Valuing Australia's protected areas: A life satisfaction approach

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Abstract

This paper uses the life satisfaction approach to value Australia's protected areas, grouped by IUCN protected area management category. We find significant positive life satisfaction effects of living in close proximity to protected areas in three of the seven categories. These life satisfaction effects correspond to implicit willingness-to-pays, in terms of annual household income, of approximately $2,950 (IUCN category IB), $6,650 (IUCN category III) and $9,650 (IUCN category IV) for a one per cent increase in the extent of that category of protected area within an individual's local area.

Keywords: Happiness; Household, Income and Labour Dynamics in Australia (HILDA); Protected Areas; Life Satisfaction; Non-market Valuation.

JEL Classification: C21; Q51; R20

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1. Introduction

It is well recognised that protected areas are the cornerstones of biodiversity conservation and provide many use and non-use benefits to humans. It is equally well recognised that many protected areas face pressure from alternative uses such as mining, forestry, agriculture and housing. Furthermore, protected areas are frequently under resourced in terms of the extent of area given protected status and the level of funding provided for management. As governments around the world seek to address budgetary concerns arising out of the global financial crisis, adequate future funding for protected natural areas is far from assured.

Australia has an extensive network of protected areas, covering approximately 95.5 million hectares or 13 per cent of the continent's land mass (Australian Government, 2012). Because many of the benefits provided by these areas are not priced, or are underpriced, there is a danger of these areas not being valued, or being undervalued; thus distorting resource allocation away from the use of protected areas for non-market purposes, towards use of the areas for activities which return an observable market value. That is, in the absence of any formal valuation put on the non-market services that the protected area provides, there may be pressure for the area to be developed for alternative uses (Tisdell, 2006). In contrast, the costs of acquiring and managing protected areas are often readily apparent and easily quantifiable in monetary terms (Dixon & Sherman, 1991).

In order to make rational resource allocation decisions among competing uses, it is necessary that *all* uses are able to be compared on an even footing. This requires the value of non-priced or under-priced uses to be estimated; this is the fundamental purpose of non-market valuation.

By convention, non-market valuation techniques are divided into two approaches. The revealed preference approach relies on observations about peoples' behaviour in markets that are someway related to the environmental good or service under consideration, while the stated preference approach uses surveys to elicit how respondents value that good or service. Techniques can be further divided into direct and indirect, depending upon whether a value is directly measured or inferred. Commonly used revealed preference techniques include hedonic pricing and the travel cost method, commonly used stated preference techniques include contingent valuation and choice modelling.

One technique to recently emerge is the 'life satisfaction approach'. Simply, this approach entails the inclusion of non-market goods as explanatory variables within micro-econometric functions of life satisfaction along with income and other covariates. The estimated coefficient for the non-market good yields first, a direct valuation in terms of life satisfaction, and second, when compared to the estimated coefficient for income, the implicit willingness-to-pay for the non-market good in monetary terms (Frey, Luechinger, & Stutzer, 2010).

The purpose of this paper is to demonstrate the use of the life satisfaction approach in the context of valuing Australia's protected areas. To the extent of our knowledge this is the first application of the life satisfaction approach to protected areas, contributing to the existing non-market valuation literature as well as the economic literature on life satisfaction. The paper proceeds as follows. Section 2 serves as a brief literature review. Methodology and data are the subject of Section 3. Results are presented and discussed in Section 4. Section 5 concludes.

2. Literature review

There is a substantial body of literature employing conventional non-market valuation techniques to value protected areas. Those seeking an extensive review of the theory, methods and literature across a range of non-market valuation techniques and applications should refer to Freeman (2003).

Greig's (1973) study of the Grampian Mountains in Victoria represents one of the earliest applications of the revealed preference travel cost method to valuing the (recreational) value of a protected area in Australia. Many subsequent travel cost studies have paid particular attention to estimating the recreational values of Australia's National Parks, with Warrumbungle (Ulph & Reynolds, 1981), Great Sandy (Fleming & Cook, 2008; Hundloe, McDonald, Blamey, Wilson, & Carter, 1990), Kakadu (Knapman & Stanley, 1991), Lamington (Scoccimarro, 1992), Hinchinbrook Island (Stoeckl, 1993), Girraween (Beal, 1995a), Carnarvon Gorge (Beal, 1995b), Mount Buffalo (Herath & Kennedy, 2004) and Bellenden Ker (Nillesen, Wesseler, & Cook, 2005) among the protected areas examined. In an application of the hedonic pricing technique, Pearson, Tisdell & Lisle (2002) estimate the impact of Noosa National Park on surrounding property values.

Australian examples of the stated preference contingent valuation method include a valuation of the Kakadu Conservation Zone (Imber, Stevenson, & Wilks, 1991), assessment of community support for a new national park in north-east New South Wales (Duthy, 2002), estimation of recreational values for Sale wetlands in Victoria (Sappideen, 1992), valuing national (Herath & Kennedy, 2004) and inner-city (Lockwood & Tracy, 1995) parks, as well as estimates of willingness-to-pay for cave conservation in Western Australia (Tapsuwan, Burton, & Perriam, 2010).

In the studies noted above, utility is inferred via either observed expenditure or stated willingness-to-pay. The use of more direct measures of utility, such as those provided by self-reported life satisfaction scores offers an alternative approach (cf. Frey, et al., 2010). Outside of the non-market valuation literature, the life satisfaction literature has devoted a great deal of effort to better understanding what determines an individual's level of life satisfaction, with a number of stylised 'facts' becoming apparent. For example, a common finding is that men are less happy than women (cf. Blanchflower & Oswald, 2004). Age is U-shaped, with happiness reaching a minimum in a person's 30s and 40s (Blanchflower & Oswald, 2004). Marriage improves a person's life satisfaction (cf. Evans & Kelley, 2004) however, Blanchflower and Oswald (2004) find second and subsequent marriages to be less happy than first marriages. Evidence on the effect of children is complex, although on balance life satisfaction appears to decrease as the number of dependent children increases (cf. Margolis & Myrskyla, 2010).

