the art & science of good

ENVIRONMENTAL DECISION-MAKING

2009

Fenner Conference on the Environment

Australian Academy of Science | LANDSCAPE LOGIC LINKING LAND AND WATER MANAGEMENT TO RESOURCE CONDITION TARGETS | αεδα Applied Environmental Decision Analysis

10–12 March 2009
The Shine Dome, Canberra

Australian Government
Department of the Environment, Water, Heritage and the Arts

AEDA and Landscape Logic are research hubs under the Commonwealth Environment Research Facilities scheme, administered by the Department of the Environment, Water, Heritage and the Arts.

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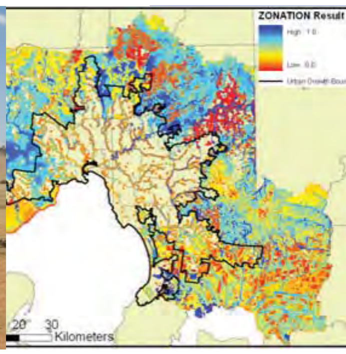
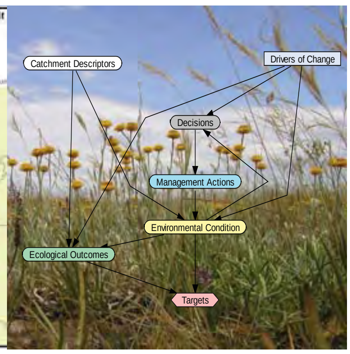
Speakers





WELCOME

Make the most of this moment

Welcome to the 2009 Fenner Conference on the Environment. The very fact that you've given up a couple of your precious days to attend this conference tells us you're interested in the art and science of decision-making. So, what can you expect from being part of this event?

For starters, you're going to hear some excellent presentations on prioritisation, adaptive management and cost-effective monitoring – the back bone of good decision-making.

You're also going to hear where we are doing these things well and where we need to do them better. You'll learn about some of the tools at our disposal to assist us in our decision-making, and there'll be a fair bit of discussion on the relevance and implication of all this for policy.

We had two aims in putting this conference together. First, to showcase work going on in AEDA (Applied Environmental Decision Analysis) and Landscape Logic, two research Hubs supported by the CERF (Commonwealth Environment Research Facilities) program. And second, to provide an opportunity for researchers, policy makers and managers to meet and network. The CERF program was set up to foster public good environmental research that will inform environmental policy and management. We want to use the opportunity of this conference to create more opportunities for dialogue between researchers and managers.

Fenner Conferences on the Environment are all about making the best science useful to environmental policy and management. The art and science of environmental decision-making lies at the heart of effective policy so our hopes are high that this particular Fenner Conference will improve engagement between researchers and environmental policy makers. For that to happen, we encourage you to be more than a passive listener.

We are pleased to have attracted a good mix of researchers, policy makers and environmental managers. Of the 240 delegates, 110 are from federal and state agencies, 88 are researchers and 42 from regional bodies, local government, NGOs and environmental consultancies. To make the most of this occasion we encourage you to consider the following stretch goal: If you're a scientist, identify a public servant or an NRM manager working in an area of some relevance to your research and introduce yourself to him or her. Attempt to engage them about your area and arrange for some form of follow up interaction and grow your decision-making network.

And if you're a policy maker or NRM officer, target one of the researchers and attempt to get that person to appreciate your policy or management requirements. And see if you can add this person to your list of information sources for future reference.

And let's not beat around the bush, time is short; Australia needs better decision-making at all levels of management and government. The challenge is enormous and growing, and our response, especially in the quality of our decision-making, leaves a lot to be desired (something that has been repeatedly pointed out by the national auditors).

Let's make this Fenner Conference one that we can all be proud of.

Hugh Possingham
Director
AEDA

Ted Lefroy
Director
Landscape Logic

Make the most of this Fenner Conference by networking. If you're a scientist, identify a public servant or an NRM manager working in an area of some relevance to your research; and if you're a policy-maker or NRM officer, target one of the researchers.

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Applied Environmental Decision Analysis

Smart science for wise decisions

The *Applied Environmental Decision Analysis* research hub (AEDA) was established in 2007 to develop and test ideas, tools and methods to support transparent decision-making for better environmental management. The ultimate aim is to assist managers and policy-makers to make better decisions.

Australia invests billions of dollars on restoring its landscapes, protecting its biodiversity and managing invading weeds and pests. Deciding how these investments will be made is a challenging task. Are resources being well spent? Are the decisions we make transparent and accountable (i.e., are they defendable)? Can we do better? Do we have the understanding for better decision-making in the face of enormous uncertainty? These are the questions that AEDA's research is attempting to help answer.

AEDA's researchers are based at the University of Queensland, the University of Melbourne, the Australian National University, RMIT and the University of Sydney.

The hub's activities focus on three areas:

Optimal monitoring

How much monitoring is enough to find out what we need to know to make good decisions and inform the public? Monitoring is critical for evaluating the ecological benefits of on-ground NRM.

Spatial prioritisation

AEDA is developing a range of tools that include uncertainty and dynamics explicitly in conservation plans and exploring how these tools might be applied in a range of situations.

Decision-making

AEDA is integrating recent developments in decision theory for dealing with severe uncertainty into adaptive management.

Join the AEDA network

The best way to keep up with AEDA's activities and research is subscribe to our free monthly magazine Decision Point. Each issue is packed with a fascinating potpourri of news, views and ideas on environmental decision-making, biodiversity, conservation planning and monitoring. You can subscribe to our email alert by visiting our news page at www.aeda.edu.au/news

DECISION POINT

Issue 25 / February 2009

Connecting conservation policy makers, researchers and practioners

Smart science for wise decisions

Measuring "true" conservation progress

You have to count what's lost as well as what's won!

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Premature eradication

When can you claim victory - p6

Bioregional planning down south

Whales, krill and conservation - p9

GLink meets decision theory

Get a GRIPP on what's important - p10

DECISION POINT

Decision Point is a monthly magazine presenting news, views and ideas on environmental decision making, biodiversity, conservation planning and monitoring. It is produced by AEDA - the Applied Environmental Decision Analysis CERF Hub. For more info on AEDA, visit our website at www.aeda.edu.au or see the back cover.

Other stories

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For more information on AEDA, its researchers, activities, information sheets or monthly magazine, please visit our website at:

www.aeda.edu.au/

LANDSCAPE LOGIC

LINKING LAND AND WATER MANAGEMENT TO RESOURCE CONDITION TARGETS

Landscape Logic is a research hub under the Commonwealth Environment Research Facilities scheme, managed by the Department of the Environment, Water, Heritage and the Arts. It is a partnership between six regional organisations, five research institutions and six state land management agencies in Tasmania and Victoria.

Our aim is to improve the quality of information available to environmental managers with responsibility for investing public funds in water quality and vegetation condition. We also aim to contribute to adaptive learning so we all have a chance to learn what works, what doesn't, and why.

Our approach is to focus on causal links between land use, land management and environmental change through historical studies of private and public investment into water quality and native vegetation condition.

Our researchers are based at CSIRO and ANU in Canberra, Charles Sturt University at Albury, RMIT University and the Department of Sustainability and Environment in Melbourne, and the University of Tasmania, Department of Primary Industry and Water and Forestry Tasmania in Hobart.

Our audience is environmental managers and policy-makers who make decisions about where, when and how to invest to achieve the best overall environmental outcomes.

Our regional partners are Goulburn Broken, North Central and North East CMAs in Victoria and the three regions in Tasmania (North, Cradle Coast and South NRM regions).

Our research approach is to use historical data, social research, contemporary data collection and modelling to establish causal links between human intervention and environmental outcomes. We have set up landscape-scale experiments to distinguish between private investment, public investment and other drivers that are shaping the condition of our waterways and native vegetation (such as climate, changed fire and grazing regimes, commodity price movements and land tenure change).

Join the Landscape Logic network

The best way to keep up with Landscape Logic's activities and research is subscribe to our free quarterly newsletter. To subscribe send an email to liam.gash@utas.edu.au

LANDSCAPE LOGIC

December 2008 Newsletter • www.landscapelogic.org.au

Contents

Green roads out of trouble

Environmental management in Australia is not short of problems. We've become so used to criticism of the way funds are allocated, failure to use the best available evidence and the inability to keep track of where we've been that we tend to miss signs of progress.

Prof Ted Lefroy, Director, Landscape Logic

For more information on Landscape Logic, its researchers, activities, publications and quarterly magazine, please visit our website at:

www.landscapelogic.org.au/

VENUE

Welcome to the Dome

The venue for the conference is the Shine Dome in Canberra. When it came to deciding on a meeting place to discuss the science of decision-making it seemed the natural choice. Built in the 1950s as a meeting place for the Australian Academy of Science, the Shine Dome is Australia's holy shrine to science. Looking like a cross between a flying saucer and an atomic fallout shelter, its copper-lined roof arcs down to a series of solid arches rooted in a duck-filled moat. You enter the dome by crossing a little concrete bridge to discover that its otherworld exterior is neatly matched by a wood-lined and cavernous interior. There's a gravity and solemnity that pervades the space within the Dome, a place for serious reflection and the sharing of big ideas.

More info: www.science.org.au/dome/index.htm

Fenner Conferences on the Environment

The Fenner Conference on the Environment is held every year in conjunction with the Australian Academy of Science. The 2009 conference will be jointly hosted by two of the CERF (Commonwealth Environment Research Facilities program) research hubs, AEDA and Landscape Logic. The conference series is named after one of Australia's science icons, Prof Frank Fenner. In addition to providing seed funding for the conference series, Frank Fenner has been a long-standing champion of science for sustainability and sound policy.

The Shine Dome

The Dome is the first building in Canberra to be included on the National Heritage List and has been nominated to the World Register of Significant Twentieth Century Architecture.

Completed in 1959, the concrete roof of the dome is sheathed in copper. Under the copper is a layer of vermiculite which partly insulates the interior from outside temperatures. This provides a degree of thermal inertia and the temperature of the dome's underside is roughly an average of the outdoor temperature of the previous 24 hours.

The dome is self-supporting and none of the internal walls actually hold up the roof. As might be expected with a novel design, once the roof was up several unexpected problems were discovered. In the centre of the dome is a conference room for 150 people – and the big concrete umbrella did some strange things to sound. It took a great deal of work by acoustic engineers to get the sound right. The solution was to use a complex series of acoustic baffles to control the sound. Some were suspended from the ceiling and others built as part of long wooden panels on the walls.

But just when they thought they'd got it right, a whole new and totally unexpected problem emerged. The elegant eucalyptus sound baffles gracing the walls did something very odd to the audience. By creating a form of optical interference, they made about half of the people in the conference room feel ill. It took quite a while to find a solution to this one, but finally one of the Fellows, Dr Victor McFarlane, who worked at the John Curtin School of Medicine at the ANU, came up with the idea of filling in the visually offending gaps with strings. This fixed the optical problem without spoiling the acoustics.

GENERAL INFORMATION

Venue
The Shine Dome is located in Gordon Street, Canberra.

Registration
On Tuesday 10 March there will be a registration desk located in the foyer of The Shine Dome in Gordon Street Canberra. Delegates will be welcomed by the registration desk team led by Luba Richards and issued with their Conference program book. The registration desk will be available on the following dates and times:

Tuesday 10 March from 3.30pm – 6pm

Wednesday 11 March from 8am – 5.30pm

Thursday 12 March from 8am – 5pm

Notice board
Located near the registration desk.

Mobile telephones
Out of respect for our presenters please ensure that your mobile communications device is switched off or switched to vibrate during conference sessions.

Wireless connect
There is a wireless service in The Shine Dome for those with laptops equipped with wireless communications.

Parking arrangements
The forecourt area of the Shine Dome is set-down and pick-up only. There is no parking in the grounds of The Shine Dome, the nearest pay parking spaces are between McCoy CCT and Gordon Street. The nearest large parking station is S&B Parking Services 113–119 Marcus Clarke St Canberra, ACT 2601 (02) 6262 5474.

The welcome function
Dress code: Neat casual

The *Welcome to the Fenner Conference* cocktail party is being held at The Shine Dome in the Jaeger Room on 10 March. Enter via the foyer and turn right past the registration desk. The Welcome commences at 6.30pm and continues until 8pm. Drinks and finger food will be served. Those who advised us of their special dietary needs will be catered for. Entry tickets will be collected at the entry to the Jaeger room.

The Conference Dinner
Dress code: Smart casual

We are stepping back in time to the ambience of *Old Parliament House, Members Dining Room*. It is said that when the room is very quiet you can hear the whispers of past government and opposition ministers!

A special three course menu has been selected accompanied by beers and wines from their extensive cellar. Those who advised us of their special dietary needs will be catered for. Entry tickets will be collected at the door please be sure to bring your ticket with you.

Table seating: Conference staff will advise you at the door of the seating plan for the dinner.

Transport to the conference dinner: Murrays Coaches have been appointed to mainly transport interstate and overseas delegates safely and comfortably to the conference dinner and afterwards back to their hotels. We request that local ACT delegates use their own transport or car pool with others.

Buses will leave from in front of The Shine Dome (Gordon St) by the following time table:

From The Shine Dome to Old Parliament house, 6.30pm and 6.45pm

From the dinner back to hotels and The Shine Dome, first bus leaves at 10.00pm, 2nd bus at 10.30pm and the final coaches at 11.00pm.

Daily conference catering
Arrival tea and coffee will be served on conference days March 11and 12.

Morning and afternoon tea and lunch will be served in the Jaeger Room each day and a variety of herbal teas will be included. Delegates are required to wear their conference badge to qualify for food service.

Seating capacity for parallel sessions rooms
There will be a sign on the door of each room with the presenters name and the number of people who can be legally seated in the room. If the room is full please proceed to an alternative session.

Smoking policy
By legislation smoking is banned in public buildings, hotels and bars.

Transfer to the airport after the conference (02) 6299 3722
You can organise your airport shuttle with Air Liner at the front desk of your hotel. The cost is minimal and the service is reliable. Local knowledge indicates that finding taxis late afternoon is difficult therefore we suggest you opt for the shuttle service.

Taxi services
Canberra Cabs can be reached on 13100

Hotels contact details
Breakfree Capitol Tower,
2 Marcus Clarke Street Canberra.
Phone (02) 6247 0759.

Rydges Lakeside, London Circuit
Canberra. Phone (02) 6247 6244.

The Diamant Boutique Hotel,
15 Edinburgh Avenue Canberra,
2601. Phone (02) 6175 222.

Hotel at ANU, Cnr Balmain and
Liversidge Streets, Acton 2601.
Phone (02) 6125 5211.

Disclaimer of liability
The host body and organising committee, their agents and their servants act as only organisers of the activities and do not accept any responsibility for an act, accidents or omissions on the part of service providers. The event organisers accept no responsibility for the accuracy or content of any statements whether written or orally made by speakers in connection with this event, delay, damage, loss of property, personal injury or death. The event organisers reserve the right to amend any part of the program without notice. Such amendments may include substitution or cancellation of speakers or tours.

Medical or dental emergency
To speak immediately with a registered nurse 24 hours a day, 7 days a week, phone Health Direct on 1800 022 222 or (02) 6207 7777.

