Socio-economic benefits from protected areas in southeastern Australia

E.C. Heagney,* † ‡ M. Kovac,* † J. Fountain,* and N. Conner*

*New South Wales Office of Environment and Heritage, P.O. Box A290, Sydney South, NSW 1232, Australia
†School of Environment, Science & Engineering, P.O. Box 157 Lismore NSW 2480, Australia

Abstract: International case studies of protected area performance increasingly report that conservation and socio-economic outcomes are interdependent. Effective conservation requires support and cooperation from local governments and communities, which in turn requires that protected areas contribute to the economic well-being of the communities in which they are sited. Despite increasing recognition of their importance, robust studies that document the socio-economic impacts of protected areas are rare, especially in the developed world context. We proposed 3 potential pathways through which protected areas might benefit local communities in the developed world: the improved local housing value, local business stimulus, and increased local funding pathways. We examined these pathways by undertaking a statistical longitudinal analysis of 110 regional and rural communities covering an area of approximately 600,000 km² in southeastern Australia. We compared trends in 10 socio-economic indicators describing employment, income, housing, business development and local government revenue from 2000 to 2010. New protected areas acquisitions led to an increased number of new dwelling approvals and associated developer contributions, increased local business numbers, and increased local government revenue from user-pays services and grants. Longer-term effects of established protected areas included increased local council revenue from a variety of sources. Our findings provide support for each of our 3 proposed benefit pathways and contribute new insights into the cycling of benefits from protected areas through the economy over time. The business and legislative models in our study are typical of those operating in many other developed countries; thus, the benefit pathways reported in our study are likely to be generalizable. By identifying and communicating socio-economic benefits from terrestrial protected areas in a developed world context, our findings represent an important step in securing local support and ongoing high-level protection for key components of the world’s biodiversity.

Keywords: general linear mixed model (GLMM), longitudinal analysis, national parks

Beneficios Socioeconómicos de las Áreas Protegidas en el Sureste de Australia

Resumen: Los estudios internacionales de caso del desempeño de las áreas protegidas cada vez más reportan que los resultados socio-económicos y de conservación son interdependientes. La conservación efectiva requiere apoyo y cooperación por parte de los gobiernos y comunidades locales, lo que a cambio requiere que las áreas protegidas contribuyan al bienestar económico de las comunidades en las que se ubican. A pesar del creciente reconocimiento de su importancia, los estudios generales que documentan los impactos socio-económicos de las áreas protegidas son raros, especialmente en el contexto de los países desarrollados. Proponemos tres vías potenciales mediante las cuales las áreas protegidas podrían beneficiar a las comunidades locales en los países desarrollados: el aumento del valor de las viviendas, el estímulo a los negocios locales y el financiamiento local incrementado. Examinamos estas tres vías al emprender un análisis estadístico longitudinal de 110 comunidades regionales y rurales en aproximadamente 600,000 km² en el sureste de Australia. Comparamos las tendencias de 10 indicadores que describen los ingresos públicos del gobierno local, el empleo, el ingreso, las viviendas y el desarrollo de negocios desde el 2000 hasta el 2010. La adquisición de nuevas áreas protegidas derivó en un incremento en la aprobación de nuevas viviendas y en los ingresos

*Address correspondence to Elizabeth C. Heagney, email elizabeth.heagney@environment.nsw.gov.au.
Paper submitted September 16, 2014; revised manuscript accepted March 18, 2015.

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited and is not used for commercial purposes.
Introduction

Protected area management has moved away from the historical land-use conflict paradigm, whereby conservation gains were generally seen to come at the expense of local economic interests. It is now widely acknowledged that protected areas should contribute to the sustainable development and economic well-being of the communities in which they are sited (McNeely 2008). Positive socio-economic outcomes from protected areas are important in their own right, but they may also be necessary to ensure that protected areas continue to deliver strong ecological outcomes. A lack of community support has been linked to failed conservation outcomes from protected area initiatives in international case studies from both developing and developed countries (Ezebilo & Mattsson 2010; Hirschnitz-Garbers & Stoll-Kleemann 2011; Ezebilo 2012). Accordingly, international best practice standards promote protected area assessment that accounts for both ecological and socio-economic outcomes (UNESCO 1996; IUCN 1998).

Quantitative longitudinal analysis has been recommended as best practice for quantifying ecological and economic outcomes from protected areas (Agrawal 2001; Lotze-Campen et al. 2008; Caro et al. 2009). In practice, however, longitudinal economic analyses are rare because large-scale long-term socio-economic monitoring programs are costly; consequently, robust socio-economic data sets that allow comparison across large numbers of sites are uncommon (Stoll-Kleemann & Job 2008). Longitudinal analysis has been used to investigate the socio-economic impact of terrestrial protected areas in Thailand (Andam et al. 2010; Sims 2010), Costa Rica (Andam et al. 2010), and Bolivia (Canavire-Bacarreza & Hanauer 2013). These studies show that protected areas can play a role in long-term poverty alleviation in developing countries. To date, longitudinal analysis of the impacts of protected areas in the developed world has been restricted to northern forests of the United States, and results show no significant effect of protected areas on either employment or wage growth (Lewis et al. 2002, 2003). Consequently, understanding of the socio-economic impacts of protected areas in the developed world is limited. This is a critical knowledge gap given that high-income countries contain 715 million km² of protected lands, equivalent to 39% of the global total, and have contributed 43% of global growth in protected area coverage from 2004 to 2012 (World Databank 2014).

