



Marine and Tropical Sciences Research Facility (MTSRF) December 2008 Milestone Report

Project 1.2.1c – Status and trends of biodiversity and ecosystem services: state of the environment reporting and gap filling.

Project Leader: Dr Petina Pert, CSIRO Sustainable Ecosystems.

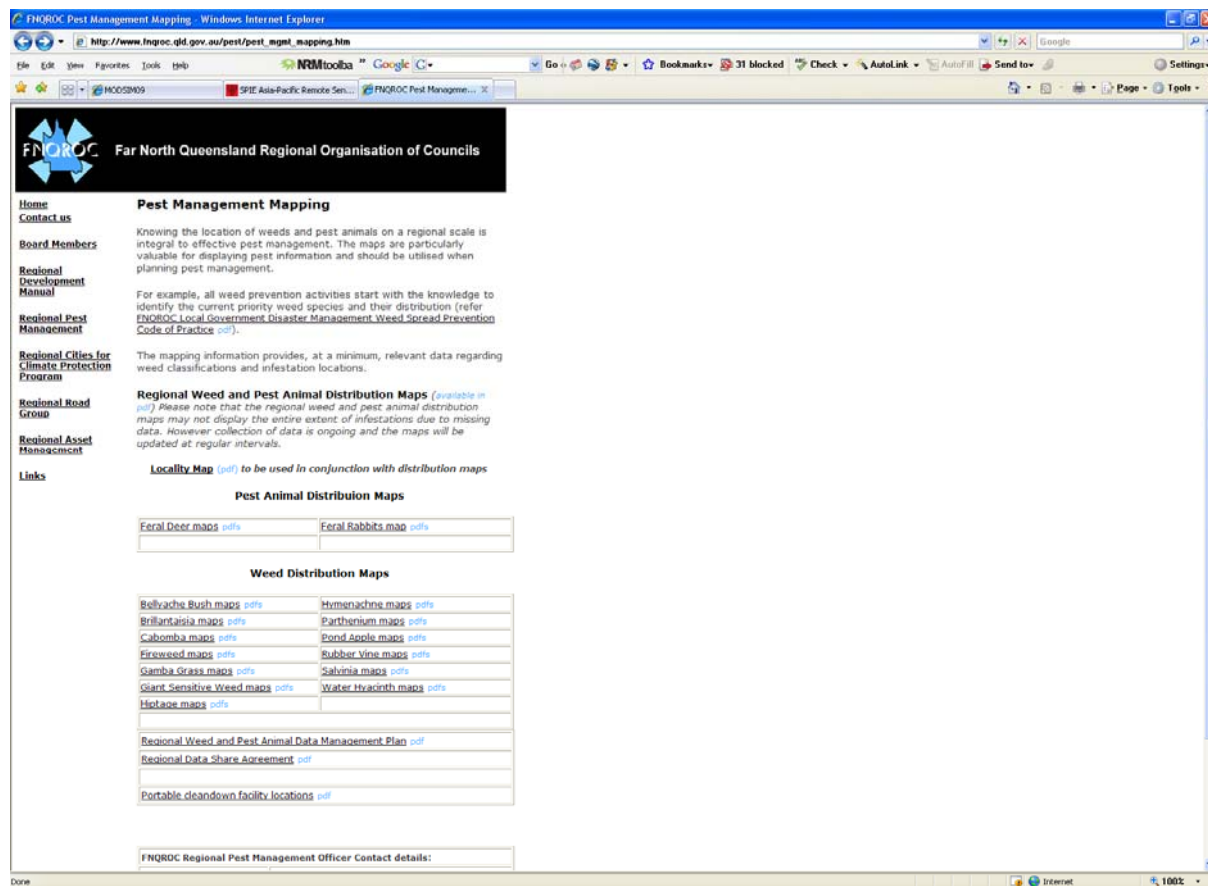
Summary

This Milestone Report summarises progress achieved during the period July – December 2008 for Project 1.2.1c 'Status and trends of biodiversity and ecosystem services: state of the environment reporting and gap filling'. The project team continues to concentrate efforts on the spatial display of status and trends of resource conditions identified, and the filling of biodiversity data gaps with field surveys.

a) State of the Environment framework: This reporting period has been largely devoted to the spatial analysis of geospatial data to display a key indicator of biodiversity condition, native vegetation extent, against a natural resource management plan target, RCT1 'no net loss of native vegetation extent by 2014'. We have produced a draft report card for this indicator. By linking with the review of the FNQ NRM Plan in 2008, Terrain's draft Resource Condition Targets (RCTs) for biodiversity have been redefined by Terrain, WTMA and CSIRO, and indicators have been developed that satisfy both WTMA and Terrain reporting requirements (**see Attachments 1, 2, 3**). Consequently the project has also begun linking with 4.9.6, which is developing fine-scale indicators for monitoring biodiversity protection as part of the Mission Beach local area planning, and the RRRC Reef Risk and Resilience Mapping Project (**see Attachment 4**). To build a platform for data sharing and collation between project partners, the CSIRO server in the Australian Tropical Forest Institute has been established to provide access to partners through a sharepoint site (**see Attachment 5**). Data share agreements have been established with Terrain NRM, WTMA, DNRW and EPA.

A joint CSIRO-Terrain NRM intern, Cyril Frazao (University of Montpellier, France) completed his internship on 15th August 2008, having arrived on 15th March 2008. During this period he worked in collaboration with Sharlene Blakeney (Terrain NRM) and Tina Lawson (CSIRO) to develop a GIS-based mapping tool for feral animals and weeds, based on 1km² grid squares, which was taken to council pest management officers and QPW rangers throughout the Wet Tropics (**see Attachment 6**). Using the tool, these officers mapped the distribution of feral animals in their areas according to their best available information, and also estimated densities using the Queensland DPI standard density classes. This is the first time such a technique has been used to obtain a complete landscape-scale picture of feral animal and weed distribution (**see Attachments 7, 8**). This data is pioneering the standardized collation and display of feral animal information by the Far North Queensland Regional Organisation of Councils (FNQROC), led by Kirby Doak. This data can be viewed on the FNQROC website: www.fnqroc.qld.gov.au/home/index.html (see below).

Feral and weeds distribution has been identified as a key pressure on biodiversity. These data will allow mapping of these pressures relative to biodiversity assets and indicators, and were presented to the Queensland Pest Animal Symposium, Cairns, in October 2008.



Techniques to map the condition of ecosystem services, and the ecological functions that underpin them, are being reviewed by Caroline Bruce (CSIRO). A draft report is in production (see Attachment 9).

b) Gap analysis and gap filling

Thirteen novel surveys have been undertaken to collect biodiversity data from putative refugial areas within the Wet Tropics. These were:

- Thornton Peak x 2
- Bell Peak North x 2
- Lambs Head x 2
- Mt Misch (Herberton Range) x 2
- Mt Sorrow (west of Cape Tribulation) x 1
- Brick Creek, west of Tully x 1
- Council Reserve in Wongaling Beach area x 1
- Black Mountain x1
- Battle Camp Road x1

These surveys represent the first ever systematic botanical surveys in these areas, and include well known locations such as Thornton Peak and Bell Peak. In addition five vouchered species from the surveys were documented at new extents of their distribution.

These specimens are currently at ATFI awaiting analysis by the Australian Tropical Herbarium. Also, discrepancies of Regional Ecosystem mapping interpreted from the surveys are being reported to the EPA and WTMA for mapping updates. The Thornton Peak survey was carried out with Queensland EPA staff and a preliminary report has been submitted to them.

For reference: Milestone extracted from Project Schedule

Date: 3 December 2008

For 2007/2008 outputs only
Milestones
Signing of contract
Progress Report 1: • Progress report on report card and available data collation for Biodiversity asset, and the undertaking of practical trials in collaboration with WTMA and Terrain • Interim report on the review of mapping ecosystem services. • Update on gap analysis and gap filling of poorly-documented species and communities, and contributions to Biodiversity asset report card. • Summary of any communication activities undertaken to date, including minutes of meetings/workshops.

Project Results

Description of the results achieved for this milestone

See attachments for detail.

Current MTSRF Project 1.2.1 is on track with native vegetation extent reported relative to RCT1 completed.

Explanation of Activity changes

In collaboration with RRRC, Program 2 (Status and Trends of Species Ecosystems in the Wet Tropics) was restructured in August 2008 to allow more efficient reporting of milestones and definition of outputs. The program has now been split into four projects, of which this is 1.2.1c. Petina Pert has taken the leadership of the Project 1.2.1c while James Butler focuses on the strategic planning and delivery of the Program.

Problems and opportunities

The opportunity to collaborate with MTSRF Projects 4.9.7 (Social resilience at the regional scale) and MTSRF project 4.9.7b were further investigated with meetings occurring to discuss integration (see Communications below). Meetings have also been held with RRRC to identify the opportunities for extending the Reef Risk and Resilience Atlas to reporting terrestrial ecosystem health.

Other issues

Linkage between the 4 projects in Program 1.2.1 continue to be developed, particularly in terms of vegetation gap analyses, and the delivery of data on the spatial distribution of weeds and ferals. Similarly, Steve Williams' JCU altitudinal survey data will soon contribute to the assessment of biodiversity condition within the World Heritage Area. Weeds and ferals mapping also involves considerable data transfer from Terrain to CSIRO, and also from EPA and regional councils. Data share agreements and the CSIRO sharepoint site are facilitating this process.

Communications, major activities or events

During milestone reporting period

The table below summarises the liaison activities undertaken to date, including contributions to Project Activities achieved from those activities.

Activity	Date	Outcome
Weeds and Ferals mapping update meeting	14 th July 2008	Demonstration to Kirby Doak (FNQROC) of feral data collected so far. Demonstration of the ArcGIS front-end tool developed for mapping weeds. Planning of next steps.
Queensland Spatial Science Institute (SSI) Conference, Surfers Paradise	17-19 th July 2008	Petina Pert and Tina Lawson attended the SSI conference and gained valuable information about potential software applications suitable for spatial analysis techniques in the Wet Tropics.
1.2.1c internal meeting	21 st July 2008	Internal CSIRO meeting to further discuss roles, responsibilities and outputs.
1.2.1c workshop – RCT 1	24 th July 2008	Discussed with Terrain and WTMA native vegetation extent and RCT 1 analysis and requirements.
Advanced ERMapper Course, Atherton	31 st -1 st August 2008	Petina Pert received advanced training in the use of the software ERMapper for remote sensing.
RRRC MTSRF Operations Meeting #7, Cairns	4 th August 2008	James Butler and Petina Pert attended and provided update on project to other project leaders and RRRC.
Meeting with RRRC to re-structure Program 2	7 th August 2008	Program 2 and Project 1.2.1 and reasons for the improved structure discussed. Melissa Jess to arrange separate schedules for reporting.
FUNGIS 2008 Annual Conference	15 th August 2008	Petina Pert and Caroline Bruce attended the FUNGIS conference and gained further information about local Far North Queensland applications suitable for spatial analysis techniques in their subject areas.
EBM Workshop, Magnetic Island	26 th August 2008	Petina Pert and Caroline Bruce attended the EBM workshop and gained valuable information about ecosystem-based tools and applications.

Activity	Date	Outcome
RRRC Special MTSRF Steering Meeting	8 th September 2008	James Butler and Petina Pert attended this special meeting to specifically present on Program 2 and Project 1.2.1c arrangements and work to date.
Meeting with John Tann – Australian Museum	23 rd September 2008	Meeting with John Tann to discuss the Living Atlas and data inputs.
Weeds and Ferals mapping update meeting	1 st October 2008	Reviewed ferals distribution information collected by Cyril Frazao, Tina Lawson and Sharlene Blakeney from council's pest management officers, QPW rangers and Biosecurity Queensland officers. Decided next steps to fill gaps, disseminate data and plan collection of weed mapping.
1.2.1c internal meeting	6 th October 2008	Feedback to other CSIRO members from MTSRF steering committee. Discussed milestone and tasks for the rest of 2008/2009. Discussed data gaps and research needs for future funding.
1.2.1c workshop – RCT 1	15 th October 2008	Practical results of RCT 1 analysis presented to Terrain and WTMA and constructive feedback received. Discussion of RCT 2, report card, abstract for upcoming SSI conference poster. Demonstration of Sharepoint (wiki) site for communication between CSIRO, WTMA and Terrain.
eConference with Spatial Vision's senior analyst Milos Pelikan	17 th October	Milos demonstrated three possible solutions for an interactive mapping platform and provided advice on costs and applications.
Queensland Pest Animal Symposium Conference, Cairns	20-21 st October 2008	James Butler presented "Mapping the distribution of feral animals in the Wet Tropics Bioregion: a landscape scale approach".
Television interview with Channel 7.	20 th October 2008	James Butler gave a television interview on Channel 7 regarding mapping the distribution of feral animals in the Wet Tropics.
Meeting with David Souter (RRRC) – Demonstration of Reef Atlas	21 st October 2008	David Souter gave a demonstration on the capabilities of Reef Atlas and we discussed how we can incorporate our terrestrial data.
SSI Northern Group Conference, Townsville	24-25 th October 2008	Poster presented at SSI conference entitled "Ecosystem services and biodiversity in the Wet Tropics – Mapping their distribution and change" (Attachment 10)
RRRC MTSF Operations Meeting #8	3 rd November 2008	James Butler and Petina Pert attended and provided update on project to other project leaders and RRRC.
Meeting with MTSRF Project 4.9.7 Measuring social resilience in relation to water quality	3 rd November 2008	James Butler and Petina Pert met with Helen Ross and Margaret Gooch et al. to discuss linkages between the two projects.
CommunityViz software demonstration	4 th November 2008	Dr Ken Lyons demonstrated the capabilities of CommunityViz ArcGIS extension.

Activity	Date	Outcome
Meeting with Peter Wood (WTMA)	5 th November 2008	Meeting with Peter Wood (WTMA) to bring him up to speed with project and how we can work together to remove any duplication in mapping and share data etc.
CSIRO/Spatial Information Services workshop/training development of CommunityViz as a possible platform for interactive mapping package of report card	11-14th November 2008	Petina Pert received training in the customisation of CommunityViz software tool. Draft biodiversity sensitivity analysis incorporating significant biodiversity attribute layers.
SPIE Asia-Pacific Remote Sensing Symposium, Noumea	17 th -21 st November 2008	Petina Pert attended the SPIE international bi-annual conference and gained further information about remote sensing techniques and applications. Petina also attended a workshop entitled "Remote Sensing Techniques and Developments for Watershed Monitoring in Tropical Countries". Meeting with IRD senior research scientists.

During next milestone reporting period

The table below summarises the liaison activities that will be undertaken during the next milestone reporting period, including expected outcomes from those activities.

Activity (Task B)	Date	Expected Outcome
ESA Conference, Sydney	1-5 th December 2008	Presentation by Petina Pert "Use of new graph-based landscape connectivity indices: towards prioritisation of habitat patches and corridors for southern cassowary conservation." Presentation by Dan Metcalfe, Helen Murphy and Barker "Weeds of the Wet Tropics – what makes a rain forest invader?" Presentation by Matt Bradford, Dan Metcalfe, David Westcott "Fruiting patterns in the Wet Tropical Rainforests of Queensland".
Dr Metcalfe and Mr Ford invited to attend an Aquatic Flora Expert Panel for the Great Barrier Reef Wetlands (Wet Tropics Region), EPA, Cairns	2 nd December 2008	The aim of the Flora Expert Panel is to identify wetland dependent, priority and alien species in the Wet Tropics. This will provide input to the Aquatic Conservation Assessment (ACA) of the Wet Tropics' riverine and non-riverine wetlands, which is being undertaken using the Aquatic Biodiversity Assessment and Mapping Method (AquaBAMM)

Activity (Task B)	Date	Expected Outcome
18 th IMACS World Congress MODSIM 09 Conference, Cairns	13-17th July 2009	
Provision of content for website updates and project visual documentation.	Ongoing	Further communication of project results to stakeholders.
Development of indicator reporting against RCT2 and RCT3, and combined report card for biodiversity asset with WTMA, Terrain and RRRC	Ongoing	Collaborative design of data and report card with Terrain and WTMA

Forecast variations to planned milestones

None in the near future.

MTSRF Project 1.2.1c Status and trends of biodiversity and ecosystem services: state of the environment reporting and gap filling

Review of native vegetation extent and RCT reporting

Seminar room, ATFI, July 24, 8.45am – 1pm

1. Attendees/apologies

Attendees: Rowena Grace, James Butler, Sharlene Blakeney, Deb Harrison, Dan Metcalfe, Steve Goosem, Petina Pert, Caroline Bruce
Apologies: Dave Westcott, Ro Hill, Steve Williams

2. Actions from previous meeting (26th May):

1. Data agreement re-written to include CSIRO as a party. Currently WTMA includes Terrain and BRS only. [Steve G, Deb and Petina to discuss] **DONE**
 - i. Organised, though note that this agreement between WTMA (and ?) has lapsed and needs to be recreated, can not just be modified
2. Establishment of a shared server to hold data – contact Mike Stott and whether this data needs updating [Petina and Mike Stott] **UNDER DISCUSSION.**
 - i. Petina: still undergoing discussion with Col/IT. Will have server established in Cairns, replication of Atherton server. Petina to organise CSIRO login for Sharlene, Mike Stott and Debra Harrison to allow access through firewall.
 - ii. Deb is currently trying to extract project data out of Terrain staff and that can go on to server
3. Notification on completion of Steve William's species maps [Steve Williams] **UNDER DISCUSSION.**
 - i. (refer email response to Petina from Steve W). Altitudinal transect data will be fed in to the species mapping
 - ii. Steve: in May, Steve W suggested this data (?) would be published in next 4-8 months.
 - iii. CB to continue to chase Steve W on this.
4. Collate data on first RCT '*no net loss of native vegetation across the region by 2014*'. For WTMA the period of interest is 1988-2008, and for Terrain it is 2004-2008. [All to pass on to Petina and shared server – Petina to manage list as data comes in] **DONE FOR TULLY**

3. 'dummy run' on reporting the first RCT for the study region : 'no net loss of native vegetation across the region by 2014'

Discussions from dummy run process:

- Petina: we've decided to focus here not on Tully only but whole of WT. Reasons: we have to do for whole region anyway and the nature of the datasets suits this.
- 20km buffer used around the study area: Steve: beware stats derived from buffer region where this extends in to regions such as the Einasleigh Uplands and Burdekin bioregions – take care when need stats eg. Proportions of vegn as a function of all occurring within the bioregion

RE/Stanton/SLATS veg mapping:

- currency of RE data: Dan: EPA as been 'about to' re-initiate update of the RE mapping for a while but timelines change. Initial focus will be the dry country. The Stanton mapping has different currency because Dan feeds back corrections to Peter Stanton, but not sure how often this is updated. Neither of these datasets pre-date 2008.
- Steve: Stanton mapping is of a higher spatial resolution. REs are dissected by landzone and there is also of amalgamation of Stanton veg classes in to REs, so resolution is both 'lost' and 'gained'. A data table is available which explains this manipulation – CB to ask Jeanette Kemp for the latest version

Revegetation datasets:

- Note 3 different definitions of 'revegetation' used in SLATS, RE (as used in VMA) and Stanton. For this project, will need to use SLATS definition (legislative and data coverage for whole area of interest). An advantage of SLATS is that it also tells you conversion information – from and to landcover types. SLATS is also interesting because it covers period **before** tree clearing legislation came in.
- VMA: plantings and regrowth same under act, regrowth definition includes proportion of biodiversity, fraction of height and canopy closure
- Damon's CRCRU dataset
- Sharlene has Cairns Council data - vegetation layer but not specifically revegetation dataset. CB to talk to Richard Bolero (responsible for collating data for Cairns and Douglas shire councils). Sharlene to forward CB Richard's contact details
- Kylie Freebody and Simon Glebe wrote up annual reports for C/wealth about revegetation activities. Kylie should have collated a lot of this information (including for Eacham Shire?) for her project with Carla Catterall. CB to talk to Kylie.
- Steve: beware of plantings that were re-done of the same areas, eg. along linear/river features. So actual areal extent values will sometimes differ to those given in reports (where there may be eg. doubling up of area due to replanting of the same area)
- Deb Harrison's NHT points: a lot of these have not been ground-truthed and there is doubt about the true area of some of these. Deb suggests not to use these
- SLATS data will give areal extent but note there definition of revegetation. CB to clarify SLATS definition of revegetation
- Proposed step: CB to compare CSC revegetation extent to SLATS data and see how 'accurate' the SLATS data is in terms of extent/currency relative to planting dates.
- Dan: there have been some big upland replantings, eg. Pelican Point, Peterson Ck – use these in assessment against SLATS so don't use just lowland data. CB to talk to Dan about what and where these areas are and then talk to Deb about the planting dates for comparison with SLATS

Other issues/datasets:

- note Stanton has naturally unvegetated areas, eg. lakes, bare rock, waterways. Keep these in mind when determining areal coverage of vegetation and change.
- The PRE-clearing data will be of use in working out thresholds, eg. no net loss: consider this in relation to what was there originally pre-1988. Be aware of existence of non-tree natural vegetation (eg. grasslands) and how these are treated in our analyses
- Note spatial differences in PRE and RE datasets between different bioregions (eg. WT more detailed than other bioregions)
- HRIC data: Raymond de Lai and Derek Tichner– Derek responsible for chasing up the data. CB to contact Derek to see if there have been any revegetation dataset

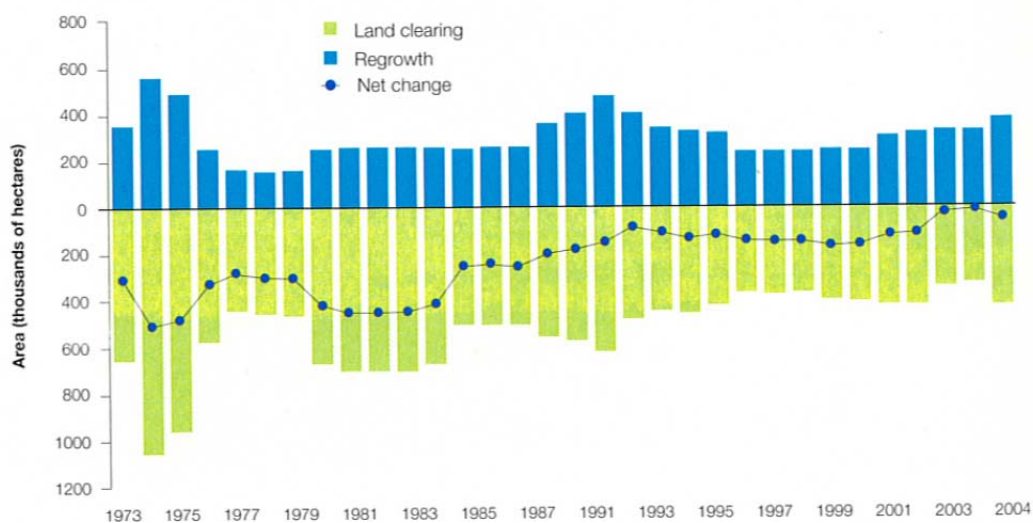
updates. CB to determine what was the agreement between CSIRO and HRIC – is this still valid? Sharlene to send CB Derek's email address.

- latest aerial photography being flown September and should be available for use early next year. Whole region to be flown at same resolution as per TC Larry imagery. Extent of photography will be further west than Larry imagery - covers at least whole bioregion, but not whole of Terrain region – upper Herbert region left out.

4. Discussion about 'dummy run' including adequacy, additional data needs, potential errors, etc.

- Discussion about output graph: Dan: use histograms rather than line graph. (Example below from State of Environment, 2006 report)

Net forest change in Australia (using forest regrowth and deforestation data) 1973–2004



- 'no net loss of vegetation' ToC – doesn't that mean no decrease at all? No net loss of vegetation: threshold of concern – isn't this no decrease at all? Dan: net loss could mean increased clearing as long as offset with revegetating.
- Combine these results with those from the RCT that looks at trend to determine condition
- Could be interesting to take note of when VMA came in to effect (1991) and how this as affected trends
- Steve: look also at cookie-cutting results in to sub-regions, catchments etc. to look at homing in on what is happening where – tell different stories from same basic data. Then can see where MATs are occurring and if they are adequate.
- General agreement of the benefit of the 'traffic light' map outputs

5. Next steps including:

1. next RCT to attack: 'no decline in 'rare' and 'threatened' native species and their habitats'
- Petina to confirm if this is correct. Where does condition of native vegetation come in to it? Is it a part of RCT1?
2. Terrain's latest RCTs (released mid-June?)

- Deb/Rowena: nothing complete/set in concrete as yet. RCTs won't change considerably anyway, just tinkering around edges but intent remains
- 3. timeframe for next meeting
 - 3 weeks or so?
 - Dan: suggest send output of this process (ie. graph) to participants of next meeting for them to have a look, assess, work out the utility of the outputs relative to the question being asked (Petina and Caroline). Also, for next meeting if looking at condition, condition means different things to different people – maybe circulate something about this prior to next meeting so participants can consider this and come to meeting more focussed, with formed discussion ideas etc. (Petina)
 - Rowena: condition – Terrain has nothing specific to report against, no set definition -> so for this project, we can determine condition as we like. Steve: doesn't have condition definition but suggests it is something that has fewer pressures on it. Dan; absence of pests, ferals, etc. So condition as a function of pressures.
 - Steve: condition is easy to assess, integrity is difficult. Dan: for some REs, will be easier to define condition than others. eg. Wet Sclerophyll – invasion by rainforest is obvious and measured. So metrics might vary between broad vegetation groups. Steve: integrity to the system might be shot because of broad resilience to the pressures – different pressures in same areas.

6. Actions from this meeting:

- Petina to organise CSIRO login for access to shared server for: Sharlene, Mike Stott and Debra Harrison
- Caroline to continue to chase Steve Williams about species maps
- Caroline to ask Jeanette Kemp for the latest version of the data table outlining manipulation of RE/Stanton data
- Caroline to clarify SLATS definition of revegetation
- Caroline to compare known revegetation extents (eg. from CSC, upland areas) to SLATS revegetation data to gain idea of how 'accurate' the SLATS data is in terms of extent/currency relative to known planting dates
- Caroline to determine what was the agreement between CSIRO and HRIC – is this still valid?
- Sharlene Blakeney to send CB Derek Tickner's email address.
- Petina to confirm RCT focus for next GIS exercise/workshop
- prior to next meeting, Petina and Caroline to send out:
 - outputs from current GIS process
 - information/options relating to the term 'condition' to help us determine how to measure it

MTSRF Project 1.2.1c Status and trends of biodiversity and ecosystem services: state of the environment reporting and gap filling

Review of native vegetation extent and RCT reporting

Wednesday, 15 October 2008 1:00 PM-3:30 PM

ATFI - CSIRO offices

Attendees: Steve Goosem, Debra Harrison, David Hinchley, Petina Pert, Caroline Bruce

Section 1: feedback about RCT1 outputs

- look at how thickening is treated within the NCAS products – as regrowth?
- derive per annum results?
- graphs:
 - o add 'cumulative change' in the title
 - o make year labels more obvious
 - o sit bars next to each other (for % only)
 - o remove Terrain graphs where reporting unit relevant to WTMA only and vice versa
 - o don't make cumulative bars for %
 - o add graphs to maps
- look at why there is a big difference in veg extent (WHA) between 2005 and 2006
- suggest use red for clearing, green for regrowth
- maps: just use % maps
- include pre-clearing data in each graph for perspective
- potentially look at change per 10km grid -> might be better at showing spatial trends. Steve G. suggests using a 17km grid, concords which previous grid work undertaken by (WTMA?)
- Debra Harrison to forward us sub-catchment dataset and use that as a reporting unit for Terrain also -> or SG suggests using this to window in on 'bad' catchments to see pattern within them
- Terrain would prefer we reported just for their catchments (remove non-Terrain areas)
- data outputs to be put on Cairns server

Actions:

- *Petina to talk to Melissa Jess about data-sharing agreements (done)*
- *Debra Harrison to forward us sub-catchment dataset (done)*
- *Caroline to look at how thickening is treated within the NCAS products – as regrowth?*
- *Caroline to look at why there is a big difference in veg extent (WHA) between 2005 and 2006*

Section 2: comments to help guide undertaking of RCT2

Steve G:

- could use VAST to compare different vegetation component types – some are in transitional states. Might be one way to set up a benchmark. Incorporates resilience
- 2 aspects of condition to consider: state and the ability to return to that state, i.e. resilience -> transitional states in VAST

Other important considerations:

- risk: use tenure dataset as surrogate, history of landuse, roads
- fragments: look at distance to continuous forest, patch sizes, number, size, relative isolation. Consider internal v. external fragmentation in WHA – two different issues.
- pest/weed distributions: some weeds will not be indicative of forest condition, but rather of the non-forest areas
- context = landuse, surroundings
- Stanton vegetation mapping – x category = structure same but canopy disturbed
- We need to look at the major factors, their surrogates
 - Key issues might be: patch size/fragmentation, invasion, disturbance, size/shape relationship (eg. boundary v. area), some general consideration of edge effect – range of buffers
 - cumulative occurrence of presence/absence of the above and modelling in Marxan?
 - Consider there will be differences in condition depending on different forests

MTSRF Project 1.2.1c Status and trends of biodiversity and ecosystem services: state of the environment reporting and gap filling

Update with WTMA on indicators and RCT reporting

ATFI, November 5, 2008

Attendees: Petina Pert, CSIRO and Peter Wood, WTMA

Background

Generally speaking the main goals of the meeting were to;

As well as a good chance for us to catch up, some aims of such a meeting could be;

1. A good chance to meet for the first time
2. Increase my familiarity with the CSIRO's and Terrain's work that is related to this project
3. Discuss and affirm the intended goals of WTMA's status and trends reporting project
4. Discuss opportunities and any limitations for the project
5. The availability, suitability and limitations of datasets
6. GIS standards such as consistent colours, map templates and reporting
7. Discuss metadata, directory structures and data documentation
8. The project server for sharing information
9. Opportunities for WTMA and CSIRO to collaborate and expand the Pressure, State Response analysis of the Wet Tropics bioregion

Outcomes

- Petina outlined the some broad goals of the Status and Trends Reporting project at the CSIRO. These include providing information that supports;
 - o No net loss of the area of native vegetation across the region
 - o Quality and extent of REs currently with an 'endangered' or 'of concern' conservation status is maintained or improved by 2014
 - o Quality and extent of riparian ecosystems maintained and improved by 2014
 - o Progressive improvement in condition of coastal ecosystems by 2014
 - o Increase in the area, conditions and integrity of areas of regional biodiversity significance by 2014
 - o No decline in the conservation status of any native species or Regional Ecosystem by 2014
- Petina is assigned to this project for 40% of her working time at CSIRO
- Petina familiarised Peter with the current progress of the project including;
 - o Maps and statistics regarding vegetation change in the Wet Tropics bioregion and WHA
 - o Caroline Bruce's assessment of vegetation dataset availability and limitations
 - o Dataset availability, limitations, directory structures and metadata

- o Map standards and related topics
- Peter is available for an average of two days per week
- Peter raised the WTMA requirement that many output project maps and statistics describe amount of a certain landscape feature (whatever they may be) that is within uncleared areas that are within the Wet tropics world heritage area, sub region and/or terrain related catchments.
 - o The reason for this is that, in many cases, WTMA is interested in PSR related statistics that relate to existing non cleared within the wet tropics area.
- Peter outlined progress so far at the WTMA including;
 - o Maps, statistics and reporting templates for herbarium records, RE VMA status and roads area datasets
 - o A generalised Wet Tropics bio region shape file dataset
 - o Consideration of adoption the standard lexicon for biodiversity conservation paper (Salafsky et al., 2008) as a framework for PSR analysis
- Peter outlined that Steve Goosem would like to compare the Stanton RE vegetation GIS dataset with the present forested area GIS datasets at CSIRO. The aim of this is to compare those datasets and confirm (or otherwise) that the resulting maps and statistics are reliable.
- Petina and Peter discussed the use of ArcGIS Model Builder to automate the analysis and reporting process. Generally speaking, they broadly concluded that;
 - o As the many datasets have different data structures (and hence different analysis characteristics) and the reporting process is likely to not be repeated too many times, then perhaps the use of Model Builder for this project is not necessary.
 - o However, a benefit of using Model Builder is that it can keep track of model processes but that can also be done by brief readme files, metadata files, and clear directory and files names.

Actions

- *Peter Wood to send the generalised wet tropics bioregion dataset to Petina. This dataset be used for displaying subregional map related results*
- *Peter to send WTMA's road network to CSIRO so they can use the road with information for road area estimates*
- *Petina to forward the cleared land GIS datasets (latest cleared land and earlier cleared land) to Peter. Peter to use this dataset for map and statistic reporting*
- *WTMA and CSIRO to continue working on the reporting template for maps, statistics and text*
- *Petina and Peter to work together to compare the Stanton RE vegetation dataset with the time series of cleared land datasets*
- *There should a document placed on the shared server that lists the type of statistics and maps that both CSIRO and Wet Tropics create and plan to create*
- *There should be active information sharing between Petina and Peter regarding the planning and development of datasets, maps, statistics and other analysis*
- *Petina to send existing documents to Peter regarding previous project meetings (Done)*
- *Petina to send CSIRO document to Peter regarding a project derived schema for classifying soil, air and climate, biodiversity, water and wetlands information into pressure, state and response criteria (Done)*

- *Under a data sharing agreement, CSIRO to share their project related datasets with WTMA so that WTMA can work on the same datasets, in the same directory structure, with the same metadata, as CSIRO.*
- *Under a data sharing agreement, WTMA to share with CSIRO, any suitable datasets that have not previously been shared with CSIRO*
- *It is recommended that Peter and Petina (cc to Steve Goosem, James Butler, Mike Stott and others) regularly inform each other regarding the datasets, maps, statistics and other analysis that are being developed or are proposed to be developed.*
- *It is recommended that there be regular two weekly meetings between Peter, Petina and any others who wish to assist, so continue planning, reviewing and progressing this project*
- *Regular documentation of such meetings to occur*
- *As necessary, outcomes of those meetings to be shared and/or discussed with others at CSIRO, WTMA and Terrain*

References

Salafsky N, Salzer A, Stattersfiel C, Hilton-Taylor R, Neugarten S (2008) A standard lexicon for biodiversity conservation: Unified classifications of threats and actions. *Conserv Biol*, 22(4):897-911

MTSRF Project 1.2.1c Status and trends of biodiversity and ecosystem services: state of the environment reporting and gap filling

Meeting with David Souter (RRRC) to discuss Reef Risk and Resilience Atlas

Tuesday 21/10/08, ATFI, JCU Cairns

Attendees: Ro Hill, Petina Pert, Martijn van Grieken, Adam Fakes, Fred Kroon, Caroline Bruce

- mapping to be run on Open Layers (open-source GIS system)
- background of the project:
 - o evolved out of MTSRF Project 1.1.5 "Report card for GBR"
 - o a lot of the datasets held in different institutions, not integrated -> idea to build a knowledge-management, web-accessible system to manage the GBR
 - o concept of atlas about 18 months old now. Concept was originally to build a central data repository for all GBR info, has since expanded to be more of a hub and spoke model – most data to remain with original data collectors. This means Atlas does not have to deal with the issues associated with being Custodian. Also means Custodians can determine what is distributed to Atlas versus not, they keep ownership, etc. Therefore less risk of the project accidentally distributing info the owners consider sensitive.
 - o in process of rebuilding the prototype using Web Map Servers, Web Feature Servers etc. Using a Web Cache server and Geoserver – opensource equivalents of ESRI GIS server.
- ultimately the aim is to allow interaction. Can currently do a query of a point, will over next 6-8 months build in polygon query analysis. By end of financial year, will be able to go through the website, upload data in number of different formats, run spatial interpolation/statistical analysis using R and conversion to a .kml file -> then back-download this output or view through Google Earth.
- for those things you can't do online, the idea will be to be able to download the data and do this processing on your own computer and maybe upload the results. A number of MTSRF programs will feed into the atlas
- ultimately, there will need to be some sort of quality control process for data being incorporated
- Resources involved:
 - o last year 450k, this year 250k
 - o 5 people:
 - Dr Glenn De'ath: statistician, spatial interpolation, R-stats, looking at identifying resilient reefs, half-time spent on Atlas, half-time research.
 - Dr Katharina Fabricius: works 1/3rd on Atlas plus research component that feeds into the atlas
 - Dr Eric Lawrey: technical brains behind the programming/configuration, architecture of the Atlas, fulltime, changed the system from static to non-static, mapping integration, use of Geoserver.
 - Pauline Perrin - website configuration, short-term contract
 - Dr David Souter: informing people about how they can interact with the Atlas
 - o future likely some of the spatial data people from GBRMPA will be involved in configuration of datasets for the Atlas.
 - o MTSRF 1.1.2: Reef project feeds in to this – AIMS long/term monitoring program, status of GBR. Also Status and Trends project including seagrass component.

- o started as a Reef Atlas, but idea is to include terrestrial/catchment side. Just started off with reef mapping to demonstrate proof of concept, get system up and running, develop functional system. Eventually, the idea is to have it as a knowledge management system, allow access to datasets about reef/rainforest, access to a huge metadata list.
- o been talking with Wetlands Info EPA people in Brisbane, set up reciprocal agreements.
- o Initially will make 'publicly' available data downloadable so there are no issues with licensing
- o downloaders of data will need to negotiate licences with external data custodians, does not occur through the website
- o currently no solid plan to incorporate the terrestrial side, but nothing stopping this happening.
- o appears to be ongoing support from Qld Govt
- o suggesting a joint venture partnership involving many of the MTSRF projects – they could contribute cash, in-kind contributions. This will be initially RRRC, GBRMPA, AIMS but could expand beyond
- o not currently linked to EPA's Reef Report Card, but could be
- o currently, can view each interpolated layer as is plus a precision layer and derived hotspot maps (based on percentiles)
- o can develop animations -> one of the things that drew them away from the ESRI system
- o if set up data shared from eg. CSIRO, data can be in any 'normal' GIS format, send WMS feed which the Reef mapping project can read, communicate with any of the 'standard' GIS systems
- o developing a model where each user has their own 'space' on the website and can upload articles, WMS feeds, contribute research papers, etc, which are then searchable through the metadata system (metadata describes not just spatial datasets, but articles etc) -> i.e. aim to have an interactive website. The data/articles you upload can be just for your use or usable by public
- o Dec/Jan : intend to 'go live'
- o Petina to talk to Eric about supplying terrestrial data via WMS feed – expose those layers to the Reef Atlas guys within next couple of months. David will talk to Eric about this and get his feedback on its feasibility

MTSRF Project 1.2.1c Status and trends of biodiversity and ecosystem services: state of the environment reporting and gap filling

Guidelines for project partners to utilise CSIRO sharepoint site for data sharing

Aim: To provide a collaboration tool for internal and external stakeholders to upload documents to and share ideas and information.

