Historically the Vegetation and Survey group (now part of Land & Vegetation) were the primary providers of vegetation mapping information for the NT government. A link to NRETAS vegetation survey and mapping can be found here:
http://www.nt.gov.au/nreta/natres/natveg/vegmapping/index.html

However a number of other branches within NRETAS and other agencies in the NT are now involved in mapping.

These include:

Table 7 NT vegetation mapping agencies

Agency	
Biodiversity Conservation NRETA North	Vegetation data is collected and described with less emphasis on stratum and species dominance. It is generally collected in conjunction with fauna surveys for habitat recognition and is usually at the association level , NVIS Level V. Biodiversity Conservation store vegetation data in an Access database including floristics, structural characteristics and environmental information.
Northern Territory Herbarium NRETA	The NT Herbarium maintains the floristic taxonomic database (Holtze) for the NT with the intention to be linked to various environmental databases across CNR. It also maintains a plot database that incorporates a complete species list identified within a 20m by 20m quadrat and geo-referenced data. Minimal structural characteristics are collected and only broad descriptive information is contained in the database. In some instances data is collected that is consistent with Biodiversity Conservation. Also maintained is a survey specific database for Nitmiluk Nat Pk that incorporates structural, floristic and environmental information.
Defence department	Terrain mobility modelling: Similar vegetation survey methodology to Land and Vegetation branch
Private consultants	Various methods
Biodiversity Conservation NRETA South	Data is collected for bio-surveys in much the same way as it is in the Top End with a few concessions for the arid zone. Methods include: 1) Steppointing data for a 100x100m Quadrat – this is primarily to tie to the satellite imagery and is a quantitative method to give me particularly accurate cover estimates for all the species in the quadrat. All species occurring in the quadrat are recorded, with those occurring, but not sampled quantitatively (they occur so sparsely they weren't stepped on) are assigned a cover of 'T' ie. Trace. 2) Full quadrat data – this is for 100 x100 m quadrats again and records the cover of all species occurring in the quadrat using a modified Braun-Blaunquet classification system and actual % cover , Both of these methods collect full site

	information as well. 3) Vegetation mapping quadrats dispense with most of the site information. They also dispense with a formally marked quadrat and each site is given a Homogenaity value (relating to landsat pixels) to measure how far the cover estimates are valid for from the point of sampling (where the GPS is taken). These sites use the same cover method as above, but dispense in collecting any data on species deemed to have a cover abundance less than 5%.
Bushfires Council	Habitat and Fire scar mapping

2.5 Vegetation mapping in other states: scales, purpose and methods

This is not a complete listing of mapping projects/agencies within a particular State or Territory. This table lists the main Government vegetation mapping agency within that particular State or Territory.

Table 8 State Government mapping agencies

State	Extent, scale and dominant use	methodology
Qld	Aim The survey and mapping program aims to provide comprehensive 1:100,000 scale vegetation and regional ecosystem information base across Queensland. Purpose Maps are an essential component for the administration of the *Vegetation Management Act 1999* and are an important tool for land management, including conservation planning. Mapping program stimulated by the need to respond to vegetation clearing restrictions.	
	ELZ: More than two-thirds of Queensland has been completed for both pre-clearing and remnant vegetation distributions at a scale of 1:100,000. The pre-clearing vegetation communities for Cape York Peninsula, South Western and Central Western Queensland are mapped at a scale of 1:250,000. These data are in the process of being upgraded to a scale of 1:100,000. The remnant and regional ecosystem coverages are currently being developed for these areas. **ILZ:** Part of Southeast Queensland is mapped at a scale of 1:50,000. The Wet Tropics bioregion has been remapped at 1:50,000 scale.	Delineation of the pre-clearing vegetation communities on **aerial photographs**, using stereoscopic pairs of photographs. The communities are determined from the survey of remnant vegetation, aerial photographs, ecological and historical knowledge. The remnant vegetation communities are delineated by the extent of clearing (land cover) which is derived from recent **Landsat TM satellite imagery.** The remnant vegetation community coverages are derived by intersecting the land cover with the pre-clearing vegetation coverage Digital elevation models (DEMs) are used to assist in the transfer of linework from the aerial photographs to the vegetation map Extensive field sampling and ground survey Geographic Information Systems (GIS) mapping and analysis.
SA	Aim To complete Statewide coverage by 2015 (including surveys and mapping) Purpose Substantially improve knowledge of the biodiversity of South Australia. Improve our ability to adequately manage nature conservation into the future. Measure the direction of long-term ecological change.	

	ELZ: Pastoral & Aboriginal Land Conducted by Biological Survey and Monitoring section. Structural vegetation mapping at a scale of 1:250,000 in cattle and Aboriginal Lands. Structural vegetation mapped at scale of 1:100,000 in sheep country	**Landsat** image classification, **aerial photography** and ground truthing. Mapping in the pastoral areas used to be done by API, and more commonly visual interpretation of hardcopy imagery. Ben Sparrow developed a new image processing technique where all available field data is collected (including veg mapping sites if fieldwork conducted for mapping) This data is then used to clip pixels from a standard unsupervised image classification . The image classes can then be attributed to the vegetation information which then has a PATN analysis conducted on it to determine vegetation groupings. By reordering the data you then find out which vegetation class each image class applies to and re-attribute the image classification. Image classes with insufficient field information still need to be interpreted, however if enough ground info is used then this is only a tiny fraction of the area of the imagery. Now implemented as a standard method.
	ILZ: Agricultural Areas Conducted by Planning SA with input from Biological Survey and Monitoring section. Floristic vegetation mapping at a scale of 1:50,000	Derived from colour air photos, PATN analysis and ground truthing,
WA	Have re-attributed Beards 1:1m map to 250k based on original information (ie have split the polygons based on original descriptive mix provided by Beard)	Currently developing a strategy for a remapping program for the state (1:100,000 scale) ; various methods proposed at this stage
Tasmania	etc	
VIC	Has mapping across whole State at 1:25,000 for Ecological Vegetation Classes.	

3.0 Drivers for finer scale vegetation mapping across the NT

3.1 Increased NRM reporting requirements

The need for finer scale vegetation mapping over much of the NT has been recognised for a number of years. More detailed spatial delineation of vegetation communities is needed to assist and improve short, medium and long term decision making, both at the local, regional and national level. Finer scale mapping combined with environmental information can be also be seen as a surrogate for habitat thus assisting fauna information

Table 9 A comparison of scales and map unit detail

Survey	Scale	Mapping Units delineated
Ntvegmap	1:1million	3
NVISver3.1	1:100,000-1:1million	7
Stray Creek	1:25,000/1:50,000	>30

The lack of a suitably detailed vegetation map of NT was emphasised during development of the following processes.

- The 'NT Parks and Conservation Masterplan' recommends the need for complete vegetation mapping at 1:250,000 scale or better for those areas of the NT proposed for development.
- Finer-scale vegetation mapping and the assessment of vegetation condition is recognised as a gap under the Integrated Natural Resource Management Plan (Many of the MATS require information at a level that is currently not available. Specifically relates to MAT3.3
    - MA3-5 Refine vegetation mapping to a regional ecosystem level using appropriate and available methods so that valuable ecosystems not currently detectable under the current scale of vegetation mapping are retained
- Past and recent M& E activities
- Native Vegetation Management Plan for the NT

3.2 Stakeholders Requirements

The need for finer scale mapping was also re-iterated in the recent workshop in Darwin and a nominal scale of 1:100,000 was deemed the most suitable and achievable within a practicable time frame. However it needs to be noted that this is still a regional scale, not a paddock level scale.

Table 10 Workshop participants requirements for future mapping (% agreement)

Participant Requirements			
Desired scale		**Extent**	
100k	250k	Priority Areas	NT wide
92%	8%	80%	20%
Participant background	Mapping	66%	34%
	Policy	86%	14%
Definitions			
Priority Areas	**general**		
	Areas subject to development pressures/Future potential high land use areas: As stated in INRM Plan Areas where land unit mapping is not done Customs operational areas e.g. coastal areas Sentinal sites related to mine rehabilitation / fisheries / mangroves		
	specific		
	Darwin, Daly Basin, Mataranka Station, Katherine, Litchfield Shire, McDonnell Ranges Wetlands / high conservation value areas Indigenous lands / Ali Curung / Tea Tree Defence training areas Potential *EPBC Act* listed vegetation communities.		
Requirements	**Vegetation Management**		
	Development assessment proposals, Assessment process implementation, Management action planning, Biodiversity management, conservation planning, Assist with future (Indigenous) land use needs, Integrated NRM (e.g. fire, weeds, vegetation)		
	Monitoring		
	environmental condition, Pastoral land, landscape condition change, Wildlife habitat land use, measuring changes in vegetation extent (native & weed species)		
	Mapping		
	vegetation extent, vegetation extent benchmarking, reduce vegetation mapping gaps, Regional ecosystems, land use capability and capacity,		
	Other		
	Carbon accounting Legislative requirements Research needs		

Interestingly, and with obvious reasons, the policy people want a shorter term fix than those involved with inventory of the information.

3.3 Linkages to NT Core business

The NT Government has obligations to provide management, monitoring and reporting processes for native vegetation at the local, regional and national levels.