It is reasonable to assume that the nature of costs and benefits associated with the implementation and management of protected areas differs between developed and developing countries. We drew on economic theory and models relating to the impact of public open spaces on population and housing development (Mansfield et al. 2005; Armsworth et al. 2006; McDonald et al. 2007) and on a number of case studies relating specifically to the impacts of protected areas in the developed world (Driml & Common 1995; Fortin & Gagnon 1999; Selby et al. 2011; Orr 2011) to propose 3 potential benefit pathways through which protected areas might impact the surrounding local economy: the improved local house value, local business stimulus, and increased local funding pathways. Each of these is described in greater detail below.

Economic theory and modeling suggest that protected areas increase house values (Mansfield et al. 2005; Armsworth et al. 2006). An observational study that tracked patterns of development across three large sites in the United States throughout the 1990s shows that at two out of three sites development rates were elevated close to protected areas (McDonald et al. 2007). We propose that increased local housing values may be a more general response to protected area acquisition and management that may arise across a range of settings.

Driml and Common (1995) document the value of tourism expenditure in towns located near World Heritage protected areas across Australia, Selby et al. (2011) document the development of tourism businesses in communities adjacent to protected areas in Finland. Two surveys of business communities operating in or near protected areas in Canada show that local business operators attribute a considerable portion of their customer base, revenues (Orr 2011), and new business opportunities (Fortin & Gagnon 1999) to nearby protected areas. We hypothesize that local business development and associated income effects may be a relatively general
socio-economic outcome associated with the implementation and management of protected areas in the developed world.

Given that protected areas are often implemented and managed by state or national governments, we expect some financial benefits to accrue to local governments and communities as a result of local expenditures by the funding body. The housing and business impacts described in the preceding paragraphs are also expected to have flow-on effects for local government institutions (including demand for municipal services and increased local rates and associated impacts on local government revenues).

In this study we sought to determine whether, and to what extent, protected areas affect the surrounding local community. We moved beyond the use of single benefits indicators to an assessment of benefit pathways that identify and account for interrelated benefits and the cycling of benefits through the economy over time. Our study is the first to undertake longitudinal analysis of multiple socio-economic indicators to provide a deeper understanding of the socio-economic impacts of protected areas in the developed world, and the first to use annual time series data to look at both the intermediate-term (3–5 year) impacts of newly acquired protected areas and longer-term impacts of established protected areas. Our study is also the second-largest longitudinal analysis of the impact of protected areas undertaken to date, covering an area ~600,000 km² in southeastern Australia.

Methods

Study Site

New South Wales (NSW) covers roughly 10% of Australia’s landmass in the southeast. The network of protected areas in NSW includes ~860 national parks and reserves, totaling ~70,000 km² and covering roughly 9% of the state. From 2000 to 2010, approximately 13,500 km² of land was acquired for conversion to national park or reserve areas (Fig. 1). Over 99% of these acquisitions were made in regional and rural areas, causing a degree of community angst regarding potential impacts on local employment and the ongoing viability of smaller rural communities. However, acquisitions over the decade of interest coincided with a severe and prolonged drought that substantially affected agricultural production and regional communities from 2001 to 2009 (Horridge et al. 2005; Edwards et al. 2009). In addition, the global financial crisis had a major impact on investment, income, and revenue of some councils and businesses (CoA 2009). It is likely that the true impact of protected areas and associated land acquisitions over this period has been obscured, to some degree, by this complex socio-economic background.

Generalized Linear Mixed Modeling

Impacts of land acquisitions and established protected areas were assessed using generalized linear mixed
modeling (GLMM) in the SPSS software package. A GLMM is considered best practice for longitudinal studies because it can accommodate missing data (Krueger & Tian 2004) and enables simultaneous analysis of both fixed and random effects (Heck et al. 2010). We assumed a normal distribution and used restricted maximum likelihood estimation and applied an auto-regressive (first order) covariance structure for time-series trends in economic performance indicators to account for the influence of previous-year performance on current-year outcomes.

We tracked economic trends in 110 local government areas (LGAs) across approximately 600,000 km² of NSW from 2000 to 2010. We isolated the influence of protected areas from background economic trends with the following model: \( X = \text{time effects} + \text{place effects} + (\text{time} \times \text{place effects}) + \text{protected area impacts} \), where \( X \) is 1 of 10 social and economic variables chosen as indicators of the 3 benefit pathways proposed in this paper (Table 1). All response variables were reported annually by LGA by either the Australian Bureau of Statistics or the NSW Division of Local Government (DLG).

Time effects = \( \text{year (1-10)} \) for the specified period. This model parameter sets a variable baseline that accounts for inter-annual trends in response variables. Place effects = economy type + \( \text{(population density, latitude, longitude)} \), where economy type is a categorical variable that describes each LGA as either regional or rural based on classifications made by the NSW DLG (2011). Regional refers to towns and centers with a relatively diversified, urban economy base, and rural refers to more remote communities with a heavier economic reliance on agriculture. Population density, latitude, and longitude are random variables used to summarize a variety of other (usually unobserved) influences on performance indicators (see Robust Modeling below). Because social and economic trends in NSW generally vary along simple east–west and north–south gradients (e.g., NSW LPI 2011), population density, latitude, and longitude were included as linear variables.

