ESTIMATING THE VALUE OF ECOSYSTEM SERVICES PROVIDED BY TRAVELLING STOCK ROUTES

A Pilot Study of selected sites in NSW

Final report

Prepared for the National Parks Association of NSW
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Curtis NRA® Australia
Land & Ecological Economists, Environmental Scientists

economists at large
ADDING VALUE TO SOCIETY

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The photo on the cover page is of a TSR in the Lachlan catchment located near Parkes, NSW.

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Contents

Executive Summary

The Travelling Stock Routes and Reserves (TSRs) comprise a vast network in New South Wales and Queensland of public land (some 3 million hectares), bordering roads and creeks and other private and public land, formerly used for intermittent grazing and to drive stock to market. Today they are largely an anachronism. Extra fodder is often purchased and graziers mostly use road transport to take animals to market. Nevertheless, they are often used by local graziers to rest stock and access is allowed to the public, who often camp alongside creeks and roads. They are acknowledged as a valuable conservation resource, often being the only intact native vegetation in a mosaic of cultivated and modified land.

The TSRs in NSW cover an area of approximately 700,000ha and are administered by the Livestock Health and Pest Authority (LHPA). The Rural Land Protection Board (RLPB) administered the TSRs until 2009.

The remnant vegetation within the TSR network is a significant national biodiversity asset but faces possible conversion due to grazing, logging, mining exploration and privatisation. The NSW Government has restructured the TSR management system with an emphasis on economic benefits of TSRs.

This report looks specifically at the economic value of the ecosystem services provided by TSRs, as a proxy for their economic benefit to society. Table 1 in Section 5 of this report provides a tabular summary of the different types of ecosystem services. Two TSR sites in NSW were selected for this pilot study. The study is intended to assess the feasibility of putting a value on the ecosystem services provided by two TSRs with a view to conducting a larger study into the value of the entire TSR network in NSW.

The Travelling Stock Routes (TSRs) used in this pilot study are Borah Creek (261ha) and Saveall Creek(64ha), two larger TSR sites near Tamworth, north-east New South Wales. These sites were selected from a conservation assessment of reserves and TSRs in the Tamworth region.

The methodology to estimate ecosystem service values used in this study was developed by Dr Ian Curtis during his Doctor of Philosophy degree at James Cook University between the years 2000 to 2003. The methodology uses an opportunity cost approach to valuing ecosystem services. Dr Curtis's methodology is based on Land Economics theory and practice, utilising the current median

unimproved land value in a bioregion to set a base value for land that is not traded, such as a National Park, or a TSR. A very simple summary of the methodology is provided in the diagram below:

The TSRs selected for this pilot study were both located near to each other in the New England Bioregion. The median unimproved value per hectare of the alienated (rateable) land in the bioregion was used as a surrogate for the median unimproved capital value per hectare of the un-alienated (public or unrateable land). Adoption of the median unimproved capital value results in a conservative estimate, allowing that other uses of land can co-exist with the provision of ecosystems services.

The mean of this data set is $1,924.43 per ha, and the median is $1,870.30 per ha. However, the 'per' hectare value to be used in this study is only the median ($1,870 per ha).

Capitalisation rates for this 'land use characteristic' would normally be 7 – 8 %, while for this 'level of protection' they would be, say 9%. The higher capitalisation rate of 9% was thus used.

Applying the capitalisation rate to the median capital value, results in an annual value $168.30 per hectare of ecological values, or the production function of the land in its natural state.

Because Borah Creek is a large parcel and majority hillside remnant, adjoining other like vegetation, rather than roadside, the impact of edge effects is likely to be only 5 per cent of the overall value.

Conversely, Saveall Creek is a linear corridor between the road and the creek, such as does exist often for TSRs in NSW. Edge effects are likely to be significant, and on both sides of the lineal corridor. In the case of this parcel edge effects are likely to be up to 50% of the overall value. This is a conservative estimate, as edge effects can extend up to 200 metres (decreasing) into a forest from an edge.

Using the median of the unimproved capital values, accounting for the status of the forest and edge effects, the dollar values of the ecosystem goods and services provided by these parcels of land are given in the table below.

Parcel	Area (Ha)	Per Ha Per Annum	Total	Status Open Forest Fig D16 contribution at 67%	Edge Effects	Total Value per Annum after edge effects
Borah Creek	261	$168	$44,555	$29,852	5%	$28,359
Saveall Creek	60	$168	$10,288	$6,893	50%	$3,446

These two areas represent just 321ha of a total of approximately 700,000ha of TSRs in New South Wales. To value the ecosystem services for these areas of public land at zero is clearly inappropriate. Despite this, putting a value on the entire network would take a considerable amount of work.

In order to put a value on the entire TSR network in New South Wales, site-specific ecological surveys would be required. These surveys would need to record the total area of the TSR, the vegetation type, density, adjoining land use and likely edge effects. Improved mapping would also be useful. These are not insurmountable barriers and this pilot study has shown that the ecosystem service values of TSRs to the public can be quantified. These values should be considered in ongoing discussion about the tenure and management of TSRs.

1.0 Introduction

The National Parks Association of New South Wales (NPA NSW) has an ongoing campaign to highlight the Travelling Stock Routes and Reserves (TSRs) network in NSW as a public resource linking critical habitats across the landscape.

The remnant vegetation within the TSR network is a significant national biodiversity asset but faces possible conversion due to grazing, logging, mining exploration and privatisation. The NSW Government has restructured the TSR management system with an emphasis on economic benefits of TSRs.