- NT legislation requirements:
- National legislations requirements:
- National data requirements for monitoring and reporting:
- NT requirements for monitoring and reporting:

3.3.1 NT legislation requirements:

Table 11 NT legislation

Activity	Better mapping to assist with	Acts/Strategy
Vegetation clearing	Extents of vegetation to be cleared, rare communities etc	*Pastoral Land Act 1996,*
Development Assessments	Type of vegetation cleared, Land use objectives	*Planning Act 1999, Soil Conservation and Land Utilisation Act 1995*
Catchment management	Water resources comprehensive catchment management	*Water Act 1992, Soil Conservation and Land Utilisation Act 1995,* Integrated Catchment Management Planning
Terrestrial bio-diversity	Threatened communities, reserve design, condition of resources.	*Parks and Wildlife Commission Act 1998,* Threatened Species Strategy.
Weed management	prioritising conservation areas and areas vulnerable to weed invasion et.	Northern Territory Weeds Strategy 1996-2005.
MPA	marine protection areas will rely on comprehensive catchment management	Integrated Catchment Management Planning. MPA under development

3.3.2 National legislation requirements:

NT is signatory to a number of national acts and agreements.

Environment Protection and Biodiversity Conservation Act 1999 provides for:

- Environmental protection and an integrated framework for the conservation of biodiversity,
- Environmental assessment and approvals of nationally significant issues,
- Development of bilateral agreements between the Commonwealth and State/Territory governments for the accreditation of State assessment and approval processes,
- Cooperative identification and monitoring of biodiversity and bioregional planning,
- Listing threatened species, ecological communities and threatening processes and development and implementation of recovery/threat abatement plans, and
- Management of Commonwealth reserves, conservation zones, World Heritage Areas and wetlands of international importance.

Inter-Governmental Agreement on the Environment 1992 /1997 Council of Australian Governments Heads of Agreement

- environmental management arrangements.
- sustainable use and conservation programs and cooperative measures with the States/Territories and other interested parties.

Australian Heritage Commission Act 1975:

- assessment, identification and listing of naturally and culturally important places

Australian Quarantine Act 1908:

- controls imports to protect against pests, weeds and diseases.

Natural Heritage Trust Act 1997:

- established Natural Heritage Trust funding reserve and grant programs such as Bushcare, Landcare, Rivercare, and the National Reserve System.

World Heritage Area Properties Conservation Act 1983:

- protection and conservation of those properties in Australia and its external territories that are of outstanding natural or cultural value.

Natural Resources Management (Financial Assistance) Act 1992

Primary Industries Research and Development Act 1989.

3.3.3 National data requirements for monitoring and reporting:

State of Environment/State of the Forests Report2008 (DEWR, NFI)

Baseline and Resource condition monitoring- (NLWRA/NVIS/DEWHA) relevant national vegetation condition indicators are:

- The extent of present native vegetation by IBRA subregion (measured in hectares)
- The extent of each priority native vegetation type by IBRA subregion (measured in hectares)
- The remaining proportion of each priority native vegetation type by IBRA subregion measured as a percentage of the estimated pre-1750 extent
- The proportion of each native vegetation type in each IBRA subregion that is estimated to be in specified condition classes based on a selected set of attributes

NLSA condition monitoring

AG reporting requires more detailed & varied information:

- without ongoing mapping AG money will eventually dry up. Better mapping & or projects leading towards this could allow leverage into some Commonwealth funds, CERF etc

3.3.4 NT requirements for monitoring and reporting:

Natural Resource Management Plan:

- Resource Condition Target 3-1 requires the setting of benchmarks relating to the extent, condition and functionality of all the Territory's regional ecosystems.
- Baseline vegetation data is required for the development of research and monitoring programs that enable environmental planning for the Territory's terrestrial biodiversity (Management Action Target 3-3).
- MAT's

Carbon accounting

- Carbon accounting has no precision without detailed structural mapping.

Fire management:

- Fire sensitive ecosystems better spatially delineated: mapping would assist with scaling up this work to delineate these types
- in combination with fire scar mapping, condition assessments and management strategies for particular vegetation types could be determined (ie different veg types require or can tolerate different fire regimes)
- Characterising fuel types for carbon accounting.

Vegetation management**:**

- On ground, veg. retention, weeds, amount of vegetation type being cleared, reserve design etc.

Impacts of climate change:

- to provide a baseline to measure against: benchmark/sentinel sites or communities

3.4 Extent of Future mapping

Why is whole of NT veg mapping required?

There is a need to approach the whole issue on a longer more forward looking basis (rather than short term project basis), and develop a strategic framework and adequate infrastructure to allow a remapping of the whole NT. A plan should be developed for a complete remapping program even though funds may not allow this to occur in the immediate future.

A number of reasons for this

- The situation that has developed over the last few years within the department has resulted in a diminishing focus on the original strategic vision of the vegetation mapping group and resulted in a more reactive, ad hoc and piecemeal approach to regional vegetation mapping. This approach will not achieve the overall strategic vision of the department as outlined in the NRETA Strategic Plan 2006-2016, nor many of the actions required for the NT INRM plan, under current conditions. As this situation was developing the need for more varied and detailed information on natural resource information at both the NT level and national level has increased.
- need to get the whole picture for comparative purposes (e.g. systematic survey). Small areas mapped at fine scale cannot really be put into context if equivalent scale mapping is not available in other regions where the same vegetation type might occur- decisions based on fine scale mapping of small areas can be counter intuitive and lack real term significance.
- a number of building blocks are in place already. (section 4)
- to attract suitable staff: length of tenure and training. Set up/train a group which forms the nucleus for expansion.
- provide a unifying force or direction for a number of disparate NRM ‘vehicles’ ie longer term thinking required rather than a plethora of short term, shotgun scatter one off NRM projects

4.0 Data Currently available

4.1 Current Resources:

4.1.1 Interpretative Material Available:

Influences Cost and Mapping technique:

Table 12 Available NRETA Darwin

Type	Comment	Suitable Scale*
Aerial photo/SPOT/ALOS:	Disjunct coverage of NT. High cost for NT wide coverage.	≤ 100,000
Landsat	Time series NT wide coverage. Updated every few years from AGO-can deliver at but some constraints. 1985-2006 NOTE: All landsat data and archives will be free by 2009	≥100,000
MODIS	Available free of cost (presently). For whole NT. Updated regularly-useful for time series	1:250,000
Ancillary data		
DEM	good	≥100,000
Clearing dataset	ILZ presently, whole NT end of year	≤ 100,000
Radio-metrics	Resolution variable over whole NT	≥100,000
Geology- variable	variable and sheet boundary issues	50,000-2.5million
Lithology	NT wide	2.5million
Regolith	NT wide-recently updated	2.5million
Land systems Top End**	Standardised from individual surveys	≥250,000
Land systems Arid	Standardised from individual surveys	1 million
Land Use mapping	Lump project-needs revision	≥100,000
Other	?	

* some of the broader scale data sets can be used for stratification purposes
**Land systems Top End: still being developed. Currently 2/3rds of Top End has been completed at 1:250k scale. The rest of NT at the 1:1million scale. The aim is to standardise and integrate into one framework all existing NT land systems mapping.

Table 13 Cost comparison: New Data acquisition-various imagery types, cost, scale resolution and applicability (circa 2007)

Imagery	NT wide	Type	Applicability		swathe/area	Res (m)	Scale	Stereo	* $ Cost/km^2	NT $million		
			map	monitor						*Top End	*Arid	Total
SPOT 5 Full Scene	y	10m multi-spectral	y		60x60 3600km^2	10	≥1:50,000	n	1.34	.69	1.0	1.69
		5m B&W	y			5	≥1:25,000	n	1.46	.75	1.9	2.65
		5m multi-spectral	y			5	≥1:25,000	n	3.0	1.6	4.0	5.6
		2.5m B& W	y			2.5	≥1:10,000	n	2.33	1.2	3.1	4.3
		2.5 multi-spectral	y			2.5	≥1:10,000	n	3.74	1.9	4.9	6.8
ALOS	y	PRISM-pan chromatic 3 components: (forward,nadir,backward) * 2 comp. needed for stereo forwards and backards best	y	y	35 x 35	2.5	≥1:25,000	Y with 2 components	0.27 (1comp) 0.81 (3comp)	0.14 0.42	0.22 0.66	0.36 1.04
		AVNIR-2 3visible+nir	y	y	70 x 70 4900	10	≥1:50,000	n	0.067	0.034	0.054	0.088
		PALSAR	?	?	Phased array L band Synthetic Aperture radar- different permutations-not sure							
LANDSAT Full scene	y	Ortho-rectified colour un mosaiced 6 bands	y	y	185x185	25	≥1:100,000	n	0.035	0.019	0.028	0.047
		Ortho-rectified colour-mosaiced	y	y	185x185	25	≥1:100,000	n	0.04	0.022	0.032	0.052
ASTER	?N	Multi VNIR-orthocorrected	y?Y	y	60x60	15	≥1:50,000	n	0.08	0.041	0.064	0.105
MODIS	y	Bands 1-2	y	y	2 images	250	≥1:250,000	n	Free online			0
		Bands 1-7	y	y	2 images	500	>1:500,000	n	Free online			0
IKONOS	?n?	4 bands basic product	y	y	7x7	1	>1:1000	n	12.5	6.4	10	16.4
* costs		costs indicative only May 2007 may not include mosaicing, colour balancing, postage etc etc										

* Bioregions	Top End: 514716.91 km^2 Arnhem Coast, Arnhem Plateau, Central Arnhem, Daly Basin, Darwin Coastal, Gulf Fall and Uplands, Gulf Coastal, Gulf Plains, Ord Victoria Plain, Sturt Plateau, Tiwi Cobourg, Victoria Bonaparte Arid: 804489.63 km^2 Burt Plain, Channel Country, Central Ranges, Davenport Murchison Ranges, Finke, Great Sandy Desert, MacDonnell Ranges, Mitchell Grass Downs, Mount Isa Inlier, Simpson, Strzelecki Dunefields, Stony Plains, Tanami	

ALOS	R,G,B,NIR-alternative source of data and a level of back-up to the Landsat series of satellites-cost effective for NT wide. Problems however with time acquisition of adjacent swathes Not suitable for some of the image processing techniques that landsat is!	
SPOT	R,G,B,NIR costs prohibitive for NT wide coverage	
Ikonos	Cost prohibitive without consideration	

4.1.2 Existing Vegetation Information

A large amount of quantitative data (sites, mapping) and qualitative information (scientific & technical reports) already exists. This will assist future map interpretation as well as save on field costs.