Time* place effects = \( \text{year (1-10)} \times \text{economy type} \). This interaction term accounts for differences in inter-annual baseline trends in regional versus rural economy types. Protected area effects = \( \text{protected area acquisitions} \times \text{economy type} + \text{established protected areas} \times \text{economy type} \), where protected area acquisitions*economy type is cumulative acquisitions from 2000 to 2010 reported by year by LGA type (regional versus rural) and established protected areas*economy type is the extent of the protected area network in each regional or rural LGA in 2000. Summary statistics for both parameters are provided in Table 2. Including interactions with economy type allowed the model to account for different impacts of protected areas in regional versus rural LGAs. Preliminary modeling included the interaction term protected area acquisitions * established protected areas to account for the possibility that the impacts of new land acquisitions may vary depending on the extent of protected areas already present within a given LGA. Including the interaction term resulted in a poor model fit, so it was excluded from final model.

In preliminary modeling, we used untransformed data relating to the extent of land acquisitions and established parks. Repeat modeling was undertaken with square-root-then fourth-root-transformed data to test for diminishing returns with increasing protected area size. We used Akaike’s information criterion (AIC) to compare models, and the best model (of the subset tested) was used as the basis for all subsequent modeling. Results of the model testing are provided in Supporting Information.

**ACCOUNTING FOR POTENTIAL BIAS**

We accounted for model bias that might arise from reverse causality, unobserved effects, and confounded baseline and covariate effects. We investigated the possibility that our modeling results might be biased as a result of pre-existing differences among LGAs with respect to the response variables, whereby the selected socio-economic performance indicators might influence the likelihood that land acquisitions would be made in a specific LGA (e.g., low incomes might indicate poor agricultural returns, low land values, a high rate of land sales, and an increased likelihood the government will purchase land in a specific LGA). We believe the patterns of protected area land acquisition in our study are independent of the selected response variables because, in NSW, protected area acquisition decisions are generally made with reference to the spatial configuration of the existing protected areas network (e.g., decisions are based on whether comprehensive, representative, and adequate ecosystem protection will be achieved) rather than economic considerations. We further investigated the potential bias that might arise from non-independence between protected area acquisition and pre-existing socio-economic factors by testing for correlation between the area of new and existing protected areas and the socio-economic index for areas (SEIFA) reported for each LGA at the start of our study. The SEIFA uses a broad range of data relating to employment, income, and other family and household characteristics to rank Australian LGAs according to their relative socio-economic advantage or disadvantage (Pink 2011). We observed no correlation between SEIFA and the area of new or established protected areas (Spearman’s, \( p = 0.19 \) and \( p = 0.79 \), respectively) and concluded that the variables protected area acquisitions and established protected areas are exogenous (Fig. 2).

We accounted for potential bias that might arise from other (unobserved) underlying differences among LGAs by including the random factors population density, latitude, and longitude in all GLMM analyses. Using these random variables minimizes the potential for confounded baseline effects and accounts for spatial auto-correlation,
Table 1. Indicators of the 3 potential benefit pathways associated with protected areas and rationale for their selection.

| Benefit pathway                      | Indicator                              | Description and rationale                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------|----------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| **Improved local housing value**     | value of residential building approvals | Residential construction is an important component of economic growth across Australia and is considered a lead indicator of general economic activity and investment. NSW planning laws require that all residential building be preapproved by local council or other government planning authorities, which provides good information about construction activity in each local government area (LGA). |
|                                      | developer contributions                 | This portion of council revenue relates to charges and contributions that are levied on developers by local council under state planning laws. Contributions are designed to help local councils meet associated increase in demand for services such as roads and infrastructure. Land acquisitions for national parks may affect council revenue from developer contributions via impacts on surrounding development - by excluding development on the acquired site or stimulating development in surrounding areas. |
|                                      | rates revenue                          | Private landholders are required to make an annual rates payment to local councils calculated based on their land value. On average, rates contribute 40% of the total revenue of regional and rural councils across NSW. State and federal government agencies are exempt from paying rates on their land holdings, so government acquisition of private land may affect local council revenue by reducing the total area of rateable land in a given LGA. |
|                                      |                                        |                                                                                                                                                                                                                                                                                                                                                           |
| **Local business stimulus**          | number of businesses                   | Changing business numbers are used to reflect general business activity within an LGA. Decreasing business numbers in response to land acquisitions may indicate reductions in primary production on follow-on processing industries; increasing business numbers may reflect new opportunities in construction and maintenance associated with park management, or increased opportunities in tourism and hospitality. Non-residential building includes building of offices, factories and production houses, warehouses, etc. It is used as an indicator of businesses expansion and investment within a given LGA. |
|                                      | value of non-residential building       | Employment is widely used as an indicator of economic activity. Unemployment also has strong links with a number of social problems, including domestic discord, family breakdown, and employment-related emigration, which can have impacts on ongoing service viability in smaller rural communities. Employment levels can therefore be used to indicate both economic and social well-being in regional and rural LGAs. |
|                                      | employment (number)                    | Average income is used as an indicator of local community wealth. It is sensitive to local employment levels, but it also accounts for changes in employment type (to higher or lower-paid jobs) or business profitability.                                                                                                                                                                        |
| **Increased local funding**          | grants                                 | Local councils can apply for state or federal grants for a range of purposes, including infrastructure, community, or conservation programs. On average, grants comprise around 15% of the total revenue of regional and rural councils across NSW, but in western parts of the state the figure may be as high as 50%. We speculate that LGAs that contain national parks may be more likely to receive funding to carry out infrastructure or conservation work that is compatible with conservation goals driving land acquisitions in the local area. |
|                                      | user fees and charges                  | In NSW local councils charge for a range of services, such as water and waste collection and disposal, on a user-pays basis. National parks managers have an informal policy of engaging user-pays council services where appropriate, but the overall impact of land acquisition on user fees and charges depends on how national park use of these services compares with services supplied in association with the prior land use. |
|                                      | total revenue                          | Sum of all council revenues                                                                                                                                                                                                                                                                                                                                 |
Table 2. Summary statistics relating to established protected areas and rates of land acquisition for new protected areas from 2000 to 2010 in regional and rural LGAs across New South Wales.