This report developed out of work done by Economists at Large outlining the various ways in which the economic benefits of TSRs could be estimated. This work was presented at the 2nd TSR conference held in Orange, NSW, in July 2011.

2.0 Scope of the Research

This report looks specifically at the economic value of the ecosystem services provided by TSRs, as a proxy for their economic benefit to society. Table 1 in Section 5 of this report provides a tabular summary of the different types of ecosystem services. Two TSR sites in NSW were selected for this pilot study. The study is intended to assess the feasibility of putting a value on the ecosystem services provided by two TSRs with a view to conducting a larger study into the value of the entire TSR network in NSW.

3.0 The Travelling Stock Routes

The Travelling Stock Routes (TSRs) comprise a vast network in New South Wales and Queensland of public land (some 3 million hectares), bordering roads and creeks and other private and public land, formerly used to drive stock to market. Today they are largely an anachronism, as graziers now largely use road transport to take animals to market. Nevertheless, they are often used by local graziers to rest stock and access is allowed to the public, who often camp alongside creeks and roads. They are acknowledged as a valuable conservation resource, often being the only intact native vegetation in a mosaic of cultivated and modified land.

The TSRs in NSW cover an area of approximately 700,000ha and are administered by the Livestock Health and Pest Authority (LHPA). Until 2009 they were administered by the Rural Land Protection Board (RLPB).

4.0 The Sites Selected for the Pilot Study

The Travelling Stock Routes (TSRs) used in this pilot study are Borah Creek and Saveall Creek, two larger TSR sites near Tamworth, north-east New South Wales. These sites were selected from a conservation assessment of reserves and TSRs in the Tamworth region, Spark (2010). Borah Creek and Saveall Creek are numbered 173 and 174 in Spark (2010), who describes them as follows:

> ***173 "Borah Creek":*** *Mature grassy Yellow Box, Blakeley's Red Gum, Roughbark Apple woodland, mixed age, natural tree and shrub density. Good riparian veg, River Oak, on lower slope/riparian. Very high native plant diversity, low exotic plant diversity, very high landscape connectivity. Linking hill remnant to creek roadside….Yellow Box woodland, good native ground cover, few weeds invading, Coolatai sparse, very controllable, good riparian veg*
>
> ***174 "Saveall Creek":*** *Linear shrubby/grassy mature woodland & open forest, White Box, Blakeley's Red Gum, Roughbark Apple, Stringybark, Mugga Ironbark, River Oak riparian; Very high native plant diversity, low exotic plant diversity, very high landscape connectivity. Linking corridor along creek and road….Linear roadside reserve, minimal disturbance, HCV woodland/open forest, few weeds, Coolatai controllable along roadside, northern granite end becomes widespread, Mugga Ironbark, fence off conservation area, with management to include 200m weed buffer, and exclude bees*

The LHPA provided maps of the sites with the following data. Maps are contained in the appendices, as the detail wasn't sufficient to be useful for inclusion in the body of this report.

Table 1. TSR sites chosen for the pilot study

	Lot and DP numbers	Area (ha)
Borah Creek TSR	1054268/7011; 1054263/7005; 1086535/7007; 1086536/7001; 93874/7003, and 1114674/7001	260.935
Saveall Creek TSR	1110766/7005; 1130035/7300, and 1112850/7002	64.251

5.0 The Research Methodology

The methodology used in this study was developed by Dr Ian Curtis during his Doctor of Philosophy degree at James Cook University between the years 2000 to 2003. The methodology uses an opportunity cost approach to valuing ecosystem services. Dr Curtis' thesis has been downloaded nearly 4,000 times by researchers in 90 countries and his findings were published in the Elsevier Journal of Ecological Economics in 2004. This journal article was in the top 25 downloads for three consecutive quarters, and has been cited 67 times. This methodology has also been published in the Australian and New Zealand Property Journal, and utilised by government, private sector, legal bodies and NGOs to value environmental assets and damage, see table 1:

Table 1: Some significant uses of Curtis NRA ecosystems service valuation methodology

User	Year	Context/publication
Brisbane City Council	**2005**	Establishing market-based instruments for conservation initiatives on private land
Powerlink Queensland	**2006**	Valuation of transmission line clearing though Allies Creek State Forest (published in the *Australian Property Journal*: June 2006 Vol 39 No.2, pp 87-96)
National Court of PNG	**2011**	Basis of decision to award US$97.2 million in damages to four tribes in the Western Province of PNG for environmental destruction caused by illegal logging. (published in the *Australian and New Zealand Property Journal*: June 2011 Vol 3 No.2, pp 63-73)
Maules Creek Community Council	**2011**	Valued the pecuniary loss of ecological services due to the clear felling of Leard State Forest (Critically Endangered EEC.) to accommodate an open cut coal mine.

Dr Curtis's methodology is based on Land Economics theory and practice, utilising the current median unimproved land value in a bioregion to set a base value for land that is not traded, such as a National Park, or a TSR. Every use of land has an opportunity cost, that being the existing use or other uses to which the land could be put (Edwards 1987; McNeeley 1988; Frank 1991). As conservation areas cannot be developed or redeveloped, the value of conservation should be at least as much as the cost of preserving it, as measured by the cost of the foregone opportunities (Allison *et al.,* 1996).