Poor health invariably lowers life satisfaction, as does unemployment (Powdthavee & Van Praag, 2011). The influence of education is not straightforward; additional years of schooling promote greater life satisfaction (cf. Oreopoulos, 2007) whereas, in developed countries at least, tertiary education has a negative or statistically insignificant influence on life satisfaction (cf. Gong, Cassells, & Keegan, 2011; Shields, Price, & Wooden, 2009; Veenhoven, 1996). This finding is explained by Helliwell (2003) as providing evidence that the benefits of education flow less through a direct impact on life satisfaction than through its positive effects on the creation and maintenance of human and social capital. A comprehensive review of life satisfaction or happiness in economics is provided by Frey and Stutzer (2002a, 2002b) and MacKerron (2011).

A small body of literature suggests that natural environments are a key driver of life satisfaction (cf. Brereton, Clinch, & Ferreira, 2008; Smyth, Mishra, & Qian, 2008). It is from this literature that the life satisfaction approach to non-market valuation has developed. The approach offers several advantages over more conventional non-market valuation techniques. For example, the approach does not rely on the assumption of weak complementarity between the non-market good and consumption expenditure (an assumption underpinning the travel cost method). Nor does it rely on housing markets being in equilibrium (an assumption underpinning the hedonic property pricing method). Further, the approach does not ask individuals to directly value the non-market good in question, as is the case in contingent valuation. Nor does it ask individuals to make explicit tradeoffs between market and non-market goods, as is the case in choice modelling. Instead, individuals are asked to evaluate their general life satisfaction. This is perceived to be less cognitively demanding, as specific knowledge of the good in question is not required and respondents are not asked to perform the unfamiliar task of placing a monetary value on a non-market good. Further, the approach avoids the problem of lexicographic preferences, where respondents to contingent valuation or choice modelling questionnaires demonstrate an unwillingness to trade off the non-market good for income (Spash & Hanley, 1995). There is also no reason to expect strategic behaviour or social desirability bias in relation to the good being valued (Welsch & Kuhling, 2009).

While there is growing evidence to support the suitability of individual's responses to life satisfaction questions for the purpose of estimating non-market values (cf. Frey, et al., 2010), some potential limitations remain. Crucially, self-reported life satisfaction must be regarded as a good proxy for an individual's utility. Evidence in support of the use of this proxy is provided by Frey and Stutzer (2002b) and Krueger and Schkade (2008).

Furthermore, in order to yield reliable non-market valuation estimates, self-reported life satisfaction measures must: (1) contain information on respondents' global evaluation of their life; (2) reflect not only stable inner states of respondents, but also current affects; (3) refer to respondents' present life; and (4) be comparable across groups of individuals under different circumstances (Luechinger & Raschky, 2009).

In applying the life satisfaction approach there is another limitation to consider; the estimation of the income coefficient. There is some evidence to suggest that people who are more satisfied with their lives earn more (that is, there is a degree of reverse causality). For example, extraverted people are more likely to report higher levels of life satisfaction and be more productive in the labour market (Powdthavee, 2010). In the most recent study to investigate this issue, however, Pischke (2010) finds evidence to suggest that the direction of the income–life satisfaction relationship is mostly causal.

There is also a large literature showing that individuals compare current income with past situations and/or the income of their peers. Therefore, both relative *and* absolute income matter (cf. Clark, Frijters, & Shields, 2008; Ferrer-i-Carbonell, 2005). As a result, when absolute income is included as an explanatory variable in life satisfaction regressions, small estimated income coefficients are common.

It is also possible that people self-select where they reside, which in this application would bias the protected areas coefficients upwards. The magnitude of this self-selection effect though is uncertain; some authors (cf. Chay & Greenstone, 2005) observe that the empirical evidence indicates that the bias is small. Together a downward bias in the income coefficient and an upward bias in the protected areas coefficients may lead to exaggerated marginal willingness-to-pay estimates.

Finally, it is important to acknowledge that there is some debate in the literature about the nature of the relationship between the hedonic pricing and life satisfaction approaches to non-market valuation. Some authors take the view that the life satisfaction approach values only the residual benefits (or costs) of the non-market good not captured in housing or labour markets (cf. Luechinger, 2009; van Praag & Baarsma, 2005). More recently, Ferreira and Moro (2010) suggest that the relationship depends on whether the hedonic markets are in equilibrium or disequilibrium, as well as on the econometric specification of the life satisfaction function. If the assumption of equilibrium in the housing and labour markets hold, then no relationship should exist between the non-market good and life satisfaction, because housing costs and wages would fully adjust to compensate. If however a significant relationship is found, then residual benefits must remain.

In an early example of the life satisfaction approach being used in practice, Welsch (2002) uses cross-section data on reported well-being for 54 countries to value urban air pollution. The author finds that, on average, an individual needs to be given USD 70 per annum compensation in order to accept a one-kiloton per capita increase in urban nitrogen dioxide load. While the valuation of air quality has dominated the literature (cf. Ferreira & Moro, 2010; Luechinger, 2009, 2010; MacKerron & Mourato, 2009; Menz, 2011), other non-market environmental goods valued via the life satisfaction approach include airport noise (cf. van Praag & Baarsma, 2005), climate (cf. Ferreira & Moro, 2010; Frijters & van Praag, 1998; Maddison & Rehdanz, 2011), greenspace (cf. MacKerron, 2010; Smyth, et al., 2008), scenic amenity (cf. Ambrey & Fleming, 2011), floods (cf. Luechinger & Raschky, 2009) and drought (Carroll, Frijters, & Shields, 2009). A review of many of these studies is provided by Welsh and Kuhling (2009).