| Established protected areas as of 2000 | New protected area land acquisitions |
|---------------------------------------|-------------------------------------|
|                                       | 2000-01  | 2001-02  | 2002-03  | 2003-04  | 2004-05  | 2005-06  | 2006-07  | 2007-08  | 2008-09  | 2009-10  | total |
| Regional LGAs (n = 37)                |          |          |          |          |          |          |          |          |          |          |
| no. LGAs with acquisitions            | 30       | 8        | 13       | 17       | 16       | 12       | 17       | 15       | 14       | 13       | 10    |
| total area (ha)                       | 1674328  | 130386   | 4794     | 61836    | 25564    | 14139    | 61409    | 28401    | 18156    | 7381     | 4056  |
| mean size (ha)                        | 44061    | 16298    | 369      | 3637     | 1598     | 1178     | 1142     | 1578     | 1210     | 568      | 406   |
| median size (ha)                      | 15140    | 5183     | 121      | 799      | 1255     | 301      | 288      | 129      | 102      | 158      | 118   |
| Rural LGAs (n = 73)                   |          |          |          |          |          |          |          |          |          |          |
| no. LGAs with acquisitions            | 59       | 6        | 8        | 18       | 7        | 14       | 19       | 15       | 11       | 13       | 8     |
| total area acquired (ha)              | 2527674  | 47917    | 8029     | 352554   | 10425    | 101935   | 320763   | 105284   | 18497    | 19694    | 19935  |
| mean size (ha)                        | 35601    | 7986     | 1004     | 19586    | 1489     | 7281     | 16882    | 7019     | 1682     | 1515     | 2492  |
| median size (ha)                      | 9378     | 4191     | 241      | 6185     | 1141     | 2590     | 9280     | 2054     | 749      | 1066     | 183   |

*Totals do not sum from annual values because multiple acquisitions have been made within some LGAs.

Figure 2. Lack of correlation between the socio-economic index for areas (SEIFA) scores and extent of protected areas (established protected areas and new land acquisitions) in 2000.

which is inherent in all land management studies (Benton 2012), by specifying that sites that are closer together are likely to have similar economic trajectories arising from underlying similarities in their natural resource base (soils, vegetation types), climate, and economic factors (e.g., distance to market). The GLMM accounted for these background environmental and economic conditions such that the influence of fixed effects (i.e., new and established protected areas) was determined by comparing outcomes from LGAs that have similar random factor values. This is analogous to “site matching” used by Andam et al. (2010) in their analysis of protected areas in Costa Rica and Thailand, but it treats baseline conditions as continuous rather than categorical inputs.

Given that the 3 benefit pathways proposed in this study rely on the potential for protected areas to affect amenity values (housing stimulus pathway) and local economic opportunities (business stimulus pathway), we undertook additional robustness checks to ensure that our results were not arising from confounded baseline or covariate effects whereby existing local amenity values and land-use patterns drive patterns of protected area acquisitions or contribute to the observed socio-economic outcomes. For example, if protected areas are more likely to be established in LGAs with larger proportions of natural vegetation coverage or where water bodies are present, any modeled socio-economic outcomes from protected areas may be wholly or partly attributable to these underlying differences. We tested
for potential confounded baseline and covariate effects by undertaking repeat GLMM analyses that included a number of alternate random variable sets relating to local amenity values (proportion of the LGA that is vegetated; proportion of an LGA covered by natural water bodies; proportion of the LGA classified as conservation and natural environments [encompassing both national parks and private lands that are subject to some form of conservation in place of or in addition to alternate land-uses]) and land-use patterns (proportion of the LGA under agricultural use; proportion of the LGA under production from relatively natural systems; proportion of the LGA that is built). All amenity and land-use variables were sourced with remotely sensed data published by the Australian Bureau of Statistics. We used an information theoretic approach, comparing Akaike’s information criterion (AIC) to assess the goodness of fit of our original and alternate models (Anderson 2008). This comparative modeling approach allowed us to estimate the likelihood that the socio-economic benefits we observed arose in response to protected areas, rather than in response to underlying differences in amenity values and land-use patterns among LGAs. Full details of alternate random variable sets and associated model probabilities are provided in Supporting Information. After alternate modeling was undertaken, the best model (of the subset tested) was selected, and histograms of residuals were inspected to ensure an approximate normal distribution (Supporting Information).