Police and Ambulance 000

Handy websites
www.conferenceplus.com.au/fennerconf/2009
www.visitcanberra.com.au

PROGRAM

TUESDAY 10 MARCH

6.30–8.00pm	**WELCOME FUNCTION AT THE SHINE DOME** – drinks and finger food

DAY 1 – WEDNESDAY 11 MARCH – ENVIRONMENTAL DECISION-MAKING

8.30–9.00am	**OPENING ADDRESS – Greg Bourne, CEO Worldwide Fund for Nature Australia, and Chair CERF Reference Panel**	

1 Environmental decision-making
CHAIR: Deborah Peterson, Department of Primary Industry, Victoria

9.00–9.30am	**DOING POLICY-RELEVANT SCIENCE**	*Marc Mangel, University of California (Santa Cruz)*
9.30–9.45am	Evidence, values and trade-offs in environmental decision-making	*Charlie Zammit, DEWHA*
9.45–10.00am	How critical is science in designing environmental policy?	*John Whittington, DPIW Tasmania*
10.00–10.15am	Conservation planning in the urban fringe: dealing with multiple actors and multiple uncertainties	*Sarah Bekessy, RMIT (AEDA)*
10.15–10.30am	Understanding implementation of conservation practices by rural landholders	*Allan Curtis, CSU (LL)*
10.30–10.40am	Questions	

MORNING TEA 10.40 TO 11.10AM

2 The art and science of prioritisation
CHAIR: Damien Wells, North Central CMA, Victoria

11.10–11.40am	**THE MIS-MEASURE OF CONSERVATION: HOW DO WE FIND OUT HOW MUCH DIFFERENCE WE MAKE?**	*Bob Pressey, JCU (AEDA)*
11.40–11.55am	INFFER-ing cost-effective environmental outcomes	*Anna Roberts, DPI*
11.55am–12.10pm	Conservation planning in complex real-world environments	*Ascelin Gordon, RMIT (AEDA)*
12.10–12.25pm	Prioritising ecological restoration	*Kerrie Wilson, UQ/TNC (AEDA)*
12.25–12.40pm	Five objections to prioritisation: Idiotic reasons not to use decision theory	*Hugh Possingham, UQ (AEDA)*
12.40–12.50pm	Questions	

LUNCH 12.50 TO 1.50PM

3 *Adaptive management*
CHAIR: Alex Rankin, Department of Environment, Water, Heritage and the Arts

1.50–2.20pm	**A.M. IN THE REAL WORLD: LESSONS FROM A 25-YEAR ODYSSEY**	*David Lindenmayer ANU (AEDA)*
2.20–2.35pm	Keeping the Auditor-General happy: Demonstrating return on Caring For Our Country	*Brendan Wintle, UMelb (AEDA)*
2.35–2.50pm	Is poor quality the new high priority for biodiversity conservation?	*Phil Gibbons, ANU (AEDA)*
2.50–3.05pm	When to stop learning and start doing: Invasive species control with limited knowledge	*Peter Baxter, UQ (AEDA)*
3.05–3.20pm	Is it really worth learning about the benefits of management?	*Mick McCarthy, UMelb (AEDA)*
3.20–3.30pm	Questions	

AFTERNOON TEA 3.30 TO 4.00PM

4	Parallel discussion sessions	
4.00–4.50pm	Science and policy	*Charlie Zammit and John Whittington*
	Environmental decision analysis	*Marc Mangel and Allan Curtis*
	Spatial prioritisation	*Bob Pressey and Sarah Bekessy*
	Adaptive management	*David Lindenmayer & Mick McCarthy*
	Prioritising investment decisions	*Hugh Possingham and Anna Ridley*
5.00–5.30pm	**ACCOUNTING FOR NATURE**	*Peter Cosier, Wentworth Group*
7 for 7.30pm	**CONFERENCE DINNER** – Old Parliment House Members Dining Room	

DAY 2 – THURSDAY 12 MARCH – MONITORING DESIGN, TOOLS AND TECHNIQUES

5	Monitoring design for biodiversity conservation CHAIR: Kimberley Dripps, Department of Sustainability and Environment, Victoria	
8.30–9.00am	**MONITORING FOR CONSERVATION: WHY, WHAT, HOW?**	*Jim Nichols, US Geological Survey*
9.00–9.15am	A change may be as good as a holiday for biodiversity management	*Eve McDonald-Madden, UQ (AEDA)*
9.15–9.30am	Search and destroy: Cost-effective surveillance for pest management	*Cindy Hauser, UMelb (AEDA)*
9.30–9.45am	Monitoring for biodiversity: making the right connections	*Tony Norton, UTAS (LL)*
9.45–10.00am	What's worked to improve extent and condition of native vegetation on private land	*Dave Duncan, DSE (LL)*
10.00–10.10am	Questions	

MORNING TEA 10.10 TO 10.40AM

6	Monitoring design for soil and water quality CHAIR: Anna Roberts, Department of Primary Industry, Victoria	
10.40–11.10am	**MONITORING CATCHMENTS TO MANAGE WATER QUALITY**	*Hamish Cresswell, CSIRO (LL)*
11.10–11.25am	Modelling nutrient loads in Tasmanian rivers across space and time	*Shane Broad, UTAS (LL)*
11.25–11.40am	Land-use and nutrients as drivers of change in Tasmanian river ecosystems: correlations and mechanisms	*Peter Davies, UTAS (LL)*
11.40am–11.55pm	The cost-effectiveness of management interventions for water quality improvements at catchment scale	*Lachlan Newham, ANU (LL)*
11.55am–12.10pm	Major estuarine types in Tasmania: implications for management strategies	*John Gibson, UTAS (LL)*
12.10–12.20pm	Questions	

LUNCH 12.20 TO 1.20PM

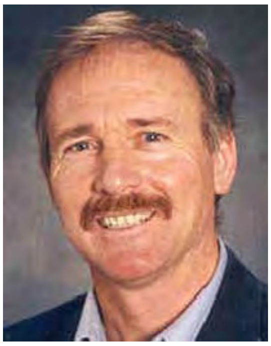
7	Tools and techniques for environmental decision-making CHAIR: Malcolm Thompson, Department of Environment, Water, Heritage and the Arts	
1.20–1.50pm	**INTEGRATED ASSESSMENT OF OPTIONS FOR IMPROVING RESOURCE CONDITION**	*Tony Jakeman, ANU (LL)*
1.50–2.05pm	Integration tools for decision-making	*Carmel Pollino, ANU (LL)*
2.05–2.20pm	Applying systems thinking to natural resource management	*Carl Smith, UQ (AEDA)*
2.20–2.35pm	Tools and techniques for environmental decision-making: Remote sensing of landscape level biodiversity	*Simon Jones, RMIT (LL)*
2.35–2.50pm	Research to adoption – Addressing the challenges	*Greg Pinkard, UTAS (LL)*
2.50–3.05pm	Tools for bio-security risk analysis	*Mark Burgman, UMelb (AEDA)*

AFTERNOON TEA 3.05 TO 3.35PM

8	Conference wrap-up	
3.35–4.00pm	Policy-maker summary	*Charlie Zammit and Peter Cochrane*
4.00–4.20pm	Wrap-up	*Ted Lefroy and Hugh Possingham*

KEYNOTE SPEAKERS

Dr Hamish Cresswell
Principal Research Scientist, CSIRO Land and Water
"High quality data sets enable conceptualisation of catchment behaviour and subsequent targeting of NRM investment in locations where environmental outcomes are likely to be maximised."



Prof Tony Jakeman
Director, Integrated Catchment Assessment and Management, ANU
"From a global perspective, assessing and managing catchments as integrated entities is, and will increasingly be, a key instrument for sustaining our economic, social, cultural and environmental assets."

Prof Ted Lefroy
Director, Landscape Logic
"Research in natural resource management is plagued by scale, time lags, a confusion of natural and human influences and an absence of good quality data collected at meaningful scales and intervals. Is it any wonder our decision-making is currently more art than science?"

Prof David Lindenmayer
Fenner School of Environment and Society, ANU
"If biodiversity was a business, the auditors would be calling for the board's resignation. It's a situation that simply wouldn't be tolerated in our corporate sector. Billions of dollars are spent managing Australia's biodiversity and we have little to no idea on how effective this investment has been."

Prof Marc Mangel
University of California
"There are many ways of knowing, but science is a special way of knowing in which the process is more permanent than the knowledge it produces and the essence of sound policy is knowing what science can and cannot tell us and using that information appropriately while acting under fundamental uncertainty"

Prof Jim Nichols
US Geological Survey
"The key to efficient conservation monitoring is to consider exactly how resulting data are to be used to make conservation decisions, and to then design the program accordingly. Monitoring is not a stand-alone activity but inherits its utility from the larger program (science or conservation) of which it is a component."

Prof Hugh Possingham
Director, AEDA
"The time to bite the bullet and embark on a serious and credible long-term monitoring program is clearly now. In the past we have monitored too many things poorly for too short a time. This needs a serious, whole-of-government effort that has institutional stability and a clear objective."

Prof Bob Pressey
James Cook University
"Measures of the effectiveness of conservation areas based on extent, percentages of regions, or representativeness should be recognised for what they are: simplistic and misleading. Real measures of the effectiveness of conservation areas are based on avoided loss and are essential if Australia is to achieve its stated goals for nature conservation."

SPEAKER

Dr Peter Baxter

p.baxter@uq.edu.au

University of Melbourne

Day 1, 2.50pm

Area of work: Conservation biology, population ecology

Area of specialty: I combine mathematical tools with ecological theory to ask how best we can manage plant or animal populations to achieve conservation objectives, whether that involves increasing threatened populations, or controlling pest populations.

When to stop learning and start doing: invasive species control with limited knowledge

The trade-off between learning and actively managing is particularly striking when applied to invasive species. Although our future control of an invasion may be greatly enhanced by studying the invasion dynamics, taking the time to do so may allow the invasion to get beyond control.

One way of improving control success is to more precisely identify locations where the invasive species is likely to occur. We focus here on the ability to predict pest occurrence in a region, and how the overall search effort should be distributed among likely occurrence sites. Presented with a limited budget, our search strategy could be to search quickly in many possibly-occupied sites, or to search fewer sites more thoroughly. In either case our search success will also depend on the reliability of our original predictions of site occupancy, and therefore a further strategy is to improve these predictions in future by diverting money from management to research. We use mathematical tools to discover which are the optimal strategies for given regional pest densities, levels of knowledge, and management time-frames.

Our results indicate that when our predictive capacity is poor, and we demand quick results, we should forego learning altogether and employ broad-scale quick searching. However, this is unlikely to be a good long-term strategy. Optimal long-term management tends to invest heavily in research at the outset, even allowing the invasion to spread initially, but thereby increasing the success of later management efforts. If our predictions of the occurrence of the species are already reasonably accurate, and the invasion is not yet widespread, we should target the most likely sites intensively. If the invasion has become widespread, we should reduce the search effort per site in order to target as many sites as possible. The decision on when to switch from learning to active management depends on the specific management objectives and the improvement in management success likely from further research: often we may already know enough to manage effectively.

Take-home messages:

1. Successful management requires some degree of knowledge
2. Knowledge gain, like management, costs money
3. By quantifying current and potential future levels of knowledge, and their knock-on benefits to management, we can better guide the allocation of resources between research and management
4. We may already know enough to stop learning and just manage.

Relevant publications

Baxter PWJ, McCarthy MA, Possingham HP, Menkhorst PW and McLean N (2006). Accounting for management costs in sensitivity analyses of matrix population models. *Conservation Biology*, 20, 893-905.

Regan TJ, McCarthy MA, Baxter PWJ, Panetta DF and Possingham HP (2006). Optimal eradication: when to stop looking for an invasive plant. *Ecology Letters*, 9, 759-766.

McDonald-Madden E, Baxter PWJ and Possingham HP (2008). Subpopulation triage: How to allocate conservation effort among populations. *Conservation Biology*, 22, 656-665.

Baxter PWJ, Sabo JL, Wilcox C, McCarthy MA and Possingham HP (2008). Cost-effective suppression and eradication of invasive predators. *Conservation Biology*, 22, 89-98.

Conservation planning in the urban fringe: dealing with multiple actors and multiple uncertainties

Accelerating urbanisation in Australia is considered one of the greatest threats to biodiversity, with over 50% of threatened species occurring in urban fringe areas. Despite the introduction of planning legislation and frameworks to preserve biodiversity, many Australian cities are facing a looming extinction crisis; short-term economic gains consistently out-compete biodiversity concerns on a localised case-by-case basis.

While the maintenance of biodiversity within and adjacent to urban areas brings numerous societal benefits, it involves complicated trade-offs between competing land uses including transport, housing, industrial development and agricultural production. Conservation strategies are constrained by the complexities of multiple stakeholders with different motives undertaking numerous actions in the face of severe uncertainty. Biodiversity planners in the urban fringe often lack ecological tools to develop optimal strategies given these real-world constraints, and as a result, there is often little ecological input into the urban planning process.

Our research group has been developing scientific tools to assist in the urban planning process to achieve better outcomes for biodiversity. Key outcomes of the project include protocols for surveying grasslands while accounting for detectability, tools to optimise growth area planning based on ecological modelling and mathematical optimisation, and simulation models to explore key sensitivities in habitat offsetting policies.

Relevant publications

Bekessy SA, Wintle BA, Lindenmayer DB, McCarthy MA, Colyvan M, and Possingham HP (in press) The biodiversity bank cannot be a lending bank. *Ecological Economics*.

Bekessy SA, Gordon A (2007) Nurturing Nature in the City. In: *Steering Sustainability in an Urbanising World: Policy, Practice and Performance* (Ed. Nelson A), Ashgate, Hampshire, pp. 227-238.

Bekessy SA, White M, Moilanen A, McCarthy M, Buxton M, Wintle BA (in press) Transparent conservation planning in the urban fringe. *Landscape and Urban Planning*.

Garrard GE, Bekessy, SA and Wintle, BA (2008) A new method for determining the survey effort necessary to detect plants during flora surveys, *Austral Ecology*. 33: 986-998.

Gordon A, Simondson D, White M, Moilanen A, Bekessy SA. (in press) Conservation Planning for Threatened Species on the Urban Fringe of Melbourne. *Landscape and Urban Planning*

Dr Sarah Bekessy

sarah.bekessy@rmit.edu.au

RMIT

Day 1, 10.00am

Area of work: Conservation science; Institutional change for sustainability

Area of specialty: Urban ecology, biodiversity planning in complex landscapes, population modelling, evaluation of market-based instruments for environmental management, education for sustainability.

Take-home messages:

- Rapidly increasing urbanisation rates pose one of the greatest threats to the substantial biodiversity values of the urban fringe and create an urgent need to improve conservation planning practices in those areas.
- We are developing tools for managers to develop optimal spatial strategies given the need to simultaneously prioritize multiple conservation actions by multiple actors and reconcile complicated trade-offs.
- We have developed protocols for dealing with imperfect detectability in threatened species surveys that will improve growth area planning.
- Habitat offsetting is rapidly becoming the most popular mechanism for managing urban fringe landscapes. The way that scientific information is incorporated into these mechanisms is crucial to their success or failure and key assumptions of some schemes are undermining their ultimate benefit for biodiversity.

SPEAKER

Dr Shane Broad
Shane.Broad@utas.edu.au
Tasmanian Institute for Agricultural Research/CSIRO Sustainable Ecosystems

Day 2, 11.10am

Area of work: Land-use and water quality

Specialty: Catchment modeling and farming systems analysis to establish links between land use/land management change and nutrient movement in agricultural catchments.

Take-home messages:

1. Generic data on nutrient generation rates for different land-uses was found to poorly reflect local conditions in northern Tasmania
2. Locally relevant relationships between land-use and end-of-catchment nutrient loads and concentrations have been generated using water-quality data and land-use mapping for 34 Tasmanian catchments.
3. The resultant land-use models are being used to test the likely effects of changes in land use and land management on water quality.
4. The aim is to provide evidence-based information for catchment managers on the range of practices most likely to improve water quality, and hence the ability to determine the type, scale and location of interventions required for particular catchments.

Modelling nutrient loads in Tasmanian rivers across space and time

Landscape Logic's 'Land Use and Land Management Retrospective' project is modeling the effects of land-use and land-management on water quality in eleven Tasmanian catchments to assist future environmental management decisions. To do this, the project is using terrain analysis software, GIS, aerial photography and various modelling tools, including the catchment models E2 and CMSS. However, determining appropriate model parameters for nutrient generation by different land uses proved to be problematic as published values, where available, are based on a wide range of experimental studies from diverse locations under varying conditions. As a result, they often poorly reflect local conditions.

To solve this problem, all available historical Tasmanian water quality data from 34 catchments, along with corresponding river flow records and up to date land-use information were used to develop Bayesian statistical models of relationships between 17 land-use categories and total annual end-of-catchment nutrient loads and concentrations. This process resulted in locally calibrated nutrient generation rates and response curves for use in subsequent modeling of the eleven catchments of interest.

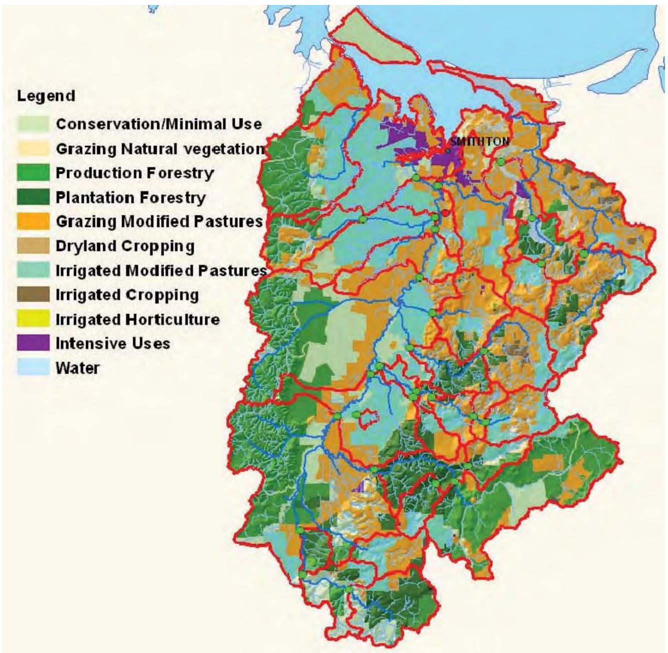
Preliminary results at the catchment scale indicate that the "improved pastures", "irrigated pastures" and "cropping" are the land uses that have the most influence on end-of-catchment nutrient loads. More detailed modeling of the Duck catchment using the E2 platform and nutrient concentration curves has provided further insights into the possible influence of land-management decisions on nutrient loads. Future work will use the models to test the likely impact of a range of land-management interventions including riparian interventions on water quality. These models will also provide input data to other Landscape Logic projects seeking to establish links between land-use and existing measures of riverine and estuarine health.