3. Methodology and data

The first step is to estimate a model where life satisfaction is a function of socio-economic and demographic characteristics, the extent of protected areas and other spatial variables. The model takes the form of an indirect utility function for individual *i* in location *k* as follows:

$$U_{i,k} = \beta_0 + \beta_1 \ln(y_{i,k}) + \beta_2 x_{i,k} + \beta_3 a_{i,k} + \beta_4 \delta_{i,k} + \varepsilon_{i,k} \quad i = 1 \dots I, k = 1 \dots K \tag{1}$$

Where $y_{i,k}$ is household income, x is a vector of socio-economic and demographic characteristics including age, marital status, employment status, education and so forth, α is a vector of protected area variables measuring the percentage of a particular type of protected area in the individual's local area and δ is a vector of spatial controls. In the micro-econometric life satisfaction function, the individual's true utility is unobservable; hence self-reported life satisfaction is used as a proxy. Table 1 provides a description of all variables employed.

[Insert Table 1 here]

As shown by Ferreira and Moro (2008) and Welsch (2010), it is possible to estimate the implicit willingness-to-pay (denoted WTP) for a marginal change in the extent of protected area by taking the partial derivative of protected area and the partial derivative of household income, as follows:

$$WTP = \frac{\frac{\partial U_{i,k}}{\partial a_{i,k}}}{\frac{\partial U_{i,k}}{\partial ln(y_{i,k})}} = \frac{\partial a_{i,k}}{\partial ln(y_{i,k})} = \bar{y}\frac{\widehat{\beta_3}}{\widehat{\beta_1}} \tag{2}$$

Where $\bar{y}$ is the mean value of household income. If non-marginal changes are to be valued, the Hicksian welfare measures of compensating and equivalent surplus can be employed. In

this case, the compensating surplus is the amount of household income a resident would need to receive (pay) following a decrease (increase) in the extent of protected area in his or her local area, in order to remain at his or her initial level of utility. Compensating surplus (denoted CS) can be calculated as follows:

$$CS = -\exp\left[\overline{\ln(y)} + \frac{\widehat{\beta_3}}{\widehat{\beta_1}}(a^1 - a^2)\right] + \bar{y} \quad (3)$$

Where a^1 is the initial, and a^2 the new extent of protected area. Similarly, the equivalent surplus is the amount of household income a resident would need to receive or pay in order to obtain the level of utility following a change, *if the change did not take place*. Equivalent surplus (denoted ES) can be calculated as follows:

$$ES = \exp\left[\overline{\ln(y)} + \frac{\widehat{\beta_3}}{\widehat{\beta_1}}(a^2 - a^1)\right] - \bar{y} \quad (4)$$

3.1. Estimation strategy

Similar to the estimation strategies employed by other authors (cf. Brereton, et al., 2008; Smyth, et al., 2008) an ordered probit is estimated by maximum likelihood estimation. To mitigate for potential personality-type biases, such as those discussed in relation to income, we include Saucier's (1994) 'Big Five' personality trait controls (extraversion; agreeableness; conscientiousness; emotional stability; and openness to experience). Further controls for job-related characteristics such as hours worked and commute time are also included, nonetheless it is likely that downward bias in the income coefficient remains.[1]

To address possible spatially omitted variable bias we include a number of controls for additional spatial factors, both natural and built, for which data are available. We also include dummy variables at the broader regional level, permitting variation at the SLA level

to be identified. Finally, as we include explanatory variables at different spatial levels, standard errors are adjusted for clustering (cf. Moulton, 1990).

3.2. Household, Income and Labour Dynamics in Australia (HILDA)

The measure of self-reported life satisfaction and socio-economic and demographic characteristics of respondents are obtained from Wave 5 (2005) of the Household, Income and Labour Dynamics in Australia (HILDA) survey.[2] First conducted in 2001, by international standards the HILDA survey is a relatively new nationally representative sample and owes much to other household panel studies conducted elsewhere in the world; particularly the German Socio-Economic Panel and the British Household Panel Survey. See Watson and Wooden (2010) for a recent review of progress and future developments of the HILDA survey.

Compared to the Australian population males, Aboriginal and Torres Strait Islanders, and the unemployed are all underrepresented in our sample. Specifically, the sample contains 88 males per 100 females compared to the general population's 99 per 100 (while males are no less likely to agree to an interview, they are less likely to be at home at the time of the interview). Aboriginal and Torres Strait Islanders make up only 1.81 per cent of the sample compared to 2.03 per cent of the general population. The unemployment rate in the sample is 2.89 per cent, whereas the unemployment rate at the time of the survey was 5.00 per cent. The underrepresentation of Aboriginal and Torres Strait Islanders, and the unemployed can be attributed to higher attrition rates for these groups (Watson & Wooden, 2004)

The life satisfaction variable is obtained from individuals' responses to the question: *'All things considered, how satisfied are you with your life?'* The life satisfaction variable is an

ordinal variable, the individual choosing a number between 0 (totally dissatisfied with life) and 10 (totally satisfied with life).

Of particular importance to the valuation aspect of this paper is the definition of household income. The income measure employed is the natural log of self-reported nominal disposable household income with imputed values for missing data. Consistent with the findings of Wooden et al. (2009), we find no statistical difference between imputed and reported values. For further detail about the imputation method used, see Hayes and Watson (2010). Descriptive statistics are provided as an Appendix.

3.3. Spatial data

Protected area data are provided by the Australian Government's Collaborative Protected Area Database (2012). The measure of protected areas (obtained using Geographic Information Systems) is the percentage of protected area within the individual's Statistical Local Area (SLA).[3] The median (mean) area of the SLAs in the sample is 46.90km^2 (1,187.83km^2). Assuming each SLA takes the shape of a circle, the median (mean) radius from the centroid or centre point is approximately 3.86km (19km). In creating the spatial control variables for urban parks, the coastline, rivers, lakes, creeks, railway stations, international airports and major roads we assign individuals a value of 1 if the centroid or centre point of the respondent's Census Collection District (CD)[4] falls within the straight line distance buffer from the nearest amenity or disamenity and a 0 otherwise.