Marginal opportunity cost can be expressed in terms of the annual net revenue foregone, in which case it would be capitalised, resulting in a land value in restricted and unrestricted use (McNeeley 1988). These concepts clearly link the natural production function of land (i.e. ecosystem services) with land valuation procedures. As ecosystem goods and services are the production function of land in its natural state (the *Usus Fructus per annum*), and as ecosystem goods and services are essential for planetary life support (Ke Chung and Weaver 1994), it could be argued that the provision of ecosystem goods and services are the 'highest and best use' of land.

Individuals in the community constantly reveal their preferences to purchase property for a multitude of uses. The pecuniary measures of these preferences are used as comparable sales by state agencies charged with the responsibility of valuing property and determining unimproved values as a basis for levying rates and taxes. The collective values thus underpin the costs of administration and provision of infrastructure in the bioregion (Lambert 1932; Herps 1942; Murray 1954; Blackwell 1994). Unimproved values are assessed on the principle of the highest and best legal use, yet assume that improvements do not and have never existed.

To rank and classify the relative value of the 20 individual ecosystem goods and services this methodology utilises the results of a Delphi Panel enquiry, which was comprised of up to 50 scientists and economists (see Table 2 on following page).

Table 2. The now commonly accepted suite of ecosystem goods and services (Curtis 2003; 2004, adapted and modified after Costanza 1997 and Cork and Shelton 2000).

Group	Type
Stabilisation Services	Gas regulation (atmospheric composition)
	Climate regulation (temperature, rainfall)
	Disturbance regulation (ecosystem resilience)
	Water regulation (hydrological cycle)
	Erosion control and soil/sediment retention
	Biological control (populations, pest/disease control)
	Refugia (habitats for resident and transient populations)
Regeneration Services	Soil formation
	Nutrient cycling and storage (including carbon sequestration)
	Assimilation of waste and attenuation, detoxification
	Purification (clean water, air)
	Pollination (movement of floral gametes)
	Biodiversity
Production of Goods	Water supply (catchment)
	Food production (that sustainable portion of GPP)
	Raw materials (that sustainable portion of GPP, timber, fibre etc.)
	Genetic resources (medicines, scientific and technological resources
Life Fulfilling Services	Recreation opportunities (nature-based tourism)
	Aesthetic, cultural and spiritual, (existence values)
	Other non-use values (bequest and quasi option values)

A summary of the methodology as applied to the pilot study sites is outlined below.

Figure 1: Summary of research methodology

6.0 Applying the methodology to NSW TSRs

6.1 Ascertaining unimproved land values

In this study, the surrogate market is the broader property market in the bioregion where the travelling stock routes are located. However, it is also necessary to determine 'what' and 'how much' is being produced in the context of ecosystem goods and services. Two models, the LOP (Level Of Protection) model and the LUC (Land Use Characteristics) model, were chosen to properly reflect the type and status of the selected TSRs, namely 'Open Forest' and 'State Forest'. Open forest refers to the level of canopy cover, a surrogate for species richness. This categorisation is only used in the LUC (land use characteristics model). State Forest refers to the level of protection (LOP model), and gives an idea of the tenure of the land, which is important in the concept of conservation, and assessment of risk.

6.2 Estimating the annual flow of benefits

To estimate the annual flow of benefits from the TSRs, it is necessary to estimate the capitalisation rate. The capitalisation rate is similar to the concept of a return on investment, being the ratio of the annual net income to capital costs for a particular asset. In other words, if a TSR has a capital value based on land values, what is the annual income value derived from the asset? Once the capital value for the land is established, identifying a suitable capitalisation rate allows for estimates of the annual value to be calculated. The capitalisation rate is determined by a study of the market relevant to scarcity and risk and by using ecological models based upon the relationship between vegetation cover and species richness, land use characteristics and level of protection. The models are proprietary, however, they are based on the collective work of Holdridge (1967), Lugo (1988), Brown and Lugo (1982), Mooney (1988) and McArthur and Wilson (1967).

The LOP model uses Level Of Protection to set the capitalisation rate. As the level of protection decreases, the capitalisation rate increases reflecting risk (Figure D4).