Because our model assessed ex-post policy outcomes relative to the counter factual, while holding all other aspects of the (temporal and spatial) environment equal, it is consistent with the criteria for establishing a causal link between policy (in this case protected areas) and observed socio-economic outcomes, as outlined by Heckman (2008).

Results

Impact of Protected Areas on Economic Performance Indicators

The GLMM identified significant effects of protected area land acquisitions on eight out of ten socio-economic performance indicators (Table 3). In each case, protected areas were associated with positive outcomes for the surrounding local community. We found support for each of the benefit pathways we proposed. A summary of significant benefits arising from each of the proposed pathways is provided in Fig 3. Protected area land acquisitions in regional LGAs were associated with an increase in the value of new residential building approvals. This increase in local housing construction delivered benefits to the local council on both intermediate- and longer-term time frames consistent with expectations from our improved local housing value pathway. Intermediate term benefits arose from increased developer contributions (which are levied on all building works under NSW planning laws to help local councils meet increasing infrastructure demand). In the longer term, increased building improved local land values and increased the local council rates base, which translated into higher rates revenue (Table 3). Increased rates revenue was the largest contributor to increased council budgets, contributing roughly two-thirds of the increase in total council revenue (Table 3).

New protected areas provided a stimulus for business building and investment in both regional and rural areas. In regional LGAs, local business building investment led to higher total income levels within the LGA; it also led to an intermediate term increase in local council revenue from user charges (a class of revenue includes waste tipping fees and other user-pays services provided by councils) (Table 3). In the longer term, local business investment also increased the business rates base and contributed to increased total council (Fig. 3).

New protected area land acquisitions were associated with increased local council revenue from grants (Table 3). Grants to local councils usually come from state or Commonwealth granting agencies and may reflect an increased likelihood of receiving funding to carry out local conservation or development works that are consistent with conservation objectives for newly acquired lands. Increased local funding also accrued from increased rates and user charge revenues associated with increased economic activity arising from improved housing value and stimulus to local business (Fig. 3).

Model Testing and Selection

For all 10 economic performance indicators, the best model fit was achieved using a fourth-root transformation for data relating to both the size of recent land acquisitions and the extent of established protected areas within an LGA. This pointed to a decreasing per hectare impact as protected area size increased, and is consistent with expectations based on economic theory relating to the law of diminishing returns. Our model also showed that the socio-economic impacts of new versus established protected areas were different. There was little overlap in the nature of impacts observed for recent land acquisitions compared with longer-term impacts associated with established protected areas.

None of the alternate models that incorporated random variable sets relating to local amenity and land-use characteristics provided a better model fit than our original model. Our results appeared not to be confounded by serial correlation between the expansion of the protected area network and other landscape characteristics.
Table 3. Results from longitudinal modeling of socio-economic indicators: effects from new land acquisitions and established protected areas.

| Benefit pathway | improved housing value | local business stimulus | increased local funding |
|-----------------|------------------------|-------------------------|------------------------|
|                  | dwelling app$^a$ | contributions (number) | rates ($) | businesses revenue ($) | business (number) | employment building app$^b$ ($) | (number) | income ($) | user ($) | grants charges | total |
| Fixed           | 393.8$^b$    | 25.4                    | 39.1      | 2027                | 101.3             | 191.7                   | 1572.0   | 24.3        | 13.5$^b$  | 167.5       |
|                | 27.6                    | 4.3                    | 18.0      | 596.8               | 28.9              | 42.7                    | 550.7    | 9.2$^b$    | 2.8        | 38.2        |
|                | $^c$ -1.5          | $^c$ -0.69              | $^c$ -2.08 | $^c$ -28.5          | $^c$ -8.0         | $^c$ -1.4                | $^c$ -26.3 | $^c$ -1.7$^c$ | $^c$ -3.4$^b$ | $^c$ 10.2$^c$ |
|                 | Protected area acquisition (1000 ha) |                    |           |                     |                   |                           |          |             |            |             |
| regional town or city | 4.70$^b$ | 4.2$^b$ | 0.07 | $^c$ -2.59 | $^c$ 7.07$^c$ | $^c$ 0.64 | 13.7$^b$ | 0.36$^b$ | 1.38$^c$ | 1.57 |
| rural           | 0.34                    | 0.03                   | 0.02      | $^c$ -0.41          | $^c$ 3.71$^b$    | 0.07                    | 0.54     | -0.09      | 0.04       | 0.05        |
| Established protected areas (1000 ha) |                    |           |           |                     |                   |                           |          |             |            |             |
| regional town or city | 1.15  | 0.14   | 2.14$^b$ | 50.54             | 1.2               | 2.84                   | 26.5     | 0.58       | 0.55$^b$  | 3.31$^b$    |
| rural           | $^c$ -0.41         | $^c$ -0.15            | 0.11      | 7.18               | $^c$ -0.18       | 0.17                    | 3.75     | 0.53       | 0.13       | 0.26        |
| Random          | $^a$ <0.0005       | $^a$ <0.0005          | 0.001     | 0.278              | 0.001             | 0.004                   | 0.008    | $^a$ <0.0005 | 0.006      |
| population density |                    |           |           |                     |                   |                           |          |             |            |             |
| latitude        | $^a$ <0.0005       | $^a$ <0.0005          | $^a$ <0.0005 | 0.016              | 0.003             | 0.001                   |          |             |            |             |
| longitude       | $^a$ <0.0005       | $^a$ <0.0005          | $^a$ <0.0005 |                    |                   |                           |          |             |            |             |

$^a$Values for random effects are levels of significance only.