This project is due to be completed by June 2010 and will be of interest to catchment managers and policy-makers as the approach used here has wider application in:

1) establishing links between land-use, land-management and water quality,

2) identifying effective interventions and

3) identifying incentives to the adoption of beneficial practices and modifications to detrimental management practices.



Land-use and sub-catchments, Duck River, northern Tasmania.

Tools for biosecurity risk analysis

Biosecurity risk relies on a mixture of sparse relevant scientific information, experience and expert judgement about pests, pathogens and diseases. The analyses assess the likelihood of entry, establishment and spread and the consequences of invasion, should it occur. This presentation outlines some developments in formal risk analysis that may enhance both qualitative and quantitative pest risk assessments. These tools may improve the reliability of expert judgements about parameters and biological processes, and provide a structured framework for reasoning and cross-examining alternative ideas and judgements.

Relevant publications

Burgman MA (2005) *Risks and decisions for conservation and environmental management*. Cambridge University Press.

Carey J and Burgman M (2008) Linguistic uncertainty in qualitative risk analysis and how to minimise it. *Annals of the New York Academy of Sciences* 1128, 13-17.

Franklin J, Sisson SA, Burgman MA and Martin JA (2008) Evaluating extreme risks in invasion ecology: learning from banking compliance. *Diversity and Distributions* 14, 581-591.

Burgman MA, Keith DA, Hopper SD, Widyatmoko D and Drill C (2007). Threat syndromes and conservation of the Australian flora. *Biological Conservation* 134, 73-82.

Professor Mark Burgman

markab@unimelb.edu.au

University of Melbourne

Day 2, 2.50pm

Area of work: Qualitative and quantitative methods for assessing biosecurity risk.

Area of specialty: I work with the Australian Centre of Excellence for Risk Analysis to assist Government to improve risk analysis methods, tools and techniques. Our primary focus is biosecurity risk, and topics include qualitative and quantitative risk analysis methods, and the sociology and psychology of risk perception and decision-making.

Take-home messages:

1. Expert judgements are a necessary part of biosecurity risk analysis because irreducible uncertainty is pervasive
2. Better understanding of uncertainties and biases in expert judgements will improve the reliability of routine risk analyses
3. Methods for improved performance of experts and for using judgements in formal risk analysis are being developed and tested.

KEYNOTE SPEAKER

Dr Hamish Cresswell
hamish.cresswell@csiro.au
CSIRO

Day 2, 10.40am

Area of work: Land-use impacts on soil and water quality

Specialty: Soil physics; agricultural land-use options with multiple objectives.

Take-home messages:

- There are new high temporal resolution water-quality monitoring technologies (minutes to hourly frequency) that can give new insight into catchment function.
- Monitoring needs to be complemented with other 'layers of evidence' to understand catchment function and provide a basis for targeted NRM investment.
- The Landscape Logic CERF project seeks to help identify forms of monitoring with high information content for understanding catchment function and then prioritising investment in managing water quality.

Monitoring catchments to manage water quality

NRM (natural resource management) actions need to be targeted in the right places. To adequately target water quality investment we need to understand 'how catchments work' with respect to sediment and nutrient delivery into rivers. The impacts of NRM actions also need to be able to be assessed.

Government seeks to determine the extent to which interventions (e.g. metres of fence line installed or hectares of riparian zones or wetlands) contribute to outcomes (e.g. improved river health). To address these needs, the Landscape Logic Project 'Catchment Sediment and Nutrient Dynamics' is developing and evaluating new methods to identify likely critical source areas for nutrients and sediments, and building spatial conceptual models of nutrient movement through the landscape and into rivers.

The project advances the role of monitoring through evaluating new high temporal frequency (five minutes to hourly) water quality measurement. High temporal frequency data will yield detailed patterns of stream nutrient dynamics, information that might give revolutionary new insights into how catchments work. This new information might well change the way we view (and subsequently model) catchment processes.

The project asks: What can high frequency monitoring offer? How should monitoring be designed (spatially and temporally) to capture the key processes? What types of monitoring provide the highest information content? High frequency catchment nutrient monitoring has not previously been evaluated in Australia. This research will enable determination of the minimum level of temporal sampling intensity that would be required to adequately monitor catchment processes. This is significant in the design of monitoring programs.

The high frequency water-quality monitoring is complemented by a spatial assessment of critical source areas that disaggregates catchments into landscape units that relate to dominant hydro-chemical process dynamics. Other spatial information is obtained by longitudinal sampling (along the length of the river and its tributaries) and targeted spatial modelling. Information about the origin of nutrients is explored using isotope analyses.

Together these multiple 'layers of evidence' aim to capture how a catchment functions: e.g. Which nutrients contribute to water quality problems? What is their origin? Where are their critical source areas? Along what hydrological pathways were the materials transported to the waterways? The research is being conducted in Tasmania and includes delivery of guidelines for development of simple spatial models of catchment function to support the design of water-quality monitoring for use by regions and government agencies.

Relevant publications

Cresswell HP (editor) (2004). *Heartlands* – Planning for Sustainable Land Use and Catchment Health. *Heartlands* Technical report, Publication HL9-04, CSIRO.

Hill P, Cresswell HP and Hubbard L (2006) Spatial prioritisation of NRM investment in the West Hume area (Murray CMA region). Technical Report, CSIRO Water for a Healthy Country National Research Flagship, Canberra. <www.clw.csiro.au/publications/science/2006/wfhc-MurrayCMAWestHume.pdf>.

Wang E, Cresswell HP, Paydar Z, and Gallant J. (2008). Impact of land use and climate variability on plant water use, surface water flow and deep drainage on a topographic sequence. *Hydrological Processess* 22 (no. 6), 736-749.

Cresswell HP, Ringrose-Voase AJ and Western AW (2008). Hydrology. In NJ McKenzie (Ed) *Guidelines for Surveying Soil and Land Resources*. Australian Soil and Land Survey Handbook Series, Vol. 6, pp 93-114. CSIRO, Australia."

Understanding implementation of conservation practices by rural landholders

The presentation draws on a large body of theory and substantial empirical research in Australia where the author has explored the implementation of sustainable farming and biodiversity conservation practices by rural landholders. This research includes an important synthesis paper (Pannell *et al*) that provides a robust theoretical framework for those wanting to explore this topic. There are papers and technical reports describing research in specific contexts. Specific studies have included river frontages in the Goulburn Broken (2002 and 2007), riparian land in Tasmania (2008–09 as part of Landscape Logic) and a series of regional-scale studies for NRM organisations in Queensland, NSW and Victoria (2001–2008). This research provides valuable insights into the scale of landholder implementation of conservation practice; the relative influence of government programs on landholders; the contributions of specific interventions; and some of the constraints to implementation. The presentation will also highlight the influence of trends to high levels of rural property turnover and to non-farming landholders.

Participants at a 'Rapid Appraisal' workshop held in Chiltern, north-east Victoria, in November 2008, discuss the drivers that have shaped native vegetation change in their local area from 1946–2004 with Landscape Logic researchers Digby Race and David Duncan.

Relevant publications

Curtis A, Race D, Sample R and McDonald S (2008) *Management of water ways and adjoining land in the Mid-Goulburn River: landholder and other stakeholder actions and perspectives*. A report to the Goulburn Broken Catchment Management. Institute for Land, Water and Society, Report #40, Charles Sturt University, Albury, NSW.

Curtis A, McDonald S, Sample R and Mendham E (2008) *Understanding the social drivers for natural resource management in the Wimmera region*. Institute for Land, Water and Society, Charles Sturt University, Albury, NSW.

Pannell DJ, Marshall GR, Barr N, Curtis A, Vanclay F and Wilkinson R (2006) Understanding and promoting adoption of conservation technologies by rural landholders. *Australasian Journal of Experimental Agriculture*. 46 (11): 1407–1424.

Curtis A, Byron I and MacKay J (2005) Integrating socio-economic and biophysical data to underpin collaborative watershed management. *Journal of the American Water Resources Association*, 41 (3):549–563.

Curtis A and Robertson A (2003) Understanding landholder management of river frontages: the Goulburn Broken. *Ecological Management and Restoration* 4(1):45–54.

Prof Allan Curtis

acurtis@csu.edu

Charles Sturt University

Day 1, 10.15am

Area of work: Social research for regional natural resource management.

Specialty: The role of local organisations in watershed management, the adoption of conservation behaviours by rural landholders and the evaluation of natural resource management programs.

Take-home messages:

Social research can make a valuable contribution to the design and implementation of successful environmental management programs. In particular, well designed social research can help us understand:

- The extent to which landholders have implemented conservation practices
- Their motivations for doing so, including the relative influence of government programs amongst other influences
- The land managers view of which interventions have been most effective in the past and why
- How demographic change is affecting what we have traditionally regarded as agricultural landscapes.

SPEAKER

Prof Peter Davies

p.e.davies@utas.edu.au
University of Tasmania (Hobart)

Day 2, 11.25am

Take-home messages:

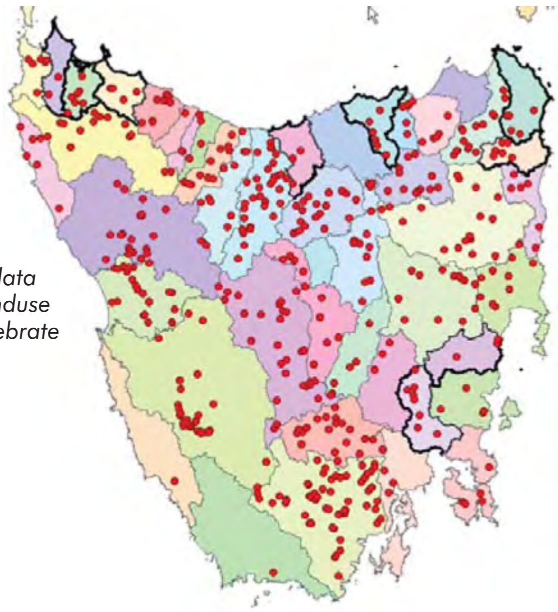
- Analysis of data from 780 stream sites in Tasmania as part of a national biomonitoring program revealed a strong correlation between the absence of sensitive macroinvertebrates and the area of catchments under grazing.
- This relationship was:
  a) stronger at whole-of-catchment than local scale;
  b) maintained across Tasmania's 4 hydrological regions;
  c) still valid when redundancy analysis removed the confounding effects of natural variables affecting macroinvertebrate distribution.
  d) characterised by a major threshold at 42% of catchment under grazing land-use.
- Subsequent intensive field sampling of 35 sites in northern Tasmania is identifying the mechanism(s) underlying links between land-use, nutrient loads, riparian condition, and stream algal and macroinvertebrate responses (e.g. the relative dominance of changes in stream habitat conditions and food resources as driven by physical and/or nutrient changes).

Land-use and nutrients as drivers of change in Tasmanian river ecosystems: correlations and mechanisms

Peter Davies[1], Steve Read[2], Regina Magierowski[1,2], Nelli Horrigan[1,2]

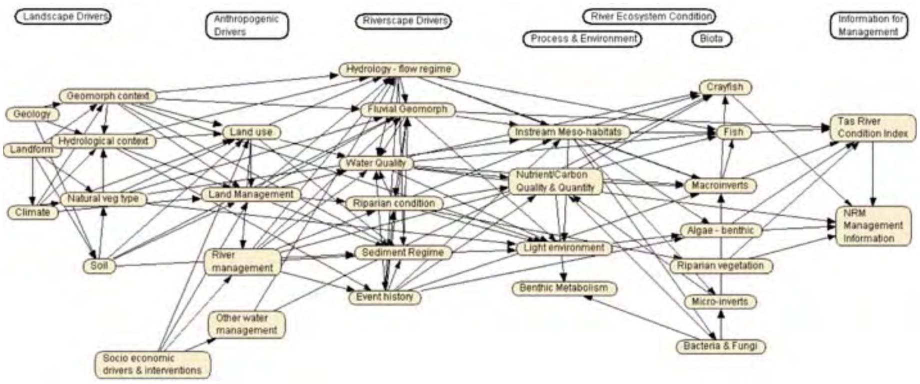
[1] School of Zoology, University of Tasmania. [2] Forestry Tasmania.

One of the challenges of analysing the 'experiment' imposed on the landscape by historical human development is distinguishing correlation and mechanism. Most survey-based field studies suffer from multiple confounding effects coupled with unknown historical contingencies. Correlative studies that relate river ecosystem responses to land use and intermediate drivers such as water quality can attempt to control for these confounding gradients by a hierarchical approach to data analysis, using residuals from which the influence of underlying natural gradients have been partially removed. On the other hand, formal field-based gradient studies can focus on collecting data that provides multiple lines of evidence for mechanistic links between drivers and responses. When combined, these approaches provide powerful insights which can aid management decisions. We explore these issues and approaches with illustrations from data-mining and field gradient studies being conducted in Tasmanian catchments across several gradients of land-use intensity.



Sites included in the data mining analysis of landuse – stream macroinvertebrate relationships.

Initial conceptual model of links between land use and stream responses.



What's worked to improve extent and condition of native vegetation on private land?

Dr David H Duncan

david.duncan@dse.vic.gov.au

Department of Sustainability and Environment (Vic)

Day 2, 9.45am

Area of work: Plant ecology

Specialty: My interest is in the functional integrity of remnant native habitat.

Our team is working to understand how NRM investments on private land have contributed to landscape change in native vegetation condition in northern Victoria. Three study areas were chosen, based on vegetation type, degree of fragmentation, mixed land-use and good local and institutional knowledge of NRM investment history on private land [Muckleford (North Central CMA), Violet Town–Longwood (Goulburn Broken CMA) and Chiltern–Springhurst (North East CMA). Native vegetation plays a vital role in the landscape, supporting biodiversity conservation, ecosystem services and ecological functions. There is considerable uncertainty around the effectiveness of management interventions designed to improve native vegetation condition (extent and quality), particularly at the landscape scale. The management of native vegetation in Victoria is undertaken by public and private land managers with support from regional Natural Resource Management (NRM) teams, comprising Catchment Management Authorities (CMAs), non-government organisations and state agencies. The NRM teams allocate funding to carry out on-ground works including revegetation, vegetation protection and enhancement.

These bodies are eager for new understandings, models and tools to help them learn about the effectiveness of their work, and make better decisions. This project aims to identify the relative impacts of targeted interventions for native vegetation condition (extent and quality). However, the effectiveness of interventions must be considered in the context of native vegetation change resulting from other drivers such as historical and contemporary land-use and land-management change. Through biophysical and social research techniques this project is providing new knowledge and improving assumptions about the responsiveness of native vegetation condition to targeted interventions.

This is being used to develop models and tools that can assist partner CMAs (and other stakeholders) in understanding, managing and reporting likely change in native vegetation condition.

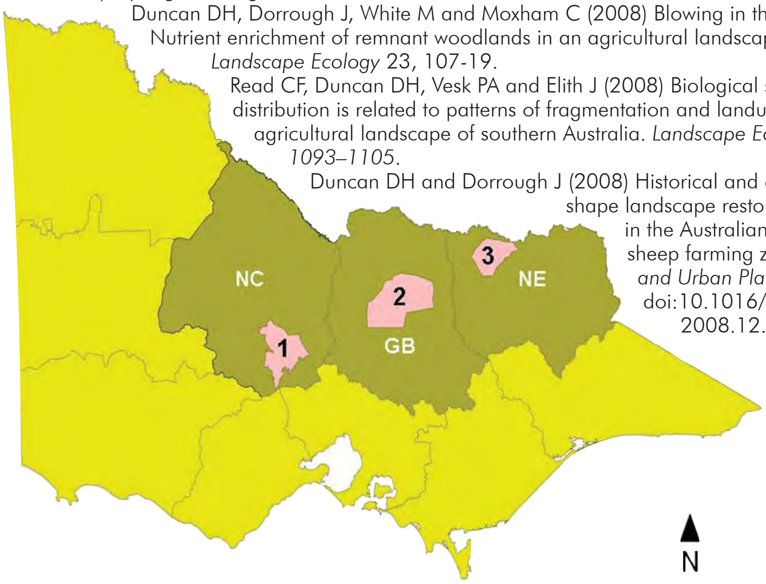
Relevant publications

Duncan DH and Wintle BA (2008) Towards adaptive management of native vegetation in regional landscapes. In *Landscape Analysis and Visualisation. Spatial Models for Natural Resource Management and Planning* (Eds. C Pettit, W Cartwright, I Bishop, K Lowell, D Pullar and D Duncan). Springer, Verlag GmbH, Berlin.