Site Data

An inventory of all vegetation site data was undertaken in 2003. Site sheets were assessed as to their quality, detail, digital storage and utility. All available site survey sheets were assessed for 182 vegetation surveys. More detail is contained in the document.

An Access database exists with all the meta-data information.

In summary

- Over 30,000 sites have been assessed. Site information varied from simple plot based species lists to fully detailed floristic, structural and environmental data.
- Site data was collected for flora and fauna surveys, land unit/land system mapping, vegetation mapping and various monitoring studies. The bulk of the NVIS Level V data (eg more detailed structural data) was collected for vegetation, land unit or land system mapping.
- Most of the data (≈94%) is now held within different sections of the Department of Natural Resources, Environment and the Arts, although all the data is not stored in the one database. Data Custodians in decreasing order.
    - Land and Vegetation Unit: Darwin (DNRETA)
    - NT Herbarium (DNRETA)
    - Biological Diversity: Darwin (DNRETA), Land and Vegetation Unit: Alice Springs (DNRETA)
    - Parks and Wildlife Commission, Defence Department
    - Bush Fires Council (DNRETA)
    - Biological Diversity: Alice Springs (DNRETA), CSIRO(TERC), EWL Sciences,Tropintel Environmental Consultants
- Approximately 66% of all sites are stored electronically. Most flora and fauna survey sites, vegetation mapping sites and various monitoring study sites, are digital.
- Structural and floristic detail varies between sites and surveys. Approximately 49% (15073) of sites assessed were deemed (qualitative judgement) to be at the NVIS hierarchy Level V. Of these NVIS Level V sites, approximately 56% (8437) are digital.
- Digital data is stored in a number of different data packages. Most sites are stored in DECODA, RAVS or Microsoft Access databases (similarly for the NVIS level 5 data). However there is no standardisation of database attributes between different databases held by different custodians. The Biological Diversity unit (DIPE) is presently compiling data into one Access database, primarily to assist with producing a Flora atlas.
- Approximately 56% of the sites were produced in conjunction with mapping, although not all of the final maps are digital.
- Site lineage varies between 1968 and 2003, with increased data collection from the late 1980's to the present.
- Vegetation Site data has been collected by organisations other than NRETA. Primarily this will be with the CDU (students), very early sites (eg pre 1960's) with various Commonwealth agencies (eg CSIRO Land Research Series, Defence department) or with private environmental consulting companies. The amount of this data is unknown.

Issues:

How to get all site data into one database is the issue relevant to the NTG but probably not for this proposal. It is currently being addressed for both vegetation and soil data by NRETA and the NT herbarium. To analyse all this data, even if it was available in one data base/format is not considered here. Most of these sites have already been analysed and vegetation descriptions produced. The descriptions are relevant, not the raw data. However creating a geo-referenced database that summarises each site based on dominant species, structure, stratum etc and environmental parameters, might be a valid task and assist a future mapping program.

Qualitative Data summary

An inventory of existing scientific and technical reports on NT vegetation was undertaken when compiling the Definitive Vegetation Types project report. The DVT report lists 374 main vegetation types, sources of that information with links to mapping and NVIS where relevant. The DVT data represents an important source of vegetation information although is still being compiled. Once completed it would contribute significantly to any future mapping program as well as being of importance in its own right. A database was developed and records are being entered (200). However more resources are needed to complete this project.

Current mapping/GIS data

Current survey extents for vegetation, land unit and land system mapping can be viewed on NRETA maps.

http://www.nt.gov.au/nreta/nretamaps/

4.1.2 Linkages/Building blocks in place:

Current information or projects such as DVT's, RAVS site database development, Native Vegetation Baseline Extent Project, Clearing extent updates (clearing in ILZ yearly, whole NT every two years), vegetation condition indicators etc. can assist future mapping. See section 4.

4.1.3 Comparison of available methods: NRETA

A range of methodologies are available. All have pros and cons, some are untested, others are impracticable under current resourcing. However the amount of existing information, both spatial and descriptive, is exponentially greater than when the first NT wide mapping project began. Mapping technologies have also advanced over the last few years. This should lead to some efficiencies.

Appropriateness of method is scale dependent, resource dependant etc. However modern GIS techniques makes the resolution of the data a more important consideration than scale.

Table 14 Interpretion: Map unit delineation

Interpretive Material	Method	Advantages	Dis-advantages	Scale Applicability/capability
Aerial Photography (API)	Manual Visual 3D Stereoscopy	Provides the best resolution and allows interpretation of topographic features: requires expertise in technique	Expensive to buy, Time consuming requires trained staff and/or long term commitment. ≤ 10% of NT covered by suitable aerial photography	≥50,000
Machine/Manual Pixel Based Classifications	Aerial photograph equivalent imagery (ALOS,SPOT) R,G,B,NIR	Provides good resolution- no 3D component though- can be interpreted manually or with software.	Little SPOT and ALOS data exists for much of NT. ALOS data appears to be a cost effective alternative to aerial photos for certain purposes.	≥50,000
	Landsat	Suitable for rapid mapping of larger areas: NRETA has a relatively comprehensive archive of Landsat data. All landsat Archives soon to be free of charge	Depending on process, is a non expert system	≥100,000
Object Oriented Classifications	Object Oriented Classifications	Combines advantages of pixel based classifications and thematic layers. Can operate on raster and vector data. Allows intuitive methods and scripting. Can operate at arrange of scales.	New software. Techniques under development.	≥50,000
Other	Hyperspectral data, Aster, LIDAR	Has potential for future	Costs prohibitive as only small footprint available	-
Modelling	Relies on a priori interpretations: spatial data	Possibly useful in some situations (see section 3).	However not a consideration for an NT wide 1:100k mapping exercise.	-

4.2 Current Resources: Personnel/work unit

The vegetation personnel (2) of the Land & Vegetation branch are more than fully occupied with current NTG projects, NRM projects as well as day to day business. Any future mapping will need to be done in collaboration with a number of different organizations and attract funding from a number of different sources

SECTION 2:

Techniques and Methodologies: Approaches

1.0 Requirements:

Although all require and need management scale mapping (e.g. 1: 25,000) the ability to achieve this level of detail, for the whole NT within a reasonable time frame, precludes further consideration. The complexity of the vegetation patterns and landscape parameters will dictate the homogeneity of the resultant map unit at whatever scale. For the purposes of this proposal, and in view of the NT environment and resources available, only two scales are considered here: nominally at 1:100,000 and 1:250,000.

From discussions and needs for various NRM projects and irrespective of final map scale or methodology the following needs to be adhered to.

- A map for **the whole** NT is required at a more detailed scale than presently available (1:1million).
- Most people agree with a **traditional hard line map** with strict boundaries as per current vegetation and land unit mapping as a final product. However this does not preclude alternative outputs such as pixel maps which can provide indications of ecotones etc and are more amenable to time series interpretation/re-interpretation.
- That mapping should be more than pure vegetation type mapping and incorporate the environmental component (ie as per regional ecosystems, ecological vegetation classes etc).
- Vegetation descriptions should comply with national standards and where possible vegetation types already described in NVISver3 should be transferred to new mapping.
- A number of mapping techniques are explored with 'indicative' costings. Although not a convinced fan of the use of land sat imagery for mapping vegetation some of the options proposed lean towards the use of this:
  - a general rapid mapping technique is required if we are to achieve things within a reasonable timeframe and to assist with targets set by the NT INRM plan.
  - the current political climate in the NTG probably precludes real investment in an environmental long term project that does not return an investment in the short term.
  - Landsat imagery will be cost free in 2009 (processing will still cost money).

Options Summary:

Option 1: 250k NT wide NT mapped at 250 k

Option 2: 100k NT wide NT mapped at 100k

Option 3: 100/250k NT wide Top End mapped at 100k, Arid regions 250k.

Top End Region: (514716.91 km^2) incudes Arnhem Coast, Arnhem Plateau, Central Arnhem, Daly Basin, Darwin Coastal, Gulf Fall and Uplands, Gulf Coastal, Gulf Plains, Ord Victoria Plain, Sturt Plateau, Tiwi Cobourg and Victoria Bonaparte bio-regions

Arid Region: (804489.63 km^2) Burt Plain, Channel Country, Central Ranges, Davenport Murchison Ranges, Finke, Great Sandy Desert, MacDonnell Ranges, Mitchell Grass Downs, Mount Isa Inlier, Simpson, Strzelecki Dunefields, Stony Plains, Tanami bio-regions

Option 4: Separate mapping of seasonally inundated floodplains and refinement of Arid region wetlands and/or discrete vegetation types.