$^b$p < 0.05.

$^c$p < 0.01.

$^d$Applications.

$^e$Maximum coefficient for years 1–10.

Figure 3. Protected area benefit pathways describing statistically significant impacts on indicators variables selected in this study (PA, protected area; LGA, local government area).

However, alternate random variable sets provided a model fit that was roughly equivalent to that of our original model in a small number of cases (n = 3). Thus, rather than being absent from our study area, serial correlations were adequately accounted for through the random model terms population density, latitude, and longitude, which provided a broad reflection of land-use, population, and vegetation patterns across the state.

Discussion

Our study provides important quantitative evidence that protected areas can provide economic benefits to surrounding local communities in the developed world. Within this study setting, protected areas presented new opportunities for regional growth and development: protected areas led to increased local housing demand,
stimulated local business investment, and improved local council financing. The effects of new and established protected areas observed in our study were different, indicating that the impacts of protected areas changed and developed over time as they cycled through the economy or as the management needs and inputs of protected areas changed. It follows that both intermediate- and longer-term outcomes need to be considered when the socio-economic impacts of protected areas are assessed. Our pathways approach is an important development in this regard; it accounts for interrelated benefits and the cycling of benefits through the economy over time.

We propose that the 3 benefit pathways we describe are causal rather than associative given that the GLMM adequately accounted for potential bias in initial conditions for protected area versus non-protected area LGAs and for potential serial correlation of the distribution and expansion of the protected area network with other landscape factors (see Accounting for Potential Bias in Methods). However, of all the socio-economic impacts of protected areas we observed, only one (increased investment in local business building) was common to both regional and rural economies. This indicates some degree of conditional causality (Heckman 2008), whereby the proposed benefits did not arise as an automatic consequence of protected areas; rather, they arose as an interaction between protected areas and some characteristic of the existing local economy. This raises an important question about the degree to which benefits we report can be generalized to other locations. In this context, it is useful to consider the benefits of protected areas observed under two broad categories: those that arose through market mechanisms and those that arose in response to regulatory and legislative mechanisms.

Market-Based Benefits

Results of studies undertaken in the United States suggest that rural and regional population and business growth is driven, in part, by the distribution of natural amenity values (Johnson & Rasker 1995; Beale & Johnson 1998; Hansen et al. 2002; Levitt 2002). Our findings highlight the potential for protected areas to play a key role in these more general market-based processes. Benefits that arise from market-based mechanisms introduce important issues for strategic conservation and land-use planning. Lands adjoining protected areas often have high biodiversity values, including high species richness and abundance (Shackleton 2000; Smart et al. 2005). Increased rates of development may encourage clearing of biodiverse areas on properties close to protected areas, with potentially adverse impacts on ecosystem quality and function inside protected areas (Hansen & DeFries 2007; Radolof et al. 2010; Butsic et al. 2012). In economic terms, increased demand for housing could also increase land values, increasing the cost of acquiring land for additional protected areas and diminishing marginal benefits of landholder participation in conservation initiatives on private land. The potential for interactions between land acquisitions and the success of future conservation initiatives highlights the need for long-term strategic spatial planning that accounts for market-based feedbacks that arise as a consequence of protected area land acquisition.

Legislated Benefits

It is difficult to determine whether the legislated benefits observed in our study, particularly those relating to improved local council finances, are a more generalized impact of protected areas because these types of impacts have rarely been the subject of formal investigation. Our finding that local councils with protected areas experienced increased levels of funding from government grants mirrors examples of co-investment from the international literature relating to protected areas in developing countries, where national or international agencies make financial contributions to conservation management, local infrastructure, or associated social projects (Wittemeyer et al. 2008). Our findings suggest that local governments in developed countries may be able to leverage funds from state or federal governments in a similar way. Improvements in other local council revenue streams such as rates and developer contributions in response to protected areas have not been reported (or investigated) in the peer-reviewed literature to date, but there is no reason to expect that these are not a generalized effect because they arise as a consequence of market-based effects that have been observed in a wide range of settings and most developed economies have a system of payments similar to that imposed under NSW law; all states of Australia and the United States, United Kingdom, Canada, and New Zealand have a requirement for rates payments to be made to the local government body in proportion to land or improved capital values (sometimes called property taxes) and a system by which developers contribute to local infrastructure costs (sometimes called monetary exactions, development levies, or community infrastructure levies). If one expects the rate and value of residential and business investment to increase in association with new protected areas across a range of settings, then so too should payments to local governments from the associated revenue streams increase.