Duncan DH, Dorrough J, White M and Moxham C (2008) Blowing in the wind? Nutrient enrichment of remnant woodlands in an agricultural landscape. *Landscape Ecology* 23, 107-19.

Read CF, Duncan DH, Vesk PA and Elith J (2008) Biological soil crust distribution is related to patterns of fragmentation and landuse in a dryland agricultural landscape of southern Australia. *Landscape Ecology 23, 1093–1105.*

Duncan DH and Dorrough J (2008) Historical and current land use shape landscape restoration options in the Australian wheat and sheep farming zone. *Landscape and Urban Planning,* doi:10.1016/j.landurbplan.2008.12.007.



Our focus case study areas in Northern Victoria:
1) Muckleford (North Central CMA)
2) Violet Town–Longwood (Goulburn-Broken CMA) and
3) Chiltern–Springhurst (North East CMA).
These areas were chosen for their location in fragmented landscapes, with mixed land-use, and good knowledge of NRM investment on private land.

Take-home messages:

1. Systematically identifying areas of change and no change from historical aerial photography can provide an experimental framework within which to examine cause and effect relationships in vegetation change.
2. Rapid appraisal workshops with landholders and other local experts have been very effective in identifying and dating vegetation change, canvassing likely cause for further scrutiny and have been enthusiastically received by participants.

SPEAKER

Dr Phil Gibbons
philip.gibbons@anu.edu.au
Australian National University

Day 1, 2.35pm

Area of work: Applied ecology.

Area of specialty: Decision support systems for natural resource management; rapid biodiversity assessment; environmental monitoring.

Take-home messages:

- Public investment in native vegetation conservation should focus on where greatest improvement – relative to the status quo – is likely.
- We should adapt our priorities in native vegetation conservation to a greater emphasis on cost-effectiveness, changes in the duty of care by private landholders towards native vegetation brought about by new legislation and current science.
- Greatest gains in native vegetation conservation are now likely to be made by investing in small patches of poor quality native vegetation in fragmented landscapes.

Is poor quality the new high priority for biodiversity conservation? Adapting our priorities to changes in politics, legislation and science

Many NRM metrics identify the highest quality native vegetation remnants as priorities for investment. If our objective is to purchase improvement in biodiversity—relative to what would occur if we weren't to invest—then we argue that our priorities should generally shift to poorer quality native vegetation within small patches and fragmented landscapes. Heresy you say? I draw from my experience developing a metric for the Australian Government's Environmental Stewardship Programme to outline three arguments in support of this position:

1. *Politics*. It seems inconsistent that on the one hand governments have embraced market-like principles (e.g. competition) to make public money go further in NRM, but are not necessarily developing metrics that identify where we get greatest bang for this buck.
2. *Legislation*. Stronger native vegetation laws in some states have increased the duty-of-care by private landholders towards intact native vegetation. We should not undermine this progress by using public money to pay for native vegetation management below this duty-of-care.
3. *Science*. Research indicates that small patches and scattered trees make a significant contribution to biodiversity conservation and that small remnants on private land are on a steep trajectory of decline relative to large remnants on private land or native vegetation on public land tenures.

Relevant publications

Gibbons P, Briggs SV, Ayers DA, Seddon JA, Doyle SJ, Cosier P, McElhinny C, Pelly V, Roberts K, (2009). An operational method to assess impacts of land clearing on terrestrial biodiversity. *Ecological Indicators*, 9: 26-40.

Gibbons P, Lindenmayer D, Fischer J, Manning A, Weinberg A, Seddon J, Ryan P, Barrett G, (2008). The future of scattered trees in agricultural landscapes. *Conservation Biology*, 22: 1309-1319.

Gibbons P and Ryan P (2008) *A conservation value index for box gum grassy woodland*. A report to the Department of the Environment, Water, Heritage and the Arts. The Fenner School of Environment and Society, unpublished.

Major estuarine types in Tasmania: implications for management strategies

Estuaries are highly productive but complex systems with significant ecological and economic value. They receive freshwater and associated organic and inorganic matter including nutrients from in-flowing rivers, as well as saltwater and nutrients from the ocean and run-off, often including waste waters from towns and industries, from the direct estuarine catchment. The health of an estuary depends largely on the flushing time of freshwater through it. Flushing time is determined by a combination of estuary hydrodynamics, tidal range and the rate of freshwater input. Using data from past and current surveys of estuarine health around Tasmania, we are examining the effects of land-based activities such as increased nutrient input (eutrophication) and sediment loads on estuarine condition. Our indicators are a subset of the recently developed national indicator set and include pressure, system and value (ecological). We've divided Tasmanian estuaries into three categories: estuaries with high flushing rates due to high rainfall and tidal ranges (on the north coast); estuaries with long residence times (low flushing) on the drier east coast; and estuaries that are intermittently closed by sand bars. We have developed conceptual models of the effects of nutrient and sediment loads on these estuary types and assessed the sensitivity of a series of response variables, including water quality, phytoplankton, zooplankton and benthic invertebrate community structure, at a range of temporal scales (days to decades, through studies of sediment cores) and spatial scales (metres to kilometres). This study will provide the first detailed framework that can be used by estuarine and other environmental managers to interpret environmental data from Tasmanian estuaries. As a result of this study managers will be able to understand why particular estuaries are more sensitive to terrestrial inputs than others. For example, east coast Tasmanian estuaries that are intermittently closed (i.e. there is irregular connection to the marine environment) are far more susceptible to the negative consequences of eutrophication such as algal blooms, low dissolved oxygen concentration and fish kills than the tidally-dominated, well-flushed systems of the north coast. From data collected in the study we are setting baseline conditions and developing preliminary trigger values and threshold levels for indicators in both types of estuaries. Furthermore, the project will provide predictive information about the likely effects of proposed land-use changes on water quality and the ecology of Tasmanian estuaries.

Dr John Gibson

John.Gibson@utas.edu.au

Tasmanian Aquaculture and Fisheries Institute, University of Tasmania

Day 2, 11.55pm

Area of work: Water quality

Specialty: Environmental chemistry, nutrient dynamics and carbon cycling.

Take-home messages:

- Understanding the sensitivities and tolerances of estuaries requires knowledge of the flushing rate, which is dependent on hydrodynamics, freshwater inflow and tidal exchange; the magnitude of external inputs from the drainage basin and the ocean; and role of internal processes such as sedimentation and photosynthesis.
- With this information we have classified Tasmanian estuaries into three groups based on sensitivity to landscape practices and are developing monitoring and management strategies for each.

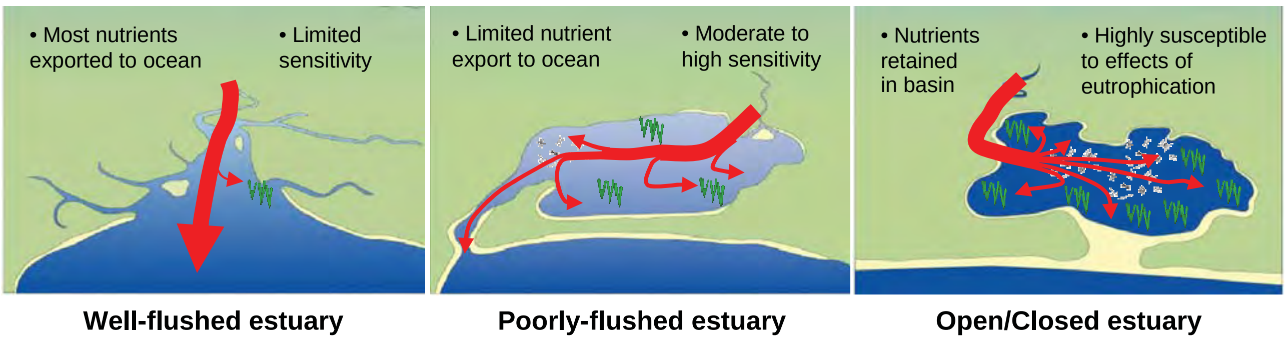
Relevant publications

Beard J, Crawford C and Hirst A (2008) *Developing a monitoring program for six key estuaries in north-west Tasmania*. <http://eprints.utas.edu.au/8223/>.

Hirst AJ, Kilpatrick R, Guest MA, Probst T and Crawford CM (2007) Determining the ecological health of estuaries in NW Tasmania: A case study assessing the status of the Duck, Montagu, Detention and Black River estuaries. <http://eprints.utas.edu.au/5847/>.

Murphy RJ, Crawford CM and Barmuta LA (2003) Estuarine health in Tasmania, status and *indicators: water quality.* <http://eprints.utas.edu.au/6649/>.

Temby N and Crawford CM (2008) *A framework for coastal and estuarine resource condition assessment: Sharing resources and knowledge for better management.* <http://eprints.utas.edu.au/8222/>.



Dr Ascelin Gordon
ascelin.gordon@rmit.edu.au
RMIT

Day 1, 11.55am

Area of work: ecological modelling and decision-making in the face of uncertainty

Area of specialty: Dealing with uncertainties in conservation planning data; setting priorities for conservation investment using ecological and economic theory; ecological populating modelling; risk and decision-making for conservation.

Take-home messages:

- It can be difficult to understand the impacts of real-world complications encountered in undertaking conservation prioritisation methods.
- These difficulties should be acknowledged, and dealt with to the extent we are currently capable.
- There is a need for tools to be developed to make the exploration of these issues more tractable to the users of conservation planning methods.

Conservation planning in complex real-world environments

Land-use change from human activities makes conservation areas crucial for the persistence of many species. This is particularly prevalent in rapidly urbanising areas around cities that often contain significant biodiversity values. Due to limited resources, investments in conservation must be strategically allocated, motivating the development and use of prioritisation methods. Resource allocation for conservation activities can encompass prioritising spatial locations (for creating or enhancing a conservation area network), through to the more difficult problem of prioritising multiple actions at multiple locations.

To deal with this challenge there has been a proliferation of prioritisation methods for systematic conservation planning. While these methods have the potential to improve resource allocations for conservation, their use in academic studies greatly outweighs their use in implementing on-ground conservation projects. This presentation will discuss some of the issues and challenges that arise in applying conservation prioritisation methods to complex real world problems. These issues include:

- significant uncertainties in the input data, budgets and availability of some locations used in prioritisations;
- the difficulty of predicting and quantifying the consequences of a given set of actions, making it hard to choose between competing prioritisation methods or solutions;
- the fact that implementing conservation actions often needs to done sequentially over time rather than all at once;
- there can be temporal changes biological values (changes in habitat condition, populations not in equilibrium) as well as uncertainties associated with ongoing anthropogenic land-use change;
- there is a trade off between allocating resources based on prioritisations with current data and using resources to improve data before prioritising.

These issues will be discussed with examples given from conservation planning projects we have been involved with in the urban fringe of Melbourne. We will also present approaches for dealing with some of these issues based on recent theoretical work undertaken at RMIT University.

Relevant publications

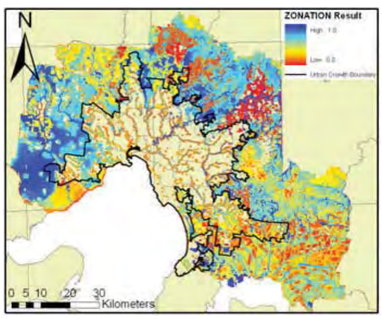
Langford WT, Gordon A, Bastin L. (in review) When do conservation planning methods deliver? Quantifying the consequences of uncertainty. *Ecological Informatics* (copy available from Ascelin Gordon).

Gordon A, Simondson D, White M, Moilanen A, Bekessy SA. (in press) Conservation Planning for Threatened Species on the Urban Fringe of Melbourne. *Landscape and Urban Planning*, doi: 10.1016/j.landurbplan.2008.12.011.

Turner WR, Wilcove DS. (2006) Adaptive Decision Rules for the Acquisition of Nature Reserves. *Conservation Biology*, 20:527-537.

Rondinini C, Wilson KA, Boitani L, Grantham H, Possingham HP. (2006) Tradeoffs of different types of species occurrence data for use in systematic conservation planning. *Ecology Letters*, 9:1136-1145.

Meir E, Andelman S, Possingham HP. (2004) Does conservation planning matter in a dynamic and uncertain world? *Ecology Letters*, 7:615-622.



Map of spatial priorities for threatened fauna habitat around Melbourne. This map was generated using the Zonation conservation planning tool, using habit maps for 30 threatened fauna species. Blue areas have the highest priority for threatened species and red the lowest.

Search and destroy: Cost-effective surveillance for pest management

My most recent study determines where and how much we should invest in surveillance to detect a pest or disease. Other researchers have developed habitat suitability maps to identify hot-spots and prioritise resources, but I've also incorporated variable detection rates and a cost-benefit analysis to create a cost-effective design. It can tell us whether we're better off searching many sites quickly, or a few high-risk sites thoroughly. Not only can we calculate how much surveillance expenditure is justified and how to prioritise sites under a limited surveillance budget, we can also assess the value of developing a habitat suitability map compared to relying on current knowledge.

This method is sufficiently flexible for use in a range of terrestrial and marine environments, where natural features and/or economically valuable species are threatened by invasive species. I've applied it to the surveillance and treatment of orange hawkweed (*Hieracium aurantiacum*) in alpine Victoria, Australia, where I was able to calculate optimal visit lengths for over 4000 x 4ha sites in a spreadsheet *(see figure below)*.

Relevant publications

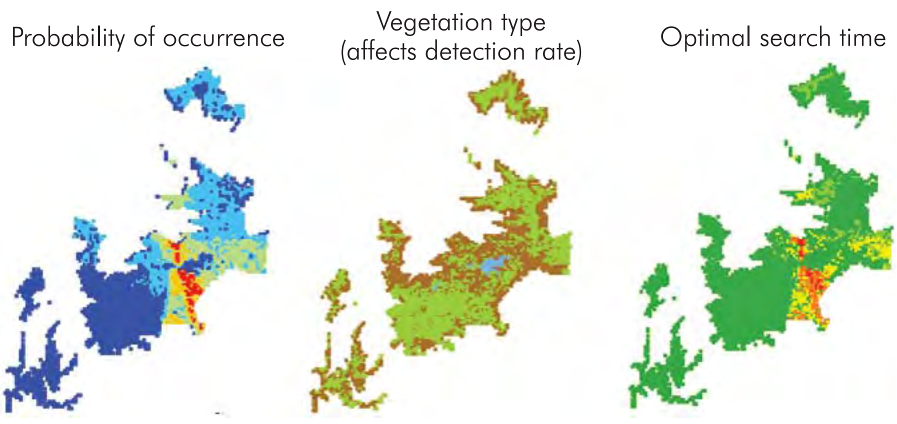
Rout TM, Hauser CE and Possingham HP. In press. Optimal adaptive management for the translocation of a threatened species. Ecological Applications.

Moore AL, Hauser CE and McCarthy MA (2008) How we value the future affects our desire to learn. Ecological Applications 18(4): 1061–1069.

Hauser CE and Possingham HP (2008) Experimental or precautionary? Adaptive management over a range of time horizons. Journal of Applied Ecology 45: 72–81.

Hauser CE, Pople AR and Possingham HP (2006) Should managed populations be monitored every year? Ecological Applications 16(2): 807–819.

Orange hawkweed surveillance on the Bogong High Plains, Victoria



Dr Cindy Hauser

chauser@unimelb.edu.au

University of Melbourne

Day 2, 9.15m

Area of work: ecological modelling and decision-making in the face of uncertainty

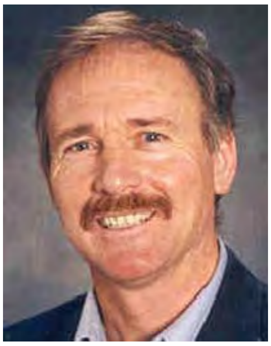
Specialty: I aim to develop rational, repeatable and transparent approaches to environmental management that account for uncertainty, incomplete knowledge and scarce data. I'm particularly interested in optimal monitoring (applying cost-benefit analysis to investment in monitoring), adaptive management (strategic management for gaining knowledge and data) and robustness (ensuring acceptable outcomes in the face of uncertainty).

Take-home messages:

To prioritise surveillance for pests and diseases, we should consider:

- where the pest is most likely to be,
- where we'll be able to find it quickly (and where it conceals itself), and
- the value of early detection in protecting assets and natural features.