3.3.1. International Union for Conservation of Nature (IUCN) categories

In 1994 Australia adopted the IUCN's definition of a protected natural area, which is as follows:[5]

"an area of land/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means."

(IUCN, 1994)

The IUCN further defines seven protective area management categories, based on primary management objective. These are presented in Table 2.

[Insert Table 2 here]

Figure 1 provides an illustration of the geographic distribution of protected areas in Australia. The National Reserve System includes 6,614 protected areas, with considerable heterogeneity both within and between the seven categories. For example, the mean area of the various categories ranges from 500 (Category III) to 78,108 (Category 1B) hectares. While, on average, Category 1B areas are the largest, they are the smallest in number, with only 61 distinct areas listed. In contrast, Category 1A areas are the most numerous (2,183 areas). The largest protected area is the almost 10 million hectare Category VI Ngaanyatjarra Lands Indigenous Protected Area in Western Australia. The smallest protected area is a 0.00071 hectare Category V site on Mount Chappell Island off the coast of Tasmania.

[Insert Figure 1 here]

4. Results

The estimated results for Equation 1 are presented in Table 3. The explanatory power of the model, as measured by an adjusted R^2 of 0.06260, is comparable to other studies of this type (cf. Brereton, et al., 2008; Smyth, et al., 2008).

In regards to socio-economic and demographic characteristics, the results largely support the existing literature and *a priori* expectations. Life satisfaction is U-shaped in age, reaching a minimum when a person is in their early forties. Once personality traits are controlled for, males are more satisfied with their lives than females. Respondents of Aboriginal and/or Torres Strait Islander origin report being more satisfied with their lives than the general population. While this result is consistent with previous studies (cf. Shields, et al., 2009) it is not expected and seems an area worthy of further research.

Immigrants from non-English speaking countries are found to be less satisfied than the native born, even after controlling for reported English speaking ability. In terms of marital status, being married is associated with higher levels of life satisfaction than being in a *defacto* relationship and people in a *defacto* relationship are more satisfied than individual's never before married. In contrast, separated and divorced individuals experience much lower levels of life satisfaction than individuals who have never been married. Lone parents are found to have lower levels of life satisfaction, even after controlling for the number of children in the household, which itself has an adverse impact on an individual's life satisfaction. Greater levels of reported physical functional health confer higher levels of life satisfaction.

Individuals with post-secondary education report lower levels of life satisfaction. Being unemployed dramatically reduces life satisfaction. Students are more satisfied with their lives than individuals who are employed full-time.

Increased household income enhances a person's life satisfaction, whereas a higher number of hours worked reduces life satisfaction. Consistent with both economic theory and prior

empirical evidence (cf. Stutzer & Frey, 2008) commuting time to place of work adversely impacts a person's life satisfaction.

All of the Big Five personality trait variables are statistically significant at the one per cent level with higher degrees of extraversion, agreeableness, conscientiousness and emotional stability all associated with higher levels of life satisfaction; whereas higher levels of openness to experience reduces an individual's life satisfaction. We also find evidence of social desirability bias, that is, a person's self-reported life satisfaction is higher if another person is present during the interview. Further discussion on the issue of social desirability bias can be found in Chen, Dai, Spector and Jex (1997).

Renters and residents living in other (non-standard) types of dwellings are found to have lower levels of life satisfaction than house owners and those living in a separate house. We find that living in a remote area is associated with higher levels of life satisfaction.

Of particular importance to this study, the percentage of the SLA that is set aside for protected areas, categories IB, III and IV are found to enhance an individual's life satisfaction, with estimated coefficients of 0.00634, 0.01425, and 0.02067 respectively. That is, we find that protected areas in three of the seven IUCN management categories (categories IB, III and IV) confer significant positive life satisfaction effects. No significant life satisfaction effects are found for categories IA, II, V and VI.

Looking first at categories IA and IB, while protected areas within these categories feature largely intact ecosystems and are more strictly protected from human visitation than the other categories, category IB is distinct in that it is comparatively less restricted, allowing some use. Thus direct use benefits may be enjoyed. Furthermore, category IB areas are often much larger than category IA areas and uniquely offer outstanding opportunities for

solitude. Given these particular attributes, we suggest that this welfare enhancing effect reflects; a premium for the completeness and extent of the ecosystems in these areas, the associated superior provision of ecosystem services, and, when compared to category IA areas, the greater potential for direct use benefits.

Contrary to *a priori* expectations, living within close proximity to a national park (category II protected areas) does not appear to contribute to a person's life satisfaction. National parks are distinct from areas managed under categories IA and IB in terms of the number of visitors and the greater amount of tourist infrastructure, and from subsequent categories (III-VI) in terms of the focus on maintaining ecological integrity at an ecosystem scale; the areas being large enough to be fairly self-sustaining. The fact that living in close proximity to national parks or tourist destinations does not enhance life satisfaction may be due to the presence of parking problems, nuisance animals, and abundance of people, weeds and insects (cf. Cooper & Morpeth, 1997).

Our finding that life satisfaction is enhanced by living within close proximity to category III areas is not surprising. The category III classification is the category most heavily influenced by human perceptions of value and is aimed at protecting a particular feature (for instance, waterfall, cliff, sand dunes and so forth). That is, category III is very much a human-value based classification as opposed to an ecological-value based classification.

In contrast, category IV protected areas focus more preserving biological values. Yet living within close proximity to this category of protected also increases life satisfaction. Category IV protected areas are defined for areas which have already undergone substantial modification, and require protection of remaining fragments, possibly with intervention. We suggest that the pronounced positive welfare effects for category IV protected areas

indicate the existence of externalities that have not already been factored into exchanges in markets. To be specific, were this protected status not to exist, market failure would ensure that the biodiversity and associated ecosystem services of such areas would be further degraded to unsustainable levels (the area's inability to be self-sustaining is a prerequisite for the category IV protected area designation).