Variation in the Impacts of Protected Areas in Different Economies

If protected area benefits can arise in a range of developed world contexts, then why were the benefits we reported (with the exception of business stimulus) only in regional and not rural economies? Variability in individual community outcomes has also been identified in
longitudinal analyses of the impacts of protected areas in the developing world (Sims 2010). Indeed, variable outcomes are inevitable given that the impacts of protected areas arise through interaction with the existing local economy; particular economic or social characteristics may act as barriers or enablers as local communities respond and adapt to new conditions (Brooks et al 2005; ABARE-BRS 2010). Comparable longitudinal research of the impacts of protected areas across a broader range of economic, social, political, and legislative contexts could provide insights into the key factors that determine the degree to which individual communities might benefit from protected areas.

Implications for Biodiversity Conservation

Developed countries contain nearly 40% of the global extent of protected areas, and a higher proportion of protected lands in selected geo-regions, including 58% in the Middle East and North Africa, 90% in East Asia and the Pacific, and 100% in North America (based on figures for high-income countries in the World Databank 2014). Understanding and communicating the socio-economic benefits of protected areas to surrounding local communities in the developed world is likely to be an important step in securing local support and ongoing high-level protection of key components of the world’s biodiversity. Our findings suggest that protected areas should be considered an alternate economic land-use with the potential to stimulate the local housing development sector, encourage local business growth, and sustain local government finances. We encourage further use of longitudinal techniques to investigate the socio-economic impacts of protected areas across a broader range of developed world settings.

Acknowledgments

We acknowledge input into project planning provided by R. Dick and C. Allen of the NSW Office of Environment and Heritage (OEH). M. Robson from NSW OEH provided GIS mapping. We gratefully acknowledge G. Syme from Edith Cowan University and A. Alasia from Statistics Canada, who reviewed our original project reports and whose comments assisted in the preparation of this manuscript. We thank two anonymous reviewers whose constructive input greatly improved the manuscript.

Supporting Information

The results of information-theoretic modeling undertaken to assess data transformations (Appendix S1), alternate random variable sets (Appendix S2), and histograms of model residuals (Appendix S3) are available online. The authors are solely responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

Literature cited

ABARE-BRS. 2010. Indicators of community vulnerability and adaptive capacity across the Murray-Darling Basin: a focus on irrigation in agriculture. Australian Bureau of Agricultural and Resource Economics-Bureau of Rural Sciences.

Agrawal A. 2001. Common property institutions and sustainable governance of resources. World Development 29:1649–1672.

Andam KS, Ferraro PJ, Sims KRE, Healy A, Holland MB. 2010. Protected areas reduced poverty in Costa Rica and Thailand. Proceedings of the National Academy of Sciences 107:9996–10001.

Anderson DR. 2008. Model based inference in the life sciences: a primer on evidence. Springer, Fort Collins, CO.

Armstrong PR, Daily GC, Kareiva P, Sanchirico JN. 2006. Land market feedbacks can undermine biodiversity conservation. Proceedings of the National Academy of Sciences 103:5403–5408.

Canavire-Bacarreza G, Hanauer MM. 2013. Estimating the impacts of Bolivia’s protected areas on poverty. World Development 41:265–285.

Beale CM, Johnson KM. 1998. The identification of recreation counties in non-metropolitan areas of the USA. Population Research and Policy Review 17:37–53.

Benton TG. 2012. Intensive farming and its role in wildlife conservation: Routes to squaring the circle? Pages 39–46 in Lindenmayer D, Cunningham S, Young A, editors. Land-use intensification: effects on agriculture, biodiversity and ecological processes. CSIRO Publishing, Collingwood, VIC.

Brooks N, Adger WN, Kelly PM. 2005. The determinants of vulnerability and adaptive capacity at the national level and the implications for adaptation. Global Environmental Change 15:151–163.

Butsic V, Gaeta JW, Radeloff V. 2012. The ability of zoning and land acquisition to increase property values and maintain largemouth bass growth rates in an amenity rich region. Landscape and Urban Planning 107:69–78.

Caro T, Gardner TA, Stoner C, Fitzherbert E, Davenport TRB. 2009. Assessing the effectiveness of protected areas: paradoxes call for pluralism in evaluating conservation performance. Diversity and Distributions 15:178–182.

CoA. 2009. Impact of the GFC on local government. The global financial crisis and regional australia. House of representatives standing committee on infrastructure, transport, regional development & local government. Commonwealth of Australia, Canberra.

DLG. 2011. Snapshot of NSW local government: comparative information on NSW Local Government Councils 2009/10. NSW Division of Local Government, Department of Premier and Cabinet, Sydney.

Drinn S, Common M. 1995. Economic and financial benefits of tourism in major protected areas. Australasian Journal of Environmental Management 2:19–29.

Edwards B, Gray M, Hunter B. 2009. A sunburnt country: the economic and financial impact of drought on rural and regional families in Australia in an era of climate change. Australian Journal of Labour Economics 12:109–151.

Ezebilo E. 2012. Community forestry as perceived by local people around Cross River National Park, Nigeria. Environmental Management 49:207–218.

Ezebilo EE, Mattsson L. 2010. Socio-economic benefits of protected areas as perceived by local people around Cross River National Park, Nigeria. Forest Policy and Economics 12:189–193.