Top End
Seasonally inundated coastal floodplains: 1:50,000-1:100,000
Chenier ridges-coastal ?

Arid
Wetlands, rivers, paleo-drainage lines, ranges : 1:100, 000-1:50,000

Methods available:

Aerial Photography Interpretation	Traditional API combined with onscreen digitizing. Traditionally line work was transferred directly on to the photos themselves then digitized off the photo. More recently the photos are scanned, geo-referenced and rectified and line work done on screen in combination with photo pairs viewed through a stereoscope. NRETA does not have digital stereo mapping software and due to cost probably won't get any in the immediate future. However new aerial photo equivalent imagery such as ALOS may make this type of software a more attractive proposition.
Imagery classifications: Pixel Based Classifications and/or Object Oriented Classifications	Supervised and unsupervised eg ERmapper, ENVI, Scripted eg Ecognition
Modelling	Relies on a priori interpretations: spatial data.

An explicit breakdown of costs is difficult. Costings are indicative and determined for NT wide mapping. Costings are based on estimates of time and staff required to complete the projects.

2.0 Option 1: Regional-National scale 1:250,000

2.1 Expectations/Benefits at this scale

- This can be achieved relatively quickly using existing data rather than field survey.
- Fill in the broader units of the 1:1 million scale map and include existing finer scale mapping of Monsoon vine forests, melaleuca forests, mangroves etc.
- GIS,Modelling, Pixel Based Classifications and/or Object Oriented Classification techniques.
- Use LANDSAT/MODIS and ancillary data sets.
- Traditional API not considered at this scale although use of ALOS a possibility.
- A valid environmental base for NT can be produced from existing data at this scale.

2.2 Techniques

2.2.1 Approach 1: Merge Top End land systems and NVISver3 vegetation data

Extent: Top End minus VRD

How: Project/consultant based

Method:

Attribute the recently developed Top End land systems data set* with the six levels of the NVIS hierarchy. Replace the broader units of the NVIS dataset (derived from the 1:1m vegmap) with the land system map units.
Develop a code system similar to Qld approach which describes the proportion and vegetation type of each component within the one land system type.
Use the SAVEG data entry tool to build the hierarchy for vegetation descriptions not already in NVIS (if descriptions are detailed enough). Overlay the existing 1:100,000 mapping of mangroves, monsoon vine-forest, lancewood, melaleuca etc.
This approach is office based and can be achieved from existing mapping and information.

*The Top End land systems data set is still being developed. Currently ~2/3rds of Top End has been completed at 1:250,000 scale. The rest of NT at the 1:1million scale. The aim is to standardise and integrate, into one framework, all existing NT land systems mapping. Approximately half the current Top End land systems data set is already attributed (Arnhem land, Roper and Gulf country) as part of NVIS version 1.

Data sets required and available:

NVIS2005 vegetation data set
Top End land systems data set and reports
NVIS vegetation description table
SAVEG data entry tool

Field component: Nil. Office based

Time frame: 4-6 weeks one person

Staff: P1 1.5 months

Essentially GIS operations and data manipulation

Project Costs/Funding required:

Table 15

Task		NTG	outsourced
data	purchase	0	0
	preparation	0	0
staff	Temporary/project duration	0	7500
	permanent	0	0
operational	capital	0	0
	field	0	0
Total		0	7500

Benefits

Could be achieved quickly as an interim measure. May also assist with any future map interpretation. I will be trailing this method in the Daly basin.

Possible Constraints:

- Funds available though Staff unavailable
- Not NT wide
- Attributing on some of the land systems is at NVIS level 3-4. (dominant stratum only)
- Map unit polygons will be mosaics.
- Some of the land system mapping is old. Vegetation cover may have changed structurally (rather than floristically) in some areas.

2.2.2 Approach 2: Trial a Modelling/Fuzzy logic Approach

Extent: Top End Region minus VRD

How: NTG/Project or consultant based-Trial first

Method:

Aims to split each individual land system of the Top End Integrated Land Systems data set into its component parts (spatially delineate the land system mosaics). These can then be attributed with existing information. Is essentially a machine based classification and data manipulation.

Create a separate data set for each land system and combine with MODIS/landsat classifications and elevation models to split the polygons. Use Ecognition and fuzzy logic (ie the process tree) to break each land system into its individual parts. Attribute each individual component with the six levels of the NVIS hierarchy. Overlay the existing 1:100,000 mapping of mangroves, monsoon vine-forest, lancewood, melaleuca etc.

Approximately half the Top End land systems dataset is already attributed as part of NVIS version 1 (Arnhemland, Roper and Gulf country, the VRD was also attributed but is currently undergoing revision). Use the SAVEG data entry tool to build NVIS hierarchy and descriptions for land systems currently not described.

Dissolve the final map based on the dominant vegetation type if necessary.

This approach would utilise existing mapping and information.

This method was trialled with the Arnhemland Land Systems and with the Daly basin NRM plan with mixed success. However I did not create a dataset for each land system (e.g. interpret each land system separately) However this method warrants further consideration. The Qld'ers? tried this approach, although I am not sure of the final outcome.

Data sets required and available:

NVIS2005 vegetation data set-part thereof
Top End land systems data set-part thereof
NVIS vegetation description table
MODIS or Landsat data
SAVEG entry tool
Elevation data
Other data

Field component: Nil or minimal

Time frame: Trial 2 months. Whole Top End land systems area 12 months

Staff: P2

Project Costs/Funding required:

Most of the time would be involved in preparing the MODIS or Landsat data sets. If MODIS proved suitable, data preparation would be considerably reduced in comparison with land sat. Trial the approach on one land system type. If this land system is contained within the Daly Basin Catchment then the landsat data is already prepared (NRM project).

Table 17

Task		**NTG or outsourced**	
		NTG Trial	**Full Top End Land system coverage Funds required/outsourced**
data	purchase	0	0
	preparation	0	0
staff	Temporary/project duration	13300	80000
	permanent	0	0
operational	capital	0	0
	field	0	0
Total		**13300**	**80000**

Benefits

- Could be done fairly quickly as interim measure. If successful would provide, albeit not perfect, a quick method to increase the spatial scale of current vegetation mapping.
- May also assist with any future map interpretation.
- May provide a technique that can be used for other land system/unit surveys.

Possible Constraints:

- Current land system amalgamation is not NT wide nor at the same scale (Top End 250k, arid region 1million scale). Funding required to assist with completion of the land system amalgamation for whole NT.
- Land system mapping has not been updated. Areas such as the lower reaches of the Daly river are now spatially inaccurate (eg the river has moved considerable since the mapping was done).
- Attribution of some of the land systems is only essentially at NVIS level 3-4. (dominant stratum only).
- Vegetation site data for much of the land system and land unit mapping for the whole NT exists but is non digital and of varying quality. However land unit/system descriptions exist in reports.

2.2.3 Approach 3: Pixel Based Classifications and/or Object Oriented Classifications

Extent: Whole NT stratified into regions

How: Project/consultant based

Tasks: GIS operations/Imagery classifications, data preparation, entry & manipulation (imagery, descriptive, site data) field work, report writing

Method:

Create a mask from the NVIS2005 data set that includes all information other than the current 1:100,000 mapping of mangroves, monsoon vine-forest, lancewood, melaleuca etc.

Use elevation bands, regolith, top end land systems, bio-regions etc to create an environmental stratification layer.
Do unsupervised classification then supervised classification (Landsat and/or MODIS) within each stratification group of the NVIS2005 mask (Ermapper, Ecognition etc).

Add the 1:100,000 mapping of mangroves, monsoon vine-forest, lancewood, melaleuca etc.

Update and attribute the current 1:250,000 wetlands mapping in Arid regions and add this.

Thematic Data sets required and available:

NVIS2005 vegetation data set
Top End land systems data set
NVIS vegetation description table
SRTM elevation data
NT regolith mapping
Bio-regions 5.3
Arid wetlands layer- needs to be refined
Existing site data-various surveys
Existing descriptive information. DVT's other

Landsat Data sets required and/or available for base interpretation:

Where possible use mosaic data already available (rather than create new data sets from individual landsat scenes) or use MODIS if suitable.

Landsat data sets include:

AGO 2000, 2004 data blocks based on the 1:500k topographic map series (a new AGO data set will be available soon) and the NORFOR 1992 landsat mosaics by bio-regions (Top End only).

Field component: Minor

Time frame: 2.5 years

Staff: 2 personnel P1/P2

How: Project/consultant based

Cost breakdown 250k:

Table 17

Task	Staff	time (months)	$k NT wide
Data purchase			0
Staff costs: time			
Data preparation: Imagery/GIS data	P1	12.00	60
Data preparation: Descriptive data: site data/reports etc	P1	12.00	60
Map interp: classifications/preliminary map	P2	12.00	80
field component	P1	3.00	15
field component	P2	3.00	20
Analysis	P1	6.00	30
Map attribution-recoding map	P1	3.00	15
Report	P1	6.00	30
Report	P2	3.00	20
NVIS database	P1	3.00	15
Staff total + overheads at 15% total salary		0.00	51
Staff Total		**63.00**	**396**
		5.25 man years	
Operational/Incidentals			**20**
Total			**416**

Possible Constraints:

Data preparation could be time consuming

2.2.4 *Manual interpretation of ALOS data.*

Extent: Whole NT

How: Project/consultant based

Tasks: GIS operations/Imagery classifications, data preparation, entry & manipulation (imagery, descriptive, site data) some field work, report writing

Method:

Use a combination of machine classifications and/or manual interpretation to map the broader polygons of the NVIS ver3 map. An older approach which might be suitable at the 250k scale. May not be a silly as it sounds considering the time wasted by some of the technofiles.