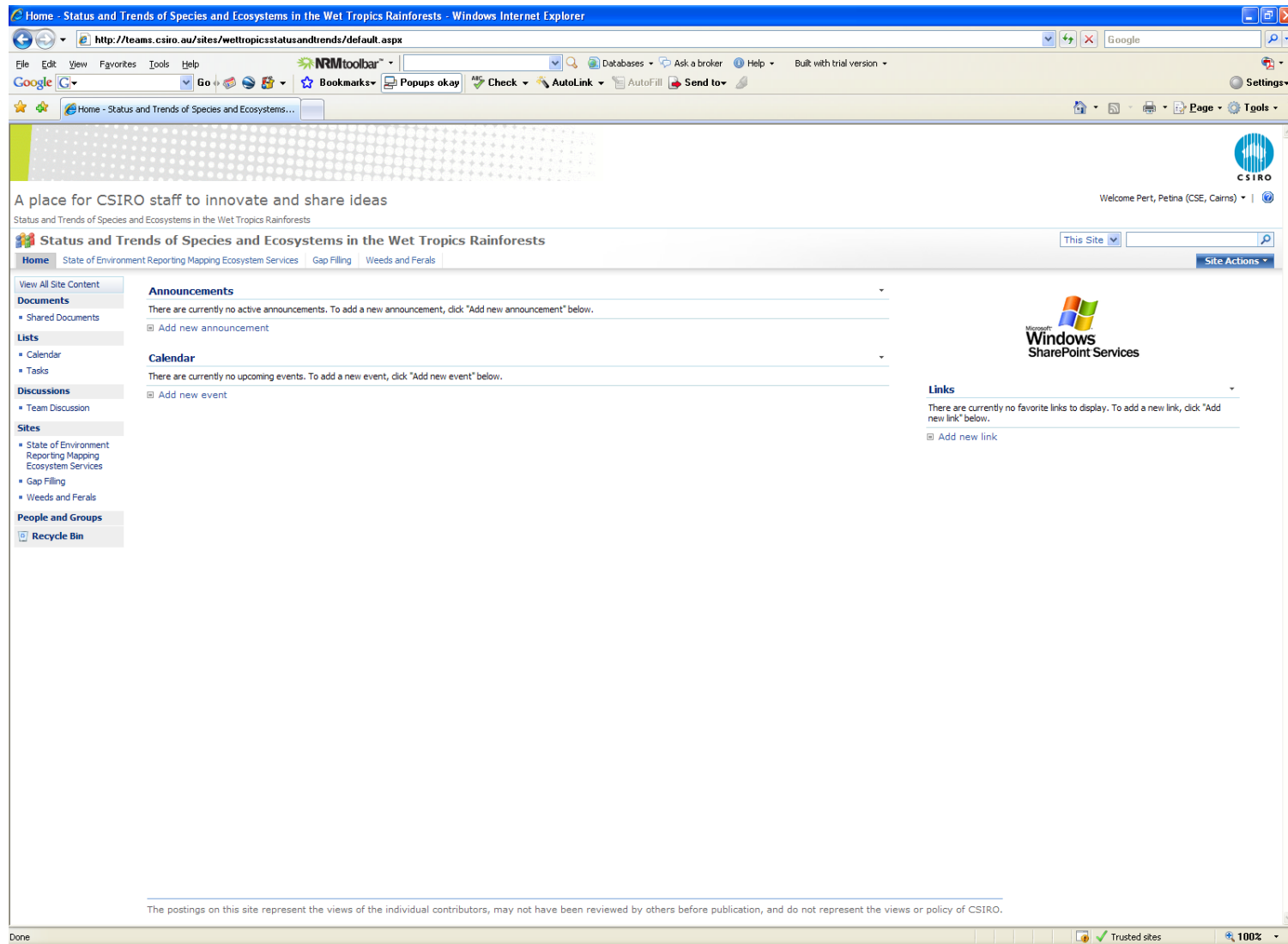
Introduction: SharePoint is a collaboration tool, which enables teams to create customised websites for working together. SharePoint is suitable for sharing documents and calendars, conducting meetings, tracking tasks and much more.

SharePoint Sites

A Site is a group of related web pages. The top-level Site (Parent Site) can have multiple Subsites (Child Sites), so can each of the Child Sites. The parent site and child sites are called a Site Collection.

Page building blocks called Web Parts can be used if advanced page design is required.

<http://teams.csiro.au/sites/wettropicsstatusandtrends/default.aspx>



Shared Documents - Windows Internet Explorer

http://teams.csiro.au/sites/wetropicsstatusandtrends/soe/Shared%20Documents/Forms/AllItems.aspx

File Edit View Favorites Tools Help

Google Go Bookmarks Popups okay Check AutoLink AutoFill Send to Settings

Shared Documents

A place for CSIRO staff to innovate and share ideas

Status and Trends of Species and Ecosystems in the Wet Tropics Rainforests

Welcome Pert, Petina (CSE, Cairns)

State of Environment Reporting Mapping Ecosystem Services

Home State of Environment Reporting Mapping Ecosystem Services Gap Filling Weeds and Ferals

Shared Documents

Share a document with the team by adding it to this document library.

New Upload Actions Settings View: All Documents

Type	Name	Modified	Modified By
Folder	Conference Abstracts and Papers	23/08/2008 4:39 AM	Pert, Petina (CSE, Cairns)
Folder	Powerpoint Presentations	23/08/2008 4:38 AM	Pert, Petina (CSE, Cairns)
Folder	RCT1	23/08/2008 4:38 AM	Pert, Petina (CSE, Cairns)
Folder	RCT2	24/09/2008 10:29 AM	Pert, Petina (CSE, Cairns)
Folder	RCT3	24/09/2008 10:29 AM	Pert, Petina (CSE, Cairns)
Folder	Relevant Reports and Literature	23/08/2008 4:39 AM	Pert, Petina (CSE, Cairns)
Folder	Team Meeting Minutes	23/08/2008 4:39 AM	Pert, Petina (CSE, Cairns)

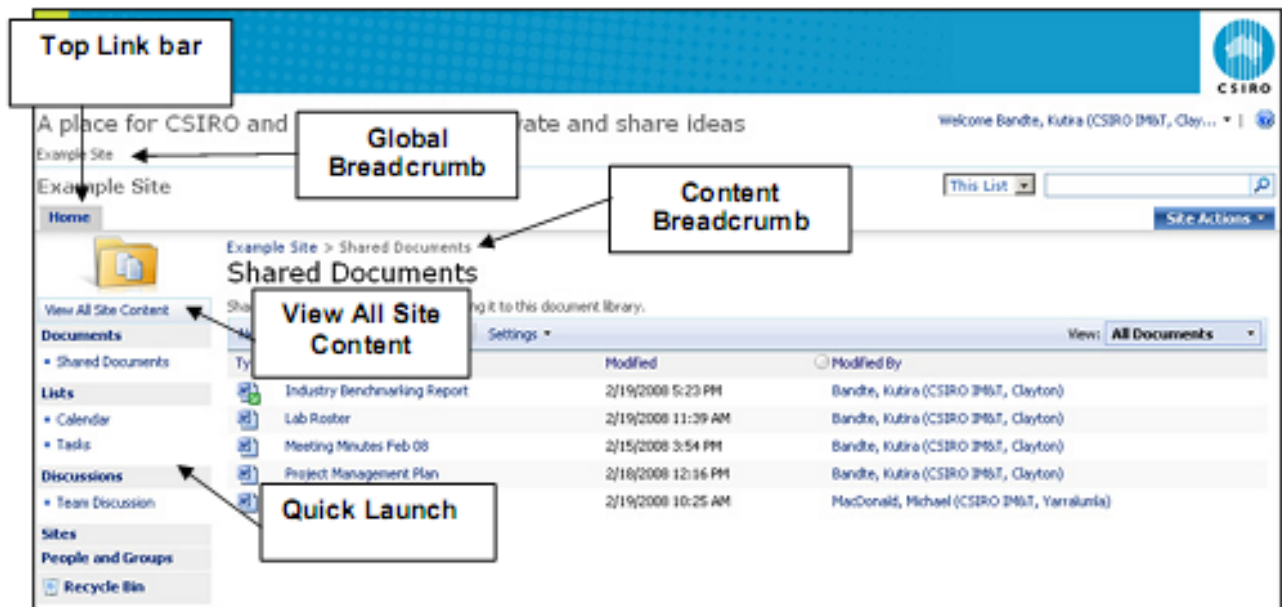
The postings on this site represent the views of the individual contributors, may not have been reviewed by others before publication, and do not represent the views or policy of CSIRO.

Done Trusted sites 100%

Site Navigation

All SharePoint sites have six site navigation elements.

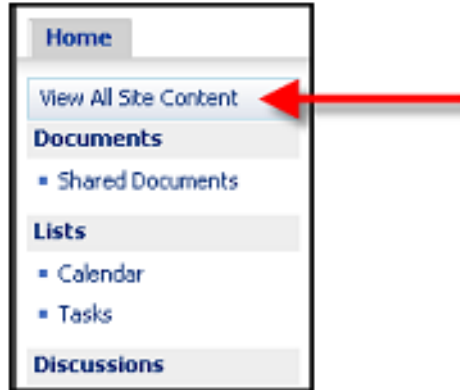
Site Navigation Element	Description
View All Site Content	- Appears as link on left-hand side of page, above Quick Launch - Contains a list of links to all lists, libraries, discussion boards, surveys and the Recycle Bin
Quick Launch (customisable)	- Appears on most pages below the link to View All Site Content page - Displays section headings and links to different areas of the site
Top Link bar (customisable)	- Appears as tabs across the top of all pages - Hyperlinks to subsites and other sites in the site collection.
Content Breadcrumb	- Appears above the name of the page to which you have navigated (Does not appear on homepage) - Hyperlinks to navigate the site
Global Breadcrumb bar	- Appears in the top-left corner of the page: above the name of the site - Hyperlinks for navigating to different sites within site collection
Tree View (must be enabled)	- Appears directly under Quick Launch - Provides Windows Explorer-type view to the site



Note: Tree View must be enabled for a site by the Site Owner.

View all Site Content

The **View All Site Content** page is a good place to start for obtaining a quick overview of the complete SharePoint site.



The **View All Site Content** page lists all lists, libraries, discussion boards and surveys on the site (also the Recycle Bin). It can be accessed via a link on the left-hand side of each SharePoint page, above the Quick Launch.

Example: View All Site Content page

All Site Content	
Create	
Name	Description
Document Libraries	
Shared Documents	Share a document with the team by adding it to this document library.
Picture Libraries	
There are no picture libraries. To create one, click Create above.	
Lists	
Announcements	Use the Announcements list to post messages on the home page of your site.
Calendar	Use the Calendar list to keep informed of upcoming meetings, deadlines, and other important events.
Links	Use the Links list for links to Web pages that your team members will find interesting or useful.
Tasks	Use the Tasks list to keep track of work that you or your team needs to complete.
Discussion Boards	
Team Discussion	Use the Team Discussion list to hold newsgroup-style discussions on topics relevant to your team.
Surveys	
There are no surveys. To create one, click Create above.	
Sites and Workspaces	
There are no subsites or workspaces. To create one, click Create above.	
Recycle Bin	
Recycle Bin	Use this page to restore items that you have deleted from this site, or to empty deleted items.

How SharePoint is organised: Sites, Lists and Libraries

SharePoint terminology can be a little confusing. Essentially there are three building blocks for all tools available in SharePoint sites. These are:

- Sites
- Lists and
- Libraries

Sites are vehicles to store **Lists** and **Libraries**.

Lists and **Libraries** hold information and documents. They can be set up for tracking document versions (aka **Version Control**, **versioning**) to enable team members to work together on the same document without getting into each other's way. An Alerts features enables you to be notified when items in **Lists** and **Libraries** are changed or updated.

Lists and **Libraries** can be organised to show **Views** of the items that are most important to team members. For example: you can create a view of the files that were created most recently, of the list items that apply to a specific working groups, or of the files created by one person.

Although the types of **Lists** and **Libraries** vary in SharePoint, the procedure for creating them is similar and so is adding items to existing **Lists** or **Libraries**.

SharePoint Lists

A **List** is a collection of information that can be shared and managed.

The types of **Lists** available in SharePoint are:

- Calendar
- Announcements
- Contacts
- Links
- Issue Tracking
- Discussion Board
- Survey
- Tasks (incl. Project Tasks) and
- Custom Lists

Some types of **Lists** allow attachments to be added to a list item.

SharePoint Libraries

A **Library** is a special list designed for storing and managing files and documents.

The types of **Libraries** available in SharePoint are:

- Document Libraries
- Picture Libraries
- Form Libraries
- Wiki Page Libraries

By default the SharePoint site contains a **Shared Documents** document library. Some **Libraries** can be set up so that content can be added via email.

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Weed and Ferals Monitoring Tool (Tina Lawson, CSIRO)

The weed monitoring tool was designed to make the entry of council weed information (spray sheets) easy and possible for non GIS people. The weed monitoring tool has a series of drop down arrows (see below) for weed species, location (the suburb), the location of the feature e.g. road, creek, street etc (the name of the road/street location needs to be typed in), a description of where the weed was found e.g. roadside, creek easement, council land, private property), the density of the weeds found e.g. high, medium, low, the operators name. There is a notes section that can be used to record the treatment of the area or the size of the infestation e.g. 2 X 2m etc. Then when you press the save values button a shapefile is created and the editor in ArcMap opens and the operator just clicks where the infestation was found and then saves their work and continues on. The shapefile created is a point file of the locations of where the weeds were found and contains the attributes entered into the form as well as the x and y coordinates.



The screenshot shows a web-based form titled "Weed Monitoring". The form contains several input fields and dropdown menus for data entry. The fields are arranged in a vertical layout on the left, with date selection fields on the right. At the bottom right, there is a "Save values" button. The URL "spatialdiversity.com.au" is visible in the bottom left corner of the browser window.

Field	Value
Output Path	c:\temp
Weed Species	- choose -
Date	27 Nov 2008 (today)
Location	- choose Suburb -
Name	- type here -
Description	- choose -
Density	- choose -
Operator	- choose -
Notes	

Feral monitoring tool

The feral monitoring does the same job as the weed monitoring tool except its for use with feral animals.

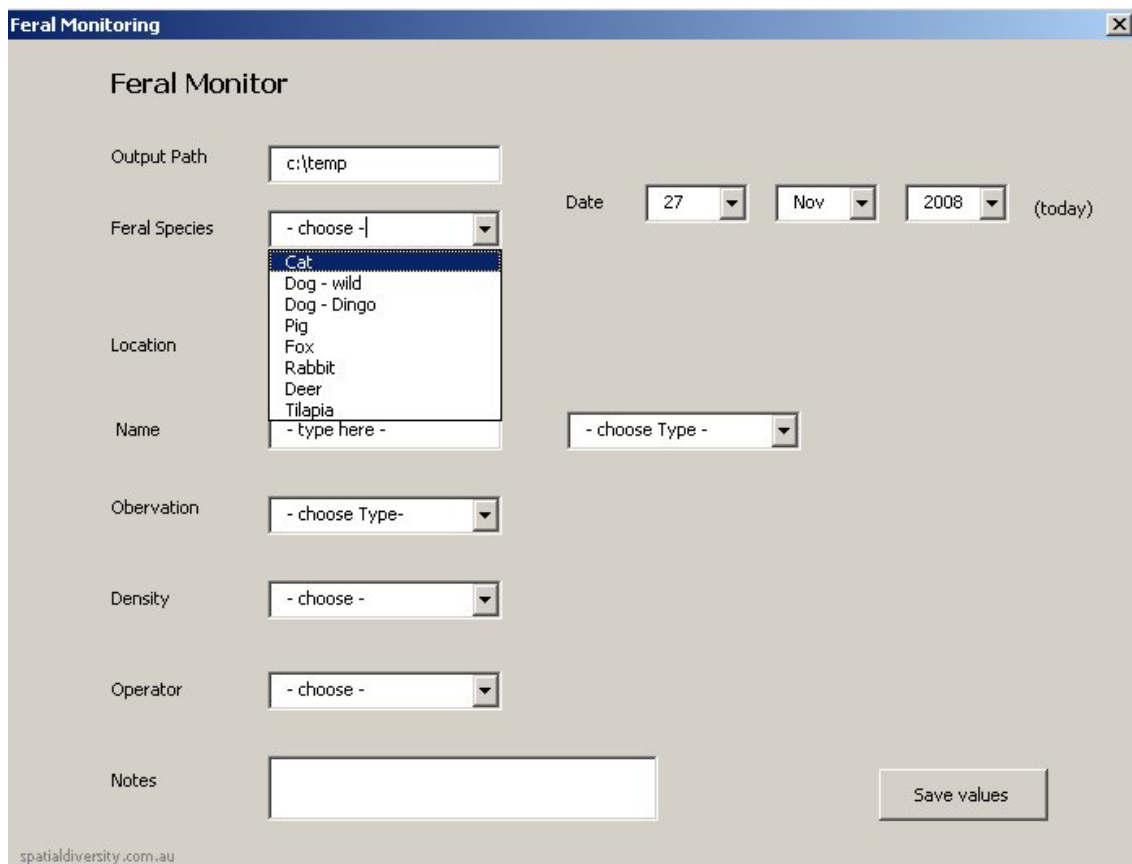


The screenshot shows a web-based form titled "Feral Monitoring" with a blue header bar. The form is titled "Feral Monitor" and contains several input fields and a "Save values" button. The fields are arranged in a grid-like fashion. The "Output Path" field contains "c:\temp". The "Date" field is split into three parts: "27", "Nov", and "2008", with a "(today)" label to the right. The "Feral Species" field is a dropdown menu with "- choose -" selected. The "Location" field is a dropdown menu with "- choose Suburb -" selected. The "Name" field is a text input with "- type here -" and a dropdown menu with "- choose Type -" selected. The "Obervation" field is a dropdown menu with "- choose Type-" selected. The "Density" field is a dropdown menu with "- choose -" selected. The "Operator" field is a dropdown menu with "- choose -" selected. The "Notes" field is a large text area. A "Save values" button is located at the bottom right. The URL "spatialdiversity.com.au" is visible in the bottom left corner.