Fortin MJ, Gagnon C. 1999. An assessment of social impacts of national parks on communities in Quebec, Canada. Environmental Conservation 26:200–211.
Hansen AJ, Rasker R, Maxwell B, Rotella JJ, Johnson JD, Parmenter AW, Langner U, Cohen WB, Lawrence RL, Kraska MPV. 2002. Ecological causes and consequences of demographic change in the new west. BioScience 52:151–162.

Hansen AJ, DeFries R. 2007. Ecological mechanisms linking protected areas to surrounding lands. Ecological Applications 17:974–988.

Heck RH, Thomas SL, Tabata LN. 2010. Multilevel and longitudinal modeling with IBM SPSS. Routledge, New York.

Heckman JJ. 2008. Econometric causality. International Statistical Review 76:1–27.

Hirschnitz-Garbers M, Stoll-Kleemann S. 2011. Opportunities and barriers in the implementation of protected area management: a qualitative meta-analysis of case studies from European protected areas. Geographical Journal 177:321–334.

Horridge M, Madden J, Wittwer G. 2005. The impact of the 2002–2003 drought on Australia. Journal of Policy Modeling 27:285–308.

IUCN (International Union for Conservation of Nature). 1998. Economic values of protected areas: guidelines for protected area managers. IUCN, Gland, Switzerland.

Johnson JD, Rasker R. 1995. The role of economic and quality of life values in rural business location. Journal of Rural Studies 11:405–416.

Krueger C, Tian L. 2004. A comparison of the general linear mixed model and repeated measures ANOVA using a dataset with multiple missing data points. Biological Research for Nursing 6:151–157.

Levitt J, editor. 2002. Conservation in the internet age. Island Press, Washington D.C.

Lewis DJ, Hunt GL, Plantinga AJ. 2002. Public conservation land and employment growth in the northern forest region. Land Economics 78:245–259.

Lewis DJ, Hunt GL, Plantinga AJ. 2003. Does public lands policy affect local wage growth? Growth and Change 34:64–86.

Lotze-Campen H, Reusswig F, Stoll-Kleemann S. 2008. Socio-ecological monitoring of biodiversity change - Building upon the world network of biosphere reserves. Gaia-Ecological Perspectives for Science and Society 17:107–115.

Mansfield C, Pattanayak SK, McDow W, McDonald R, Halpin P. 2005. Shades of green: measuring the value of urban forests in the housing market. Journal of Forest Economics 11:177–199.

McDonald RI, Yuan-Farrell C, Fievet C, Moeller M, Kareiva P, Foster D, Gragson T, Kinzig A, Kuby L, Redman C. 2007. Estimating the effect of protected lands on the development and conservation of their surroundings. Conservation Biology 21:1526–1536.

McNeely JA. 2008. Conservation in a world of eight billion. GAIA—Ecological perspectives for Science and Society 17(Suppl. 1):104–106.

NSW LPI. 2011. Atlas of New South Wales: Social inclusion. http://atlas.nsw.gov.au/public/nsw/home/topic/article/social-inclusion-html (accessed 6 January 2015).

Orr SK. 2011. The private sector on public land: Policy implications of a SWOT analysis of Banff National Park. Journal of Natural Resources Policy Research 3:341–354.

Pink B. 2011. Socio-economic indexes for areas (SEIFA). Australian Bureau of Statistics Technical Paper. 2033.0.55.001.

Radeloff VC, Stewart SL, Hawnbaker TJ, Gimmi U, Pidgeon AM, Flather CH, Hammer RB, Helmers DP. 2010. Housing growth in and near United States protected areas limits their conservation value. Proceedings of the National Academy of Sciences 107:940–945.

Selby A, Petäjästö L, Huhtala M. 2011. The realisation of tourism business opportunities adjacent to three national parks in southern Finland: entrepreneurs and local decision-makers matter. Forest Policy and Economics 13:446–455.

Shackleton CM. 2000. Comparison of plant diversity in protected and communal lands in the Bushbuckridge lowveld savanna, South Africa. Biological Conservation 94:273–285.

Sims KRE. 2010. Conservation and development: evidence from Thai protected areas. Journal of Environmental Economics and Management 60:94–114.

Smart R, Whiting MJ, Twine W. 2005. Lizards and landscapes: integrating field surveys and interviews to assess the impact of human disturbance on lizard assemblages and selected reptiles in a savanna in South Africa. Biological Conservation 122:23–31.

Stoll-Kleemann S, Job H. 2008. The relevance of effective protected areas for biodiversity conservation: An introduction. Gaia-Ecological Perspectives for Science and Society 17:86–89.

UNESCO. 1996. Biosphere reserves: The Seville strategy & the statutory framework of the world network. UNESCO Man and the Biosphere Programme, Paris.

Wittenmyer G, Elsen P, Bean WT, Coleman A, Burton O, Brashares JS. 2008. Accelerated human population growth at protected area edges. Science 321:123–126.

World Databank. 2014. World Databank. Terrestrial protected areas (% of total land area). World Bank, Washington D.C., Available from http://data.worldbank.org/indicator/ER.LND.PTLD.ZS (accessed November 2014).

Conservation Biology
Volume 29, No. 6, 2015