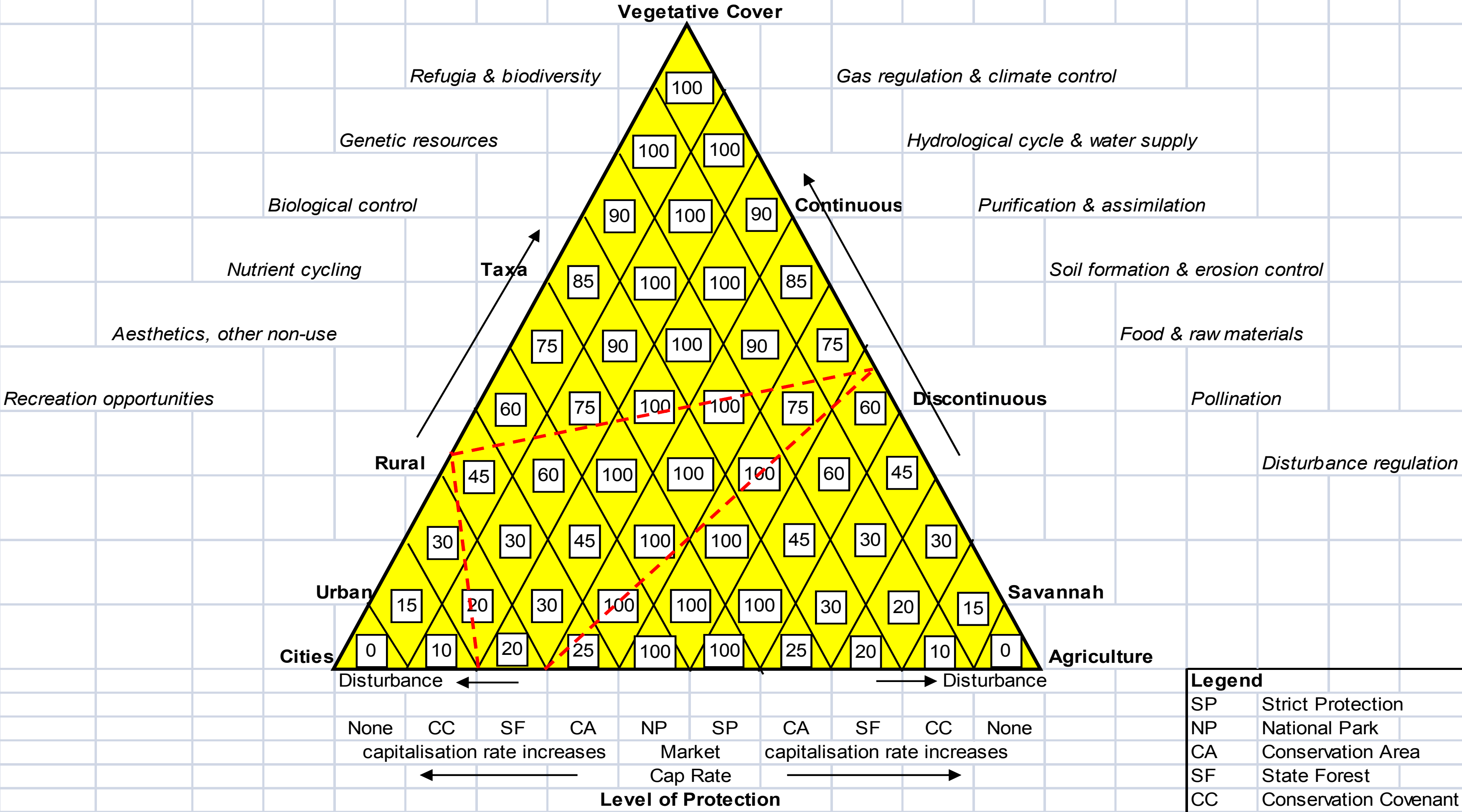
The LUC model uses Land Use Characteristics to set the capitalisation rate. As human and climate induced modification increases, so does the capitalisation rate in order to reflect scarcity of ecosystem goods and services (Figure D16). Both models are also used to determine 'how much' ecosystem goods and services are being produced, which are expressed as a range.

The relationship between vegetation cover and species richness is generally 3:2, except for Mediterranean climate ecosystems, where it is generally 1:1 (Mooney 1988). As both alienated and un-alienated land provide ecosystem services it is important to be able to estimate the extent to which the land contributes to the overall contribution. Depending on the level of disturbance, other human activities on the land can co-exist with the provision of ecosystem services.

6.3 Factoring in edge effects

Edge effects is a term used in ecology to refer to the impact of two different habitats meeting at their respective boundaries. In the case of the sites selected, this refers to the effects at boundaries with cleared non-TSR land. Edge effects can encompass both human induced and other biophysical effects, including microclimate variables across the ecotone. Edge effects can serve to reduce the ecosystem service value of a TSR where the remnant vegetation is adversely impacted.

An example of an edge effect is the amount of photosynthetically active radiation (PAR) reaching the forest floor, which has a significant relationship with distance from clearing – the effect is greatest at the edge and decreases with distance from the edge. Increases in PAR cause increases in soil temperatures at the surface and to some depth and can lead to emergence of alien species. The effect extends inwards depending on the orientation of the corridor and season. Wide clearings or gaps without canopy retention allow greater invasion of weeds, and result in greater penetration of disturbance indicator species (Goosem and Turton 2000). Such effects can extend further into an open forest environment, such as these sites, though are often more pronounced in closed canopy environments, i.e. rainforest, as changes in air temperatures and vapour pressure deficits are caused by the edge (Goosem and Turton 2000).