In regards to categories V and VI, these management categories are closely aligned with the sustainable direct use of the area for the provision of market goods and services; the benefits of this area may, therefore, already be predominantly reflected in other markets, leaving few residual benefits to be picked up by the life satisfaction approach.

[Insert Table 3 here]

4.1. Valuation estimates

Following the procedure described in Equation 2, the average implicit willingness-to-pay is calculated at the level of the household and on a per-capita basis. Following Equations 3 and 4, compensating and equivalent surpluses are also calculated.

As shown in Table 4, the implicit willingness-to-pays, in terms of household income, for a one per cent increase in the extent of protected areas IB, III and IV are approximately \$2,950, \$6,650 and \$9,650[6] respectively. As this is the first study to value protected areas using the life satisfaction approach, there is no comparable reference point with which to compare these estimates. Further, it is difficult to compare these estimates with those found in studies employing more conventional non-market valuation techniques, as it is widely recognised that these studies often fail to capture the full benefits provided by protected areas (cf. Nunes & van den Bergh, 2001). Nonetheless, it is clear that the monetary estimates and the direct life satisfaction effects are substantial.

[Insert Table 4 here]

5. Conclusion

This paper set out to use the life satisfaction approach to value Australia's protected areas. To the extent of our knowledge this is the first application of the life satisfaction approach to protected areas, contributing to the existing non-market valuation literature as well as the economic literature on life satisfaction. Furthermore, this study serves to aid policy makers by demonstrating the application of another tool to assist in the estimation of the benefits of non-market goods, thus helping to ensure that the many non-market services provided by these goods are recognised, and in so doing, facilitate the efficient allocation of scarce resources.

The observed positive and significant life satisfaction effects associated with the provision of three out of the seven IUCN protected area categories reaffirms the importance of preserving Australia's protected areas. The challenge for policy makers is to manage the pressures of population and economic growth in the face of budgetary constraints. At a Federal level, building the National Reserve System is one of six priorities under the Australian Government's Caring for our Country environmental initiative. It is therefore encouraging to see that, despite the well-publicised promise to return the budget to surplus in 2013, $2.2 billion has been committed to continuing this initiative until 2017-18 (Burke, 2012).

From a theoretical perspective these life satisfaction effects point towards a substantial residual shadow value associated with the provision of protected areas that is not captured in housing costs or wages. Consistent with earlier life satisfaction valuation literature (cf. Luechinger, 2009; van Praag & Baarsma, 2005), this finding challenges the validity of the

assumption of equilibrium in housing and wage markets, which underpins many models that rely on choice. In this context, the life satisfaction approach may serve as a useful complement to the hedonic method when attempting to value non-market goods. In all, these results should encourage further research at a theoretical and applied level into the life satisfaction approach to non-market valuation.

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Table 1: Model variables

Variable name	Definition
Age	Respondent's age
Male	Respondent is male
ATSI	Respondent is of Aboriginal and/or Torres Strait Islander origin
Immigrant English	Respondent is born in a Main English Speaking country (Main English speaking countries are: United Kingdom; New Zealand; Canada; USA; Ireland; and South Africa)
Immigrant non-English	Respondent is not born in Australia or a Main English Speaking country
Poor English	Respondent speaks English either not well or not at all
Married	Respondent is legally married
Defacto	Respondent is in a defacto relationship
Separated	Respondent is separated
Divorced	Respondent is divorced
Widow	Respondent is a widow
Lone parent	Respondent is a lone parent
Number of children	Number of respondent's own resident children in respondent's household at least 50 per cent of the time and number of own children who usually live in a non-private dwelling but spend the rest of the time mainly with the respondent
SF-35 PCS	Respondent's physical component summary (PCS) score (scale 0-100)
Year 12	Respondent has a long-term health condition limiting the amount or type of work that the respondent can do
Certificate or diploma	Respondent has a long-term health condition and cannot work
Bachelors degree or higher	Respondent's highest level of education is Year 12 or below
Employed part-time	Respondent is employed and works less than 35 hours per week
Self employed	Respondent is self employed
Unemployed	Respondent is not employed but is looking for work
Retired	Respondent is retired
Home duties	Respondent performs home duties
Student	Respondent is a non-working student
Non-participant	Respondent falls into the other non-participant category including individuals less than 15 years old at the end of the last financial year
Disposable income (ln)	Natural log of disposable household income
Hours worked	Number of hours worked per week by respondent
Commute time	Number of hours spent travelling to and from paid employment per week by respondent
Extraversion	Degree of extraversion (scale 1 to 7)
Agreeableness	Degree of agreeableness (scale 1 to 7)
Conscientiousness	Degree of conscientiousness (scale 1 to 7)
Emotional stability	Degree of emotional stability (scale 1 to 7)
Openness to experience	Degree of openness to experience (scale 1 to 7)
Others present	Someone other than the respondent was present during the interview