KEYNOTE SPEAKER



Prof Tony Jakeman

tony.jakeman@anu.edu.au

Australian National University

Day 2, 1.20pm

Area of work: Environmental modelling

Specialty: Integrated assessment and modelling of water resources issues

Take-home messages:

1. Natural resource management is characterized by wicked problems (high levels of uncertainty, conflicting values and interests, no right answers).
2. Integrated Assessment (IA) is a response to these challenges, using an open approach to building models that reflect our current understanding of how natural systems work from established knowledge, expert opinion, and empirical data.
3. Landscape Logic is using IA approaches to develop decision support tools with catchment managers in 6 of Australia's NRM regions to explore the likely impact of interventions on water quality and vegetation condition.
4. Key lessons in this application have been establishing clear goals amongst all parties from the start, maintaining clear lines of communication, distinguishing between research challenges and procedural tasks, recognising the differing time cycles of research and management, and identifying the value of collaboration for all parties involved, and recognising that IA takes time.

Integrated Assessment of options for improving resource condition

Integrated Assessment (IA) is a meta-discipline that offers a way forward for addressing the wicked problems that pervade natural resource management. IA is a process of integrating knowledge from various disciplines and stakeholder groups in order to evaluate a problem situation from a variety of perspectives and provide support for its resolution. Necessarily it involves modelling.

Models are essential for wicked problems in order to systematically integrate and capture our understanding, taking into account uncertainties and characterising them as far as possible. In the case of NRM, IA modelling is typically about how changes in management, climate, demographics and other factors affect selected indicators of system health so that the consequences of management options can be clarified. In line with the principles of IA, transparency, accountability, engagement of stakeholders and knowledge elicitation need to be properties of the ongoing process. Increasingly, decision support systems, usually incorporating models, are being adopted as a facilitating mechanism in IA exercises.

To this end, modelling and its incorporation in information or decision support systems can aid the development of:

(i) ways to gather, record and share conventional and unconventional environmental system information;

(ii) improved tools to capture and express qualitative as well as quantitative knowledge;

(iii) methods for testing knowledge, identifying gaps and designing experiments;

(iv) monitoring techniques able to distinguish the effects of changed management practices from the large natural variations associated with most systems; and

(v) approaches to screening and testing a broad range of alternative policies

The presentation will illustrate a range of experiences in undertaking IA and summarise the key lessons to take us forward in NRM.

Relevant publications

Jakeman AJ, Voinov A, Rizzoli A and Chen S (Eds) (2008) *Environmental Modelling, Software and Decision Support: state of the art and new perspectives*. Elsevier series on Integrated Environmental Assessment, 369pp.

Giupponi C, Jakeman A, Karssenberg G and Hare M (Eds) (2006) *Sustainable Management of Water Resources: an Integrated Approach*. Edward Elgar Publishing, Cheltenham, UK, 361 pp.

Jakeman AJ and Letcher RA (2003) Integrated Assessment and Modelling: Features, Principles and Examples for Catchment Management. *Environmental Modelling and Software*, 18: 491-501.

Croke BFW and Jakeman AJ (2001). Predictions in catchment hydrology: an Australian perspective. *Mar. Freshwater Res*, 52: 65-79.

Jakeman AJ, Letcher RA and Norton JP (2006). Ten iterative steps in development and evaluation of environmental models. *Environmental Modelling and Software*, 21: 602-614.

Tools and techniques for environmental decision-making: Remote sensing of landscape level biodiversity

SD Jones, A Lechner, N Miura, KJ Reinke, K Sheffield, E Farmer.
Geospatial Science, Royal Melbourne Institute of Technology.

Biodiversity assessments currently undertaken in Australia (habitat hectares, biometric, NVC –Tasmania, to name but a few) use plot based assessments to measure key attributes or metrics. Our team at Landscape Logic have been working to determine the utility of remote sensing in producing landscape-level assessments of these variables. This presentation gives an overview of this work and highlights two studies underway to improve our quantification of landscape-level biodiversity. The first project explores landscape configuration and issues of data uncertainty. Remote sensing is widely used in ecology to measure and monitor patch size, shape and connectivity. However, choice of: satellite sensor, spatial and spectral resolution, classification technique and class description, can produce large differences in predictions of extend and patchiness and the accuracy of these predictions varies considerably. This section of the presentation will focus on providing case studies, guidance and tools for producing maps of ecological parameters.

The second project explores the utility of LiDAR (airborne laser scanning) for predicting structural components of landscape level biodiversity. Waveform LiDAR systems generate discrete pulses of energy (at 1–1.5um) which bounce off landscape objects. Each of these returns is time stamped and has range and distance information allowing the structure to be mapped as 3D images. Results show the system's utility in assessing canopy cover, course woody debris and stem density.

Relevant publications

Lechner AM, Jones SD and Bekessy SA. (2008) A study on the impact of scale dependent factors on the classification of land-cover maps. In *Quality Aspects in Spatial Data Mining*. (Ed. A Stein, J Shi and B Wietske). Chapman and Hall/CRC Press.

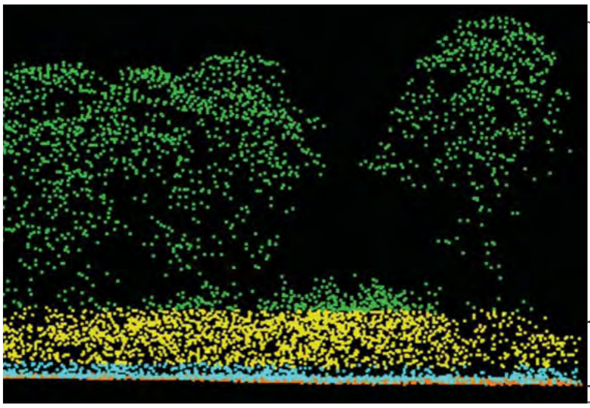
Reinke KJ and Jones SD (2006). Implementation of a Prototype Toolbox for Communicating Spatial data Quality and Uncertainty Using a Wildfire Risk Example. In *Spatial Data Handling*. (Eds. by A Riedl, W Kainz, G Elmes). Springer, pp. 321-337.

Hunter GJ, Jones SD, Bregt A and Masters EG (2003) Spatial Data Quality. In *Advanced Geographic Information Systems*. (Eds. CMB Medeiros). Encyclopedia of Life Support Systems (EOLSS), developed under the auspices of the UNESCO, EOLSS Publishers, Oxford, UK (www.eolss.com) *Advanced Geographic Information Systems Volume I,* ISBN 978-1-905839-91-9; Advanced Geographic Information Systems Volume II ISBN 978-1-905839-92-6.

Reinke R, Jones SD (2006) Issues Arising from the Integration of Regional Scale Remotely Sensed Data with Site Based Assessments of Native Vegetation Condition, *Ecological Management & Restoration Vol 7*, Supp 1, pp. 18-23, ISSN 1442-7001.

Miura N, Jones SD (2008) Characterising the ecological structure of a dry Eucalypt forest landscape. *SilviLaser 2008*, Sept. 17-19, 2008, Edinburgh, UK.

Eucalyptus amygdalina and Leptospermum scoparium (common teatree) in the Rubicon catchment (1 of 14 sites surveyed).



Prof Simon Jones
Simon.Jones@rmit.edu.au

Royal Melbourne Institute of Technology

Day 2, 2.20pm

Area of work: Remote sensing of environment

Specialty: Linking biological phenomena with earth observation and associated issues of scale.

Take-home messages:

1. The selection of remote sensing used to map vegetation (satellite and aerial sensor, spatial and spectral resolution, vegetation class description) can significantly influence estimates of extent and patchiness.
2. By understanding the sources of this variation, we have demonstrated that we can improve the consistency and accuracy of remote sensing based assessments of biodiversity parameters.
3. LiDAR (airborne laser scanning) can be used to generate 3D images of vegetation, revealing structural characteristics from canopy top to ground level in great detail.
4. Our research is demonstrating the utility of LiDAR in measuring canopy cover and course woody debris with considerable accuracy relative to site based measurement.

KEYNOTE SPEAKER

Professor David Lindenmayer

david.lindenmayer@anu.edu.au

Australian National University

Day 1, 1.50pm

Area of work: landscape ecology and conservation biology

Area of specialty: integrated wildlife management and timber production, the effectiveness of landscape restoration for biodiversity, woodland conservation and restoration and endangered species conservation and management.

Adaptive Management in the real world: lessons from a 25-year odyssey

Adaptive Management is discussed in countless books, articles and other publications. It is an inherently intuitive and sensible approach to management natural resources and ecosystems. However, despite the level discussion about it, adaptive management is very rarely implemented and in the few cases where it is, most adaptive management projects have a very short lifespan – thereby greatly limiting their value.

These failures have occurred, in part, because adaptive management is much harder to do in the real world than in the written academic world. In many respects, the long-term nature of true adaptive management experiments and associated monitoring is the antithesis of modern academic life and modern management and societal psyche and culture. For example, academic reward systems do not foster long-term studies or the large syntheses of work that often accompany high quality adaptive management experiments. Moreover, the neat, highly controlled experiments that appeal to many scientists will not pass the test of management relevance for many policy makers and natural resource managers and answer the questions they need answering.

Yet, the need for well targeted adaptive management experiments and long-term monitoring programs are now more important than at any time in the past 50 years. New approaches based on joint question setting between scientists, policy-makers and resource managers are urgently needed to instigate and then maintain credible adaptive management experiments and associated monitoring programs.

This presentation highlights some of these new approaches. It also outlines some of the obstacles to establishing and maintaining true adaptive management experiments and associated monitoring programs based on 25 years experience in the wet ash forests of the Central Highlands of Victoria.

Take-home messages:

1. Adaptive management is much harder to do in the real world then in the written academic world.
2. The need for well targeted adaptive management experiments and long-term monitoring programs is now more important than at any time in the past 50 years.
3. New approaches based on joint question setting between scientists, policy-makers and resource managers are urgently needed to instigate and then maintain credible adaptive management experiments.

Relevant publications

Lindenmayer, D. B., Burton, P., and Franklin, J.F. 2008. *Salvage logging and its ecological consequences.* Island Press, Washington, D.C.

Lindenmayer, D. B., Dovers, S., Hariss Olsen and Morton, S. 2008. *Ten Commitments: Reshaping the Lucky Country's Environment*. CSIRO Publishing, Melbourne.

Lindenmayer, D. B., Cunningham, R.B., MacGregor, C., Crane, M., Michael, D., Fischer, J., Montague-Drake, R., Felton, A. and Manning, A. 2008. Temporal changes in vertebrates during landscape transformation: a large-scale natural experiment. *Ecological Monographs* 78: 567-590.

Lindenmayer, D. B., and Fischer, J. 2006. *Habitat fragmentation and landscape change*. Island Press: Washington D.C.

Lindenmayer, D. B., and Burgman, M. A. 2005. *Practical conservation biology.* 2nd ed. CSIRO Publishing: Melbourne.

Doing policy-relevant science, understanding policy-relevant science: The essential tension

Policy relevant science takes place in Pasteur's Quadrant, where a quest for fundamental understanding is motivated by an important applied problem, and involves highly difficult and unstructured problems. Incorporating science into policy requires an iterative interaction between the two. Scientists need to recognize that they have values and that such values affect their choice of problem and how problems are approached. Uncertainty is a key feature of important applied problems. Stochastic dynamic programming and Bayesian statistics are the fundamental tools of such work, since the former allows the evaluation of a wide set of policy options and risk analysis and the latter allows us to incorporate various sources of information and forces us to be honest about uncertainties.

Political success consists of substantive achievements, but scientific success often consists of exploding fallacies and this creates an essential tension. Understanding policy relevant science requires that we see models as maps, and recognize that although we live in the material world, maps are important and that theory is not just a guess. At the boundaries of knowledge, all science is messy. Ecological science is central to environmental problem solving and proper framing of the question is key to good answers. Science and values interact, but science is not just another stakeholder, and no amount of scientific work will resolve conflicts of values. When involving teams of scientists in policy, recognise that diversity trumps ability. Like scientists, policy-makers must embrace uncertainty, recognize the limits of scientific knowledge and the different kinds of prediction, and be prepared to act under fundamental uncertainty. The essence of sound policy is knowing what science can and cannot tell us and using that information wisely.

Relevant publications

Ludwig D, Mangel M and Haddad B (2001) Ecology, conservation and public policy. *Annual Review of Ecology and Systematics* 32:481-517.

Pikitch EK, Santora C, Babcock EA, Bakun A, Bonfil R, Conover DO, Dayton P, Doukakis P, Fluharty D, Heneman B, Houde ED, Link J, Livingston PA, Mangel M, McAllister MK, Pope J and Sainsbury KJ (2004) Ecosystem-based fishery management. *Science* 305:346-347.

Mangel M and Levin PS (2005) Regime, phase and paradigm shifts: making community ecology the basic science for fisheries. *Philosophical Transactions of the Royal Society* B. 360:95-105.

Munch SB, Kottas A and Mangel M (2005) Bayesian nonparametric analysis of stock-recruitment relationships. *Canadian Journal of Fisheries and Aquatic Sciences* 62:1808-1821.

Mangel M, Levin P and Patil A (2006) Using life history and persistence criteria to prioritize habitats for management and conservartion. *Ecological Applications* 16:797-806.

Professor Marc Mangel

msmangel@ams.ucsc.edu

University of California

Santa Cruz, CA

Day 1, 9.00am

Area of work: Mathematical and theoretical biology

Area of specialty: We use mathematical methods to solve problems in biological and ecological science. Current themes include quantitative methods for fishery management and evolutionary aspects of health and disease.

Take-home messages:

1. There are many ways of knowing, but science is a special way of knowing in which the process is more permanent than the knowledge it produces.
2. Scientists have values that affect their choice of problem and how problems are approached.
3. Doing policy relevant science is an iterative process.
4. Stochastic dynamic programing and Bayesian statistics are the fundamental tools of policy relevant science.

SPEAKER

Dr Mick McCarthy

mamcca@unimelb.edu.au

University of Melbourne

Day 1, 3.05pm

Area of work: population ecology, decision-making and risk analysis

Specialty: I examine factors that contribute to the risk of extinction, and ways to manage this risk.

Take-home messages:

The value of active actively learning about environmental management problems depends on how:

- the future is valued;
- broadly knowledge is applied; and
- success is measured.

Is it really worth learning about the benefits of management?

Adaptive management is learning by doing; management strategies are implemented, their effectiveness is monitored, and then the mix of management strategies is adjusted depending on the outcomes of the monitoring. The number of examples of adaptive management is increasing, with researchers determining the best way to conduct management and monitor outcomes to achieve particular objectives. But in most of these examples, the benefits of adaptive management are predicted to be small, even when monitoring is inexpensive.

This is a surprising result. It suggests that knowledge and learning are not as beneficial as scientists might like to think and that managers should mostly implement management strategies using the best available information, rather than planning on obtaining more information.

Are these suggestions reasonable and why does adaptive management often predict modest improvements in management? The answers to these questions depend on:

1) the way in which knowledge is updated in adaptive management problems;

2) how broadly the results of monitoring are applied; and

3) the degree by which the value of future returns are discounted.

The usual way of updating knowledge in adaptive management studies is to use Bayes' rule, which limits the range of outcomes to a pre-conceived set of options; complete changes in paradigm are precluded, limiting the perceived value of new information. The value of information is limited when adaptive management results are only applied within a particular case study. Standard discounting of future returns also limits the value of information.

Adaptive management is most beneficial when changes in paradigm are considered, the results of monitoring are applied beyond the case study and the future is not heavily discounted. These ideas are illustrated using a number of case studies with a particular focus on learning about re-vegetation strategies.

Relevant publications

McCarthy MA and Parris KM (2008). Optimal marking of threatened species to balance benefits of information with impacts of marking. *Conservation Biology,* 10.1111/j.15231739.2008.00999.x

Chadès I, McDonald-Madden E, McCarthy MA, Wintle B, Linkie M and Possingham HP (2008) When to stop managing or monitoring cryptic threatened species. *Proceedings of the National Academy of Sciences* 105: 13936–13940.

McCarthy MA, Thompson CJ and Garnett ST (2008). Optimal investment in conservation of species. *Journal of Applied Ecology* 45: 1428–1435.

Moore AL, Hauser CE and McCarthy MA (2008). How we value the future affects our desire to learn. *Ecological Applications* 18: 1061–1069.

McCarthy MA and Possingham HP (2007). Active adaptive management for conservation. *Conservation.*

A change may be as good as a holiday for biodiversity management

Conservation decision-making is restricted by a paucity of knowledge regarding the systems we are trying to conserve. Given the urgency of conservation issues many conservation scientists and managers have been contemplating how best we can learn about these systems whilst we manage. This is the crux of adaptive management, a term now synonymous with the policy of most environmental agencies. Indeed, adaptive management has been widely discussed as the best, and maybe only, way to track and adapt to the environmental impacts of a changing climate.