Time: 1.5-2 years

Staff: P1/P2

Cost:

Data purchase: $100k

Salary: ~$300k

Operational: 50

Table 18

Task	$k NT wide
Data Purchase	100
Salary	~300
Operational	50
Total	~450

2.3 Cost Summary

Table 19 Cost summary: 250k mapping

Approach	Total cost $k	Extent
1. Merge Top End land systems and NVISver3 vegetation data	7	2/3rds Top End
2. Modelling	80 (trial are 13)	2/3rds Top End
3. Imagery based	416	NT wide
4. ALOS	~450	NT wide

3.0 Option 2: Local to regional scale 1:100,000

3.1 Benefits/Constraints at this scale

- Exponential increase in resources required (time, staff , funds etc). Would need to decide whether was project based (general rapid mapping whole NT) or a working group formed to map priority regions and build on that.
- The NT mapped at this scale would probably address most NRM issues and would not need to remap the whole NT again-except for monitoring.
- Need to decide whether to incorporate existing 1:100,000 mapping.
- 100k still local to regional scale- not management/paddock scale.

3.2 Methods

3.2.1 Approach 1: Traditional API

Extent: Priority regions

How: NTG work group. Requires considerable and long term commitment from NT Government. Set up on the Queensland Herbarium model.

Method:

Traditional stereo API in combination with on screen digitizing, GIS operations, data preparation, entry & manipulation (descriptive, site data) field work, report writing.

Survey Costing:

Costing 1

The Upper Mary River Catchment Resource Assessment & Degradation Survey 2002 (D.Napier & C.Stein) is used to determine costings for API techniques at the 1:100k scale. Detailed figures were kept on the cost of this survey. However it involved both soil and vegetation survey so costs for pure vegetation mapping should be less than shown here. Area mapped was 5600 km^2. Project included an NHT component.

The table below does not include costs of purchasing photos.

Table 20 Upper Mary River Catchment Resource Assessment

Task	$k Mary River	$k/km	$m Top	$m Arid	$m NT	%
Salaries	550	0.098214	50.6	79	129.6	63.5
operational	298	0.053214	27.4	42.8	70.2	34.4
capital	18	0.003214	1.7	2.6	4.3	2.1
Total	866	0.154643	**79.7**	**124.4**	**204.1**	100.0
Staff time	Mary River (yrs)		Top (yrs)	Arid (yrs)	NT (yrs)	
P2	3.78		38.9	60.9	99.8	
P1	2.7		27.8	43.5	71.3	
P3	0.67		6.9	10.8	17.7	
T4	0.14		1.4	2.3	3.7	
T3	0.8		8.2	12.9	21.1	
T2	0.14		1.4	2.3	3.7	
Total	8.23		**84.7**	**132.5**	**217.2**	

Task Breakdown

Data breakdown/info search	5%
API	10%
Field work	15%
Data analysis, editing, data entry	25
Map attribution and finalising	10
Other reports, expenditure	
Accounting	10%
Report production	25%

Based on the tasks breakdown, and considering mapping vegetation alone, you could probably halve the field component, data entry, expenditure accounting and report component of this survey. This amounts to $127million for whole NT (this still appears a bit high to me).

Aerial Photo Costs:

A reasonable amount of aerial photography exists although is of variable scale and age. Most of the more recent photography occurs over urban or peri urban regions.

An estimate of ~8% of NT is currently covered with aerial photography suitable for production of a map at the 1:100,000 scale. Most of this occurs over urban or peri urban regions.

A considerable amount of new photography would need to be purchased and/or flown if a systematic survey of the NT was commenced.

A reasonable amount of 1960's Old BW variable scale photography exists for Melville Island, Adelaide-Darwin and areas of Arnhem land (old forestry data). Newer aerial photography exists over Arnhem land, Kakadu National Park and the greater Darwin area.

At this stage a full inventory of available photography was not embarked on because of the time this would take. Suffice it to say there would be sufficient photography to set up a training group which may form the nucleus for further expansion. Quickbird imagery could be purchased for the whole NT.

3.2.2 Approach 2: Imagery equivalent to aerial photos (SPOT, ALOS etc)

ALOS imagery is being trialled in the Katherine region and soon in the Arid region (2008). ALOS data is cost effective when compared to SPOT imagery or the purchase of hard copy photos for broader scale mapping. It has 3D capability. The resolution of ALOS would be suitable for 100k scale mapping although the recurrent return rate of the satellite would make mosaics to cover large areas, problematic. It would be suitable for mapping discrete vegetation types such as wetlands, riparian etc.

Will need to wait for ALOS to be trialled. It probably has potential to replace traditional hard copy API techniques for broader scale mapping in the future. It might be particularly suitable for use with digital stereo mapping software. However due to the small historic archive of ALOS data and the different dates of adjacent images it would be difficult, at this stage, to produce large area mosaics with calibrated and standard values across the whole mosaic.

For this project SPOT imagery would be too expensive to purchase for the whole NT and is not considered further. However a whole of government acquisition of SPOT imagery could be feasible if enough NT players were found. NSW and Qld are acquiring full coverage of SPOT data across there States from 2008 onwards.

3.2.3 Approach 3: Pixel Based Classifications and/or Object Oriented Classifications using Landsat/MODIS

This is a similar approach and methodology as for the 250 scale mapping however more detailed. Data preparation would need to be more precise and would probably take much longer. Assumes the use of currently available imagery data (NRETA).

Extent: Whole NT stratified into regions.

Method:

Prepare interpretation data. Average the landsat bands as per WA method to remove anomalies (eg fire scars, seasonal effects).

Create a mask from the NVIS2005 data set that includes all information other than the current 1:100,000 mapping of mangroves, monsoon vine-forest, lancewood, melaleuca etc.

Use elevation bands, regolith, land systems, bio-regions etc to create an environmental stratification layer.

Do unsupervised classification or supervised classification (Landsat and/or MODIS) within each stratification group for the NVIS2005 mask (Ermapper, Ecognition etc).

Overlay the current 1:100,000 mapping of mangroves, monsoon vine-forest, lancewood, melaleuca etc.

Update and attribute the current 1:250,000 wetlands mapping in Arid regions and overlay the NVIS2005 mask.

Thematic Data sets required and available:

NVIS2005 vegetation data set
Top End land systems data set
NVIS vegetation description table
SRTM elevation data
NT regolith mapping
Bio-regions 5.3
Radiometrics
Arid wetlands layer-this will need to be refined to 1:100,000 scale as a separate exercise
Existing site data-various surveys
Existing descriptive information. DVT's and other

Landsat Data sets required and/or available for base interpretation:

Choose from:

- Time series individual land sat scenes-would need to be mosaiced
- AGO 2000, 2004 mosaics based on 1:500k map series available.
- NORFOR 1992 landsat mosaics based on bio-regions (Top End only).

Field component: Major

Time frame: 5-6 years or ongoing

Staff: 2- 5 on and off

Tasks: NT Government work group or Project/consultant based GIS operations/Imagery classifications, data preparation, entry & manipulation (imagery, descriptive, site data) field work, report writing.

Costing:

A number of costing methods have been used. All approaches only 'indicative'.

Costing 1:
Based on Daly Basin NRM project: based on real figures and estimates: Costs reduced to $ per square kilometre basis and multiplied by area of Top End and Arid regions. Calculated on task basis

Table 21 Costings based on estimates for Daly basin project

	Staff	time (mths)	$k	$/km DALY	$k-Top end	$k-Arid	$k-Total	Top end (mths)	Arid (mths)	Total time (mths)	Total time (years)	% Time
Data purchase			0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.00	
Staff costs: time											0.00	
Data preparation: Imagery/GIS data	P1	2.00	9.9	0.000198	101.9	159.4	261.3	20.6	32.2	52.8	4.40	12.8
Data preparation: Descriptive data: site data/reports etc	P2	1.00	13.5	0.00027	138.9	217.4	356.3	10.3	16.1	26.4	2.20	6.4
Map interp:classification /preliminary map	P2	1.50	6.6	0.000132	67.9	106.3	174.2	15.4	24.2	39.6	3.30	9.6
field component	P1	1.30	6.5	0.00013	66.9	104.7	171.5	13.4	20.9	34.3	2.86	8.3
field component	P1	1.30	6.5	0.00013	66.9	104.7	171.5	13.4	20.9	34.3	2.86	8.3
Site data entry and analysis	P1	2.00	9.9	0.000198	101.9	159.4	261.3	20.6	32.2	52.8	4.40	12.8
Map attribution-recoding map	P1	1.00	5	0.0001	51.5	80.5	132.0	10.3	16.1	26.4	2.20	6.4
Report	P1	3.00	15	0.0003	154.4	241.5	395.9	30.9	48.3	79.2	6.60	19.2
Report	P2	1.00	6.6	0.000132	67.9	106.3	174.2	10.3	16.1	26.4	2.20	6.4
NVIS database	P1	1.50	7.5	0.00015	77.2	120.8	197.9	15.4	24.2	39.6	3.30	9.6
Staff Total					895.2	1400.7	2295.9	**160.5**	**251.2**	**411.7**	**34.3**	100.0
Staff total + overheads at 15% total salary		0.00			**1029.5**	**1610.8**	**2640.3**					
Operational												
other: travel allowance ($2450 for five weeks)	P1	0.00	0	0	25.2	39.4	64.7					
other: travel allowance ($2450 for five weeks)	P1	0.00	0	0	25.2	39.4	64.7					
Consumables (fuel,camp gear etc$ 1500 for five weeks)					25.2	39.4	64.7					
TOTAL					**75.6**	**39.4**	**194.0**					
TOTAL:Staff + Operational					**1105.1**	**1650.3**	**2834.3**					
TOTAL:Staff + Operational+publication: map,report ($60,000)		0.00	0	0	0.0	0.0	**2894.3**					
Total Time							**34 man years**					

Staff costs based on P1=60k,P2=80k (current NRETA rates)
Top End is 10.29 times the area of DALY Project
Arid Region is 16.1 times size of DALY Project

Costing 2:

Based on the original Daly Basin NRM project No breakdown on tasks. Daly basin project originally costed at $162,000 for an area of approximately 50,000 km^2. Calculated on total project funds: one permanent staff member. P2 + 2 * P1 3 months (field, data entry, preparation etc).