Renter	Respondent is renting the home or is involved in a rent to buy scheme
Rent free	Respondent resides in the home rent free
Medium rise	Respondent resides in a townhouse, or one to three storey apartment
High rise	Respondent resides in a four or more storey apartment
Other dwelling	Respondent resides in other dwelling, for instance, a non-private dwelling, a caravan, or a houseboat
Inner regional	Respondent resides in inner regional Australia
Outer regional	Respondent resides in outer regional Australia
Remote	Respondent resides in a remote or migratory region of Australia
Population density	Number of individuals per square kilometre in the CD
SEIFA index	The Australian Bearu of Statistics' (ABS) Socio-Economic Indexes for Areas (SEIFA) Index of Relative Socio-economic Disadvantage measured in deciles for the CD, where a higher decile is relatively less disadvantaged and conversely a lower decile is relatively more disadvantaged (deciles 1-10)
Protected area (IA)	Percentage of SLA that is IUCN category IA protected area
Protected area (IB)	Percentage of SLA that is IUCN category IB protected area
Protected area (II)	Percentage of SLA that is IUCN category II protected area
Protected area (III)	Percentage of SLA that is IUCN category III protected area
Protected area (IV)	Percentage of SLA that is IUCN category IV protected area
Protected area (V)	Percentage of SLA that is IUCN category V protected area
Protected area (VI)	Percentage of SLA that is IUCN category VI protected area
Proximity to coastline	Dummy variable = 1 if respondent resides within 3km; between 3km and 5km; between 5km and 10km of a coastline
Proximity to river	Dummy variable = 1 if respondent resides within 3km; between 3km and 5km; between 5km and 10km of a river
Proximity to lake	Dummy variable = 1 if respondent resides within 3km; between 3km and 5km; between 5km and 10km of a lake
Proximity to creek	Dummy variable = 1 if respondent resides within 3km; between 3km and 5km; between 5km and 10km of a creek
Proximity to airport	Dummy variable = 1 if respondent resides within 3km; between 3km and 5km; between 5km and 10km of an international airport
Proximity to railway	Dummy variable = 1 if respondent resides within 3km; between 3km and 5km; between 5km and 10km of a railway station
Proximity to major road	Dummy variable = 1 if respondent resides within 1km and between 1km and 3km of a major road
Melbourne	Respondent resides in Melbourne
Brisbane	Respondent resides in Brisbane
Adelaide	Respondent resides in Adelaide
Perth	Respondent resides in Perth
Hobart	Respondent resides in Hobart
Darwin	Respondent resides in Darwin
Canberra	Respondent resides in Canberra

Table 2: International Union for Conservation of Nature (IUCN) categories[3]

Category	Title	Definition
IA	Strict Nature Reserve: Protected area managed mainly for science	Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring.
IB	Wilderness Area: Protected area managed mainly for wilderness protection	Large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.
II	National Park: protected area managed mainly for ecosystem protection and recreation	Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.
III	Natural Monument: protected area managed mainly for conservation of specific natural features	Area containing one or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities or cultural significance.
IV	Habitat/Species Management Area: protected area managed mainly for conservation through management intervention	Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.
V	Protected Landscape/Seascape: protected area managed mainly for landscape/seascape conservation and recreation	Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.
VI	Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems	Area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

Source: http://www.environment.gov.au/parks/iucn.html

[3] For a more detail see http://www.iucn.org/about/work/programmes/pa/pa_products/wcpa_categories/.

Table 3: Ordered probit model results

Variable name	Estimate (standard error)	Variable name	Estimate (standard error)
Age	-0.043784*** (0.00471)	Hours worked	-0.00321*** (0.00106)
Age squared	0.00053*** (0.00005)	Commute time	-0.00674* (0.00347)
Male	0.05707** (0.02352)	Extraversion	0.08529*** (0.01104)
ATSI	0.20739* (0.10622)	Agreeableness	0.17583*** (0.01519)
Immigrant English	-0.00193 (0.03723)	Conscientiousness	0.06006*** (0.01174)
Immigrant non-English	-0.10480*** (0.04030)	Emotional stability	0.16136*** (0.01211)
Poor English	-0.12086 (0.12147)	Openness to experience	-0.04728*** (0.01211)
Married	0.18896*** (0.04363)	Others present	0.04087* (0.02367)
Defacto	0.13862*** (0.04700)	Renter	-0.14674*** (0.03227)
Separated	-0.30104*** (0.08784)	Rent free	-0.11204 (0.07538)
Divorced	-0.13482** (0.06185)	Medium rise	0.02863 (0.039823)
Widow	0.04478 (0.08195)	High rise	-0.06286 (0.10182)
Lone parent	-0.10857** (0.05021)	Other dwelling	-0.17649* (0.10347)
Number of children	-0.04401*** (0.01285)	Inner regional	0.03233 (0.04798)
SF-36 PCS	0.00804*** (0.00069)	Outer regional	0.08693 (0.06380)
Year 12	0.01397 (0.05726)	Remote	0.21006* (0.11420)
Certificate or diploma	-0.05751** (0.02557)	Population density	-0.00000 (0.00000)
Bachelor's degree or higher	-0.14301*** (0.03296)	SEFIA index	0.00145 (0.00422)
Employed part-time	0.03489 (0.03742)	Protected area (IA)	0.00215 (0.00700)
Self employed	-0.10633 (0.04280)	Protected area (IB)	0.00634*** (0.00207)
Unemployed	-0.23114*** (0.08723)	Protected area (II)	-0.00088 (0.00107)
Student	0.12882* (0.07108)	Protected area (III)	0.01425* (0.00746)
Non-participant	-0.05739	Protected area (IV)	0.02067*

	(0.11067)		(0.01078)
Retired	-0.01226	Protected area (V)	-0.00838
	(0.06733)		(0.00716)
Home duties	0.10734	Protected area (VI)	-0.00205
	(0.06629)		(0.00351)
Disposable income (ln)	0.09417***		
	(0.01269)		
Summary statistics			
Number of observations	9739		
Pseudo R^2	0.0626		

*** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Omitted cases are: Female; Not of indigenous origin; Country of birth Australia; Speaks English well or very well; Never married and not de facto; Not a lone parent; Year 11 or below; Not self employed; Employed working 35 hours or more per week; No others present during the interview or don't know – telephone interview; Owns/paying off mortgage on home; Separate house; Major city.

Spatial controls for proximity to amenities and disamenities are included. The omitted cases are: Greater than 10km from the coastline; Greater than 10km from a river; Greater than 10km from a lake; Greater than 10km from a creek; Greater than 10km from an airport; Greater than 10km from a railway station; Greater than 3km from a major road.