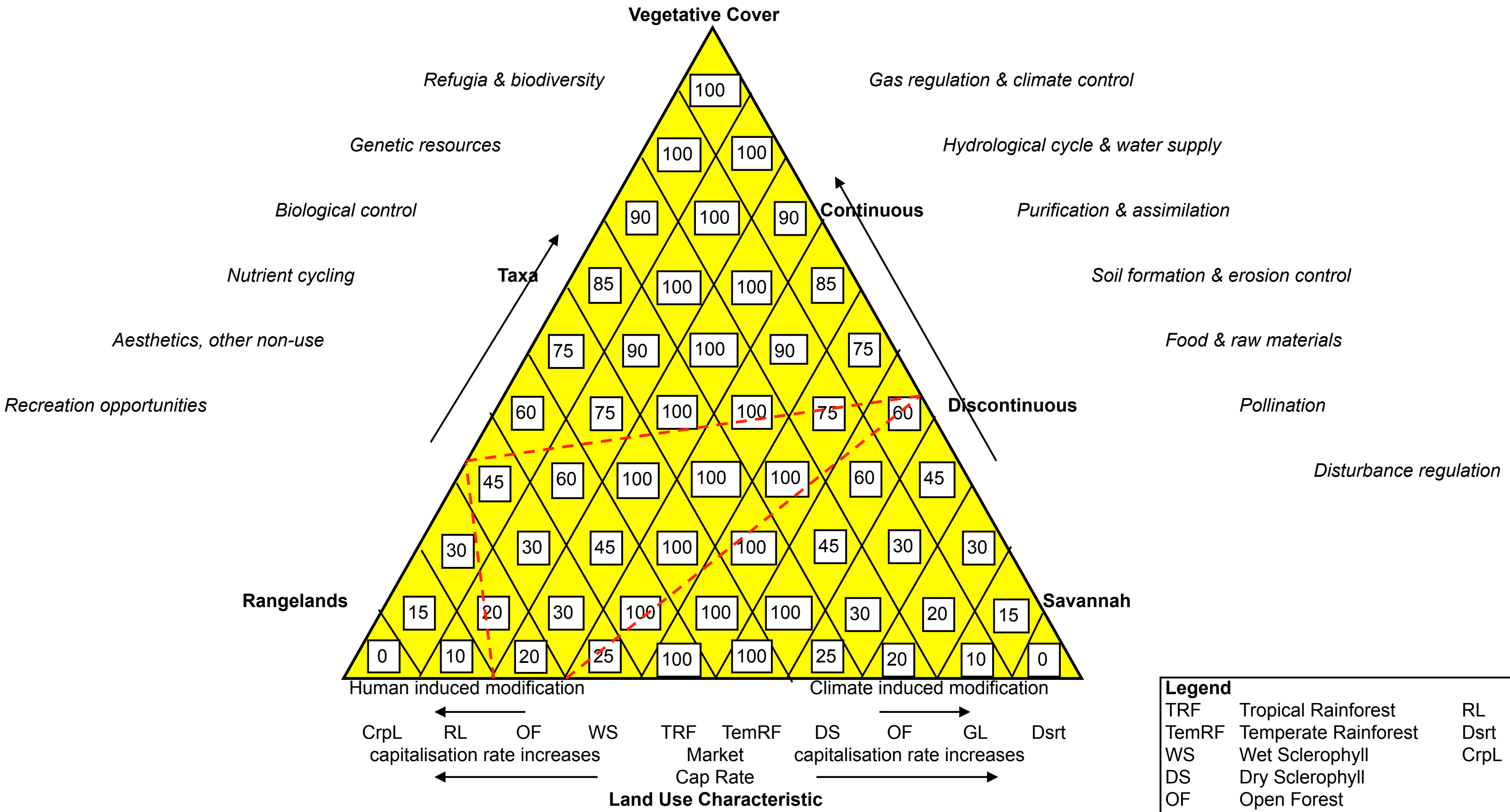


Legend	
SP	Strict Protection
NP	National Park
CA	Conservation Area
SF	State Forest
CC	Conservation Covenant
None	No protection

Figure D4. Triangulation model to assess extent of ecosystem services intact under a given level of protection or no protection

Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.

This example, State Forest: 66%



Legend			
TRF	Tropical Rainforest	RL	Rangelands
TemRF	Temperate Rainforest	Dsrt	Desert
WS	Wet Sclerophyll	CrpL	Croplands
DS	Dry Sclerophyll		
OF	Open Forest		
GL	Grasslands		

Figure D16. Triangulation model to assess extent of ecosystem services intact under a given land use characteristic
Scoring: Calculate the mean of the values within the diamonds included in the selection as well as those the dotted line passes through.

7.0 Applying the methodology to the pilot sites

The TSRs selected for this pilot study were both located near to each other in the New England Bioregion. The local government areas (LGAs) that are contained wholly within or that administer parts of the bioregion were ascertained and consulted as to the total rateable value of alienated land within their jurisdiction, and the total area of that land. A dollar value per hectare was calculated for each LGA (total rateable value/total area). Statistical analysis was performed on the resulting set of dollar values for the LGAs, and the range, mean, median, mode, standard deviation and skewness calculated. Owing to the variability in the data (range), due to varying degrees of urbanisation, development, use, distance from services, and average parcel size, the data set could have been expected to have a high degree of positive skewness (in this case Armidale Dumaresq). The measure of central tendency most commonly accepted for this type of skewed data set is the 'median', which will provide the fairest approximation of all of the uses to which land is put in the bioregion on a *broadacre* basis and will take into account all of the various principles and factors that affect the value of land.

7.1 Ascertaining unimproved land values

The median unimproved value per hectare of the alienated (rateable) land in the bioregion was then used as a surrogate for the median unimproved capital value per hectare of the un-alienated (public or unrateable land). This is consistent with valuation practice (McNamara 1983). However adoption of the median unimproved capital value as a surrogate value implies that the value is for the 'median' use in the region and not the single 'highest and best' use. It is thus a conservative estimate, allowing that other uses of land can co-exist with the provision of ecosystems services.

Table 3. The current real property valuation calculations for each shire in the New England Bioregion (as supplied to the relevant Shire Councils by the NSW Valuer General).

LGA	Total VG valuation (for rating purposes)	Gross Shire Area (Ha)	$ value per hectare
Tenterfield	$891,963,115	713,439	$1,250.23
Glenn Innes Severen	$988,291,300	548,700	$1,800.15
Guyra	$847,776,537	436,900	$1,940.44
Uralla	$700,628,210	321,500	$2,179.25
Armidale Dumaresq	$1,881,029,555	432,500	$2,938.98
Walcha	$920,052,917	640,028	$1,437.52

The mean of this data set is $1,924.43 per ha, and the median is $1,870.30 per ha. However, the 'per' hectare value to be used in this study is only the median ($1,870 per ha).