Therefore, based on this figure to map:

Top End $ 1.7m
Arid region $ 2.6m
$ 4.3m 40 man years

Efficiencies would be gained if work group established rather than costing for one off NRM project.

Costing 3:

Consultant rates for preliminary map product which then needs to be field truthed, data entry, report etc

Table 22 Costings based on Daly Basin NRM Project

Task	Who		Cost	Time	$Top End	$Arid	$Total
Data purchase			0		0	0	0
Data preparation*	Consultant	Imagery/GIS data	13,200	15 days Daly	135.8	212.5	348.3
Map interpr.	consultant	classifications	6,138	6 days Daly	63	98	161
Finalize preliminary mapping	consultant	Preliminary map	13,200	15 days Daly	135.8	212.5	348.3
Total consultant Costs					**334.6**	**523**	**857.6**
Costs from Table 1 Above	NTG						
Descriptive data: site data/reports etc/GIS data	NTG				101.9	159.4	261.3
					0	0	0
field component	NTG				134	210	344
Site data entry and analysis	NTG				101.9	159.4	261.3
Map attribution-recoding map	NTG				51.5	80.5	132.0
Report	NTG				222	346	568
NVIS database	NTG				77.2	120.8	197.9
TA & Consumables	NTG				75.6	139.4	194.0
Overheads	NTG				88	137.5	225.5
Total					**1186.7**	**1876**	**3041.6**

Costing 4:

Educated guess based on estimates of time taken for each task.

Duration: ~5-6 years (~20 man years ?)
Extent: Whole NT

Indicative Costing:

Table 23 Cost: Based on time taken for each task for Whole NT

		$k salary+onc	$k	$k publish
Data				
Data preparation imagery	P2 (1.5 yr over project)	120		
Data compilation vector, site data	P2 (1.5 yr over project)	120		
Map Interpretation	2 (P1,P2-3 yrs)	420		
Personnel Field	2 (P1,P2-2 yrs)	280	60+TA	
Data analysis, Attribution	2 (P1,P2-1.5 yrs)	210		
Report	2 (P1,P2-2 yrs)	280		
NVIS database entry/update	P1 (1 yr)	60		
Publication costs		0		60,000
Fuel/consumables/vehicle lease		-	50	
Overheads?	Building,HR etc 15% of salary	224		
		1714	110	60
Total				**1.88**

Costing 5:
Dickinson and Kirkpatrick (consultant report 1986): Estimated 35 man years using Landsat. Assume one person for length of project and no data costs.

Table 24

Component	$k (P1 + P2)/2		
Salary + onc	2450	Mid range salary between P1 & P2 (70,000)	
Overheads	367		
Operational	194	Based on costing table 1	
Total	**3011**		

3.3 Costing Summaries: 100k map

Table 25

Method		man years	Total NT ($ million)
API			< 204
Imagery classifications:*			
Cost method			
1	Based on Daly Basin NRM project-breakdown of costs	34	2.9
2	Based on Daly Basin NRM project-total project cost	40	4.3
3	Consultant produces preliminary map	31.4	3.0
4	Educated guess	20	1.9
5	Dickinson and Kirkpatrick (consultant report 1986).	35	3.0
* appears a figure of about $3million maybe near the mark for this			

3.0 Option 3: Top End 100k, Arid 250k

Imagery based approach as per 2.2.3 and 3.2.3 above

Table 26

Top end (Costings from Table 21 above)	$k	Total time (man years)
Staff total + overheads at 15% total salary	1029.5	13.3
Operational	75.6	-
Top End total	**1105.1**	**13.3**
Arid *		
Arid total	**254**	**3.2**
NT TOTAL	**1359**	**16.5**
* determined as a percentage of total NT costs based on table 17 (does not include separate wetlands mapping)		

4.0 Option 4: 100k Arid Region Wetlands, drainage lines, paleo lakes etc.

Requires further work. A hydrology dataset based on 100k topographic digital data is available on the NRETA spatial data server. This digital data shows the extent of lakes, rivers, billabongs, inundation regions, paleo-lakes wetlands etc although they are not classified into type. This could serve as a suitable starting point for creating a wetland layer which can be classified using the recently published Wetland Classification

5.0 Option 5: 100k/50k mapping seasonally inundated floodplains Top End coastal.

The seasonally inundated coastal floodplains of the Top End have not been mapped although their extents are digitally available. Due to seasonality of these floodplains different and/or time series data

Current Situation NT:

- Mangroves and Melaleuca forests, where they occur adjacent to the floodplain proper have already been mapped (100k scale)**.** New mapping would be of the floodplain proper-the black soil plain component.
- Studies by Woodroffe and Chappel have mapped the geomorphology (broad classes) for a number of floodplains (Mary River, Sth Alligator + others)
- Mary River, Arafura swamp and Magela creek have been mapped at 1:100k or better although this mapping is quite old now. Also some floating mat vegetation has been mapped although this vegetation type is highly variable as well.
- May need to map the same floodplain more than once to reflect their dynamic seasonal nature. Otherwise map when they are dry.
- A sub metre accuracy elevation model, if available, might be a consideration as an interpretive base. Essentially the less static vegetation types on the floodplains respond to the rainfall and water depth on a seasonal basis. Hypothesis as to what should occur and when could be inferred from expected water depths (perhaps).

6.0 State & National mapping projects

6.1 Current commitment: NRETA Land and Vegetation Branch

Table 27

	Staff (permanent only)	$k Salary Costs Only	$k External	$k Operational
Vegetation Survey and Mapping group	1.5 * P2/0.5*P1/P3*0.1	159	385	~120 however the bulk of this disappears in computer and car leasing costs.
Soil and land use	P3*0.9/P2*1.5/P1*2.5/T3*2	471	?	

6.2 Vegetation Mapping programs elsewhere in Australia

From Audit/BRS Vegetation Information Products: not for public release as yet.
Indicative only to get some idea what is being spent elsewhere in Australia. I am not sure if salaries are included in the Agency figures. I assume the partner projects include a salary and operational component. Table is not complete.

Table 28 State vegetation mapping Programs

State	$k Agency	$k Partner (ie funded outside)	
NT	155	385	
QLD herbarium - Eco system Mapping	$1.4m/yr ?		
QLD EPA- Wetlands mapping and inventory	415	505	
SA DEH	110	516	Various projects-Agency costs may not include salaries

AG- NLWRA/BRS Vegetation Information Projects Coordinator	100	-	
NSW	*Not complete*		
WA	*Not complete*		
TAS	*Not complete*		
VIC	*Not complete*		
ACT	*Not complete*		

SECTION 3:

Funding Sources: Working Grp 3

The amount of external funding and/or NTG commitment will depend on the final approach adopted. It will be influenced by:

- Scale adopted:
- Extent: NT wide or priority areas
- Method:
- Available or desired timeframes:
- Who does the work: Project based (eg externally funded), NTG or combination/Collaboration-Funds/staff provided by a number of agencies/sources
- Short or long term objectives

A business plan is being developed to address this and will be part of the final reporting for RIS2007/167.

SECTION 4:

Current Initiatives/Complementary Projects

A large amount of spatial and descriptive data already exists but needs to be brought together and/or inventoried. A number of current projects may assist with a new mapping project. Also a strategic mapping program could provide the impetus to integrate and complete a number of these current initiatives which can not be completed with present resources. The following is not a complete list of vegetation related projects being undertaken by NRETA. Those more relevant to a mapping proposal are included.

1.0 Inventory of Existing Data

2.0 Site data and mapping

2.1 Site Data Inventory

Need to bring all vegetation site data into one standard site database. This is currently being addressed for both soil and vegetation site data.

2.2 Vegetation mapping

Most if not all the broader ranging vegetation mapping has been incorporated into one map product (NVIS2005). Other vegetation or land unit/system mapping can be used for truthing/validation in the office: classifications etc

2.3 Remote Sensing Data sets

Need to do a full inventory of available data sets held by NRETA, NTG and other organisations.