Field	Value
Output Path	c:\temp
Date	27 Nov 2008 (today)
Feral Species	- choose -
Location	- choose Suburb -
Name	- type here -
Obervation	- choose Type-
Density	- choose -
Operator	- choose -
Notes	

spatialdiversity.com.au

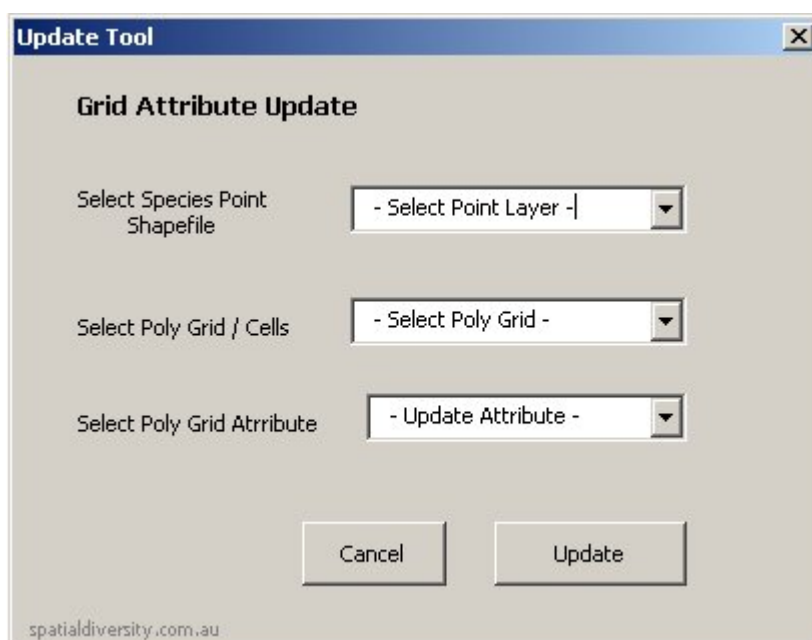
Save values



The screenshot shows the 'Feral Monitor' application window. It has a title bar with the text 'Feral Monitoring' and a close button. The main area is titled 'Feral Monitor'. It contains several input fields and dropdown menus: 'Output Path' with a text box containing 'c:\temp'; 'Feral Species' with a dropdown menu showing a list of species including 'Cat', 'Dog - wild', 'Dog - Dingo', 'Pig', 'Fox', 'Rabbit', 'Deer', and 'Tilapia'; 'Date' with three dropdown menus for day (27), month (Nov), and year (2008), followed by '(today)'; 'Location' with a dropdown menu; 'Name' with a text box containing '- type here -' and a dropdown menu for '- choose Type -'; 'Observation' with a dropdown menu for '- choose Type-'; 'Density' with a dropdown menu for '- choose -'; 'Operator' with a dropdown menu for '- choose -'; and 'Notes' with a large text area. A 'Save values' button is located at the bottom right. The URL 'spatialdiversity.com.au' is visible in the bottom left corner.

Grid attribute update tool

This tool is used to update the attributes of the 1km grid shapefile which covers the Terrain regional body as well as the wet tropics with the data that was created from the feral and weed monitoring tools. Again, this tool can be used by a non GIS person with practically no room for user error.



The screenshot shows the 'Grid Attribute Update' application window. It has a title bar with the text 'Update Tool' and a close button. The main area is titled 'Grid Attribute Update'. It contains three dropdown menus: 'Select Species Point Shapefile' with a dropdown menu for '- Select Point Layer -'; 'Select Poly Grid / Cells' with a dropdown menu for '- Select Poly Grid -'; and 'Select Poly Grid Attribute' with a dropdown menu for '- Update Attribute -'. At the bottom, there are two buttons: 'Cancel' and 'Update'. The URL 'spatialdiversity.com.au' is visible in the bottom left corner.

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Weeds and Ferals Mapping Meeting

1st October 2008, ATFI, James Cook University, Cairns

Attendees: Tina Lawson, James Butler, Petina Pert (CSIRO), Kirby Doak (FNQROC), Andrew Colvill (QPW), Michael Graham (Biosecurity Queensland), Russell Wild (Cairns Regional Council)

Purpose of meeting: To review ferals distribution information collected by Cyril Frazao, Tina Lawson and Sharlene Blakeney from councils' pest management officers, QPW rangers and Biosecurity Queensland officers, and decide next steps to a) fill gaps b) disseminate data c) plan collation of weed mapping.

1. Current Mapping Method

Cyril went to QPW offices and asked officers about pigs.

- Presence/absence in 1km² grid in your jurisdiction
- Density in 1 km² grid (using standard DPI densities)

Michael Graham joined Sharlene in her office to map his areas of Unallocated State Land.

Issues to consider:

- Different people had different perceptions of densities
- There was overlap in reporting in some areas, with different densities recorded
- There are areas where no-one has any idea if ferals are present or not because they are either inaccessible or never visited as part of routine activities.

Discussion:

Andrew: QPW mapped data into our system (ParkInfo Spatial Database) which is based on points, polygons etc. Mapped polygons by densities and sent them to Sharlene. Some presence was based on trapping records (for pigs and wild dogs). The quality of these records varied. Data not stored in Wildnet as they are generally polygons and Wildnet is an Oracle database and not really spatial – only has x ,y coordinates.

Kirby: Rabbits existing on tablelands existing on certain soil types.

Tina: Need to bring habitat suitability modelling into this – model out distributions from this.

Kirby: 1km grid – original idea to use it for publicly displaying maps of infestations to raise public awareness. It is good for capturing initial data and highlighting areas needing further investigation, but not ideal for on-ground management, which requires more detail.

Andrew: NRW PestInfo will not provide anything under 1km grid. Won't give you points.

Kirby – Of existing data, rabbits and deer are displayed on FNQROC website to generate feedback from the public (see www.fnqroc.qld.gov.au/home/index.html). Sharlene puts her maps up as pdf's, and we could put all of current data up in this fashion.

James: I can promote this website at the Queensland Pest Animal Symposium, Cairns, 20 – 21 October 2008.

Andrew: For QPW rangers they can capture data at points or polygons. But will be forced to enter as a polygon and record against poly what they have seen, density measure, etc. One way forward might be a regional agreement between land managers to measure pig rooting monthly/quarterly (i.e. by GPS) and entered in system – to map trends in feral presence. This would provide the next level of detail required.

James: 1 km² grid – this should be the first screening where management should be thinking about where to target management action and research.

Andrew: How the grids are selected is very important. Trends between seasons are also important and not picked up – quarterly or monthly. A more refined process is required.

Kirby: Radio tracking of pigs has been done, to look at seasonal patterns, how they move through the landscape for 60 days, etc. It might be possible to couple the map and radio tracking data where they exist.

Tina: We can do habitat suitability modelling for wet and dry seasons, and then take to experts and compare with the results of the 1km² grids.

James: We need to draw on ecological modelling to better validate reports and then extrapolate.

Kirby: A good example is Ian Holloway's pond apple maps. He estimated where is it likely to occur, where is it susceptible? E.g. Yarrabah – doesn't occur there.

James: There was interesting reporting which overlapped between jurisdictions (e.g. QPW vs Councils)

Kirby: Could also use the maps to identify key areas (i.e. pigs in lowlands) as priorities – then identify these areas to target in droughts.

James: For the Status & Trends project we'd like to overlay this with regional ecosystems, vulnerable assets, habitats.

Andrew: Detailed information doesn't exist, and where it does it is masked by less accurate information broad scale data.

Michael: DPI completed a survey of farmers asking about pig problems. Limitations as farmers thought they were getting money and everyone said they had problems with pigs.

Kirby: Mapping is trying to take away administrative boundaries – where are the pigs coming from, and how can we tackle this collectively across landholder boundaries.

Russell: Another approach is threat abatement. Key objectives of agencies differs from place to place i.e. for the Cairns Regional Council, in the Daintree the priority is conservation, in Cairns it is residents having pigs coming into their yards. For each area the Council is addressing a different threat with different methods.

2. Next steps

1. Need maps of hard data (e.g. trap records) as separate layers.
2. Develop triggers to ensure data is captured as best as possible. For example, for fire there is an annual trigger for QPW rangers to report what they burnt last year. Guidance on frequency of data collection needed. Power of overarching group (FNQROC/CSIRO/Terrain or MTSRF) to make these kind of recommendations to various agencies.
3. Need habitat-ecological and impact data for ferals:
 - Rabbits – use existing data from Dave Berman. Little info on impacts.
 - Pigs – use existing data from Michael Graham, Bill Dorney and Jim Mitchell – releasing pest management manual at Pest Animal Symposium. Plenty of data on impacts.
 - Dogs – little local information, but two CSIRO-JCU PhDs coming). Lee Allen useful contact
 - Deer – little local information, or on impacts. Bill Dorney may have some info.
 - Foxes – no understanding of ecology in Wet Tropics. Scott Burnett did a little work in 1990s. Important to understand relationship with rabbits. DPI Toowoomba may have some input.
 - Cats – no information on ecology or impacts. Scott Burnett has some limited info from 1990s.
 - Cattle – No data on ecology or impacts
 - Horse – Little data on ecology or impacts. QPW Carnarvon Gorge research important.
 - Goats – No data on ecology or impacts. Some info from Tully River (but who?)
 - Liz Poon – review of current knowledge and data requirements for MTSRF 2.6.2 Invasive Species.
4. Need to contact Paul Davis (Biosecurity Queensland) in Malanda to get feral distributions for Tablelands Unallocated State Land. Michael did not give Sharlene the area from top of Palmerston to the top of Kuranda Range.
5. Queensland Pest Animal Symposium: James to present on behalf of group. Good for complete picture of manager's opinions across the landscape but not perfect picture of actual distribution.
6. Mapping weeds: 6 months advanced warning to QPW officers so that they can prepare on their opinions of distribution. Dan Metcalfe's list of 10 pilot weeds needs to be circulated.

3. Actions

ACTION: Tina Lawson to contact Paul Davis to map ferals on Unallocated State Land for Tablelands, reaching from top of the Palmerston to top of Kuranda Range. Paul Davis mobile - 0419 76 8014, work - 4096 7703.

ACTION: Dan Metcalfe/Tina Lawson to check with Travis Sydes on the 10 priority weed species to be circulated as advance warning to all councils and QPW rangers.

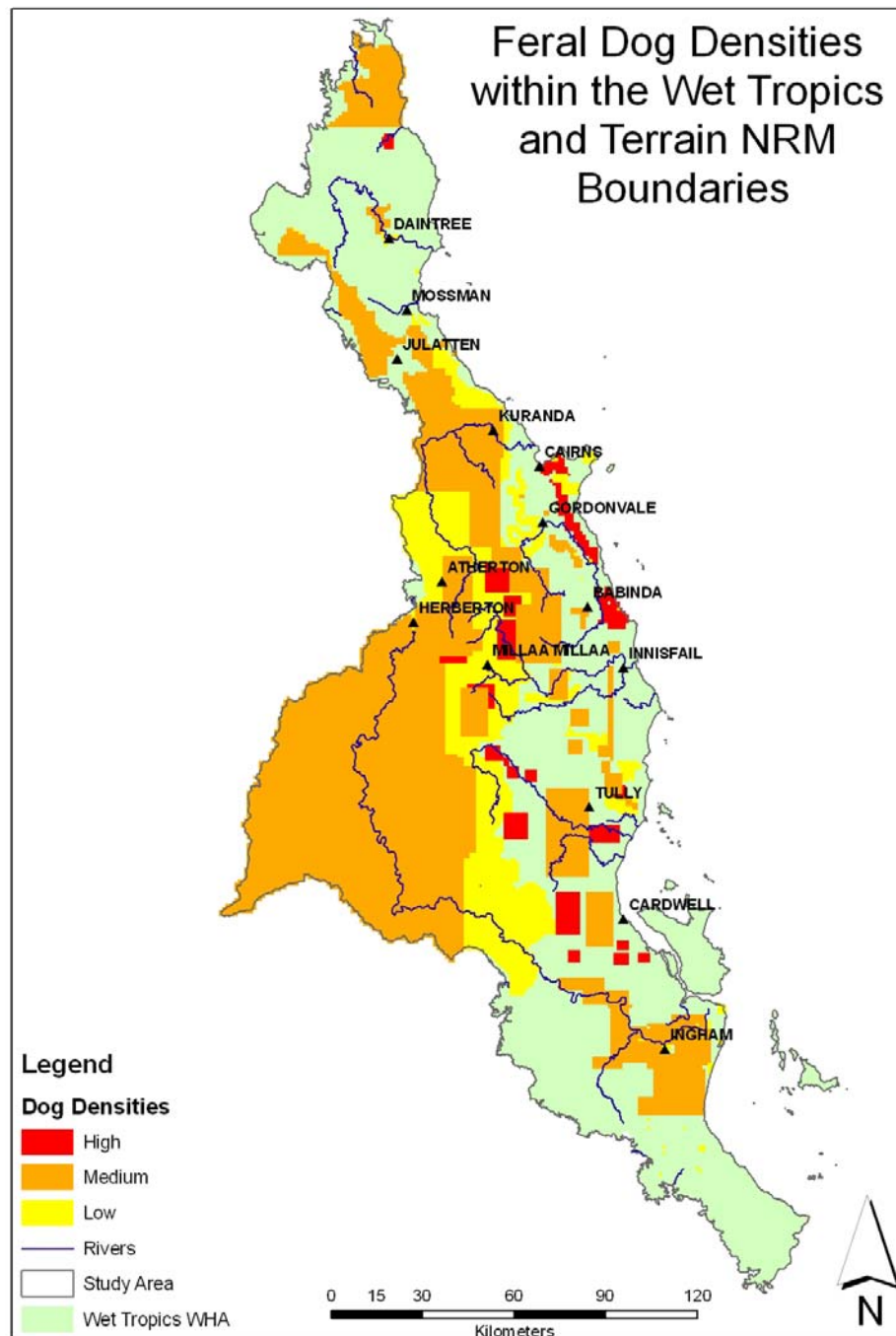
ACTION: Kirby to contact Sharlene and get maps published on FNQROC website with health warnings

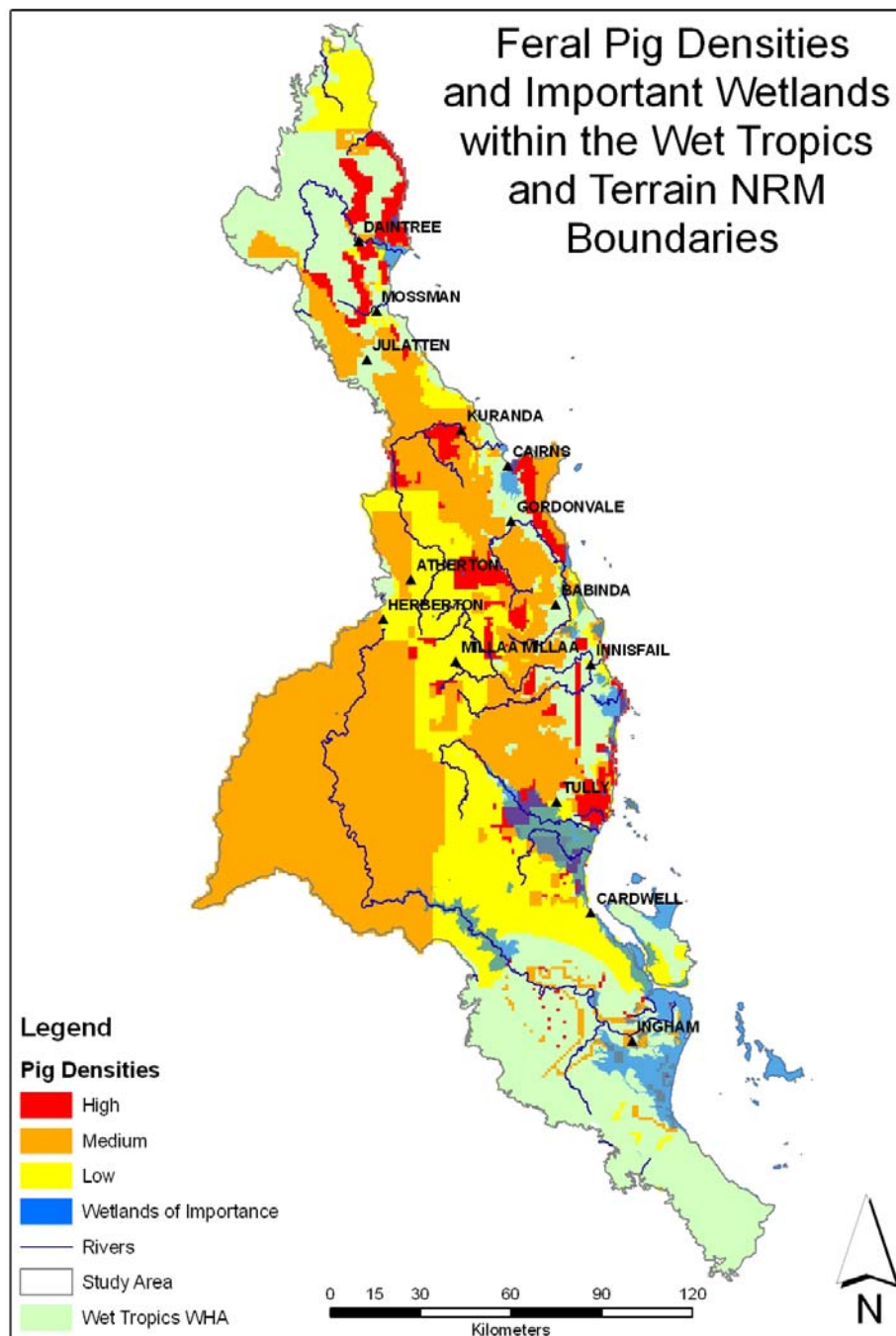
ACTION: James to check with Dan/Tina/Sharlene on progress and completion of Terrain/CSIRO Data Sharing Agreement.

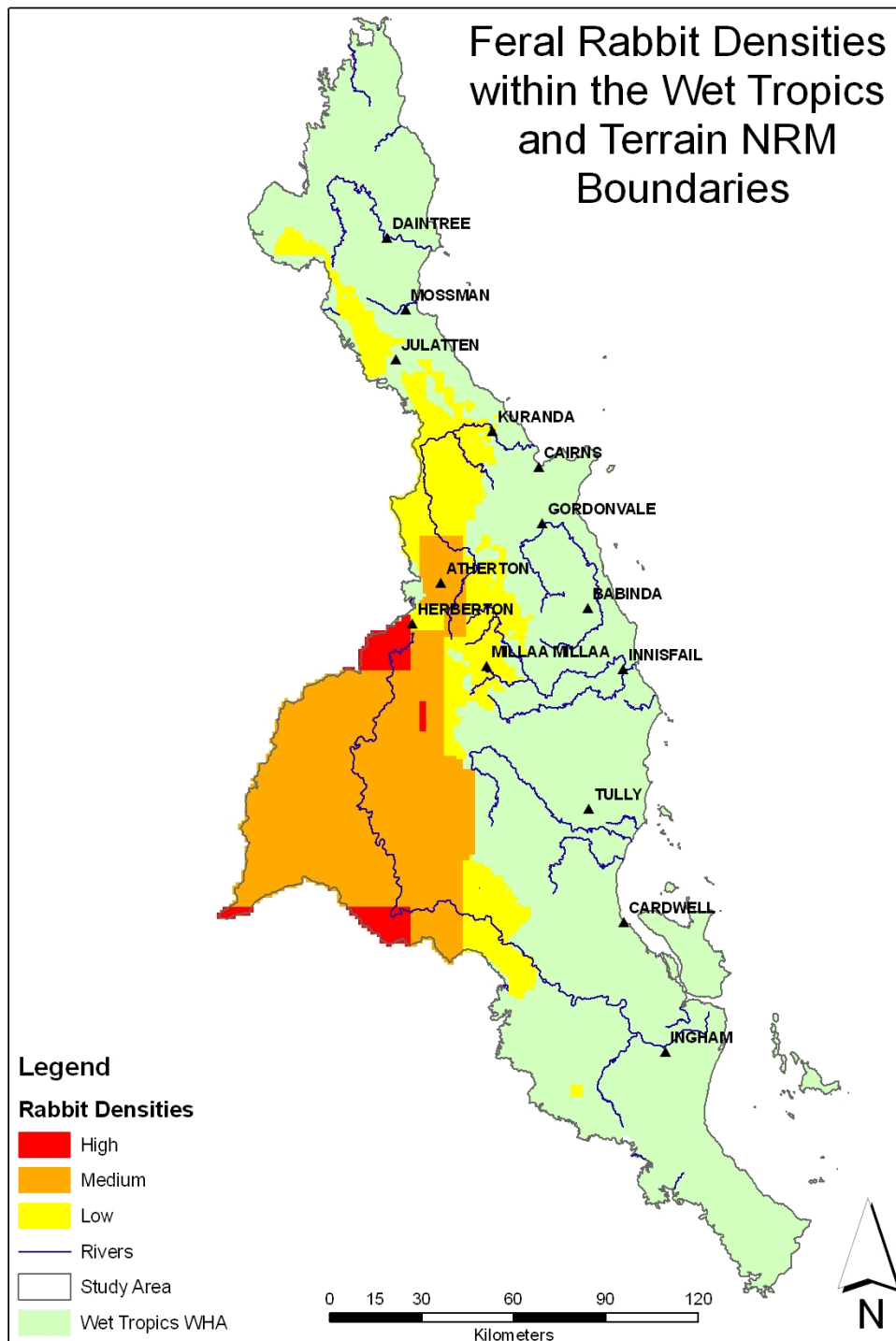
ACTION: Once Paul Davis data imputed, Sharlene too email all maps (densities and all land use, 1km² grid) to Andrew Colvill for QPWS distribution.