Using the LOP and LUC models for 'open forest' and 'state forest', the level of contributions of ecosystem services compared to the highest level, which is a closed canopy tropical rainforest, are 66% and 67%.

7.2 Estimating the annual flow of benefits

Capitalisation rates for this 'land use characteristic' would normally be 7 – 8 %, while for this 'level of protection' they would be, say 9%, that is higher than for say, a Wet Tropics World Heritage Area rainforest, as the higher capitalisation rate reflects an elevated risk. In the case of these TSRs, clearly there has been little formal protection afforded by their status, or the native vegetation clearing laws. Under these circumstances, the higher capitalisation rate of 9% will be adopted for the purpose of this report.

Applying the capitalisation rate to the median capital value, results in an annual value $168.30 per hectare of ecological values, or the production function of the land in its natural state.

7.3 Factoring in edge effects

In considering the ecological service values of these sites, it is important to note the location of the two sites in the broader landscape. As Saveall Creek is a linear reserve with frontage along a road and a creek, it will have more pronounced edge effects than Borah Creek.

Borah Creek and Saveall Creek have significant ecological value, as being largely undisturbed, and with minimal threatening processes in play. Borah Creek, being midslope, and extending down to the roadside, has limited edge effects, that is to say the edge effects are limited to the road boundary. Borah Creek is also a large parcel (260.935 hectares), majority hillside remnant, adjoining other like vegetation, rather than roadside, and as such the impact of edge effects is likely to be only 5 per cent of the overall value.

Conversely, Saveall Creek (60.251ha) is a linear corridor between the road and the creek, such as does exist often for TSRs in NSW. Edge effects are likely to be significant, and on both sides of the lineal corridor. In the case of this parcel edge effects are likely to be up to 50% of the overall value. This is a conservative estimate, as edge effects can extend up to 200 metres (decreasing) into a forest from an edge.

7.4 Annual ecosystem service value estimates

Using the median of the unimproved capital values in Table 2 above, the dollar values of the ecosystem goods and services provided by these parcels of land are given in Table3 below.

Table 4. Estimates of ecosystem service values of pilot TSR sites

Parcel	Area (Ha)	Per Ha Per Annum	Total	Status Open Forest Fig D16 contribution at 67%	Edge Effects	Total Value per Annum after edge effects
Borah Creek	261	$168	$44,555	$29,852	5%	$28,359
Saveall Creek	60	$168	$10,288	$6,893	50%	$3,446

7.0 Conclusions and recommendations

This pilot study estimated the ecosystem service values per annum for two travelling stock route sites within New South Wales, Borah Creek and Saveall Creek. The study used unimproved land valuations for the region to estimate a proxy value for the annual flow of ecosystem services. After considering edge effects, the total per annum value of ecosystem services is estimated at $28,000 for Borah Creek and $3,400 for Saveall Creek. These two areas represent just 321ha of a total of 700,000ha of TSRs in New South Wales. To value the ecosystem services for these areas of public land at zero is clearly inappropriate. Despite this, putting a value on the entire network would take a considerable amount of work.

In order to put a value on the entire TSR network in New South Wales, site-specific ecological surveys would be required. These surveys would need to record the total area of the TSR, the vegetation type, density, adjoining land use and likely edge effects. Improved mapping would also be useful. These are not insurmountable barriers and this pilot study has shown that the ecosystem service values of TSRs to the public can be quantified. These values should be considered in ongoing discussion about the tenure and management of TSRs.