Monitoring plays a vital role in learning and informing the decisions of management agencies, and is a key component of adaptive management. Despite this, current monitoring practices are generally poorly connected with decision-making. Indeed, even when monitoring is justified by a need to improve management, clear connections between monitoring and management, are rarely formalised. In this talk we will discuss the role of monitoring in how we learn and adaptively manage the environment. We will highlight these ideas with real-world conservation management case studies.

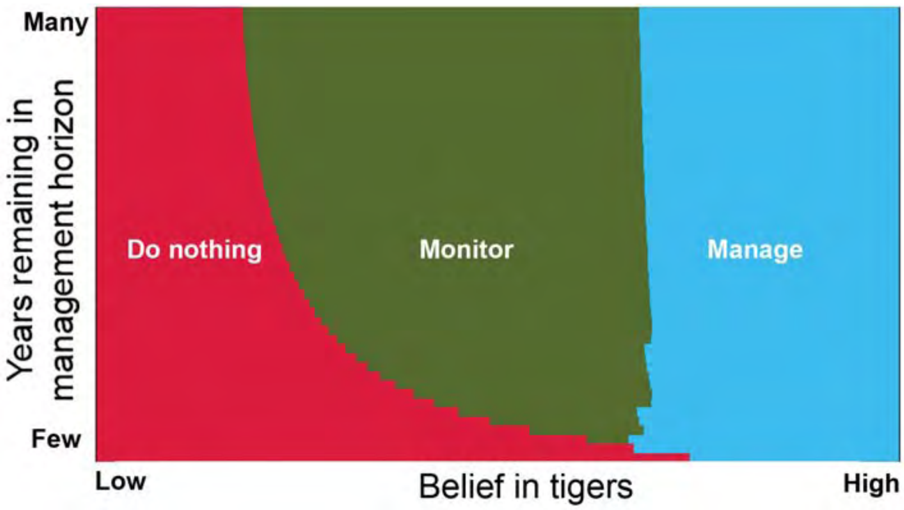
Relevant publications

McDonald-Madden E, Baxter PWJ, Possingham HP (2008) Making robust decisions for conservation with restricted money and knowledge. *Journal of Applied Ecology* 45, 1360-1638.

Chadès I, McDonald-Madden E, McCarthy MA, Wintle B, Linkie M and Possingham HP (2008) When to stop managing or surveying cryptic threatened species. *Proceedings of the National Academy of Sciences*, 105, 13936-13940.

McDonald-Madden E, Bode M, Game ET, Grantham H, Possingham HP (2008) The need for speed: informed land acquisitions for conservation in a dynamic property market. *Ecology Letters* 11, 1169-1177.

McDonald-Madden E, Gordon A, Wintle B, Grantham H, Walker S, Carvalho S, Bottrill M, Joseph M, Ponce R, Stewart R, Possingham HP (2009) 'True' conservation progress. *Science* 323, 43-44.



Drs Eve McDonald-Madden and Iadine Chades along with other collaborators from AEDA headed a study to investigate when to protect, monitor or do nothing for a threatened species given the costs and benefits of implementing these actions. Decisions in this study were based around how strongly managers believed a species was present in an area. Particularly interesting was the incorporation of the ability of a monitoring strategy to detect the species of concern and thus impact a manager's belief in species persistence. As a case study they focussed on management of the highly valued Sumatran Tiger in Kerinci Seblat National Park.

Dr Eve McDonald-Madden

e.mcdonaldmadden@uq.edu.au

University of Queensland

Day 2, 9.00am

Area of work: Conservation Management

Area of specialty: My research is essentially applied theoretical ecology focussing on integrating optimal monitoring strategies into a decision theory approach for wildlife management and conservation planning. In particular, I am interested in the use of this framework for evaluating the ecological and economic costs and benefits of adaptive management in conservation for threatened species management, invasive species control, land acquisition for reservation and zoning of conservation areas.

Take-home messages:

1. Contemplate the wise words of Confucius who once said "Learning without thought is labour lost".
2. Monitoring can benefit management for a variety of reasons but should not be considered a compulsory action.
3. It is important to realise that sometimes the best monitoring plan may be to not monitor at all!

Dr Lachlan Newham
lachlan.newham@anu.edu.au
The Australian National University

Day 2, 11.40am

Area of work: Water quality

Specialty: Integrated catchment assessment and management with a focus on water quality assessment and modelling.

Take-home messages:

1. Considerable environmental benefits are to be gained through well-targeted remediation efforts for water quality improvement.
2. Water quality assessment and modelling require careful consideration of processes driving water quality. A one-size-fits-all approach to modelling usually doesn't. Models should be tailored to specific applications and should be flexible to evolve as new information becomes available.
3. In terms of increasing knowledge amongst end users, the process of model development is equally, if not more, important than the resulting model.
4. The process of model development allows knowledge gaps to be identified effectively, can assist in reducing uncertainty and provides transparency and defensibility for decision-making.

The cost-effectiveness of management interventions for water quality improvements at catchment scale

This paper describes modelling-based investigations into the cost-effectiveness of management interventions for water quality improvement at catchment scales. Case studies from the Georges Bay catchment of north east Tasmania, the Avon-Richardson catchment of north central Victoria and the Eurobodalla catchments of the NSW south coast are presented.

The common thread between the case studies is the application of the CatchMODS model which provides a focus for targeted scientific investigations and a means of incorporating new process knowledge as it becomes available. The objectives, the integrated scientific and modelling approach and results are described for each case study. The case studies demonstrate the utility of modelling as an element of an adaptive approach to managing water quality.

Discussion is also made of the learning that has evolved amongst the case studies. It is shown that a one-size-fits-all approach to water quality modelling is unsuitable for building the knowledge required for cost-effective water-quality management.

Relevant publications

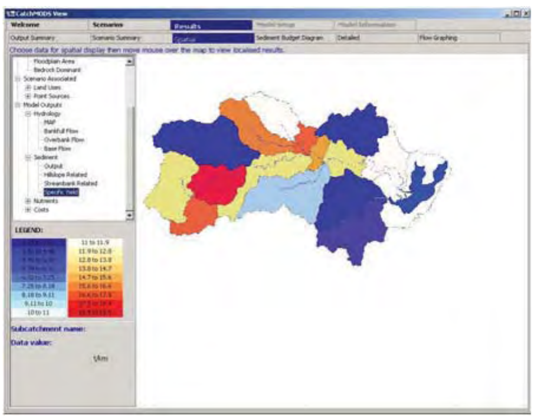
Drewry JJ, Newham LTH, Croke BFW (in-press). Suspended sediment, nitrogen and phosphorus concentrations and exports during storm-events to the Tuross estuary, Australia, *Journal of Environmental Management*. vol. 90, pp. 879-887.

Croke BFW, Ticehurst JL, Letcher RA, Norton JP, Newham LTH and Jakeman AJ (2007) Integrated Assessment of Water Resources: Australian Experiences, *Water Resources Management*, vol. 21, pp. 351-373.

Newham LTH, Cuddy SM, Rutherford JC, Jakeman AJ (2007) The role of modelling in catchment management. In *Salt, Nutrient, Sediment and Interactions: Findings from the National River Contaminants Program* (Eds S Lovett, P Price and B Edgar) Land & Water Australia, Canberra pp. 141-150.

Drewry JJ, Newham LTH, Green RSB, Jakeman AJ and Croke BFW (2006) A review of nitrogen and phosphorus export to waterways: context for catchment modelling, *Marine and Freshwater Research*, vol. 57, pp. 757-774.

Newham LTH, Jakeman AJ and Letcher RA (2006) Stakeholder Participation in Modelling for Integrated Catchment Assessment and Management: An Australian Case Study in Participation, *International Journal of River Basin Management*, vol. 4(3), pp. 1-13.



Screen from CatchMODS showing relative contribution of 12 sub-catchments to sediment load.

Monitoring for conservation: Why, What, How?

Professor Jim Nichols

jnichols@usgs.gov

US Geological Survey

Day 2, 8.30am

Area of work: Wildlife biology

Area of specialty: Animal population dynamics and management, demographic estimation methods.

Monitoring programs have been developed throughout the world for the purpose of tracking natural resources. Such programs are usually motivated and justified by the claim that they are needed for proper resource management and conservation. Certainly most monitoring programs do provide some information that can be useful to managers. However, I claim that the designs of most existing monitoring programs do not adequately consider the questions: why, what and how. This results in inefficient use of the substantial effort and funding that they require. If the answer to the question "why monitor" is "to inform conservation efforts", then monitoring should be designed to yield data for the following specific uses:

(1) state-specific decision-making;

(2) assessing progress towards management objectives;

(3) discriminating among competing hypotheses about system response to management actions.

Monitoring programs designed with these uses in mind are likely to be much more useful for conservation than omnibus, unfocused programs. The answer to the question of what to monitor should be inherited directly from the purpose of the program (the answer to "why?"). Selection of what to monitor is frequently straightforward for single-species management, but can be more problematic for conservation programs directed at communities or systems. In such cases, community-level state variables (e.g., species richness) can be used, or "indicator species" can be selected. Potential objective approaches to selection of indicator species include attractor-based and information-theoretic methods. The question of how to monitor natural resource systems requires attention to two key sources of variation in monitoring data: geographic variation and detection probability. Geographic variation refers to the typical situation in which not all of the area containing the population or system of interest can be directly surveyed. In such cases, decisions about where to survey frequently involve distinguishing strata or areas of differing relevance to management decisions and hypotheses. Within such strata, designs seek to select locations for sampling that permit inferences about the locations not sampled and, hence, about the entire stratum. The issue of detectability involves the usual situation for animals, and even many plants, in which survey methods at a location fail to detect all individuals of the focal species that are present. Instead, surveyors detect some fraction of the true number of individuals present, and inference about state variables such as abundance then requires inference about detection probability. Luckily, statisticians and quantitative ecologists have developed various methodological approaches to dealing with spatial variation and detection probability, although it is disappointing that these approaches see so little use in existing monitoring programs.

Relevant publications

Nichols JD (1991) Extensive monitoring programs viewed as long-term population studies: the case of North American waterfowl. Ibis 133 suppl. 1:89-98.

Nichols JD (2000) Monitoring is not enough: on the need for a model-based approach to migratory bird management. In Strategies for Bird Conservation: The Partners in Flight Planning Process. Proceedings RMRS-P-16. (Eds R Bonney, DN Pashley, R Cooper and L Niles). Pages 121-123. Ogden, UT, U.S. Dept. Agric. Forest Service, Rocky Mountain Research Station.

Yoccoz NG, Nichols JD and Boulinier T (2001) Monitoring of biological diversity in space and time. Trends in Ecology and Evolution 16:446-453.

Williams BK, Nichols JD and Conroy MJ (2002) Analysis and management of animal populations. Academic Press, San Diego. 817pp.

Nichols JD and Williams BK (2006) Monitoring for conservation. Trends in Ecology and Evolution 21:668-673.

Take-home messages:

- Natural resource monitoring has become a popular activity, yet much current monitoring is inefficient.
- The design phase of new monitoring programs should include increased attention to the questions why, what and how?
- Monitoring is not a stand-alone activity but attains utility as a component of a larger program of science or management.
- It is usually unwise to base management decisions on trend detection.
- Spatial sampling and detection probability are not statistical fine-points, and should be important foci of monitoring program design.

SPEAKER

Prof Tony Norton

Tony.Norton@utas.edu.au

Tasmania Institute for Agricultural Research (TIAR),
University of Tasmania

Day 2, 9.30am

Area of work: Native vegetation condition, assessment, monitoring and sustainable management.

Specialty: Environmental science, spatial information science, natural resource management.

Take-home messages:

1. Remnant patches of native vegetation on private land are widely considered to provide important ecosystem services.
2. Remotely assessing and monitoring native vegetation can assist NGOs and government agencies in improving connectivity between areas of native vegetation and thereby extending and improving habitat and other ecosystem services.
3. The combination of remote sensing and ground-based surveys can quickly provide accurate information on the extent and condition of native vegetation.

Monitoring for biodiversity: making the right connections

Professor Tony Norton[1], Dr Karyl Michaels[1], Dr Michael Lacey[1], Grant Dickins[2], Professor Jann Williams[2]
[1]University of Tasmania, C/- Private Bag 3523, Burnie TAS 7320
[2]RMIT University, GPO Box 252 Melbourne VIC 3001.

This paper reports an initiative to enhance the sustainable management of native vegetation in Tasmania. The focus is on the status (extent and condition) of native vegetation, and improving methods to systematically assess and monitor native vegetation at a site to landscape scale to help prioritise management interventions. Spatial metrics based on Fragstats were used to examine the degree of fragmentation of native vegetation within and across different land uses at a catchment scale in Tasmania. We assessed in turn the extent, condition (using site-based floristic and structural data, disturbance models), biodiversity complement (using listed taxonomic data and measures of species richness) and conservation status of native vegetation. Patches of native vegetation that appear likely to play a significant role in maintaining ecosystem services (e.g. watershed protection, vegetation connectivity) and providing important habitat for a range of biota can be identified. This information can be used to support improved management of native vegetation, assist with the recovery and management of threatened and priority species, design new ground-based surveys of key patches and facilitate conservation and habitat restoration planning at a regional scale.

Relevant publications

Michaels K, Lacey M and Norton T (2008). Vegetation Futures for Tasmania. Presentation to ESA Conference, Sydney.

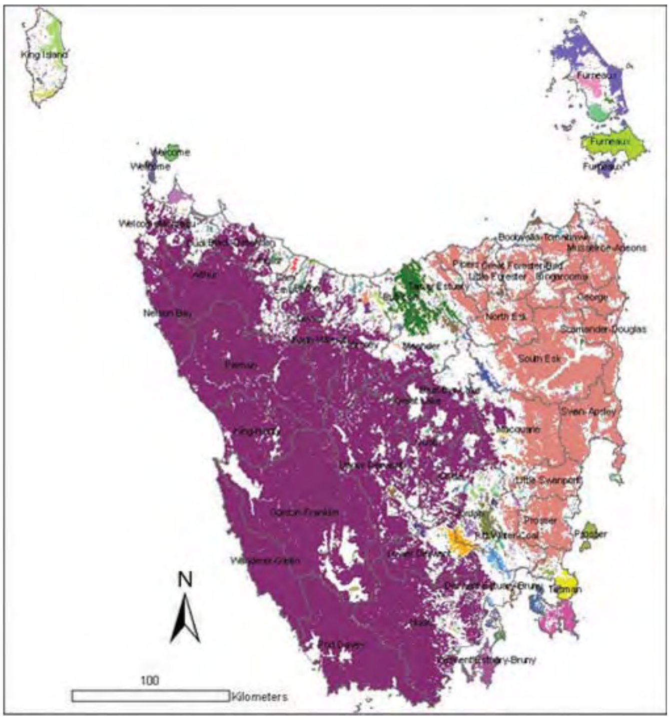
Michaels K, Lacey M, Norton T and Williams J (2008). Vegetation Futures for Tasmania. Presentation to the Veg Futures 08 Conference, Toowoomba, <www.greeningaustralia.org.au/resources/veg-futures-08/veg-futures-proceedings>.

Lefroy EC, Bailey K, Unwin G and Norton T (2008). *Biodiversity: Integrating Conservation and Production: Case studies from Australian farms, forests and fisheries*, CSIRO Publishing, Victoria.

Landscape Logic (2007). Futures for Native Vegetation Condition Research in Tasmania and Victoria, *Landscape Logic Technical Report*.

Mount R, Lacey M and Pedersen T (2007). Spatial (landscape ecology) metrics tool for assessing the biodiversity of agricultural land. Spatial Sciences Institute International Biennial Conference, May 14-18, 2007, Hobart, Australia.

Michaels KF (2006). TASVEG Vegetation Condition Assessment Manual. Biodiversity Conservation Branch, Department Primary Industries and Water, Hobart.



Patch analysis of Tasmanian vegetation using a 50m separation rule (33,700 patches). Such spatial analysis is a useful aid to targeting interventions for improved extent and condition

Research to adoption – Addressing the challenges

Natural resource management involves large spatial scales, long time lags and complex interactions between a wide range of natural resources. Whilst theses present major challenges to developing useful knowledge, there are additional challenges to turning knowledge into change on the ground.

Landscape Logic set out to establish links between management actions and natural resource condition, and in doing so improve the way scientific information is used to aid decision-making. To ensure effective adoption and implementation of the research findings by natural research managers, policy-makers and decision-makers, Landscape Logic has adopted approaches to manage these RD&E challenges.

Some of the challenges facing the adoption of environmental information include:

Biophysical

- long time lags between intervention and response
- large spatial scales
- multiple and varied drivers
- high levels of uncertainty.