3.0 Research Proposals

3.1 Research Grant CDU

The objective of this research grant was to examine the potential for object based image classification (Definiens software), remotely sensed imagery (MODIS & Landsat) and ancillary datasets for mapping vegetation at a nominal scale of 1:250,000. The project will focus on mapping vegetation in the Daly Basin and will produce;

- a digital vegetation map of the study area
- short report that describes and evaluates the developed classification approach and data sources.
- Definiens process tree.

$20,000 has been assigned to this project from sources other than NHT grants. A brief report was produced as to the efficacy of the mapping method.. The main outcome of this study was that without sufficient field data the proposed technique would not work.

3.2 Research Proposal: Mapping CDU-NRETA

Similar to above but in much more detail at a 1:100k scale. Not funded at present.

3.3 Definitive Vegetation Types

Most vegetation types in the NT have been described following map or floristic surveys over the last 20 years. However this information is in many different sources (scientific papers, technical reports etc). The definitive vegetation type project aims to bring all this information together in a standardised manner.

In 2008 the AG government, via DEWHA provided a $50,000 grant to further develop the Definitive Vegetation Types of the Northern Territory. BRS provided the initial seed funding ($30,000) to develop the concept in 2002 . The ultimate aim for the Australian Government is to have a national listing of vegetation types incorporating those from all States and Territories.

For the NT the DVT database is to provide a systematic taxonomy of vegetation types in the NT and capture within the one database/knowledge source all the published information and data for NT vegetation communities. It still requires funds, beyond the resources currently available. The DVT concept provides efficiencies in terms of capitalising on previous work, provides all the information in one source and can assist in more rapid field assessment. Also if the DVT database was completed prior to any new mapping project it would help considerably in reducing costs (ie 90%+ of NT vegetation types have already been described in some report or other). Two hundred vegetation types have been entered into this database at present. A database has been built and 200 records added

4.0 Current Initiatives/Projects

For more information on some of these projects and information on other projects visit the NRETA web site.

http://www.nt.gov.au/nreta/naturalresources/index.html

4.1 Monitoring Vegetation extents.

Monitoring the extent of native vegetation is currently implemented by the Rangelands Monitoring Branch of NRETA. Clearing within the Intensive land use zone of the NT (north-western portion) is updated annually. In 2008 this is to be extended to include the whole NT. The clearing whole NT will be updated ever two years there-after.

Clearing data sets produced by the Rangelands Monitoring Branch of NRETA can be used to update vegetation mapping.

Vegetation extent monitoring will not be considered further as regards this proposal.

4.2 Baseline Extent of native vegetation in NT

A project to provide LWA with base-line extent of native vegetation in the NT circa 2004. Project completed in 2008 and map and report available from NRETA.

4.3 Vegetation map of the Katherine Region NT

Trialling the use of SPOT and ALOS data to map vegetation types in the Katherine region. Land & Vegetation Branch, NRETA.

4.4 Trialling ALOS data for Mapping in Arid regions of the NT.

Commencing in 2009

4.5 Time series clearing extents in the Intensive Land-use Zones of the NT.

Project to determine when clearing has occurred in the NT, on yearly basis, back to the early 1970's. Project includes developing non native vegetation categories as well as determining the current state of the cleared land (Rangelands Monitoring Branch of NRETA).

4.6 Land Systems Integration

Integration of all land system mapping in the NT. Project is still in progress. Currently 2/3rds of Top End has been completed at 1:250k scale, the rest of NT at the 1:1million scale. The aim is to standardise and integrate, into one framework, all existing NT land systems mapping. The vegetation component of the land systems has not been compiled.

4.7 NVIS database and information

Where possible current NVIS descriptions should be transferred to new mapping. New mapping units would need to be added to the NVIS database resident at NRETA.

4.8 Vegetation Condition Indicators

Indicators have been developed. However they are under review as a landscape function component might be incorporated. A condition component should be built into any field work program.

5.0 Future Projects/Requirements

5.1 Environmental Base for NT.

The land systems integrated data set, once completed, would provide a suitable base for the Top End at the 1:250k scale (in a similar vein to the Land Zones of Qld). Regional-ecosystems can be derived from this at the 1:250k scale. However at the 1:100k scale a new base would need to be created (eg use elevation bands, regolith, radiometrics, land systems, bio-regions etc to create an environmental stratification layer).

5.2 Land Systems vegetation information

Compile the vegetation information for all land systems in the NT to complement the NT Land systems integration project.

5.3 Seasonally inundated floodplains of the NT

Develop and cost a program for mapping the seasonally inundated floodplains of NT. Techniques for mapping floodplains need to be different from those used to map the dryland vegetation. Floodplains would need to be mapped at least 4 times a year to capture the change that occurs temporally between the flooding and drying cycles. Alternatively a sub metre DEM could be used to infer the vegetation communities which would occur at various times of the year.

SECTION 5:

Protocols

For any future mapping a number of local as well as national protocols should be adhered to. These incorporate survey methodologies, site selection, map attribution, classification systems etc. All mapping should adhere to the principles of the National Vegetation Information System. These protocols are well referenced and available from various web sites so no detail is given here. A web site list is provided

Northern Territory Guidelines and Field Methodology for Vegetation Survey and Mapping

http://www.nt.gov.au/nreta/natres/natveg/seminar/pdf/guidelines_fieldmethods.pdf

National Vegetation Information System:

http://www.environment.gov.au/erin/nvis/index.html

Field Survey for Vegetation Classification: Version 1 - 2008 - Yellow Book:

http://www.affashop.gov.au/product.asp?prodid=13881

Assessing Vegetation Assets States and Transitions VAST

http://www.daff.gov.au/brs/forest-veg/vast

Other related Australian Government sites for vegetation information include

http://www.daff.gov.au/forest-veg
http://www.nlwra.gov.au/

SECTION 6:

References

Dickinson, K and Kirkpatrick, J., 1986. *A Vegetation map for the Northern Territory*. Report to the Conservation Commission of the Northern Territory, Darwin NT.

National Land and Water Resources Audit (2001). *Australian Native Vegetation Assessment 2001.* National Land and Water Resources Audit, Canberra.

Northern Territory Government (1997). *Northern Territory Parks Masterplan*. Parks and Wildlife Service of the Northern Territory, Darwin.

Thackway, R., Sonntag, S. and Donohue, R., 2001. *Compilation of the National Vegetation Information System (NVIS) Vegetation 2000 dataset*. Final Report

Appendix 1 Vegetation Mapping Workshop

Finer scale Vegetation Mapping workshop:

Workshop Aim : To determine the needs for a standardized finer scale vegetation map of the Northern Territory and options for a mapping program to achieve this.

Date: 27/3/2007 (9.00 am – 12.00 pm)
Location: CSIRO Conference Room Berimah NT
Minutes: Mike Misso (AGNRM) / Anne Grattidge (DNRETA)
Meeting Agenda: Refer to Attachment One (Page 7)

Workshop Participants:

Name	Organisation	Contact details
John Gilmour	DNRETA - Exec Dir. Land & Water (9-10 am)	John.gilmour@nt.gov.au (08) 89994523
Peter Brocklehurst	DNRETA Land & Water	Peter.Brocklehurst@nt.gov.au (08) 89993623
Stuart Gold	DNRETA - Policy	Stuart Gold@nt.gov.au (08) 89994418
Peter Whitehead	DNRETA - Policy	Peter.Whitehead@nt.gov.au (08) 89994561
Kym Brennan	DNRETA – Biodiversity (9-10.30 am)	Kym.Brennan@nt.gov.au (08) 89955021
Luke Peel	DNRETA- Remote sensing	Luke.Peel@nt.gov.au (08) 89993411
John Woinarski	DNRETA - Biodiversity	John.Woinarski@nt.gov.au (08) 89955001
Ben Sparrow	DNRETA-Alice Springs-veg mapping	Ben.Sparrow@nt.gov.au (08) 89518244
Anne Grattidge	DNRETA – M & E coordinator	Anne.Grattidge@nt.gov.au (08) 89993640
Chris Kelly	DPIFM	Chris.kelly&nt.gov.au (08) 89992157
Greg Ansell	DPIFM	Greg.ansell@nt.gov.au
Bruce Wilson	Qld Herbarium	bruce.wilson@epa.qld.gov.au (07) 38969465
Mike Clark	GANT & NRMB	mike.clark@nt.greeningaustralia.org.au (08) 89811344
Guy Boggs	CDU-mapping	Guy.boggs@cdu.edu.au (08) 8946 7138
Phillipe Puig	EWLS & Private Consultant	Philippe.puig@ewlsciences.com.au (08) 89225219
Robyn Maurer	Australian Government – ADF	Robyn.maurer@defence.gov.au
Mike Misso	Australian Government NRM (meeting Facilitator)	mike.misso@nt.gov.au (08) 8999 4429

Other contacts:

Name	Organisation	Contact details
Juanita Croft	EPA	Juanita.croft@nt.gov.au (08) 89244138
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Mark Gardener	EWL sciences	mark.gardener@ewlsciences.com.au
Christine Long	Crops, Forestry and Horticulture Division.	Christine.Long@nt.gov.au (08) 89992394
Brett Easton	NRETA Vegetation management	Brett.easton@nt.gov.au (08) 89993467
Garry Cook	CSIRO	Garry.cook@csiro.au

1) Background

Peter Brocklehurst coordinated and planned the workshop with an Aim to:

- Determine the needs for a standardized finer scale vegetation map of the Northern Territory and options for a mapping program to do this

The workshop was divided into two sessions:

Session One: (9-10.15 am) - Vegetation Mapping Presentations:
Peter Brocklehurst and Bruce Wilson gave presentations on the status of vegetation mapping (NT & QLD) and potential NT options.