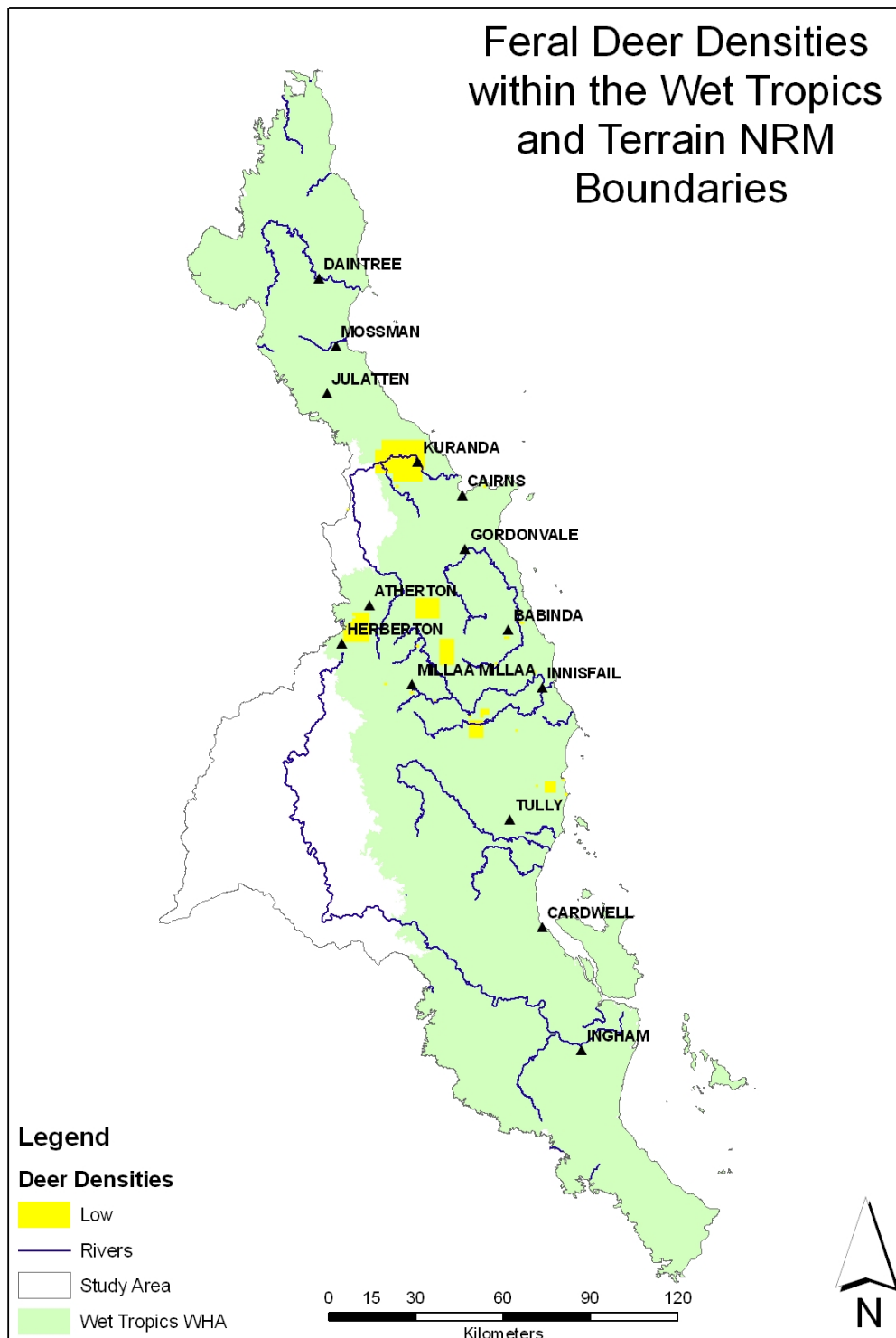
MTSRF Project 1.2.1c Status and trends of biodiversity and ecosystem services: state of the environment reporting and gap filling

Examples of feral animal distribution and density data gathered by Cyril Frazao, June-August 2008











DRAFT:

Mapping Ecosystem Services – Process and Considerations

Caroline M. Bruce and James R.A. Butler

Draft 1 – December 1, 2008.



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Figure 1 Headings for Figures use the Caption Paragraph defined. Error! Bookmark not

List of Tables

Table 1: Headings for Tables use the Caption Paragraph Style defined. Error! Bookmark not

1. OVERVIEW

Ecosystems are increasingly recognised as of value for the goods and services they provide for the well-being of humanity. Termed 'ecosystem services', these goods and services include water purification, climate regulation, soil formation and sense of place. The general global trend of increasing environmental degradation means that the ability of ecosystems to provide these services is diminishing.

The understanding, assessment and mapping of ecosystem services is therefore of increasing importance. However, this is a highly complex task as it requires the addressing of a number of challenging key issues. For example, we need to know where ecosystem services occur, how they provide us with benefits, what the key components are, how to value them, how their ability to provide services changes with time and space, and what the implications of the changing provision of services means not just for humanity but also for nature. Addressing these issues requires us to understand and integrate concepts and information from a variety of disciplines including ecology, agronomy, economics, anthropology, hydrology, ethics and philosophy.

The study and knowledge of some of these fields in themselves is mature, but the integrative study of these fields as they relate to ecosystem service mapping is generally quite novel and highlights an array of assumptions and limitations.

A number of studies have attempted to map ecosystem services using a variety of methods. These studies range from relatively simple assessments of an individual ecosystem service's extent and variation based on a simple surrogate indicator such as landcover type, to much more complex undertakings which aim to explicitly characterise multiple ecosystem services occurring over different scales and ranges in time and space.

This report synthesises the current knowledge on some of the key concepts pertaining to ecosystem service mapping. We provide a brief overview of what ecosystem services are, their relation to sustainable development and methods used in their valuation, then focus on methods and real-world examples of the actual mapping of ecosystem services. We conclude with a chapter on some of the challenges which arise in the mapping of ecosystem services.

2. WHAT ARE ECOSYSTEM SERVICES?

'Ecosystem services' are generally defined as the benefits people obtain from ecosystems (4). Variations in the understanding of the term relate to whether both natural and human-modified ecosystems are deemed to be sources of ecosystem services (54), whether or not the actual components of the ecosystem are included (otherwise termed 'ecosystem functions' or 'ecosystem processes') (7), and whether or not both the tangible and intangible benefits humans derive from ecosystems are included. These tangible and intangible benefits are sometimes categorised as 'goods' and 'services' respectively (4).

2.1 Categorisations of ecosystem services

Several attempts have been made to both categorise and comprehensively list ecosystem services (eg. de Groot et al. (56)), though there is no present consensus on a useful taxonomy (14). The over-arching categorisations as defined in the Millennium Ecosystem Assessment (4) have been widely accepted in the literature. These groupings align ecosystem functions and processes in to 4 categories of ecosystem services: provisioning, regulating, and cultural services that directly affect people, and supporting services needed to maintain the other three services. Daily et al. (in 24) also recognise the conservation of options. Table 1 defines these categorisations and broad groupings of the ecosystem services within each.

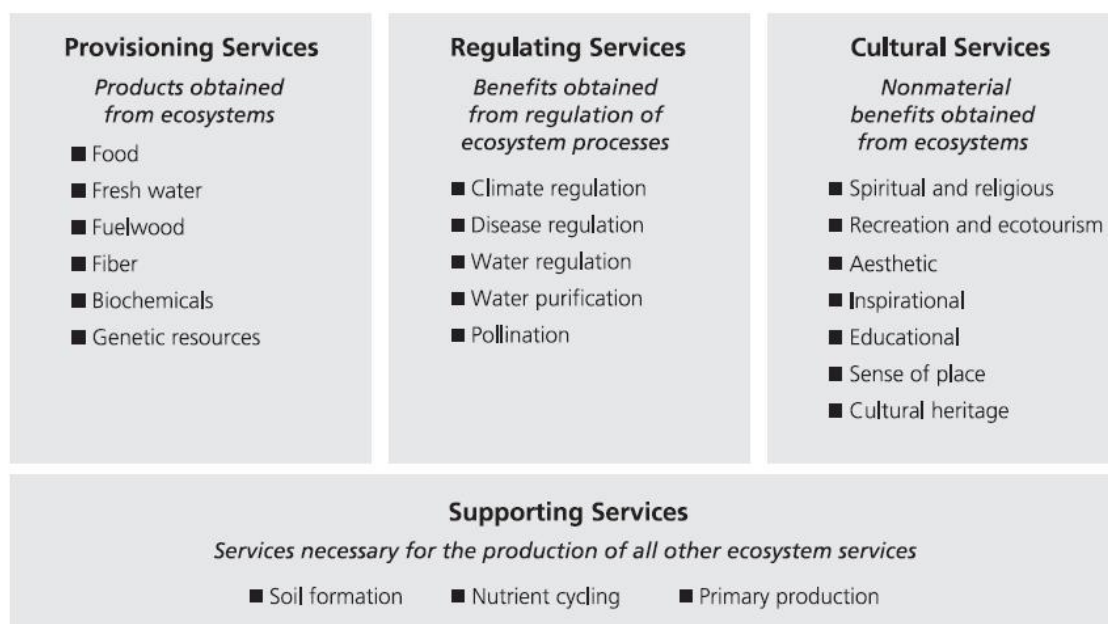


Table 1: Ecosystem Service categories (from 4, p57)

2.2 Ecosystem services and sustainable development

Sustainable development relies on the effective integration of environmental concerns into development policies. This is recognised by many of the world's leading institutions, which advocate that the sustainable development of the Earth's natural resources can only be achieved through an 'ecosystem approach' to their management (4). The Convention on Biological Diversity defines this as "a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way" (in 4). Such an integrative, holistic approach is inherently compatible with the management of ecosystem services, because ecosystem services flow from interactions among the whole set of processes occurring within and between the land, water and living resource components of ecosystems.

It is recognised that reversing the degradation of ecosystems while meeting the increased demands for their services is a difficult challenge (4). Chapter 4 of the MEA (4 – p64 onwards) details the most critical indirect and direct drivers causing this degradation that need to be addressed. Coupled with addressing these drivers of change is the need to implement changes in policies, institutions and practices to overcome barriers relating to issues such as inappropriate institutional and governance arrangements, market failures, misalignment of economic incentives, and social and behavioural factors (4, 26).

In addition, the effective management of ecosystems is constrained both by the lack of knowledge and information about different aspects of ecosystems and by the failure to use adequately the information that does exist in support of management decisions. These are detailed in Chapter 9 of the Millennium Ecosystem Assessment (4, p101->).

Furthermore, it is difficult to assess the implications of ecosystem changes and to manage ecosystems effectively because many of the effects are slow to become apparent, because they may be expressed primarily at some distance from where the ecosystem was changed, and because the costs and benefits of changes often accrue to different sets of stakeholders. 4)

To date, real progress towards sustainable development has been slow (26). Sixty per cent of the ecosystem services studied by the Millennium Ecosystem Assessment are being degraded or used unsustainably (26). Their degradation could grow significantly worse in the future due to rapidly growing demands for food, freshwater, timber, fibre and fuel, as well as from increasing pollution and climate change (4). Some authors even warn of ecological collapse due to extreme degradation (14, 26).

Improvements in sustainable development of resources rely on improvements to the understanding and quantification of ecosystem services combined with the appropriate dissemination of this information to decision makers and the public. The mapping and reporting of the distribution and current and future trends of ecosystem services is crucial to this whole process.

3. FRAMEWORKS

something here about different frameworks? eg. MEA framework (used by SEQC), OECS's PCR framework (used by Qld for their SoE reporting), etc.

7: p51: It should be noted, that a fundamental outcome of the findings from both projects (the MA (2005) and the SEQ Ecosystem Services Project) was that the assessment of ecosystem services must evolve around a sound ecological and scientific foundation drawing from both quantitative and qualitative data analysis (MA, 2005f).

7: p28: identifying a Strategy to Develop the SEQ Ecosystem Services Framework; The De Groot Framework (2002); The Millennium Ecosystem Assessment Framework (2005); Beitz Framework (2005)

7: p80: The De Groot (2002) framework takes a pragmatic view of ecosystem services, identifying economic methods and monetary valuations for each type of ecosystem function. In contrast, the MA (2005a) framework places human well-being as the central focus for assessments. Beitz (2005) however takes neither a pragmatic view nor makes human well-being the central focus, but recognises human dependency on the natural environment for the provision of environmental, social and economic benefits.

5: p37: Figure of conceptual framework used in MEA

5: p42: the conceptual framework used in the MA differs from the standard environmental impact assessment (EIA) framework in that it places ecosystems and the environment in a central role in the effort to reach development goals.

5: p42: the framework also differs from the commonly used pressure-state-impact-response (PSIR) framework by virtue of the feedbacks that it incorporates. The PSIR framework is designed to focus on the impacts of pressures (driving forces) on the environment and the responses that can be taken to alter negative impacts. The MA framework extends the PSIR framework by incorporating the consequences of the environmental impacts on human well-being and as a result turns the relatively linear PSIR framework into a more dynamic system in which environmental changes (the I) can change the human condition and thereby change the pressures (the P).

5: p42: equally significant, the MA framework differs from frameworks such as the PSIR or EIA by explicitly including multi-scale considerations, as described in the next section.

26: The GEO-4 assessment uses the drivers-pressures state- impacts-responses (DPSIR) framework. The concepts of human well-being and ecosystem services are core in the analysis. However, the report broadens its assessment from focusing exclusively on ecosystems to cover the entire environment and the interaction with society.

4. APPROACHES TO VALUATION OF ECOSYSTEM SERVICES

The science of valuation of ecosystem services is new, and still developing basic conceptual and methodological rigour and agreement. However, it has already been very instructive, since the value of such services is generally ignored or underestimated at decision and policy making levels and hence leading to their mismanagement (26). Therefore, identifying economic values of ecosystem services, together with the notions of intrinsic value and other factors, will assist significantly in future decisions relating to trade-offs in ecosystem management.

'Value' can be assigned to ecosystems as a means of defining their importance. The three types are:

- *ecological value*: based on ecological sustainability
- *socio-cultural value*: based on equity and cultural perceptions
- *economic value*: based on efficiency and cost-effectiveness

Below is a brief description of these methods as adapted from (56). Refer to Farber et al. (2002), Limburg et al. (2002), Howarth and Farber (2002), Wilson and Howarth (2002) for more detailed discussion of the concepts.

4.1 Ecological value

The ecological value of an ecosystem is determined both by the integrity of ecological functions underpinning ecosystem services, and by ecosystem parameters such as complexity, diversity, and rarity (De Groot et al., 2000). Sustainable use is a key component of ecological value. Since most functions and related ecosystem processes are inter-linked, sustainable use levels should be determined under complex system conditions (see Limburg et al., 2002), taking due account of the dynamic interactions between functions, values and processes (Boumans et al., 2002).

4.2 Socio-cultural value

Social values (such as equity) and perceptions play an important role in determining the importance of natural ecosystems and their functions to human society. This is evidenced, for example, in a report by English Nature (1994), where social reasons are mentioned as playing an important role in identifying important environmental functions, emphasizing physical and mental health, education, cultural diversity and identity (heritage value), freedom and spiritual values. Natural systems are thus a crucial source of non-material well-being and indispensable for a sustainable society (Norton, 1987).

4.3 Economic value

There are four basic types of economic valuation methods:

- direct market valuation
- indirect market valuation
- contingent valuation
- group valuation.

Each of these methods has its strengths and weaknesses (see Farber et al., 2002; Wilson and Howarth, 2002) and many valuation methods can be used to value any one ecosystem function (eg. see 56).

(56) suggests that to both avoid double counting when attempting to value ecosystem services, and to make valuation studies more comparable, a type of 'rank ordering' should be developed to determine the most preferred valuation method(s).

4.3.1 Direct market valuation

Direct market valuation is the exchange value that ecosystem services have in trade, mainly applicable to the functions such as food, raw materials and genetic resources but also to non-'goods' functions such as recreation and pollinations. For example, New York City sought to use natural water regulation services of largely undeveloped watersheds, through purchase or easements, to deliver safe water and avoid the alternative cost of a \$6 billion water filtration plant. This implies those watersheds are worth up to \$6 billion to New York City.

4.3.2 Indirect market valuation

When there are no explicit markets for services, more indirect means of assessing values can be used. A variety of valuation techniques can be used to establish the (revealed) Willingness To Pay (WTP) or Willingness To Accept compensation (WTA) for the availability or loss of these services:

1. Avoided Cost (AC): services allow society to avoid costs that would have been incurred in the absence of those services. Examples are flood control (which avoids property damages) and waste treatment (which avoids health costs) by wetlands.
2. Replacement Cost (RC): services could be replaced with human-made systems; an example is natural waste treatment by marshes which can be (partly) replaced with costly artificial treatment systems.
3. Factor Income (FI): many ecosystem services enhance incomes; an example is natural water quality improvements which increase commercial fisheries catch and thereby incomes of fishermen.

4. Travel Cost (TC): use of ecosystem services may require travel. The travel costs can be seen as a reflection of the implied value of the service. An example is recreation areas that attract distant visitors whose value placed on that area must be at least what they were willing to pay to travel to it.
5. Hedonic Pricing (HP): service demand may be reflected in the prices people will pay for associated goods; an example is that housing prices at beaches usually exceed prices of identical inland homes near less attractive scenery.

4.3.3 Contingent valuation (CV)

Service demand may be elicited by posing hypothetical scenarios that involve the description of alternatives in a social survey questionnaire. For example, a survey questionnaire might ask respondents to express their willingness to pay (i.e. their stated preference as opposed to revealed preference) to increase the level of water quality in a stream, lake or river so that they might enjoy activities like swimming, boating, or fishing (Wilson and Carpenter, 1999).