Institutional

- multiple ownership of natural resources (private and public)
- jurisdictional boundaries (Australian, state and local government, regional bodies)
- changing State and Federal government priorities and programs
- different planning, budgeting and reporting cycles
- varied organisational cultures and disciplinary language

Social

- wide range of audiences (land owners and managers, catchment managers,
- turnover of personnel within partner institutions and target audiences.

The approaches and tools being used to address these challenges include

1. Participatory RD&E to ensure end-user ownership of the research. This involved scoping research topics and issues in partnership with natural resource managers, policy-makers and decision-makers and holding regular end-user communication activities such as project reviews, workshops and briefings.
2. Retrospective research that draws on archived data such as water quality and flow data and historical aerial photography. While historical data is often patchy, it is one of the few ways to overcome the long time lags involved in ecological processes.
3. Knowledge integration. This involves a range of different modeling approaches operating at different scales from state to region to catchment and sub-catchment including the use of Bayesian Decision Networks as the integrative tool to bring together model outputs and expert opinion.

Some of these approaches address more than one challenge. Some work better than others. The lessons learnt from Landscape Logic will hopefully be of benefit to other integrated natural resource management RD&E.

Greg Pinkard

greg.pinkard@utas.edu.au

University of Tasmania

Day 2, 2.35pm

Area of work: Knowledge broking

Specialty: Ensuring the outputs of Landscape Logic meet the needs of, and are adopted by, natural resource managers, policy-makers and decision-makers in Tasmania.

Take-home messages:

1. NRM managers and other end-users of environmental research should not be regarded as passive recipients of knowledge. Their insights and experience can be valuable in the design, implementation and delivery of research programs.
2. Participatory RD&E approaches can help to overcome the problems of limited relevance and low levels of adoption of NRM research outputs
3. The changing emphasis of State and Federal government programs and the differing planning, budgeting and reporting cycles remain significant challenges to participatory RD&E.

Dr Carmel Pollino
carmel.pollino@anu.edu.au
The Australian National University

Day 2, 1.50pm

Area of work: Integrated assessment

Specialty: Bringing good science to decision-making through developing innovative, enduring and adaptive processes, tools and techniques.

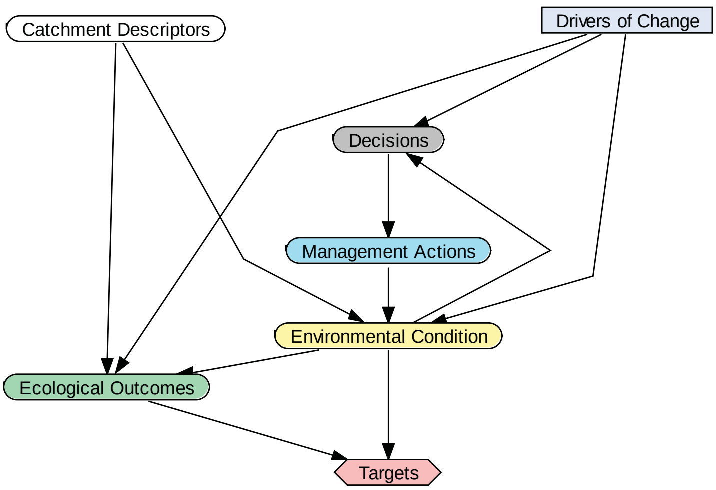
Take-home messages:

1. When dealing with landscape-scale processes, qualitative and quantitative knowledge from a variety of sources needs to be systematically incorporated into a single decision-support tool to assist catchment managers and other investors.
2. Bayesian Networks are sufficiently flexible to allow incorporation of different types of knowledge and the participation of end-users, and probabilistic in nature, meaning they can incorporate the uncertainty inherent in large-scale processes with long time lags.
3. These features are likely to be important if decision support systems are to be adopted and widely used.

Integration tools for decision-making

The aim of Landscape Logic is to link the management of land and water to natural resource condition across landscapes. Achieving this aim is a complex interdisciplinary task, requiring input from a range of fields including social science, ecology, mathematical modelling and natural resource management. The best available knowledge we have from these disciplines can range from 'gut feel' to a detailed process-based understanding. To integrate these different forms of knowledge across disciplines we need flexible integration tools that can (a) structure knowledge and (b) represent information in a usable and adaptive form for natural resource managers. In Landscape Logic we are seeking to do this by using Bayesian Networks (BNs). BNs are ideal for: structuring management and assessment objectives; enabling participation of users in model building; targeting evidence collection; and aiding inclusion of good science into decision-making. BNs are being used to explore system interactions (e.g. investment decisions ➔ on-ground activities ➔ processes/impacts ➔ resource condition outcomes), while capturing the uncertainties in this knowledge. Our experiences with BNs suggest they are an accessible and intuitive modelling approach that allows researchers and decision-makers to document knowledge and interrogate system interactions within an adaptive framework.

To communicate and interact with the integration models, as well as house the new knowledge and information generated from Landscape Logic, we are constructing a Decision Support System (DSS). The Landscape Logic DSS will act as a warehouse of information, containing maps, facts sheets, and a range of interactive tools, including integration models. The DSS will be built using a philosophy of adaptive decision support, allowing information to be updated and adapted as we gain new system knowledge. In order to achieve the goals of integration in the Landscape Logic program, the integration team has three inter-linked themes: capacity-building, model-building and development of decision support systems. The integration team within Landscape Logic is building capacity within its research teams as well as natural resource management bodies to establish a skill base and encourage adoption of decision support tools. Model-building activities are targeted at Landscape Logic research projects which are forming the basis of the DSS. The development of the DSS is being lead by an integration team, in consultation with Landscape Logic projects and partners. The Landscape Logic DSS will be completed by July 2010.



Relevant publications

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Pollino CA, Woodberry O, Nicholson AE, Korb KB and Hart BT (2007) Parameterisation of a Bayesian network for use in ecological risk management. *Environmental Modelling & Software* 22, 1140-1152.

Tighe MK, Pollino CA, Cuddy SM, Whitfield S. (2007) Climate Change Pressures on Natural Resource Management in the Central West of NSW; 2007; MODSIM 2007 Christchurch, New Zealand.

Hart BT, Pollino CA (2008) Increased Use of Bayesian Network Models Will Improve Ecological Risk Assessments. *Human and Ecological Risk Assessment* 14, 851-853.

Five objections to prioritisation: Idiotic reasons not to use decision theory

I have given almost 200 seminars on using decision theory to solve environmental problems, during which I've heard a broad range of objections on its use. In this presentation I will review the most common objections and discuss their strengths and weaknesses.

Objection 1: "This is all ecological modelling and ecological models are all wrong."

Objection 2: The principles of decision theory are founded in economics and it is economics that has made a mess of the world. (i.e. decision theory is the tool of the devil.)

Objection 3: Using decision theory takes too long. While the general idea is good, we haven't got the time or money to use these approaches.

Objection 4: Nobody wants to have a computer tell them what to do. "Black-box" solutions to problems will never fly with politicians and stakeholders.

Objection 5: There is too much uncertainty and risk to use a decision theory approach.

It's important to dispel the myths surrounding these objections to the use of prioritisation. To ignore the value of environmental decision theory is to repeat the many mistakes that we have made in the last two decades. As a nation we're failing hopelessly to secure our most precious and unique natural asset – Australia's biodiversity. Since 1990, the Australian federal government has announced seven major natural resource programs collectively worth $6.51 billion, and the skeptics have consistently pointed out that we have no quantifiable objectives, limited knowledge of what we have achieved and little idea about how investments were chosen.

Relevant publications

Possingham HP (2001) *The Business of Biodiversity*. Australian Conservation Foundation TELA Series No. 9, 44 pp. <www.acfonline.org.au/uploads/res/res_tp009.pdf>.

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Hoegh-Guldberg O, Hughes L, McIntyre S, Lindenmayer DB, Parmesan C, Possingham HP and Thomas CD (2008) Assisted colonization and rapid climate change. *Science*, 321, 345-346.

Prof Hugh Possingham

h.possingham@uq.edu.au

University of Queensland

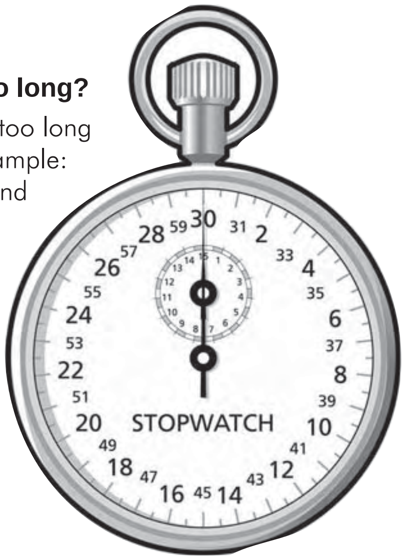
Day 1, 12.25pm

Area of work: ecological modelling and decision-making in the face of uncertainty

Area of specialty: Rational, repeatable and transparent approaches to environmental management that account for uncertainty, incomplete knowledge and scarce data. I'm particularly interested in optimal monitoring, adaptive management and robustness (ensuring acceptable outcomes in the face of uncertainty).

It takes too long?

Some claim that decision theory takes too long to achieve results. Consider this example: in conjunction with AEDA, the New Zealand Department of Conservation has developed the Project Prioritisation Protocol (Joseph *et al* 2009). In less than three years they have not only developed action plans for over 600 species, they have costed and prioritised them – all because the decision-making framework made recovery planning more focussed.



Take-home messages:

- Environmental values do not have to be turned into dollars and cents for them to be used in decision theory.
- Decision theory approaches and tools inform decisions rather than make decisions.
- Decision theory has many ways of rigorously accounting for uncertainty.

KEYNOTE SPEAKER

Professor Bob Pressey

bob.pressey@jcu.edu.au

ARC Centre of Excellence for Coral Reef Studies
James Cook University

Day 1, 11.10am

Area of work: conservation planning

Area of specialty: Developing innovative science that is relevant for conservation planning in the real world

Take-home messages:

- Residual conservation areas do not represent real conservation progress.
- Measures of the effectiveness of conservation areas based on extent, percentages of regions, or representativeness should be recognised for what they are: simplistic and misleading.
- Real measures of the effectiveness of conservation areas are based on avoided loss and are essential if Australia is to achieve its stated goals for nature conservation.

The mis-measure of conservation: How do we find out how much difference we make?

To arrest the attrition of biodiversity and other valued aspects of the natural world, we place much faith and hope in protected areas and other places managed for nature conservation (collectively "conservation areas"). If we look at where conservation areas are, across Australia and around the world, they tend to be concentrated in areas that have least value for extractive uses and, therefore, least need for protection (Pressey *et al*, 2000). This tendency for conservation areas to be residual to human requirements is reflected in terrestrial conservation areas having one or more of these characteristics: infertile, rugged, arid, remote, poorly drained, high, and disease prone. There are many analogues in the marine realm. Why is residual conservation a bad thing? The main reason is that the areas most in need of protection don't get it, while the areas more prone to loss of their distinctive biodiversity and other natural values continue to languish. Related to this, each additional residual conservation area entails an irretrievable opportunity cost: loss elsewhere that could have been avoided but was not.

Common measures of the effectiveness of conservation areas hide the residual nature of conservation areas and wrongly infer that progress is being made. Measures of extent or percentages of regions covered by conservation areas are, in themselves, meaningless. They say nothing about how well conservation areas have achieved their role: to avoid the loss of natural values. Measures of representation are only slight improvements. An increase in representation of vegetation types from 35 to 52 in an Australian biogeographic region is not necessarily an advance for conservation. Much depends on whether the additional 17 vegetation types were the ones that most needed protection because they were most prone to depletion in the absence of conservation intervention.

More than 30 years ago, Jared Diamond (1976) wrote: "the question is not which refuge system contains more total species, but which contains more species that would be doomed to extinction in the absence of refuges". Diamond was talking about the importance of distinguishing means from ends. Conservation areas are the means to the end of avoiding loss of biodiversity and other natural features. If we base our measures of conservation progress on means (conservation areas) and avoid measuring how well we have achieved our stated ends (avoided loss), there are few prospects for real conservation gains. Moreover, we will waste a great deal of money, skill and time on establishing conservation areas in places that are not real priorities for our limited resources.

The way forward is to develop measures that reflect how well we have used conservation resources to avoid the loss of the things we purport to care about. Early steps have already been taken by researchers. Strong and rapid progress in practical, informative measures is possible, but only if the crucial importance of measuring avoided loss is accepted by policy-makers and used to guide further expansions of protected areas and other conservation actions.

Relevant publications

Diamond JM (1976) Island biogeography and conservation: strategy and limitations. Science, 193, 1027-1029.

Ferraro PJ and Pattanayak SK (2006) Money for nothing? A call for empirical evaluation of biodiversity conservation investments. PLoS Biology, 4, 482-488.

Pressey RL, Hager TC, Ryan KM, Schwarz J, Wall S, Ferrier S and Creaser PM (2000) Using abiotic data for conservation assessments over extensive regions: quantitative methods applied across New South Wales, Australia. Biological Conservation, 96, 55-82.

Pressey RL and Taffs KH (2001) Sampling of land types by protected areas: three measures of effectiveness applied to western New South Wales. Biological Conservation, 101, 105-117.

INFFER-ing cost-effective environmental outcomes

We have developed a framework called INFFER (Investment Framework for Environmental Resources). It is an asset-based approach to help regions and governments make more robust and defensible decisions to achieve realistic and cost-effective environmental outcomes.

We are currently working in a training/help-desk capacity with 10 regions in three states. Some regions are using INFFER to underpin the competitive grants component within Caring for Our Country. Others want to use it to underpin their next major Regional Catchment Strategy; whilst others are wanting to see how far away from their existing approaches it is (always very different!).

As well as working in regions, we are also developing and utilising existing research to develop simple decision frameworks for biodiversity, water quality and pest issues, having already achieved this for dryland salinity. Formalised accredited training is also being developed through our partnership with the Future Farm Industries Cooperative Centre.

We believe that much more cost-effective environmental decisions can be made now, whilst we continue to integrate research into decision frameworks over our next three years of research.

Commonwealth and state policy-makers are very interested and engaged at differing levels in our research. The Western Australian government has adopted INFFER as it's recommended asset-based approach. The Victorian government is strongly supportive of our work and we are hopeful of INFFER becoming a recommended approach in the upcoming new land and biodiversity policy strategy. Both DEHWA and DAFF have indicated strong support for INFFER principles within Caring for Our Country.

Relevant publications

Pannell DJ and Roberts AM (2009) Conducting and delivering integrated research to influence land-use policy: an Australian case study. (*Environmental Science and Policy*, accepted for publication)

Roberts AM, Helmers M and Fillery IRF (2009) The adoptability of perennial-based farming systems for hydrologic and salinity control in dryland farming systems in Australia and the United States. *Crop and Pasture Science* (accepted for publication)

Roberts AM and Pannell DJ (2009). Piloting a systematic framework (SIF3) for public investment in regional natural resource management in dryland salinity in Australia. *Land Use Policy* (submitted)

Ridley AM and Pannell DJ (2005). The role of plants and plant-based R&D in managing dryland salinity in southern Australia. *Australian Journal of Experimental Agriculture* 45, 1341–1355

Ridley AM (2004). The role of applied science to help farmers make decisions about environmental sustainability. *Australian Journal of Experimental Agriculture* 44, 959–968.

Dr Anna Roberts

anna.roberts@dpi.vic.gov.au

Department of Primary Industries

Day 1, 11.40am

Area of work: Catchment management, prioritisation, investment, water quality

Specialty: My work, as part of a team (including David Pannell, Geoff Park and Jennifer Alexander) focuses on assisting regional bodies and governments improve the public benefits and demonstrated outcomes from investment in natural resource management.

Take-home messages:

1. Previous programs such as the National Action Plan for Salinity and Water Quality and the Natural Heritage Trust failed to deliver significant environmental outcomes and INFFER provides a robust framework to achieve such
2. In response to concerns from Treasury INFFER has been adopted in Western Australia to underpin regional investment, and looks likely to be used also in Victoria
3. INFFER if used well, will improve environmental outcomes from the Caring for Our Country Program.

SPEAKER

Dr Carl Smith

c.smith2@uq.edu.au

University of Queensland

Day 2, 2.05pm

Area of work: Agriculture and Natural Resource Management

Specialty: Systems thinking, Participatory systems analysis, Decision Support and Bayesian Networks

Take-home messages:

1. Stakeholders often disagree over actions and policies needed to achieve NRM goals. Systems thinking provides a mechanism for identifying root causes of NRM problems, and when combined with stakeholder participation, assists in creating a common understanding among stakeholders about these causes and the actions and policies needed to tackle them.
2. Bayesian networks are a flexible and visual system modelling tool, capable of integrating qualitative and quantitative data and accommodating uncertainty. This, in combination with their scenario and diagnostic capabilities, makes them well suited to use in participatory systems analysis activities.
3. When implemented within an adaptive management cycle, participatory systems analysis provides a learning environment in which stakeholders can evaluate their assumptions based on the outcomes of previously implemented actions and policies.