Session Two: (10.30 am – 12.00 pm) - Participants views on vegetation mapping:
The workshop involved a round table discussion where each participant
gave a brief summary of their indicative views on NT mapping needs (addressing extent/ priority areas; scale and requirements e.g. uses & rationale). An open discussion followed which identified some key issues, considerations and suggested steps to develop a finer mapping proposal.

2) Session One – Vegetation Mapping Presentations (Summaries):

1) Background, Current Status NT: Peter Brocklehurst

Key points:

- Some selected areas in the NT are mapped at fine scales (e.g. 1:100,000 for mangroves) but the majority of NT is only mapped at 1:1,000,000).
- National Criteria for vegetation mapping recommends idea scales for wetlands/ riparian and remnant vegetation as 1:25,000; Agricultural lands as 1:50,000 or 1:100,000 and rangelands as 1:250,000.
- All states and the ACT have vegetation mapped finer scales that the NT.
- Potentially there are a wide range of current and potential uses for finer scale vegetation mapping (e.g. NVIS; National Land and Water Audit; Parks Masterplan, INRM Plan; SOE Reporting; Carbon accounting; Vegetation condition monitoring; Development Assessments etc).
- As some finer scale map and site data exists any new mapping program will not need to start from scratch.
- Current vegetation mapping at local/regional scales has significant gaps in vegetation extent, type, currency and condition information.

2) QLD Vegetation Mapping): Guest Speaker: Bruce Wilson

Key points:

- A centralised approach for vegetation mapping is critical
- Mapping is largely driven by vegetation clearance; carbon monitoring/ accounting, biodiversity/CAR NRS planning; development assessment;
- Developing a 1:50,000 map costs 4 times more than a 1:100,000 map for not much more advantage.
- Current QLD mapping program with ~ 34 people developed from a small core trained group over time. Significant expansion of the mapping group following political and public debate over QLD land clearing (ie development).
- QLD systems enable ongoing monitoring of changes in vegetation extent – this should be a key component of any NT mapping system that is developed.
- QLD map data sets are updated and statistics reports are developed every two years.
- QLD still needs to: Conduct accuracy assessments; Surrogacy – refine what is or isn't the mapping good for; whole landscape mapping, not just remnants; Condition assessment and Ongoing training.
- Whatever mapping technique used should already be operational & proven to be effective. Start with a core group of people who can be trained and which would form a nucleus for further expansion at some future date.

3) Mapping Options & Possible Scenarios: Peter Brocklehurst

Key points

- 1:250,000 NT wide mapping
    - Can probably be achieved relatively quickly using existing data rather than field surveys.
    - Less detail
    - 1.5 - 2 years work – Indicative costing $295,000
- 1:100,000 NT wide mapping: Landsat
    - Would probably address most vegetation mapping needs
    - General rapid one off mapping using landsat & other imagery.
    - Exponential increase in resources (time, money) compared to 1:250,000.
    - 5 years work (12-13 person years?) – Indicative costing $1.1-1.4 million.
- Daly Basin vegetation mapping project is being implemented as a pilot study, and if successful the methodologies used there may be able to be used in other areas.

3) Session Two Workshop - Participants views for more detailed NT vegetation mapping:

Session Two (10.30 am -12.00 pm) involved two components:

- An open group discussion with all participants about NT finer scale vegetation mapping options and considerations.
- Identifying individual participant's views on NT finer scale vegetation mapping requirements (see Table One)

Key principles & considerations

Participants all agreed that finer scale mapping is needed and that the rationale for such a system needs to be clearly presented to potential funding bodies. In addition participants though that any finer scale mapping system/program that is developed should:

- Have the capacity to be updated with new information.
- Maintain IBRA bioregion uniformity by mapping whole bioregions at a time.
- Keep relationships between land and vegetation mapping units close.

- Be an adaptive system that enables even finer scale mapping to be conducted in the future.
- Provide for engagement of Indigenous Land holders (via Land Councils).

Open discussion – key points

- A scale of 1:100,000 was deemed the most appropriate
- Agreed mapping criteria needs to be developed that focuses on identifying mapping issues, needs and aims (e.g. INRM Plan, conservation planning, National Reporting requirements etc). The development of mapping criteria will guide the mapping system/methodology choice and help determine the requirements and potential for multiple map uses.
- Assessments should be done that identify:
    - The impediments that have prevented a finer scale vegetation mapping program from being implemented.
    - How impediments can be cost effectively overcome.
- Carbon accounting could be a potential use of finer scale mapping, although it is not necessarily required for carbon accounting.
- The Daly River could be a potential trial area for finer scale mapping, potentially in collaboration with Charles Darwin University (TRACK Research). This trail could then be used to help market/promote funding support for a wider program.
- Some spatial and attribute data can be missed at 1:100,000 scale and some fine scale mapping needs are very issue and stakeholder specific (e.g. 1:5,000 for mine rehabilitation, property scale mapping etc). Methodologies and data sharing/storing protocols for these purposes needs to be clear and consistent.
- Appropriate mapping units (pure vegetation or ecosystem units) need to be determined.
- Mapping needs are driven by where the threat pressures and needs are the greatest (e.g. vegetation clearance/assessing developmental proposals). Surrogates for capability mapping could also be high priority areas.
- Some key locations for finer scale mapping are the Daly River; Darwin region/harbour; Tiwi islands; Mataranka; Katherine; Pastoral lands; Priority conservation areas/significant wildlife habitat and Rainforest.
- A future lack of trained people in mapping & remote sensing techniques appears to becoming evident.
- Also to attract experienced personnel requires reasonable tenure period (eg 1yr +)

Key Actions:

- It was agreed that a finer scale mapping proposal will be developed:

  Stage 1) – Develop a finer scale mapping criteria paper
  Develop and circulate a mapping criteria paper to workshop participants.
  Who - Peter Brocklehurst, Bruce Wilson & Ben Sparrow (& other interested participants).

  Stage 2) – Establish a finer scale mapping working group
  Based on the mapping criteria paper, establish a Working Group of interested workshop participants.
  Who - Peter Brocklehurst & Bruce Wilson (confirmed)
  - Other members to be decided through intra agency nomination processes.

  Stage 3) Develop a finer scale mapping proposal
  Develop a specific finer scale mapping proposal and a strategy to implement the proposal (e.g. assess funding /collaborative opportunities; collate and assess existing map data; promote and market to Northern Territory and Australian Governments etc).
  Who - Working Group

- Finer scale mapping project already underway in Daly basin but requires personnel. The Daly basin project encapsulates a lot of the issues identified

Table One: Participants views on NT finer scale vegetation mapping requirements.

Workshop Participant	Desired mapping extent and/or priority areas	Desired scale	Desired Requirements and/or Rationale
DNRETA - Ben Sparrow	Areas subject to development pressures. Other areas TBA.	1:100,000	Development assessment proposals / reduce vegetation mapping gaps
QLD Herbarium - Bruce Wilson	Daly Basin/areas subject to development pressures	1:100,000	Assessment process implementation
DNRETA - Peter Whitehead	Built up areas	1: 250,000 and finer scale in sensitive/selected areas.	Land use monitoring / Carbon accounting / Biodiversity management / Legislative requirements
DNRETA - John Woinarski	As stated in INRM Plan & Built up areas	INRM Plan requirements (MA3-6). Finer scale in sensitive/wetland areas	Land use monitoring / Carbon accounting / Biodiversity management / Legislative requirements
CDU - Guy Boggs	Darwin / Daly Basin / Mataranka Station	1:100,000	Research needs (e.g. environmental condition monitoring).
EWLS (ERA) - Phillipe Puig	Sentinal sites related to mine rehabilitation / fisheries- mangroves / Litchfield Shire	1:100,000	Wildlife habitat monitoring & conservation planning Ensure maps are regularly updated
Greening Australia &NRMB - Mike Clark	NT wide & finer scales for greater Darwin region, Daly River, Katherine and McDonnell Ranges	Regional (1:100,000) to appropriate selected property scales	Management action planning / Pastoral land monitoring / vegetation extent & landscape condition change monitoring / biodiversity management / vegetation extent benchmarking
DNRETA - Anne Grattidge	Future potential high land use areas	1:100,000	Integrated NRM needs
DNRETA - Luke Peel	Future potential high land use areas	1:100,000	Integrated NRM (e.g. fire / weeds vegetation) / Regional ecosystem management
DNRETA - Stuart Gold	Future potential high land use areas / wetlands / high conservation value areas	1:100,000 and finer scale for high value conservation area planning	Integrated NRM (e.g. fire / weeds vegetation) / Regional ecosystem Regional ecosystem and biodiversity management
DPIFM - Greg Ansell	Areas where land unit mapping is not done	1:100,000	To help assess land use capability and capacity
DPIFM - Chris Kelly	Indigenous lands / Ali Curung / Tea Tree	1:100,000	Assist with future (Indigenous) land use needs / measuring changes in vegetation extent (native & weed species)
ADF - Robyn Maurer	Defence training areas / AQIS & Customs operational areas e.g. coastal areas / potential *EPBC Act* listed vegetation communities.	1:100,000 & smaller scale for other smaller bases/range areas	Biodiversity assessment / Land use capability / measuring vegetation extent changes