4.3.4 Group valuation

Another approach to ecosystem service valuation that has gained increasing attention recently involves group deliberation (Wilson and Howarth, 2002; Jacobs, 1997; Sagoff, 1998). Derived from social and political theory, this valuation approach is based on principles of deliberative democracy and the assumption that public decision making should result, not from the aggregation of separately measured individual preferences, but from open public debate.

Two or more of the above valuation methods can be combined to define the Total Value (TV) of an ecosystem service (56). The aggregation and weighing of different values is an important process and presents its own suite of challenges.

7: Ecosystem services include the tangible and in-tangible (material and non-material) goods and services people receive from ecosystems. The importance or 'value' of ecosystem services is dependant on the philosophical, ethical, religious, cultural or professional views of individuals, organisations and communities (MA, 2005a; De Groot et al, 2002; World Bank, 2004 and WRI, 2007). People place value on ecosystem services due to both their 'use' values (e.g. direct use values such as timber and food products; indirect use values such as storm protection; option values such as future uses; and bequest values providing for future generations) and non-use values (e.g. existence values such as just knowing particular resources exist even if they never expect to use that resource) (MA, 2005a; World Bank, 2004 and WRI, 2007). Throughout the thesis the terms 'value' and 'valuation' will refer to the collective values of those described above and the process of identifying these values, unless specifically stated otherwise.

7: According to the World Bank (2004), it is not enough just to know that ecosystems are valuable, we also need to know just how valuable they are. Determining the value

of ecosystem services is important to enhance the ability of decision makers to evaluate trade-offs, management regimes, prioritise investments and courses of social action that may be applied to better improve the provision of ecosystem services and human well-being (MA, 2005a). The purpose of valuing ecosystem services is to make disparate services provided by ecosystems comparable to each other using a common metric (usually in monetary terms) (MA, 2005a and World Bank, 2004).

7: Valuation of ecosystem functions, goods and services must take into consideration the non-linear linkages between ecosystem functions, goods and services and the spatial scales and temporal rates at which ecosystem functions may occur (De Groot et al, 2002 and MA, 2005a). Often ecosystem services are undervalued or not valued at all in market economies as they are not easily measured or priced and therefore are difficult to capture in market transactions (e.g. what is the value of gas regulation to the global community and to future generations?) (Krupnik and Siikamaki, 2007; De Groot et al, 2002 and MA, 2005a). The public good nature of many ecosystem services also provokes issues such as property rights and management responsibilities.

26: Environmental impacts are, however, often not factored into operations of the social and economic sectors as a cost, and hence these impacts are referred to as externalities. The externalization of such costs does not allow for a true trade-off in terms of costs and benefits when development decisions are taken. These sectors are instrumental in utilizing ecosystem services and natural resources. They also affect ecosystem services, and are affected by ecosystem change (see Figure 8.2).

the problem of aggregation and weighing of different values in the decision making process is an important issue

26: p373: It is therefore important to consider the trade-offs and synergies that can arise between and among ecosystem services and human well-being when developing management options.

26: p471: In part, environmental problems and mismanagement of natural resources result from not paying the full price for the use of ecosystem services (Pearce 2004).

5: p127: Decision-making concerning ecosystems and their services can be particularly challenging because different disciplines, philosophical views, and schools of thought conceive of the value of ecosystems differently.

5: p127: In the utilitarian (anthropocentric) concept of value, ecosystems and the services they provide have value to human societies because people derive utility from their use, either directly or indirectly (use values). People also value ecosystem services that they are not currently using (non-use values).

26: p489: good discussion about payment for ESs incl. info on a new approach – ‘payments for environmental services (PES)’ and combined solutions

26: p143: The economic valuation of ecosystem services provided by the water environment (such as water filtration, nutrient cycling, flood control and habitat for

biodiversity) can provide a powerful tool for mainstreaming aquatic ecosystem integrity into development planning and decision making.

15: How can we decide how to value coastal wetlands and whether such proposals have merit? An emerging field aims to deliver answers. A new paradigm is emerging in environmental economics. It views the natural environment as a form of capital asset, natural capital.

4: p23: promising interventions include incorporation of nonmarket values of ecosystems

5: p127: In the utilitarian (anthropocentric) concept of value, ecosystems and the services they provide have value to human societies because people derive utility from their use, either directly or indirectly (use values). People also value ecosystem services that they are not currently using (non-use values).

5: p127->: other info about valuation of ESs

14: the most common and most appropriate approach to nonmarket valuation is called total economic value (TEV). This approach does not necessarily assess the total value of an ecosystem, but rather allows changes to be calculated for all values (use and non-use values) associated with one or several ecosystem functions. Any calculation of TEV will depend heavily on the spatial and temporal scales being assessed, so analysts must be clear about the intended scope of their study. TEV can be assessed as willingness to pay (WTP) or willingness to accept (WTA) payment.

14: many problems must be solved before the valuation of ecosystem services can become a mainstream activity. Primarily, we need to acquire sufficient information about ecosystem processes to make valuation possible. Beyond that basic biophysical information, we also lack an understanding of how economic value scales with ecosystem processes

20: some parameters would be relatively easy to quantify, and geographically explicit measures such as terrestrial net primary productivity (NPP) already are being produced for the country (Figure 2). Others are not so easily measured (eg aesthetic and recreational services) or provide complex, regionally specific benefits that we may not yet know how to assess (eg biodiversity; Figure 3).

22: The potential of market-based instruments is increasingly being considered in the debate about the appropriateness of alternative options for management of natural resources and the environment. More particularly, there is a growing interest in creating market-like mechanisms to manage environmental outputs at the lowest economic cost. With this focus comes a need to build capacity in communities, government and research organisations as to how, when and where these tools should be applied.

24: we follow the approach of Davis et al. [65] by avoiding the most problematic valuation methods (e.g., contingent valuation) and the difficult question of a common currency for disparate preferences and principles.

26: Beyond legislation and regulation, the use of payments for ecosystem services, as exemplified by the emerging carbon market, represents an innovative though somewhat controversial approach to addressing the impacts of energy use on the environment

30: a few studies in the past few decades have tried to estimate the values of a variety of ecosystem services. Peters et al. (1989) presented an assessment of the economic value of a tropical Amazon rainforest in Brazil, and proposed a strategy for the sustainable use of rainforests in the region. Tobias and Mendelsohn (1991), Bacilli and Mendelsohn (1992) and Chopra (1993) have also discussed the values of tropical forests. Pearce and Moran (1994) discussed methods of economic valuation of different biological resources and their interpretations. They listed the values of tropical forests, wetlands, rangelands and marine systems worldwide. McNeely (1993) analyzed economic incentives for biodiversity conservation in Africa. Cacha (1994), Lacy and Lockwood (1994) and Munasinghe (1994) discussed the economic evaluation of protected areas. Hyde and Kanel (1994), Kramer and Munasinghe (1994) and White et al. (1997) studied the economic value of endangered species management through some case studies. Gren et al. (1995) estimated the economic value of Danube floodplains. Costanza et al. (1997) assessed the value of the world's ecosystem services. Abramovitz (1998) pointed out that ecosystem services have extensive economic value but that they are not credited for their non-market value until they become depleted.

30: using model estimations, we have examined the economic value of several services of forest ecosystems in Qinba mountains

31: In recent times, use of market-based instruments to facilitate enhanced protection or production of ecosystem services has achieved a high public profile through the development of water markets and the initiation of the National Market Based Instruments Pilots Program among others. However, much work remains to apply these tools in practice

31/32: MBIs – market-based instruments

14: economists and ecologists are just beginning to credibly assign economic value to ecosystem processes, transforming these processes into tradable, marketable services.

26: p30-> and tables 1.2, 1.3: economic instruments incl. valuation. economic instruments such as market creation and charge systems may be used to help spur environmentally sustainable behaviour. Valuation can help policy-makers make informed decisions about the value of changes to ecosystem services. Noneconomic instruments should be used to address both well-known problems with proven solutions and less clear emerging problems.

11: new techniques have led to a much greater ability to quantify economic values associated with natural ecosystems in a wide variety of contexts [18,19].

11: despite these advances, explicit analyses of economic costs and benefits have yet to become widely incorporated into conservation planning exercises. In part, this is because conservation planning is inherently spatial and thus presents special challenges for the quantification of both costs and benefits. For costs, spatially explicit data on land prices at the necessary resolution are lacking for many parts of the world, in which case they must be modeled [22,23]. For benefits, the biophysical delivery of ecosystem goods and services must first be spatially quantified, a difficult task in itself [24,25], and then these ecosystem services must be assigned an economic value in a spatially explicit manner. This requires knowledge of who the beneficiaries are, where they reside, how they perceive the value provided by an individual ecosystem service, and how the spatial pattern and scale of an ecosystem service affects the resulting economic values at the scale of interest

18: Techniques for valuing ESs:

- Avoided Cost (AC): services allow society to avoid costs that would have been incurred in the absence of those services; flood control (barrier islands) avoids property damages, and waste treatment by wetlands avoids incurred health costs.
- Replacement Cost (RC): services could be replaced with man-made systems; natural waste treatment can be replaced with costly treatment systems.
- Factor Income (FI): services provide for the enhancement of incomes; water quality improvements increase commercial fisheries harvest and thus, incomes of fishermen.
- Travel Cost (TC): service demand may require travel, whose costs can reflect the implied value of the service; recreation areas attract distant visitors whose value placed on that area must be at least what they were willing to pay to travel to it.
- Hedonic Pricing (HP): service demand may be reflected in the prices people will pay for associated goods: For example, housing prices along the shore of pristine freshwater lakes tend to exceed the prices of inland homes.
- Contingent Valuation (CV): service demand may be elicited by posing hypothetical scenarios that involve some valuation of alternatives; people would be willing to pay for increased water quality in freshwater lakes and streams.
- Marginal Product Estimation (MP): Service demand is generated in a dynamic modeling environment using production function (i.e., Cobb-Douglas) to estimate value of output in response to corresponding material input.
- Group Valuation (GV): This approach is based on principles of deliberative democracy and the assumption that public decision making should result, not from the aggregation of separately measured individual preferences, but from public debate.

8: we develop the economist's concept of value as opportunity cost and discuss the ways in which decisions imply values through revealed preference.

We distinguish between the ideas of incremental and total value and argue that only the former is of importance in practical decision-making. The relationship between

price and value is articulated and related to the distinction between public and private goods. Finally, we enumerate the various ways economists use to determine the value of ESs – these include use of prices, methods of revealed preference, voting schemes and contingent valuation

8: to an economist, the problem of measuring value is the problem of determining operational tradeoff rates. In particular, value is relative – we have no concept of absolute or intrinsic value. In assessing the value of an object, we ask what is its equivalent in terms of other resources we would be willing to give up in order to have it. The answer, sometimes referred to as 'opportunity cost' is operational in that it can be used to determine which changes in social policy are in society's best interests.

8: focus on total economic value of ESs is not very interesting – any collection of services that are indispensable to human life will give the same intuitively obvious answer. However, it is still important to know how to evaluate non-marginal changes that are not so large as to endanger our existence but are large enough to vitiate the additivity property.

8: economists generally assume that the decision as to whether or not a particular good or service is allocated through the market is made rationally – that is items are marketed if and only if it is relatively efficient to do so. The biggest impediment to using markets for efficient allocation involve commodities or items that have a 'public' character. ... As a general rule, we find that such commodities do not have markets. ... Publicness does not entirely preclude the use of markets but does imply that if employed they will work very poorly at best.

8: the simplest paradigm to use in measuring valuation is one in which we divide the list of goods and services into two mutually excl. and exhaustive categories: those that can be optimally allocated by the market (private) and those that are allocated entirely outside the market system through the political process (public).

8: some ESs are allocated through the market (eg. pollination through beehives) but many are not (public goods). how the latter are valued is an old and vexing question with many proposed solutions, none of them entirely satisfactory – eg. auctions. Another possibility is to learn something about preferences for public goods from observable behaviour, typically behaviour on related private good markets (eg. rent on sites with dirty v. clean air) = hedonic methods. Contingent valuation – people asked how much a good is of value to them.

8: externality costs, existence values, use values

8: many impediments to true valuation of services. The best we can do is rely on certain kinds of approximations, eg. upper and lower bounds of costs

16: value transfer approach: The transfer method constitutes the application of values and other data from the original study site (empirically obtained) to the present policy site (Loomis 1992, Desvousges et al. 1998). Following Desvousges et al. (1998) the term value transfer is used instead of benefit transfer, since transfer method is not restricted to economic benefits, but can also be extended to include the analysis of potential

economic costs, as well as value functions themselves. Therefore, value transfer involves the adaptation of existing valuation information or data to new policy contexts. Issues with this technique.

16: p80: Literature on the value transfer approach reveals different conclusions as to the effect of including socio-economic variables suggested by Spash and Vatn (2006). Most studies that are based on function transfer include variables that cover income, gender, age, and education.

16: p87-> : limitations of the value transfer approach

10: use value transfer (adaptation of existing valuation info to new contexts) – an increasingly practical way to inform decisions when primary data collection is not feasible. Increasingly used, but academic debate over validity of the method continues. Not ideal, but better than the assigning a value of zero to ESs

10: potential pitfall: value transfer from study sites in very different context

10: while much attention has focused on the economic theory and practice of environmental value transfer itself, much less attention has been paid to the inherently spatial nature of many environmental values: “The spatial dimension to economic valuation has barely been investigated...The adoption of a spatial approach to economic valuation is desirable in terms of producing more accurate economic valuation figures, for use as a repository for benefits estimates, examining spatial sustainability, and facilitating the introduction of natural capital concepts into environmental decision-making processes (p. 109).”

10: p440: Once the typology was set, empirical valuation studies were analyzed and entered into the Natural Assets Information System™ system and standardized to 2001 dollar equivalents. This process yielded 42 viable peer-reviewed empirical studies and 65 valuation data points that were used in the final analysis. In the interests of space a complete bibliography of valuation studies is not given for any of the case studies here; rather, bibliographies are contained in each individual project report

10: the availability of empirical economic valuation studies is one of the most significant constraints to spatially explicit value transfer today.

10: p445: The availability of valuation data is further limited by the fact that only economic studies whose valuation coefficients were derived in a similar context to the policy site should be used for value transfer. Yet, defining contextual similarity itself can be challenging and, because of the limited number of studies available, must involve tradeoffs among specificity, reliability and applicability. This lack of comparability among studies, stemming from differences in the characteristics and context of the resources being valued, has been cited as a significant limitation in meta-analysis and value transfer

10: three critical factors must be considered when assessing comparability between the source data and policy context. First, one must consider the biogeophysical similarity of the policy site and the study site. Second, the human population

characteristics of source data must be considered. Third, similarity in the level of scarcity of the service should be considered. Also, complicating factor is the availability of spatial data. These problems have led to gaps in landscape valuation. Such gaps can mislead users if the limitations are not made explicit.

10: p447: problems associated with the ES value transfer method and large spatial extent ... requires marginal analysis, increasing heterogeneity in classes. Finally, perhaps the most important lessons learned from these case studies relate to how to make use of the results. For results to have validity in a management context there must be transparency and meticulous documentation at every step. Further, clients must understand that ESV estimates alone should not be the sole basis for management decisions.

10: future directions: The number of studies measuring the economic value of ecosystem services has increased dramatically over the last decade (Heal et al., 2005; Rosenberger and Stanley, 2006-this issue), resulting in greater levels of specificity and reliability in our efforts to quantify the value of key ecosystem services. With the release of global reports such as the Millennium Ecosystem Assessment (2003), we anticipate that this trend will continue. Also increase in quality and availability of digital spatial data incl. LIDAR

11: spatial cost-benefit analysis can powerfully inform conservation planning, even though the availability of relevant data may be limited, as was the case in our study area. It can help us understand the synergies between biodiversity conservation and economic development when the two are indeed aligned and to clearly understand the trade-offs when they are not.

11: costs (eg. land costs, opportunity costs) v. benefits (ESs)

11: cost-benefit analyses, where the economic costs and benefits of a proposed policy or project are tallied and used to inform decision making, are widely used in a variety of issue areas

11: on the benefits side, there has been an increased awareness of the economic value of ecosystem services provided by natural systems [5,15]. Quantifying these values, however, remains complex and has become a major area of research in both environmental and ecological economics

11: We compared the ecosystem service values to the cost of conserving the natural habitat that underlies their provision [29] and asked which areas would pass a cost-benefit test.

11: we are unaware of previous studies that have estimated the economic costs and benefits of conservation in a spatially explicit manner

11: this study is based on a utilitarian view of conservation, where benefits and costs are assessed in purely economic terms. We do not consider here deeper issues of "value," such as the intrinsic value of nature and ethical issues associated with conservation.

11: p2155: weakness of methodology the use of past conversion rates in developing the opp. cost layer. Also did not consider other costs eg. management costs

11: ESs based on forest cover map – mapped forest types, assessed 5 different ESs for each of these. For some services, site-specific valuation information did not exist; in these instances, we took a benefits transfer approach to estimating values. A discussion of benefits transfer (i.e., the transfer of economic value estimates derived at one geographical location to a different location) is outside the scope of this paper; however, we note that the development and reliability of such methods is greatly debated in the environmental economics literature

11: p2155->: methods for valuing ESs: bushmeat, timber harvesting, bioprospecting, existence value, carbon storage

5. MAPPING ECOSYSTEM SERVICES

The Millennium Ecosystem Assessment has been described as possibly the boldest move to date to embrace and understand ecosystem services (14) and has generally been praised as a pre-cursor and instigator of serious ecosystem mapping effort. A number of other key studies have since taken place (eg. 54, ...), relevant to different scales and employing different methodologies. Generally, the field of ecosystem service mapping is in its initial stages, but it continues to develop rapidly.

Mapping ecosystem services is a huge and complex field. As such, a rigorous, systematic methodology for the mapping of ecosystem services has not been developed which can be applied to all ecosystem services at all spatial and temporal scales. Inherent differences between ecosystem services and even within each service (due, for example, to different locations) mean that different methods are applicable to the mapping of different services.

Following a brief discussion of why ecosystem services should be mapped, we present and discuss some examples of where different methods have been applied to the mapping of ecosystems both external to and within Australia.

5.1 Why map ecosystem services?

As discussed in Section 2.2, the mapping of ecosystem services is critical to our understanding of natural processes and the changes to these processes due to natural or human-induced means. A grasp on the functioning of these natural processes is in turn a key component to the implementation of sustainable development practices.

In spite of the crucial ecological, cultural and economic importance of ecosystem services, many ecosystems around the world are in poor or continually deteriorating condition (4, 17) due to the underestimation of their value to human welfare and therefore inappropriate and/or incomplete valuation, policies and mis-management of resources. For example, the globalisation of agriculture and inappropriate agricultural policies have been identified as leading drivers influencing the loss of species and ecosystem services (26)

The mapping of ecosystem services in itself is not sufficient to infer the appropriate management and improvement in the functioning of ecosystems, but it is part of the broader process of identifying, understanding, valuing and managing ecosystems.

24: in recent years, however, there have been tremendous advances in the science, economic valuation, institutional design, and social capacity needed for ecosystem-service conservation. These advances have come on numerous fronts, including the following: (i) the maturation of conservation planning [4– 7]; (ii) the Millennium Ecosystem Assessment [8,9] and related work on particular services such as crop pollination [10–13], the regulation of water flow and hydropower production [14], the provision of water quality and quantity [15], and recreation [16]; (iii) the application of

economic valuation techniques to ecosystem services [17–21]; (iv) the refinement of quantitative approaches and tools for decision-making [22–29]; and (v) institutional and other social change for ecosystem-service protection [30–32]. Yet, perhaps the most important and certainly the most innovative advances in ecosystem-service protection come from the emergence worldwide of small-scale systems of payment for ecosystem services [33–35].