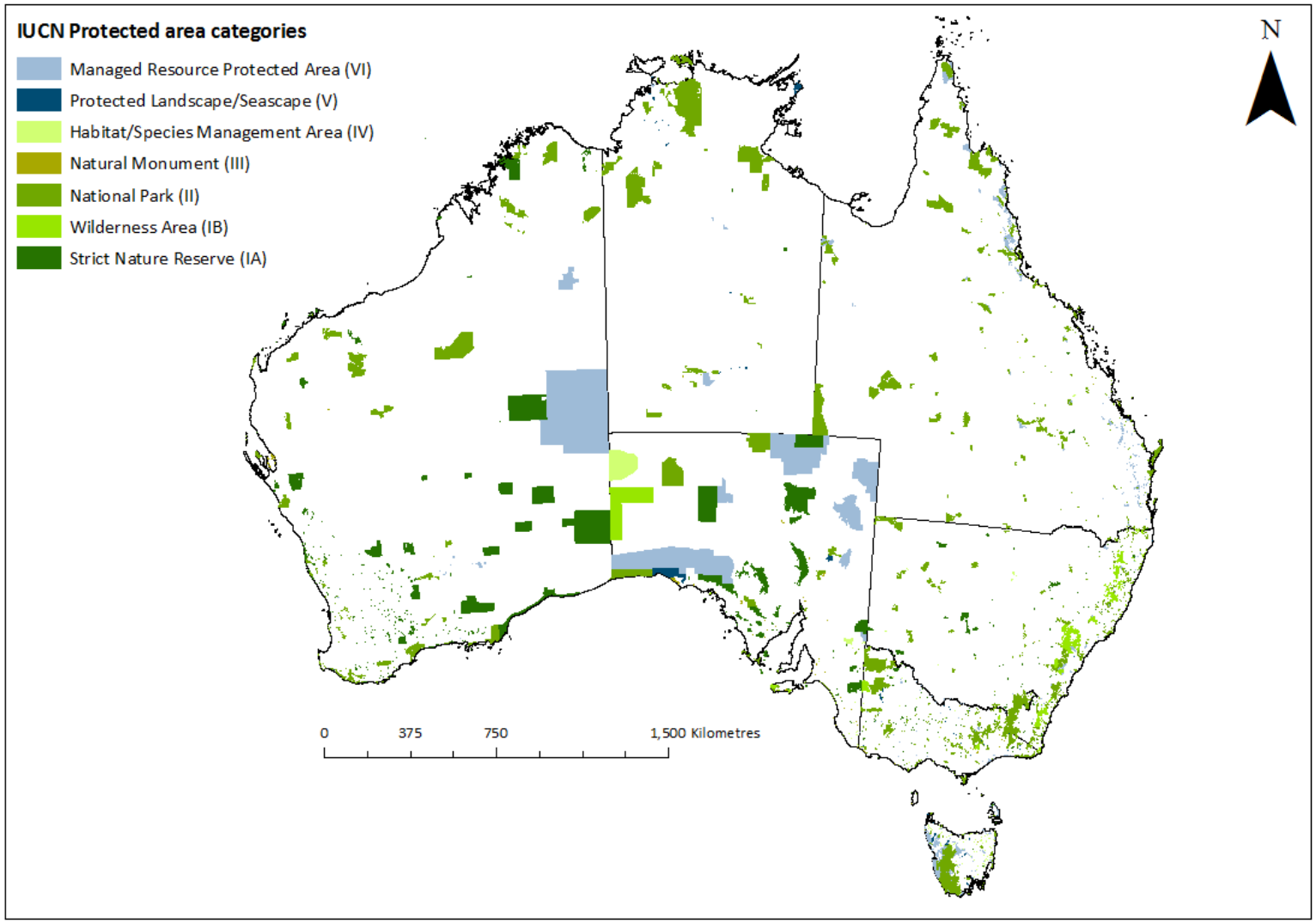
State and territory controls and major statistical region controls included.

Table 4: Valuation estimates

Protected areas	WTP	90% lower bound	90% upper bound	Per capita WTP	Compensating surplus	Equivalent surplus	Standard deviation
IA	$1,004.73	-$4,369.41	$6,378.87	$436.84	$2,536.14	$1,637.35	1.60
IB***	$2,955.88	$1,371.59	$4,543.31	$1,285.17	$14,373.83	$17,116.33	4.89
II	-$408.89	-$1,228.16	$410.38	-$177.78	-$5,291.90	-$4,356.27	11.22
III*	$6,649.18	$925.43	$12,372.92	$2,890.95	$11,572.05	$7,333.78	1.02
IV*	$9,640.88	$1,371.59	$17,910.17	$4,191.69	$15,668.61	$10,900.96	1.01
V	-$3,907.30	-$9,397.44	$1,582.80	-$1,698.83	-$16,418.26	-$8,976.61	2.57
VI	$954.96	-$1,734.68	$3,644.59	$415.20	$4,067.81	$3,441.91	3.47

*** significant at the 1% level; ** significant at the 5% level; * significant at the 10% level.

Figure 1: Australia's protected areas



Source: Australian Government (2012)