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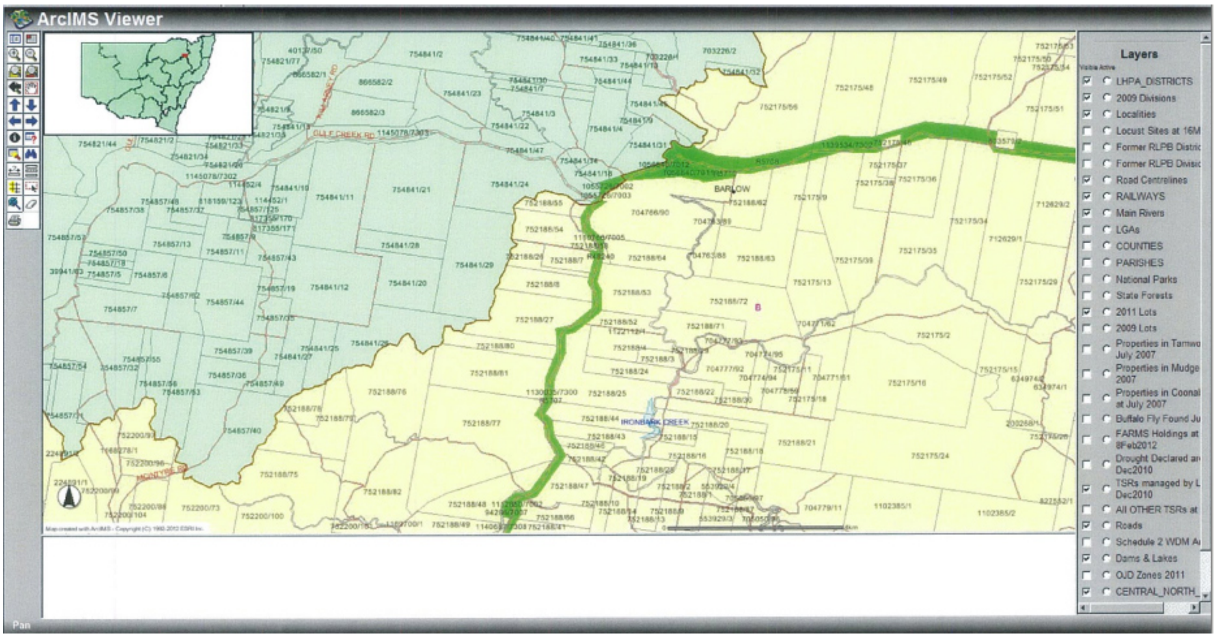
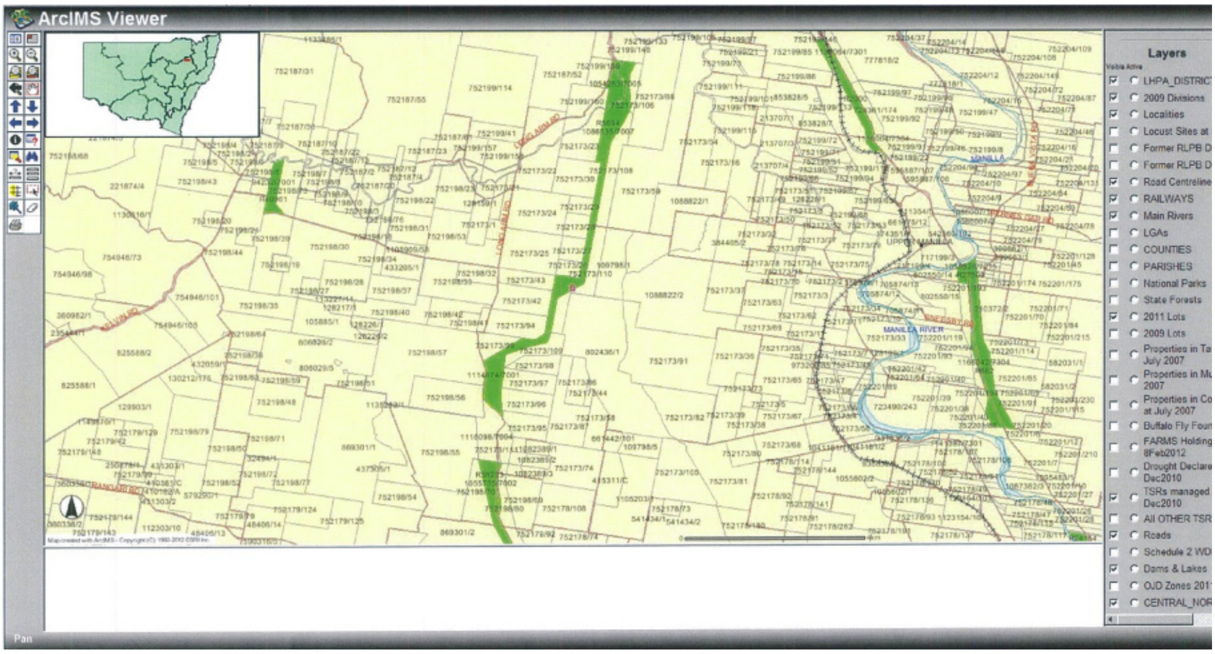
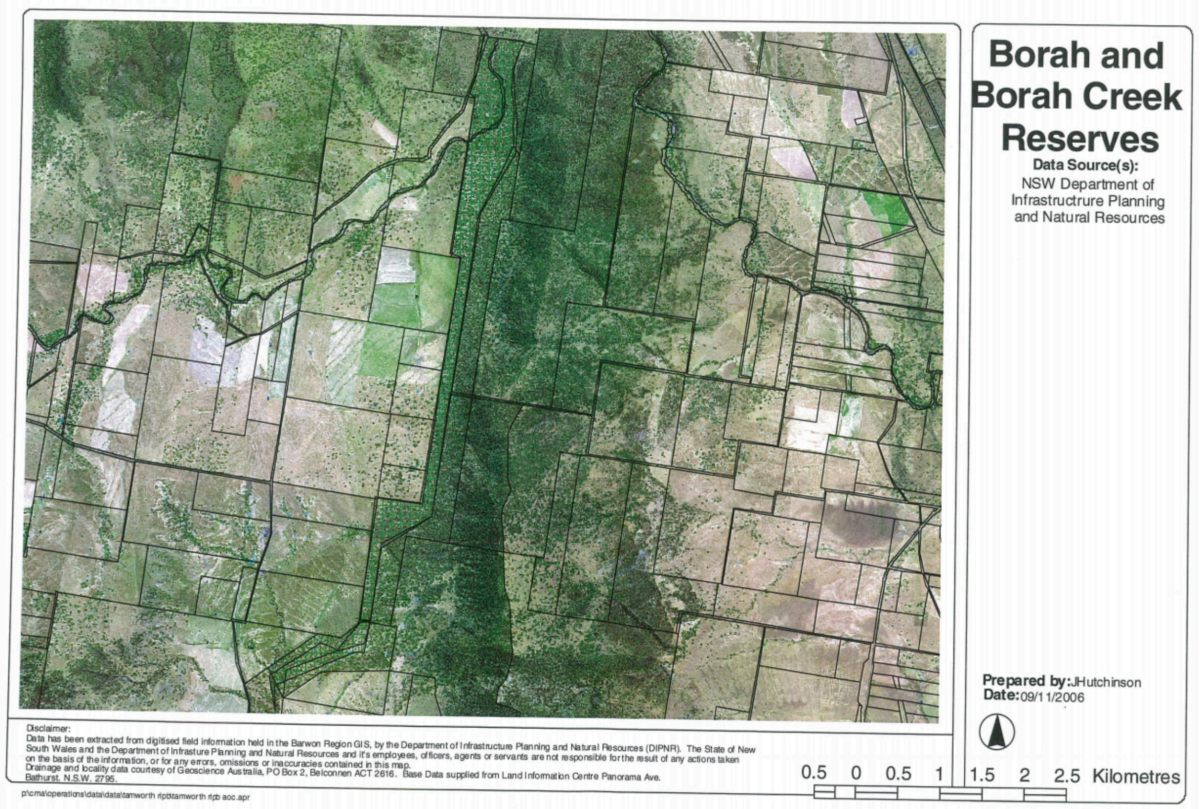
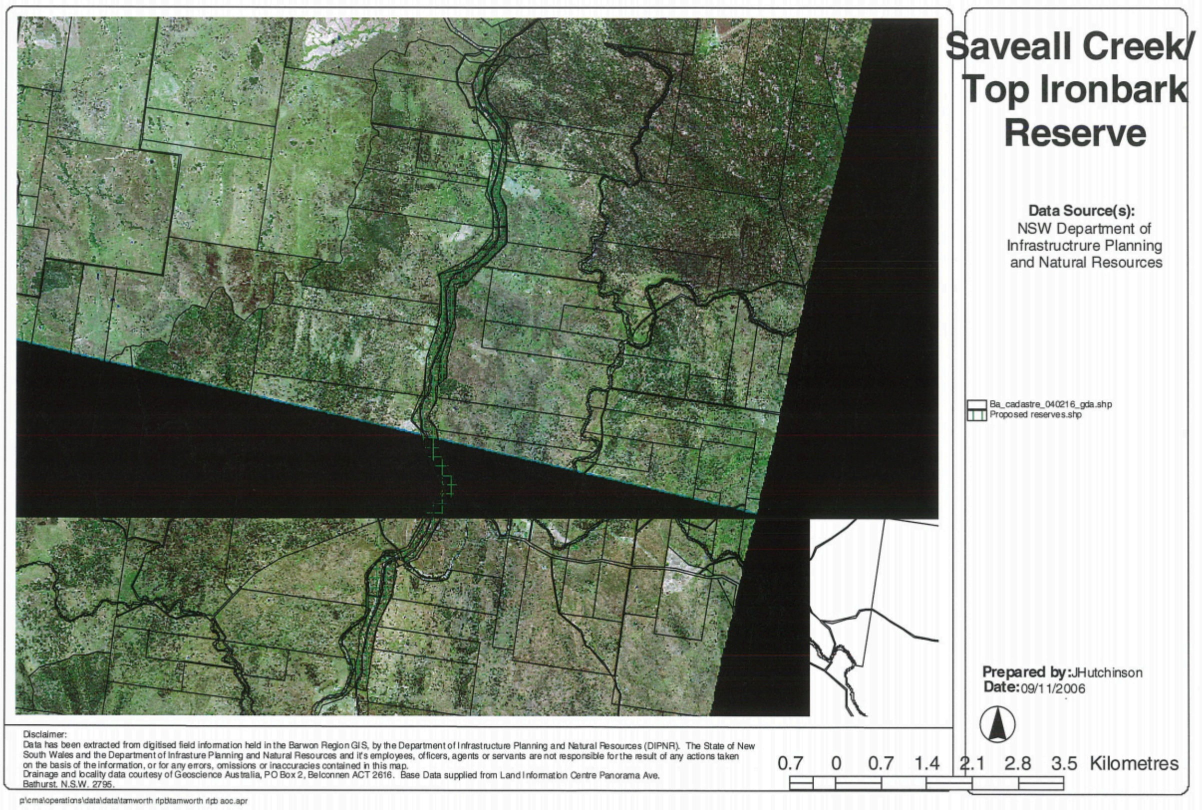
Appendices