Applying systems thinking to natural resource management

This presentation focuses on the application of participatory systems analysis (PSA) and Bayesian networks (BNs) as knowledge integration tools in natural resource management decision-making. PSA is a decision-making approach in which stakeholders participate in solving management problems using systems thinking to identify and relate factors that may affect management objectives. The PSA process involves setting management objectives, abstract modelling to explore the effect of decisions on these objectives, identifying preferred management interventions and monitoring to track the success of implemented management interventions.

Two applications of PSA are given in the presentation: the Queensland Parks and Wildlife Service identifying stumbling blocks to the adaptive fire management in conservation reserves; and in the Philippines where PSA was used to identify policy interventions for improving the quality of tree-seedling production and the effectiveness of tree nurseries.

The purpose of PSA in both cases was for decision support, policy assessment and the prioritisation of management interventions. Bayesian networks (BNs) are used for knowledge integration and a decision-support tool because their graphical nature makes them relatively easy for stakeholders and non-modellers to understand. BNs also use probabilities to relate system factors, giving users the ability to accommodate uncertainty in decision-making. These probabilities can come from several different sources: available data-sets, expert opinion and other models.

This makes BNs a good tool for integrating available knowledge in decision support. BNs can also be used to perform scenario and sensitivity analysis quite quickly and easily, allowing stakeholder groups to identify management intervention points and potential consequences of management and policy decisions. The outcome of these two projects has been the creation of a common understanding among stakeholders regarding management and policy interventions that are most likely to lead to success.

This has allowed investment to be targeted at the most promising interventions and also facilitated the adoption and implementation of these interventions due to stakeholder agreement over what needs to be done. For natural resource management in Australia, PSA and BNs provide tools for tackling complex natural resource management problems with multiple stakeholders. PSA is an effective mechanism for engaging stakeholders, eliciting knowledge and developing a common understanding about the causes of problems and potential solutions.

BNs are an effective tool for integrating available knowledge, accommodating uncertainty and performing scenario analysis so that the most promising set of interventions and policies can be identified. If you're in the business of tackling complex NRM problems with scattered knowledge, multiple stakeholders, uncertainty and a need to achieve coordinated actions among stakeholders, then you will be interested in this work.

Relevant publications

Bosch OJH, King CA, Herbohn JL, Russell IW and Smith CS (2007). Getting the big picture in natural resource management – systems thinking as 'method' for scientists, policy-makers and other stakeholders. *Systems Research and Behavioral Science* 24, 217-232.

Smith C, Howes AL, Price B and McAlpine CA (2007). Using a Bayesian belief network to predict suitable habitat of an endangered mammal – the Julia Creek Dunnart (Sminthopsis douglasi). *Biological Conservation* 139, 333-347.

Smith C, Felderhof L, Bosch OJH (2007). Adaptive management: making it happen through participatory systems analysis. *Systems Research and Behavioral Science* 24, 567-587. (in press) (Accepted 26 April 2007).

Bashari H, Smith C and Bosch OJH (2009). Developing decision support tools for rangeland management by combining state and transition models and Bayesian belief networks. *Agricultural Systems,* 99:23-34.

Sinay L, Smith C and Carter RW (2008). Modelling indigenous cultural change in protected areas. In *Monitoring, Simulation and Management of Visitor Landscapes* (Eds R Gimblett and H Skov-Petersen). University of Arizona Press, Tucson. pp 213-238.

How critical is science in designing environmental policy?

Environmental management presents policy problems that are scientifically, socially and politically complex. Policy solutions that fail to consider and accommodate this complexity will inevitably fail to achieve their desired outcomes.

Across public policy, from aged care to the environment, Governments are demanding that the public sector develop robust evidence-based policy options; that is, policy options that are built on rigorously established objective evidence. In the context of environmental management it would be easy to assume that evidence-based policy design should fundamentally be a science-driven process. This would, however, be a mistake.

Science is just one of class of evidence used in policy formulation. There are clearly legitimate and important roles for scientific knowledge in evidence-based environmental policy design. Scientific knowledge informs the policy debate; it helps identify and articulate potential policy solutions and informs the likely outcomes of a chosen policy solution.

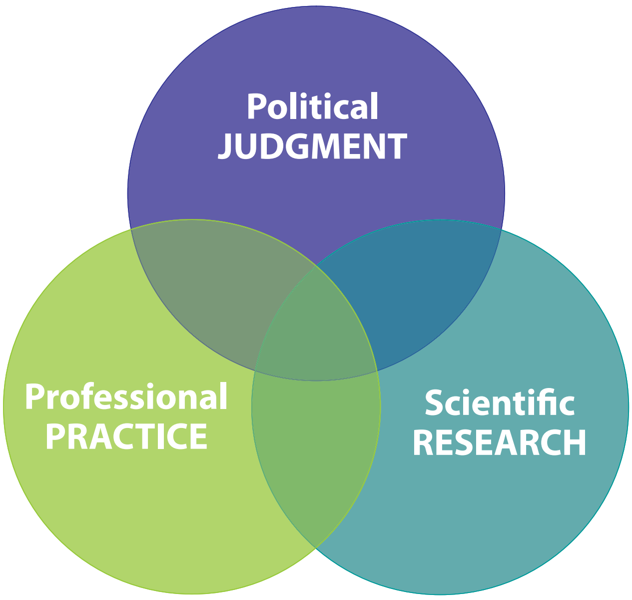
Ensuring that scientific knowledge is appropriately considered requires more than just doing relevant research: it demands that those who manage scientific knowledge clearly understand the policy development process and the roles that they can play in that process. Building on from the previous paper by Charlie Zammit I will draw on recent examples of the role of scientific knowledge in the environmental policy decision-making process.

Relevant publications

Head B (2008) Evidence-based policy: three lenses. *Australian Journal of Public Administration*, 67(1) pp 1-11.

Marston G and Watts R (2003) Tampering with the Evidence: A Critical Appraisal of Evidence-Based Policy-Making. *The Drawing Board: An Australian Review of Public Affairs* 3(3) 143-163.

Rudd K (2008) Address to Heads of Agencies and Members of Senior Executive Service, Canberra. <www.pm.gov.au/media/Speech/2008/speech_0226.cfm>.



Head (2008).

Dr John Whittington

john.whittington@dpiw.tas.gov.au

Department of Primary Industries and Water, Tasmania.

Day 1, 9.45am

Area of work: Government policy – resource and information management.

Specialty: Development and implementation of evidence-based resource management policy.

Take-home messages:

- Effective environmental policy must take into account the scientific, social and political complexity of the issue.
- Scientific knowledge is only one source of evidence used to design evidence-based environmental policy.
- The managers of scientific knowledge need to understand the policy development process and the roles that they can legitimately play if they are to participate effectively in the design of environmental policy.

Dr. Kerrie Wilson

k.wilson2@uq.edu.au

University of Queensland

Day 1, 12.10pm

Area of work: Conservation ecology

Specialty: Setting priorities for conservation investment using ecological and economic theory and accounting for land-use changes and uncertainty.

Take-home messages:

We can prioritise where, when and how to restore using information on the:

- cost of restoration,
- likelihood of restoration success,
- constraints to restoration (e.g. the available budget or capacity), and
- relationship between the area restored and the ecological benefit derived.

Prioritising ecological restoration

The funding available for biodiversity conservation is limited, yet the urgency for effective conservation intervention is escalating. By prioritising our conservation investments we stand a greater chance of making better use of the limited funds and human resources that are available for conservation (Wilson, Underwood *et al*. 2007). While our general preference might be to prevent habitat loss, in some cases there is a need to reverse habitat degradation. Ecological restoration is now widely regarded as essential for biodiversity conservation, particularly in human dominated ecosystems. The prioritisation of restoration activities is critical when there are multiple sites requiring restoration and a variety of restoration approaches that could be implemented (Hobbs and Kristjanson 2003).

In essence we must determine how, where and when a restoration should occur in order to maximise the benefit gained given the available resources. We have developed and applied a restoration prioritisation approach to assist with decisions regarding which restoration actions are the most important to do first, where, and when. We have applied this framework to the Irvine Ranch Reserve in Santa Ana Mountains, Southern California. This 44,000 acre property contains some of the best remaining native ecosystems of Southern California. Although these wildlands are fully protected, they are under significant short and long-term ecological stress from multiple historic and contemporary sources. Without effective and cost-efficient restoration, the hundreds of millions of dollars of public and private funding spent to acquire and protect these lands may be wasted.

A situation that is also common in many areas of Australia and has direct relevance to our research in other regions, such as the Gondwana Link project area of South Western Australia. Our restoration prioritisation approach facilitates the identification of the combination of restoration sites and activities, and the schedule for their implementation that will provide the greatest and most resilient improvement in habitat coverage for a fixed budget. Our approach is spatially- and temporally explicit and accounts for the likelihood of restoration success, the probability of a major catastrophic events (such as fire), and the benefit of spatial connectivity. We can explore the sensitivity of our results to uncertainties in key parameters and compare restoration schedules under alternative benefit functions to demonstrate trade-offs associated with different objectives, assumptions, and preferences for particular outcomes.

Relevant publications

Wilson KA, Carwardine J and Possingham HP. In Press. Setting Conservation Priorities. *Annals of the New York Academy of Sciences*.

Wilson KA, Underwood EC, Morrison SA, Klausmeyer KR, Murdoch WW, Reyers B, Wardell-Johnson G, Marquet PA, Rundel PW, McBride MF, Pressey RL, Bode M, Hoekstra JM, Andelman SJ, Looker M, Rondinini C, Kareiva P, Shaw MR and Possingham HP (2007) Maximising the Conservation of the World's Biodiversity: What to do, Where and When. *PLoS Biology*. 5. e233.

Wilson KA, McBride M, Bode M and Possingham HP (2006) Prioritising global conservation efforts. *Nature*. 440:337-340.

McBride M, Wilson KA, Bode M and Possingham HP (2007) Incorporating the effects of socioeconomic uncertainty into priority setting for conservation investment. *Conservation Biology* 21: 1463-1474.

Murdoch W, Polasky S, Wilson KA, Possingham HP, Kareiva P and Shaw R (2007) Maximising return on investment in conservation. *Biological Conservation* 139:375-388.

Keeping the Auditor-General happy: Demonstrating return on *Caring for Our Country*

After two less-than-glowing reports on the accountability of Australia's natural resource management investments, the Audit Office will expect to see a clear statement on the return on current *Caring for our Country* investments. Substantial challenges remain in:

- identifying and attributing benefits arising from investments
- developing a framework for monitoring
- learning lessons about the cost-effectiveness of these frameworks.

Adaptive management provides a coherent framework for monitoring, learning and improvement. However, developing a coherent adaptive management strategy is not trivial and few practical examples of true adaptive management exist. Two key components of adaptive management that are commonly overlooked are the setting of clear and measurable management objectives and the role of cause-and-effect models in both action prioritisation and monitoring design.

I will discuss some of the key challenges facing the Australian government in designing investment, reporting and improvement strategies under *Caring for our Country*. I will discuss some cause-and-effect modelling and cost-utility analysis methods that may help in addressing these challenges.

Relevant publications

Duncan D and Wintle BA (2008) Towards adaptive management of native vegetation in regional landscapes. In *Landscape Analysis and Visualisation. Spatial Models for Natural Resource Management and Planning*. (Eds C Pettit, I Bishop, W Cartwright, D Duncan, K Lowell and D Pullar). Springer – Verlag GmbH, Berlin.

Wintle BA and Lindenmayer DB (2008) Adaptive risk management for certifiably sustainable forest management. *Forest Ecology and Management* 256:1311-1319.

Cain J (2001) *Planning improvements in natural resources management: Guidelines for using Bayesian networks to support the planning and management of development programmes in the water sector and beyond.* Centre for Ecology & Hydrology, Crowmarsh Gifford, Wallingford, UK.

Dr Brendan Wintle

brendanw@unimelb.edu.au

University of Melbourne

Day 1, 2.20pm

Area of work: Ecology and conservation management.

Area of specialty: Modelling, monitoring, uncertainty analysis, decision-making and furry animals.

Take-home messages:

- Conceptual cause-and-effect models provide the backbone for coherent investment prioritisation, learning and improvement.
- Conceptual models need not be prohibitively complex. Influence diagrams and Bayes Nets provide a relatively simple way to represent a cause-and-effect relationships that can be updated with monitoring data or new information as it arises.
- Adaptive management is a coherent approach for learning and achieving long-term improvements in the cost-efficiency of natural resource management, but it's not simple to design and implement. Documented working examples of adaptive management are sorely needed.

SPEAKER

Dr Charlie Zammit
Charlie.Zammit@deh.gov.au
Department of the Environment, Water, Heritage and the Arts

Day 1, 9.30am

Take-home messages:

1. Building effective professional relationships between research and policy/ management practitioners benefits both: its worth the effort.
2. Understanding the likely and not so likely consequences of different environmental decisions is fundamentally important to government.
3. Government decision-making can be greatly informed by understandable and credible science, but cannot be substituted for by 'black-box' technical tools.

Evidence, values and trade-offs in environmental decision-making

Making decisions about the environment is everyone's business, and these decisions often trade-off a private benefit against a public cost. Understanding and managing the impacts of these costs falls to elected governments through their environment policies and programs.

The history of environmental policy and research in Australia reveals steady advances in reliable evidence of the scale and impact of environmental problems. Alongside this, society continues to demand greater influence over government decision-making through more participatory arrangements that reveal a diversity of competing values and preferences. Moreover, government expenditure on the environment is increasingly expected to deliver a measurable return on investment in the public interest.

Here I will draw on recent examples of decision-making in complex policy situations that illustrate some of the successes and highlight some of the challenges. This policy complexity plays out in a number of ways, including through the institutional arrangements of our federal system of government, the spatial and temporal complexity of ecological systems and the variety of societal values and preferences.

The politics of climate change, water and food security and the global financial crisis will add additional complexities to environmental decision-making, that will both test the effectiveness of existing approaches and open up new opportunities for innovation.

Relevant publications

Gibbons P, Zammit C and 16 others (2008) Some practical suggestions for improving engagement between researchers and policy-makers in natural resource management. *Ecological Management and Restoration* 9(3) pp 182-186.

Head B (2008) Evidence-based policy: three lenses. *Australian Journal of Public Administration*, 67(1) pp 1-11.

Zammit, C, Cockfield G and Funnell S (2000) *A outcomes-based framework for evaluating natural resources management policies and programs*. Land & Water Australia, SIRP Project 6.250/USQ3.

Conference registrants

Mr Jason Alexandra, Murray Darling Basin Commission
Mr David Andrew, DEWHA
Dr Mark Antos, Parks Victoria
Ms Sonya Ardill, DECC New South Wales
Mr Andrew Baldwin, NRM North
Graeme Barden, DEWHA
Mr Tim Barlow, Goulburn Broken CMA
Mr Thomas Barrett, DECC New South Wales
Dr Simon Barry, CSIRO
Prof Nic Bax, Univeristy of Tasmania
Dr Peter Baxter, University of Queensland
Mrs Pamela Beattie, Randall McGuckian Consultants
Ms Sarah Bekessy, RMIT University
Dr Ulrike Bende-Michl, CSIRO
Mr Justin Billing, DEWHA
Dr Michael Bode, University of Melbourne
Ms Annie Bond, O'Connor NRM
Mr Tim Bond, DEWHA
Ms Jenny Boshier, DEWHA
Mr Jeremy Bourgoin, University of Queensland
Mr Greg Bourne, WWF-Australia
Dr Anthony Boxshall, EPA Victoria
Ms Jane Breeding, University of Queensland
Mr David Brewer, CSIRO
Dr Shane Broad, University of Tasmania
Dr Brett Bryan, CSIRO
Dr Yvonne Buckley, University of Queensland
Dr Ashley Bunce, EPA Old
Prof Mark Burgman, University of Melbourne
Dr Emma Burns, DEWHA
Mr Peter Butcher, Glenelg Hopkins CMA
Mr Brian Bycroft, DEWHA
Mr Kerry Cameron, DEWHA
Mr John Carse, Sydney Metro CMA
Dr Iadine Chades, University of Queensland
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Dmitri Young, DECC NSW
Dr Charlie Zammit, DEWHA

DAFF = Department of Agriculture, Forestry and Fisheries DCC = Department of Climate Change
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DPI = Department of Primary Industry DSE = Vic Dept of Sustainability and Environment