26: Choices made today will determine how these threats will unfold in the future. Reversing such adverse environmental trends will be an immense challenge. Ecosystem services collapse is a distinct possibility if action is not taken. Finding solutions to these problems today is therefore urgent.

24: flows of ecosystem services remain poorly characterized at local-to-regional scales, and their protection has not generally been made a priority.

17: The benefits provided by natural ecosystems though widely recognized, are poorly understood and quantified.

17: ecosystems are continually deteriorating worldwide as the value of ecosystems to human welfare is still underestimated and the ES are not, or only partly, captured in conventional market economics.

11: 2162: Although mapping and valuing ecosystem services can help to inform planning efforts, it is not sufficient to motivate conservation. For most ecosystem services, financial mechanisms and institutions (e.g., markets, subsidies) do not exist to capture values and compensate landowners for bearing the costs of providing them [21]. An increasing number of examples demonstrate the potential of such mechanisms, including payments for services from forests in Costa Rica [81], water purification in New York [82], and water table maintenance in Australia [83]. For all but these and a few other exceptions, however, payment schemes for services outside traditional markets are typically absent. Without such mechanisms, many economic values associated with natural habitats will remain outside the calculus of agents who actually make land-use decisions.

5.2 Methods for mapping ecosystem services

5: p49: The ability of ecosystems to deliver services can be assessed by a variety of qualitative and quantitative methods.

5: p49: an assessment of the condition of ecosystems, the provision of services, and their relation to human well-being requires an integrated approach. This enables a decision process to determine which service or set of services is valued most highly and how to develop approaches to maintain services by managing the system sustainably.

something about input from peer-reviewed lit, datasets and models? Eg. 4: the Millennium Ecosystem Assessment synthesizes information from the scientific literature and relevant peer-reviewed datasets and models.

input of expert knowledge? eg. 4: assessments like this one apply the judgment of experts to existing knowledge to provide scientifically credible answers to policy-relevant questions. The focus on policy-relevant questions and the explicit use of expert judgment distinguish this type of assessment from a scientific review.

10: In this paper, a decision framework designed for spatially explicit value transfer was used to estimate ecosystem service flow values and to map results for three case studies representing a diversity of spatial scales and locations in the USA. In each case, a unique typology of land cover and aquatic resources was developed and relevant economic valuation studies were queried in order to assign estimates of ecosystem service values to each category in the typology. GIS analysis was then used to map the spatial distribution of each cover class at each study site. ... They also discuss how variability in the site characteristics and data availability for each project limits the ability to generalize a single comprehensive methodology.

10: p435: Thanks to the increased ease of using Geographic Information Systems (GIS) and the public availability of high quality land cover data sets, bio-geographic entities such as forests, wetlands and beaches can now more easily be attributed with the ecosystem services they deliver on the ground. This approach compliments the other transfer techniques discussed in this Special Issue of Ecological Economics.

10: p.436: the ability to integrate biophysical and ecosystem service valuation data is a relatively new phenomenon (Kreuter et al., 2001; Wilson and Troy, 2005). Rather than argue for a single unified methodological approach that can apply to all possible circumstances, our goal is to outline a set of decision rules that have served as the basis of our efforts in three case studies.

24: Planning for services is inherently more complex than planning for biodiversity conservation

12: There are a number of ecosystem services related to the world's tropical forests. These services include the provision of food and raw materials (Lambin 1994), protection against soil erosion, sedimentation and flooding (Douglas 1999), water cycling and impacts on rainfall patterns (Koninck 1999), exceptional biological diversity (Whitmore 1991) and carbon storage in regenerating tropical forests (Foody et al. 1996). These forest ecosystem services vary with forest type and consequently knowing the extent of the various forest types becomes important for the effective management of the tropical forests. However, quantitative data on the extent and variation of the tropical forest ecosystem are incomplete and sometimes inaccurate.

14: high biodiversity does not necessarily correspond to the greatest ecosystem services — a reality that may cause conservation efforts to broaden their goals beyond simply maximising biodiversity.

24: we compared the degree to which four contrasting conservation network designs protect biodiversity and the flow of the six services. We found that biodiversity conservation protects substantial collateral flows of services. Targeting ecosystem services directly can meet the multiple ecosystem services and biodiversity goals more efficiently but cannot substitute for targeted biodiversity protection

24: used Marxan to assemble networks of conservation areas for each ES

23: Assessing ecosystem function using a landscape-scale approach helps focus land-use planning on critical regional problems thereby minimizing the cost and increasing the effectiveness of restoration. A landscape approach can provide a comprehensive method of assessing whether ecosystem processes have been altered; identifying the mechanism and geographic location of alteration; and determining viable restoration opportunities.

23: an effective landscape analysis does not require exhaustive collection of new data, development of complex models to predict cumulative impacts, or lengthy analysis involving multiple development scenarios. Through use of existing data and land-use information and the application of some basic landscape principles, a comprehensive framework for protecting natural resources can be attained.

24: We used a spatially explicit conservation planning framework to explore the trade-offs and opportunities for aligning conservation goals for biodiversity with six ecosystem services (carbon storage, flood control, forage production, outdoor recreation, crop pollination, and water provision) in the Central Coast ecoregion of California, United States.

5.3 Examples

5.3.1 Global

Relatively few ecosystem services have been the focus of research and monitoring and, as a consequence, research findings and data are often inadequate for a detailed global assessment (4). Moreover, the data and information that are available are generally related to either the characteristics of the ecological system or the characteristics of the social system, not to the all-important interactions between these systems that are integral to the mapping of ecosystem services.

The Millennium Ecosystem Assessment was initiated by the United Nations in 2001 as a first step towards addressing this gap. Its objective was to “assess the consequences of ecosystem change for human well-being and to establish the scientific basis for actions needed to enhance the conservation and sustainable use of ecosystems and their contributions to well-being” (4, p.ii). The focus was therefore on the linkages between ecosystems and human well-being and, in particular, on ecosystem services.

Core questions posed by the MEA to address this objective included: How have ecosystems and their services changed? What has caused these changes? How have these changes affected human well-being? How might ecosystems change in the future and what are the implications for human well-being? What options exist to enhance the conservation of ecosystems and their contribution to human well-being? (4)

In order to attempt to answer these questions, the assessment was conducted as a multi-scale exercise, with interlinked assessments undertaken at local, watershed, national, regional and global scales. Information was synthesized from the scientific literature and relevant peer-reviewed datasets and models (4).

5.3.2 Non-global, non-Australian examples

A number of studies have aimed to map various aspects of different ecosystem service. These studies appear to generally have occurred in the United States, perhaps because of the maturity of conservation and sustainable development policies and practices here relative to many other parts of the world.

A significant paper by Troy and Wilson (10) describes how ecosystem service flow values were estimated and mapped using a decision framework designed for spatially explicit value transfer. They used three case studies representing a diversity of spatial scales and locations in the USA. In each case, a unique typology of land cover and aquatic resources was developed and relevant economic valuation studies were queried in order to assign estimates of ecosystem service values to each category in the typology. GIS analysis was then used to map the spatial distribution of each cover class at each study site.

10: The authors present some of the practical challenges that accompany spatially explicit ecosystem service value transfer. They also discuss how variability in the site characteristics and data availability for each project limits the ability to generalize a single comprehensive methodology.

10: p438: ... the total ES value flow of a given cover type is calculated by adding up the individual ES values associated with that cover type and multiplying by area

10: The approach presented in this paper forms the foundation of the Natural Assets Information System™, a decision support system framework developed by Spatial Informatics Group, LLC (<http://www.sig-gis.com>). The framework, which builds upon the value transfer methodology, is implemented in three case studies and consists of five core steps: 1) spatial designation of the study extent; 2) establishment of a land cover2 typology whose classes predict significant differences in the flow and value of ecosystem services; 3) meta-analysis of peer-reviewed valuation literature to link per unit area coefficients to available cover types; 4) mapping land cover and associated ecosystem service flows; 5) calculation of total ESV and breakdown by cover class; 6) tabulation and summary of ESVs by relevant management geographies and; 7) scenario or historic change analysis. These steps are described generally in the

following paragraphs and in more detail in the Applications section below. Note that we limit our discussion here to the calculation of ecosystem service value flows. However, ecosystem service stocks may also be calculated through estimating the net present value of the future flow of ecosystem services.

10: p440: Once the typology was set, empirical valuation studies were analyzed and entered into the Natural Assets Information System™ system and standardized to 2001 dollar equivalents. This process yielded 42 viable peer-reviewed empirical studies and 65 valuation data points that were used in the final analysis. In the interests of space a complete bibliography of valuation studies is not given for any of the case studies here; rather, bibliographies are contained in each individual project report

Both simulation models and GIS were used to estimate the annual economic value of some ecosystem services provided by terrestrial ecosystems in a mountainous region of China (30).

In this case, ecosystem services were derived for different vegetation types – each vegetation type being considered to provide different functions which were separately analysed.

Naidoo and Ricketts (11) also assessed multiple ecosystem services based on vegetation, but this time not on specific vegetation types but on presence/absence of forested areas in the Atlantic forests of Paraguay. They extended their analysis beyond deriving value for each of five ecosystem services to determining also the opportunity costs of conservation and comparing the results. Although they found that non-availability of relevant data limited the comprehensiveness of the study, the whole exercise was of value in helping to understand the synergies and trade-offs between biodiversity conservation and economic development.

11: for a landscape in the Atlantic forests of Paraguay. We considered five ecosystem services (i.e., sustainable bushmeat harvest, sustainable timber harvest, bioprospecting for pharmaceutical products, existence value, and carbon storage in aboveground biomass) and compared them to estimates of the opportunity costs of conservation.

5.3.3 Australia

In Australia, State of the Environment reports are prepared by various shire and city councils as well as by most states and the Commonwealth. These reports present known information on various 'indicators' (eg. the Core Environmental Indicators as defined by ANZECC) which are surrogates of environmental condition. These reports usually fall short in addressing and mapping how these indicators relate to extent and condition of ecosystem services. As such, literature describing the mapping in Australia of ecosystem services as such is lacking.

A couple of exceptions include work undertaken as part of CSIRO's Ecosystem Services project, documented in reports by Freudenberger et al. These studies strove to understand and improve ecosystem function in the Murray Mallee and Wimmera

Bioregions, through practical application of market-based instruments. This included creation of a framework to describe the interactions amongst some of the more highly valued ecosystem services in the region and native vegetation types.

The value of non-terrestrial ecosystem services was assessed as part of Robinson's report: 'The Economic Value of Australia's Estuaries'. Here, economic value was derived for a number of estuarine dependent and estuarine opportunist commercial fisheries, a number of recreational fisheries and for a number of large ports located on estuaries around Australia. This was purely an economic valuation study, so these values were not mapped. Some of the input values however, would have relied upon mapped information, for example port locations and estuary extents. One of the findings of this project was the relative abundance of human capital information relative to natural capital information. This is a consistent finding in many studies assessing ecosystem services.

NLWRA, 2004, Australia: assessed data requirements and availability to address natural resource condition and trend indicators as defined in the National NRM Monitoring & Evaluation Framework

9: This report presents a set of indicators, referred to as the 'core' set, for reporting on the state of the environment across Commonwealth and State and Territory jurisdictions. The core indicators have been developed by the Australian and New Zealand Environment and Conservation Council (ANZECC)

9: Together with the more specific indicators currently in use by the various States, Territories and Local Governments, these core indicators will help to build a truly national picture of trends in the Australian environment.

9: p4: who reports on the SoE (national, state, etc)

9: it should be noted that at this stage, some important issues are not measured by core indicators because of data limitations, scientific uncertainty or a lack of robust measurement techniques. As a consequence, it is not yet possible to derive a complete picture of Australia's environment using the core environmental indicators alone. Hence it is expected that the core indicators will evolve further over time as these problems are overcome.

9: appendix 1: examples of recent SoE report in Aus

5.3.4 Queensland

The Queensland Environment Protection Agency's 4-yearly State of the Environment reports summarise and integrate available information on the condition of the environment in a form that is useful to decision makers, policy makers, planners and members of the broader community (2). They provide information on pressures affecting the environment and trends in its condition or quality, reporting at the level of Natural Resource Management Regions. The indicators selected are a combination of the ANZECC Core Environmental Indicators and the state-specific indicators reported

against in State of the Environment Queensland 1999. Data are not available for many of the indicators and this lack of data has been recognised as a major problem. although the identification of data gaps is useful.

(Statement clearly linking these SoE reports to ES mapping, work undertaken by the NRM bodies)

The NRM bodies have been instrumental in providing some of the information reported in the State of the Environment reports and some are also making advances in to the more detailed mapping and analysis of ecosystem services. The South East Queensland Ecosystem Services Project is an example. This project was established in response to Management Action Targets identified in the Integrated Natural Resource Management Plan for SEQ and Desired Regional Outcomes under the SEQ Regional Plan 2005-2026 (1). It was initiated to develop an agreed framework for defining and assessing the ecosystem services of South East Queensland. The process has involved the mapping of biomes and identification and mapping of ecosystem functions. Through this process, different ecosystem services and their distribution have been identified and prioritised. (1)

mapped biomes, EFs. To prioritise different areas on the basis of the ESs they generate, expert panel workshop held – produced weighted spatial representations of the provision of ESs

also workshop to value ESs depending on the benefits they provide (as per MEA framework recommendations)

1: the process for deriving weights (as opposed to the mathematical formulae used to calculate them) depends very much on institutional arrangements and consultative or participatory mechanisms involving relevant stakeholders. The first step is for all stakeholders to agree on the structure of the general framework and to ensure that all data, assumptions and value judgments in any application are completely transparent.

aim of the SEQ framework to be a decision support tool, not a decision-making tool

State of the environment reporting is a statutory requirement under both the Environmental Protection Act 1994 (the EP Act) and the Coastal Protection and Management Act 1995 (the Coastal Act). The EP Act requirement applies to Queensland's environment generally, while the Coastal Act requirement relates specifically to the coastal zone.

Qld SOE: uses OECS's PCR framework

5.3.5 Wet Tropics of Queensland

As Far North Queensland NRM, Terrain conducted the 'Catchments to Coast' pilot project in conjunction with NLWRA and BRS in 2006. This project was intended to support the State of the Regions Reporting. Project but did not progress beyond producing a Catchment Condition report card template, generic regional reporting

framework and listing of datasets. The dataset listing is quite valuable for the identification of what data does and does not exist in the Wet Tropics for environmental reporting and hence for ecosystem service mapping. Unfortunately, many gaps were identified.

SOR reporting build on the strategies and planning framework set out in the WT Regional Natural Resource Management Plan (2004/5)

WTMA publishes each year a combined Annual Report and State of the Wet Tropics Report. These reports highlight threats to the integrity of the Area and what is being done to improve the health of the area's ecosystems. In addition, every 6 yrs WTMA produces a Periodic Report for the WH Committee of UNESCO.

information on specific studies looking at ESs, eg:

29: using methodology that allows the comparison of uneven streams of costs and benefits, it is found that – at present prices – payments for sequestered carbon defray only a small proportion of costs, providing a level of incentive insufficient to stimulate restoration

29:the paper highlights the asymmetry between the availability of credits for carbon and of credits for biodiversity and the need for public investment in conservation and restoration. Requiring further investigation is the potential demand for carbon offsets with high biodiversity benefits – so called “boutique abatements” – that could readily be supplied in the Queensland Wet Tropics.

6. CHALLENGES TO MAPPING ECOSYSTEM SERVICES

6.1 Temporal dynamics

4: p88->: what is known about time scales, inertia, and the risk of nonlinear changes in ecosystems, resilience

5: p107->: other scale issues – temporal and spatial

19: baselines - Recognize that baseline projections beyond a 10-year period are not likely to be realistic—rates of land-use change are subject to many factors which are difficult to predict over the long term

6.2 Spatial dynamics

something here about reporting units that are used?

different processes working at different scales

different things happening at different places:

4: p11: It is difficult to assess the implications of ecosystem changes and to manage ecosystems effectively because many of the effects are slow to become apparent, because they may be expressed primarily at some distance from where the ecosystem was changed, and because the costs and benefits of changes often accrue to different sets of stakeholders.

5: p26: A full assessment of the interactions between people and ecosystems requires a multi-scale approach, as this better reflects the multi-scale nature of decision-making, allows the examination of driving forces from outside particular regions, and provides a means of examining the differential impact of ecosystem changes and policy responses on different regions and groups within regions.

5: p107->: other scale issues – temporal and spatial

6.3 Resilience and non-linearity of change

4: p88->: what is known about time scales, inertia, and the risk of nonlinear changes in ecosystems, resilience

28: Methods for assessing habitat sensitivity to human impacts are needed to gauge the sustainability of existing impacts, develop spatial management plans and support

meaningful environmental impact assessments. These methods should be quantitative, validated, repeatable and applicable at the scales of impact and management.

28: we have developed a method that meets the criteria for assessing the sensitivity of seabed habitats to physical disturbance, and delineating and mapping habitat sensitivity at large spatial scales (>105km²)

6.4 Data and model limitations

4: p23: Effective management of ecosystems is constrained both by the lack of knowledge and information about different aspects of ecosystems and by the failure to use adequately the information that does exist in support of management decisions.

4: p23: in most regions, for example, relatively limited information exists about the status and economic value of most ecosystem services, and their depletion is rarely tracked in national economic accounts. Basic global data on the extent and trend in different types of ecosystems and land use are surprisingly scarce. Models used to project future environmental and economic conditions have limited capability of incorporating ecological “feedbacks,” including nonlinear changes in ecosystems, as well as behavioral feedbacks such as learning that may take place through adaptive management of ecosystems.

6.4.1 Data availability

incl. geographic extent, temporal extent, resolution, taxonomy and economic sector

eg. for ref2

4 - relatively few ecosystem services have been the focus of research and monitoring and, as a consequence, research findings and data are often inadequate for a detailed global assessment. Moreover, the data and information that are available are generally related to either the characteristics of the ecological system or the characteristics of the social system, not to the all-important interactions between these systems.

4: p101->: data gaps etc. relating to condition and trends, scenarios, response options

5: p148-> analytical approaches within the MA: incl. data inputs (and deficiencies), use of models, scenario development, uncertainties

5: p154->: challenges in using data

5: p154: Perhaps the greatest challenge is that the MA aims to be a global and integrated assessment, yet the available and relevant data continue to be of uneven quality in terms of geographic and temporal extent as well as resolution, taxonomy, and economic sector.

5: p155: Unfortunately, from a geographical perspective, the completeness and reliability of data are often inversely related to the rate of ecosystem change and to levels of human welfare.

5: p157: data QA

30: because of the lack of ample data and efficient methods, we could not assess the economic value of every forest ecosystem service, such as air purification, noise dampening, protection of the ozone layer, etc.

36: Advances in technology and decreases in cost are making remote sensing (RS) and geographic information systems (GIS) practical and attractive for use in coastal resource management. They are also allowing researchers and managers to take a broader view of ecological patterns and processes. Landscape-level environmental indicators that can be detected by Landsat Thematic Mapper (TM) and other remote sensors are available to provide quantitative estimates of coastal and estuarine habitat conditions and trends. Such indicators include watershed land cover, riparian buffers, shoreline and wetland changes, among others. With the launch of Landsat 7, the cost of TM imagery has dropped by nearly a factor of 10, decreasing the cost of monitoring large coastal areas and estuaries. New satellites, carrying sensors with much finer spatial (1–5 m) and spectral (200 narrow bands) resolutions are being launched, providing a capability to more accurately detect changes in coastal habitat and wetland health. Advances in the application of GIS help incorporate ancillary data layers to improve the accuracy of satellite land-cover classification. When these techniques for generating, organizing, storing, and analyzing spatial information are combined with mathematical models, coastal planners and managers have a means for assessing the impacts of alternative management practices.