Maps of sites for pilot study






Borah and Borah Creek Reserves
Data Source(s):
NSW Department of Infrastructrure Planning and Natural Resources
Prepared by: JHutchinson
Date: 09/11/2006
0.5 0 0.5 1 1.5 2 2.5 Kilometres
Disclaimer:
Data has been extracted from digitised field information held in the Barwon Region GIS, by the Department of Infrastructure Planning and Natural Resources (DIPNR). The State of New South Wales and the Department of Infrasture Planning and Natural Resources and it's employees, officers, agents or servants are not responsible for the result of any actions taken on the basis of the information, or for any errors, omissions or inaccuracies contained in this map.
Drainage and locality data courtesy of Geoscience Australia, PO Box 2, Belconnen ACT 2616. Base Data supplied from Land Information Centre Panorama Ave. Bathurst. N.S.W. 2795.
p:\cma\operations\data\data\tamworth rlpb\tamworth rlpb aoc.apr


Saveall Creek/ Top Ironbark Reserve
Data Source(s):
NSW Department of Infrastructrure Planning and Natural Resources
Ba_cadastre_040216_gda.shp
Proposed reserves.shp
Prepared by: JHutchinson
Date: 09/11/2006
0.7 0 0.7 1.4 2.1 2.8 3.5 Kilometres
Disclaimer:
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