Appendix: Descriptive statistics

Variable name	Mean	Minimum	Maximum	Standard deviation
Age	43.89830	15	100	17.91964
Male	0.46856	0	1	0.49904
ATSI	0.01813	0	1	0.13342
Immigrant English	0.10385	0	1	0.30508
Immigrant non-English	0.10170	0	1	0.30227
Poor English	0.00686	0	1	0.08256
Number of children	0.70186	0	11	1.08584
Married	0.51137	0	1	0.49990
Defacto	0.11717	0	1	0.32163
Separated	0.02642	0	1	0.16040
Divorced	0.06258	0	1	0.24221
Widow	0.04711	0	1	0.21189
Lone parent	0.09412	0	1	0.29201
SF-36 PCS	83.53482	0	100	22.82220
Year 12	0.03380	0	1	0.18071
Certificate or diploma	0.29619	0	1	0.45660
Bachelors degree or higher	0.21764	0	1	0.41266
Employed part-time	0.21456	0	1	0.41054
Self employed	0.06749	0	1	0.25089
Unemployed	0.02888	0	1	0.16748
Retired	0.17769	0	1	0.38227
Home duties	0.08019	0	1	0.27161
Student	0.04629	0	1	0.21013
Non-participant	0.01700	0	1	0.12928
Disposable income (ln)	10.79297	0	13.94899	0.89391
Hours worked	23.36380	0	105	21.14464
Commute time	2.43762	0	40	3.57030
Extraversion	4.43815	1	7	1.07677
Agreeableness	5.38395	1	7	0.93444
Conscientiousness	5.09234	1	7	1.04006
Emotional stability	4.23757	1	7	1.05509
Openness to experience	4.23757	1	7	1.05509
Others present	0.34791	0	1	0.47633
Renter	0.24928	0	1	0.43262
Rent free	0.02724	0	1	0.16280
Medium rise	0.14276	0	1	0.34986
High rise	0.01127	0	1	0.10555
Other dwelling	0.01270	0	1	0.11198

Inner regional	0.24580	0	1	0.43058
Outer regional	0.11041	0	1	0.31341
Remote	0.01915	0	1	0.13707
Population density	1958.902 00	0.06704	61072.0000 0	2283.707 00
SEIFA index	5.60621	1	10	2.89809
Protected areas				
Protected area (IA)	0.53773	0	18.11329	1.73409
Protected area (IB)	0.75332	0	53.47287	4.79098
Protected area (II)	4.70936	0	73.95847	11.73111
Protected area (III)	0.27931	0	18.71223	1.40983
Protected area (IV)	0.18642	0	9.52203	0.87752
Protected area (V)	0.19526	0	99.98904	2.23237
Protected area (VI)	0.97809	0	64.44255	3.95717
Proximity to urban park				
($\delta_{i,k} \leq 3$ km)	0.90649	0	1	0.29116
($3 < \delta_{i,k} \leq 5$ km)	0.01884	0	1	0.13598
($5 < \delta_{i,k} \leq 10$ km)	0.03851	0	1	0.19243
Proximity to coastline				
($\delta_{i,k} \leq 3$ km)	0.20524	0	1	0.40390
($3 < \delta_{i,k} \leq 5$ km)	0.08695	0	1	0.28178
($5 < \delta_{i,k} \leq 10$ km)	0.14512	0	1	0.35224
Proximity to river				
($\delta_{i,k} \leq 3$ km)	0.18558	0	1	0.38879
($3 < \delta_{i,k} \leq 5$ km)	0.10426	0	1	0.30561
($5 < \delta_{i,k} \leq 10$ km)	0.31473	0	1	0.46443
Proximity to lake				
($\delta_{i,k} \leq 3$ km)	0.68353	0	1	0.46512
($3 < \delta_{i,k} \leq 5$ km)	0.12034	0	1	0.32538
($5 < \delta_{i,k} \leq 10$ km)	0.10631	0	1	0.30825
Proximity to creek				
($\delta_{i,k} \leq 3$ km)	0.36655	0	1	0.48189
($3 < \delta_{i,k} \leq 5$ km)	0.10150	0	1	0.30200
($5 < \delta_{i,k} \leq 10$ km)	0.18947	0	1	0.39190
Proximity to airport				
($\delta_{i,k} \leq 3$ km)	0.00655	0	1	0.08070
($3 < \delta_{i,k} \leq 5$ km)	0.02151	0	1	0.14508
($5 < \delta_{i,k} \leq 10$ km)	0.07691	0	1	0.26647
Proximity to railway				
($\delta_{i,k} \leq 3$ km)	0.58869	0	1	0.49210
($3 < \delta_{i,k} \leq 5$ km)	0.12095	0	1	0.32609
($5 < \delta_{i,k} \leq 10$ km)	0.10979	0	1	0.31264

Proximity to major road				
($\delta_{i,k} \leq 1$ km)	0.65998	0	1	0.47374
($1 < \delta_{i,k} \leq 3$ km)	0.20361	0	1	0.40270
Victoria	0.23525	0	1	0.42418
Queensland	0.20371	0	1	0.40277
South Australia	0.10109	0	1	0.30146
Western Australia	0.09504	0	1	0.29329
Tasmania	0.03677	0	1	0.18820
Northern Territory	0.00615	0	1	0.07815
Australian Capital Territory	0.02151	0	1	0.14508

[1] Using Pischke's (2010) rationale for industry wage differentials an attempt was made to instrument household income using the proportion of individuals in the household in a particular industry for each different industry. Specifically, we included alongside other usual covariates in the life satisfaction function; the proportion of household members not in the work force, the proportion of household members unemployed, the individual's job satisfaction and occupation controls. However, the instrument proved quite weak and hence was not proceeded with.

[2] Wave 5 is employed as it closely matches the date of collection of the spatial data. Further, Wave 5 includes a range of personality trait questions, thus allowing the Big Five personality traits to be controlled for in model estimation.

[3] The Statistical Local Area (SLA) is defined as an area which consists of one or more Collection Districts (CDs). SLAs are Local Government Areas (LGAs), or parts thereof. Where there is no incorporated body of local government, SLAs are defined to cover the unincorporated areas. SLAs cover, in aggregate, the whole of Australia without gaps or overlaps (Australian Bureau of Statistics, 2010).

[4] The CD is the smallest spatial unit in the Australian Standard Geographical Classification. (Australian Bureau of Statistics, 2010)

[5] This definition has subsequently changed (Dudley, 2008); the 1994 definition was in use at the time of spatial data collection.

[6] Unless otherwise stated, all figures are in AUD. As at 15 May 2012 1 AUD = 1.283 NZD; 1 AUD = 0.998 USD; 1 AUD = 0.778 EUR.