6.4.2 Scale issues

20: quantifying and monitoring the flows of ecosystem services is critical, yet the scale at which services can and should be reported is a matter of serious debate.

20: Ecosystem services are often provided locally or regionally

5: p107: There is seldom one, ideal scale at which to conduct an ecosystem assessment that will suit several purposes. The Millennium Ecosystem Assessment (MA) advocates a multiscale approach.

5: p107: Many environmental problems originate from the mismatch between the scale at which ecological processes occur and the scale at which decisions on them are made. Outcomes at a given scale are often critically influenced by interactions of ecological, socioeconomic, and political factors from other scales. Focusing solely on a single scale is likely to miss such interactions, which are critically important in understanding ecosystem determinants and their implications for human well-being.

5: p107: Assessments need to be conducted within a scale domain appropriate to the processes or phenomena being examined.

Those applicable to large areas generally use data at coarse resolutions, which may not detect fine-resolution processes. Even if data are collected at a fine level of detail, presentation of the findings at a larger scale means local patterns, anomalies, and the exceeding of thresholds disappear.

5: p107->: other scale issues – temporal and spatial

5: p173-> overarching issues, incl. matters of scale, review and validation procedures, analysis of uncertainty

11: our analysis emphasizes several issues that may arise when evaluating the economic value of ecosystem services in a spatially explicit manner: eg. identification of beneficiaries (scale), same service different vals to different people, limits of benefits transfer, non-incorporation of human behaviour models

6.4.3 Attribute adequacy

covered in 5.4.1?

6.5 Model limitations

Integration

4: the scientific and assessment tools and models available to undertake a cross-scale integrated assessment and to project future changes in ecosystem services are only now being developed.

5: p148-> analytical approaches within the MA: incl. data inputs (and deficiencies), use of models, scenario development, uncertainties

5: p162->: modeling issues: environmental models, human models, integrated models. ... For the most part, each genre of environmental models can be applied at various scales—local, regional, continental, and global. Their usefulness at various scales depends on their capability to capture input data and processes at a resolution that is consistent with processes at play at those scales.

10: p.436: the ability to integrate biophysical and ecosystem service valuation data is a relatively new phenomenon (Kreuter et al., 2001; Wilson and Troy, 2005).

Model assumptions and uncertainties?

5: p148-> analytical approaches within the MA: incl. data inputs (and deficiencies), use of models, scenario development, uncertainties

15: development of integrated ecological-economic models – can also allow assessment of different scenarios/tradeoffs

26: p203: In recognition of the transboundary nature of environmental pressures and impacts, better models of managing shared environments have emerged, such as regional seas

6.6 Units of analysis and reporting

5: p159: units of analysis and reporting. Because the MA is concerned fundamentally with ecosystems and their functioning, it is necessary to describe these ecosystems and their spatial extent in as consistent a way possible, reflecting the state of scientific understanding. At the most basic level, there are two fundamentally different ecosystem classifications: those based on actual ecosystem extent and those based on “original” or “potential” extent. In fact, comparing the two types of classifications, especially where they differ, can yield insights into the relative extent of conversion of original habitat types. Several issues must be considered.... (p160->)

5: p161->: relating ecological and human-centered units. An ecosystem's function and its ability to supply services to a particular human population are often best evaluated across its full extent, not only in the political unit in which that population lives.... Because ecological and political boundaries rarely overlap exactly, these translations among units are often difficult. For instance, it is hard to attribute human population densities collected on a national level to the country's ecosystems accurately.

6.7 Mapping one versus mapping many

20: National scale aggregate indicators of ecosystem services are useful for stimulating and supporting a broad public discussion about trends in the provision of these services. There are important considerations involved in producing an aggregate indicator, including whether the scientific and technological capacity exists, how to address varying perceptions of the societal importance of different services, and how to communicate information about these services to both decision makers and the general public.

10: issues with spatial disaggregation/aggregation of ESs – problems of scale of data

10: p438: ... the total ES value flow of a given cover type is calculated by adding up the individual ES values associated with that cover type and multiplying by area

15: Although the NAS report found that, to date, there has been good progress in establishing this “mapping” from ecological function to economic valuation for certain well-defined single ecosystem services of aquatic systems, valuing multiple ecosystem services typically greatly increases the difficulty of evaluation and, as a result, has yielded fewer successes.

20: The State of the Nation's Ecosystems report (The Heinz Center 2002) recognized the quantification of ecosystem services as essential to evaluating the condition of major US biomes.

However, measuring and aggregating the status of services other than food, fiber, water, and recreation proved to be a daunting task. The report acknowledged that reaching agreement on aggregating services such as nitrogen removal or plant pollination would be difficult and would require filling many gaps in our knowledge

20: parameterization of an aggregate indicator will probably necessitate a number of metrics, requiring difficult choices every step of the way. The terms used to create this indicator formula would ideally be value-free, but in reality they will reflect the values of those making the decisions

20: ecosystem services occur at various scales and are quantified by different metrics, making aggregation into a single equation dependent on creative and thoughtful scholarship (and unavoidable value judgments).. The “indicator equation” must have differential geographic weighting for different parts of the country.

24: although there has been some analysis of the provision of multiple ecosystem services simultaneously, these studies have generally been conducted at coarse spatial scales, not included space explicitly, or not accounted for variation in demand for services [31,38–47].

6.8 Which ecosystem services do we map?

5: p158: Global assessments of ecosystems and their services by definition involve the handling and evaluation of a huge number and variety of data and themes. It is clear that an assessment is only manageable if experts can focus on a limited number of representative indicators of ecosystems and their services. Because of the great weight these indicators hold, they must be carefully chosen.

6.9 Other issues

5: p173-> overarching issues, incl. matters of scale, review and validation procedures, analysis of uncertainty

7: p77: limitations of GIS mapping

9: it should be noted that at this stage, some important issues are not measured by core indicators because of data limitations, scientific uncertainty or a lack of robust measurement techniques. As a consequence, it is not yet possible to derive a complete picture of Australia's environment using the core environmental indicators alone. Hence it is expected that the core indicators will evolve further over time as these problems are overcome.

10: p437: issues of spatial context – recognized as of importance but functionally meaningful classifications of ecol. resources have yet to be developed for value transfer. Ecologists have developed such classifications for characterizing the ecological function of landscapes, but these characterizations may not always be

appropriate for economic applications. Our challenge is therefore to link economic valuation data to landscapes using typological characterizations that are functionally meaningful.

10: p444: While this paper offers a framework for the spatial analysis of ESVs, the case studies described above clearly illustrate how each application of the framework is subject to variability relating to limitations in the available spatial data and economic valuation studies, as well as differences between site characteristics, spatial and temporal scale, and management objectives.

10: the availability of empirical economic valuation studies is one of the most significant constraints to spatially explicit value transfer today.

10: p445: The availability of valuation data is further limited by the fact that only economic studies whose valuation coefficients were derived in a similar context to the policy site should be used for value transfer. Yet, defining contextual similarity itself can be challenging and, because of the limited number of studies available, must involve tradeoffs among specificity, reliability and applicability. This lack of comparability among studies, stemming from differences in the characteristics and context of the resources being valued, has been cited as a significant limitation in meta-analysis and value transfer

10: three critical factors must be considered when assessing comparability between the source data and policy context. First, one must consider the biogeophysical similarity of the policy site and the study site. Second, the human population characteristics of source data must be considered. Third, similarity in the level of scarcity of the service should be considered. Also, complicating factor is the availability of spatial data. These problems have led to gaps in landscape valuation. Such gaps can mislead users if the limitations are not made explicit.

11: although the biological aspects of consvn approaches have advanced rapidly, relatively little attention has been paid to the economic side of conservation planning (i.e., the science of systematically prioritizing conservation interventions), even though planning invariably involves both costs and benefits.

11: despite these advances, explicit analyses of economic costs and benefits have yet to become widely incorporated into conservation planning exercises. In part, this is because conservation planning is inherently spatial and thus presents special challenges for the quantification of both costs and benefits. For costs, spatially explicit data on land prices at the necessary resolution are lacking for many parts of the world, in which case they must be modeled [22,23]. For benefits, the biophysical delivery of ecosystem goods and services must first be spatially quantified, a difficult task in itself [24,25], and then these ecosystem services must be assigned an economic value in a spatially explicit manner. This requires knowledge of who the beneficiaries are, where they reside, how they perceive the value provided by an individual ecosystem service, and how the spatial pattern and scale of an ecosystem service affects the resulting economic values at the scale of interest

11: p2157; assumptions incl. True spatial modeling (i.e., that explicitly considers the effect of one parcel or patch on another; see [61] for spatial modeling of resource exploitation) for ecosystem service valuation was beyond this analysis because of limitations in our theoretical understanding of spatial interdependencies and a lack of relevant empirical data.

11: 2161: This result illustrates the inefficiency risks of using area as a proxy for cost in conservation planning [11]. Actual economic cost data, instead of area or other proxies like human population density [67] or aggregate measures of human conflict [68], can more directly inform land-use decisions, which almost always include financial considerations

11: 2162: For each of the services we investigated, we were forced to make simplifying assumptions due to lack of data on biophysical distribution, economic valuation, or both. ... This highlights a serious gap in our knowledge of environmental valuation and suggests that much original research will need to be done to value ecosystem goods and services in novel contexts.

11: our analysis emphasizes several issues that may arise when evaluating the economic value of ecosystem services in a spatially explicit manner: eg. identification of beneficiaries (scale), same service different vals to different people, limits of benefits transfer, non-incorporation of human behaviour models

economic issues, but valuation not focus here, but mapping

20: an ecosystem services indicator could not be all-inclusive; we would therefore need to make decisions about which services to include, how each should be weighted, and how to characterize the tradeoffs between services

38: info about the monetary value of the natural capital and the goods and services provided by estuaries is limited because they are not routinely marketed.

Future trends?

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37

Ecosystem services & biodiversity in the Wet Tropics

Mapping their distribution and change

Introduction

Project 1.2.1 within the Marine & Tropical Sciences Research Facility (MTSRF) is 'Status and trends of biodiversity and ecosystem services: state of the environment reporting and gap filling'. The aim of the project is to provide the knowledge, methods and results of accurate and up-to-date state of the environment reporting on the key biodiversity and ecosystem services assets of north Queensland. These will support future iterations of NRM planning and the management of the Wet Tropics World Heritage Area (WHA).

Study area

The study area incorporates the Wet Tropics WHA, Wet Tropics Bioregion and Wet Tropics terrain NRM region (Figure 1). The area supports a range of complex and diverse ecosystems and a large number of rare, endemic or iconic species. These natural assets provide a broad range of ecosystem services to the local community and society at large.

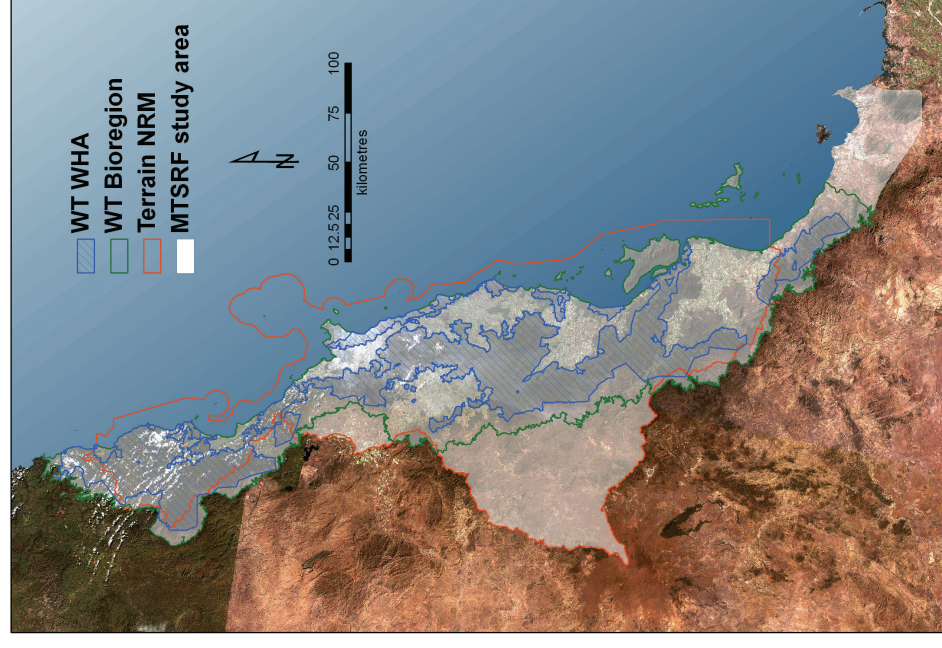


Figure 1: MTSRF project study area

What are ecosystem services?

Ecosystem services are the conditions and processes through which natural ecosystems, and the species that comprise them, sustain and fulfil human life. These services include pollination, maintenance of soil fertility and regulation of river flows. CSIRO and stakeholders have undertaken significant research into the region's socio-ecological system, including the identification of 29 ecosystem services and 45 ecosystem functions for the Wet Tropics

The project

Through workshops, expert opinion and data mining, this project has identified key ecosystem services provided by the area's assets, developed indicators for tracking their status and trends, presented results and will trial a reporting framework suitable for all partners. It will also create a synthesis of current knowledge and databases on key biological and environmental assets in the Wet Tropics.

Current work

The project is currently focusing on delivering a 'report card' for the biodiversity asset, using available data. This will combine the requirements of WTMA for reporting WHA condition and pressures, and Terrain NRM's review of the Wet Tropics Natural Resource Management Plan, including Resource Condition Targets and Management Action Targets.

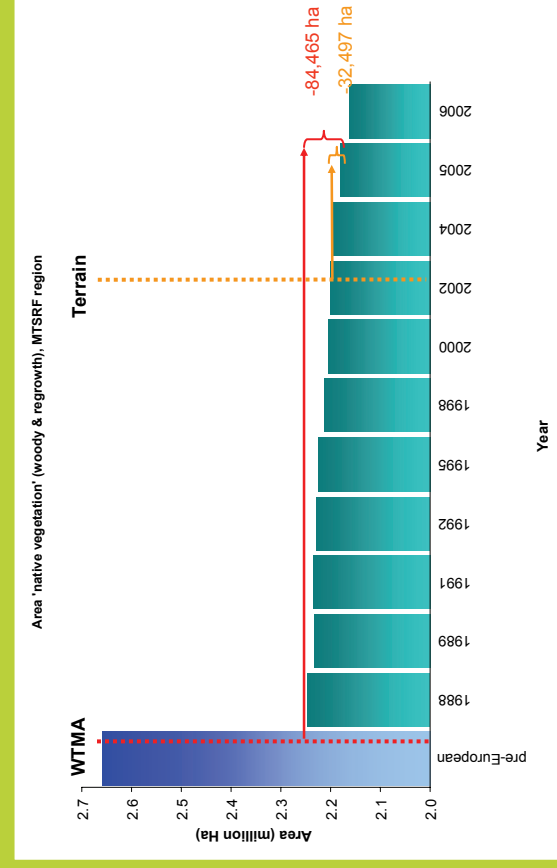


Figure 2: Changing area of 'native' vegetation extent relative to pre-European extent for entire study area, highlighting vegetation loss since 1988 and 2004.

Results

Outputs were produced in map and graphic form (Figures 2,3), for specific reporting areas and relative to 1988 and 2004 (WTMA's and Terrain's baseline years respectively). An accompanying report is currently being produced.

Future work

Mapping of biodiversity assets will be completed by June 2009 and then will move on to mapping the ecosystem services provided by biodiversity, water, soil and air/climate natural assets.

Example: mapping changed extent of 'native' vegetation

Method

Native vegetation extent is a key indicator of ecosystem health. We reviewed and compared existing relevant data layers (NVIS, REs, Stanton, SLATS FPC and landcover, QLUMP, NCAS forest and regrowth, Landsat, council/project revegetation). We selected the NCAS AGO forest extent and regrowth datasets for further analysis. ESRI ArcGIS and Microsoft Excel were used for dataset processing and statistics generation.

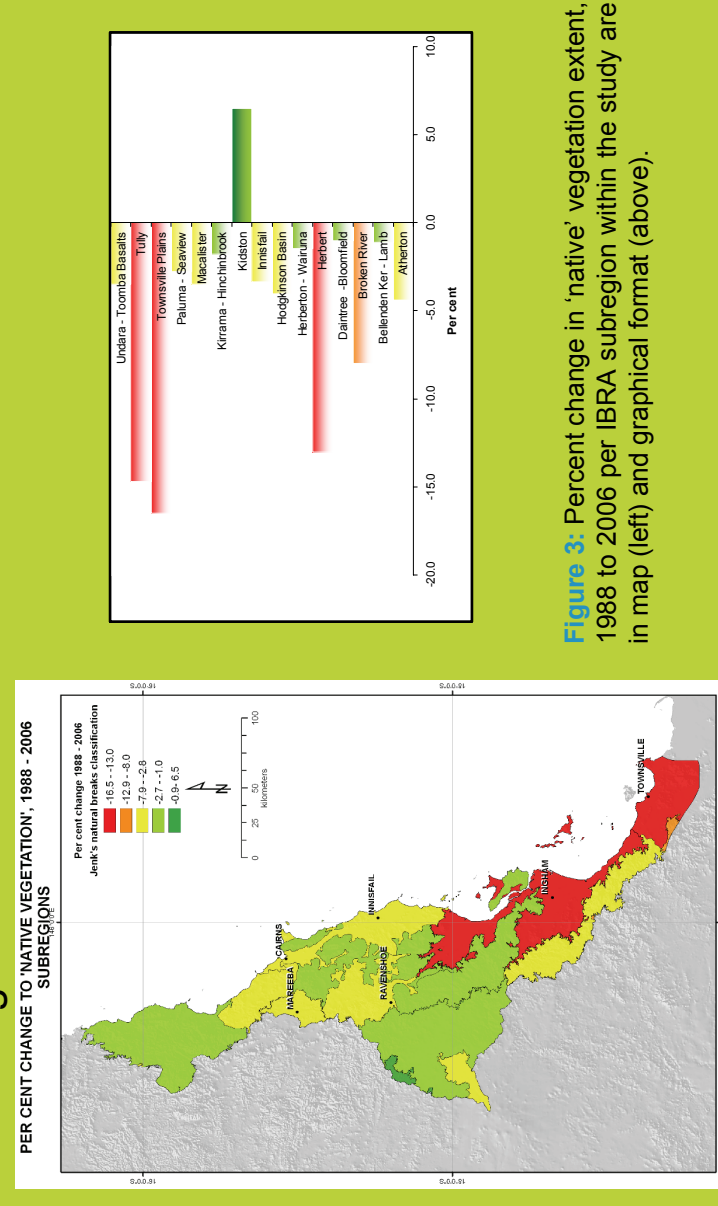


Figure 3: Percent change in 'native' vegetation extent, 1988 to 2006 per IBRA subregion within the study area in map (left) and graphical format (above).



Further information

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