Natural Capital, Ecosystem Services, and Subjective Wellbeing

A Systematic Review

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INTRODUCTION

It has long been recognised that natural environments make important contributions to human wellbeing. However, the multiple pathways by which ecosystem benefits flow toward physical and mental wellbeing are less well understood. This makes it difficult to quantify or value the benefits we enjoy from experiencing nature or benefiting from hard to perceive ecosystem services, either *in situ* or remotely.

This chapter begins with an overview of the conceptual frameworks that have emerged over the past two decades seeking to describe the interlinked system of humans and the rest of nature. It then considers the growing body of empirical literature that has sought to measure the relationships between the natural environment and human wellbeing. In this chapter, we focus on a subjective wellbeing approach, also known as self-reported life satisfaction, while acknowledging the limitations of this approach in assessing overall wellbeing. We consider the various proxies for the environment that have been used when trying to empirically measure and quantify relationships with subjective wellbeing. Finally, we consider the lessons learned from this body of empirical research, seeking to both guide further research and to make recommendations for public policy approaches that can contribute to improved human wellbeing in the future.

THE COMPLEX SYSTEM OF HUMANS AND THE REST OF NATURE

The body of literature investigating the relationship between the wellbeing of humans and the natural environments they inhabit has grown significantly over recent years. It reflects a range of conceptual frameworks and methodological approaches emerging within separate academic disciplines and from multi- and transdisciplinary work. These frameworks seek to increase understanding of how human wellbeing depends on the natural environment.

The mechanisms by which the rest of nature contributes to human wellbeing are complex and operate as part of an interlinked and interdependent social-economic-environmental system. The physical extent and condition of the world's ecosystems and natural assets are frequently described using the term 'natural capital', representing the stock of environmental assets, while the flow of benefits that result from using natural capital are frequently described as 'ecosystem services'. In simplistic terms, ecosystem services are the benefits to humans provided as a result of the contributions of natural capital.

In some early conceptualisations of ecosystem services frameworks, the different types of services enjoyed from nature were considered in isolation and portrayed as a flow of benefits from nature toward humans; that is, a fairly simple, one-directional flow. Such frameworks generally recognised a number of different categorisations of ecosystem services, such as the regulating, provisioning, and cultural services model, underpinned by support services. A particularly well-known framework of this type is that presented within the Millennium Ecosystem Assessment (2005). *Regulating services* refer to the natural processes by which organisms mediate or moderate the environment in ways that affect humans, such as waste assimilation, water purification, storm protection, and carbon sequestration. *Provisioning services* refer to the provision of nutritional and non-nutritional outputs such as food, drinking water, and timber. Finally, *cultural services* refer to the nonmaterial outputs that affect the physical and mental states of people, whether *in situ* or remotely, and include providing aesthetic, intellectual, and spiritual benefits, such as ocean swimming, bush walking, scientific investigation and educational uses, and spiritual and religious interactions with the natural environment (Haines-Young & Potschin, 2018).

Early conceptualisations of the flow of benefits provided by ecosystems to wellbeing, in the form of ecosystem services, focused on the nature–human system alone, implying that the benefits to human wellbeing flowed directly from nature. Indeed, early definitions of sustainability focused on the substitutability of natural with physical capital as underpinning Hartwick's Law for (weak) sustainability (Hartwick, 1977). However, Costanza, de Groot, et al. (2014) highlighted that the benefits from natural capital flow when ecosystem services are created in interaction with social, human, and built capital (as depicted in Figure 18.1). This shows the inherent complementarity of the relationship between natural and other forms of capital. Understanding this system is further complicated by the overlapping and inseparable characteristics of
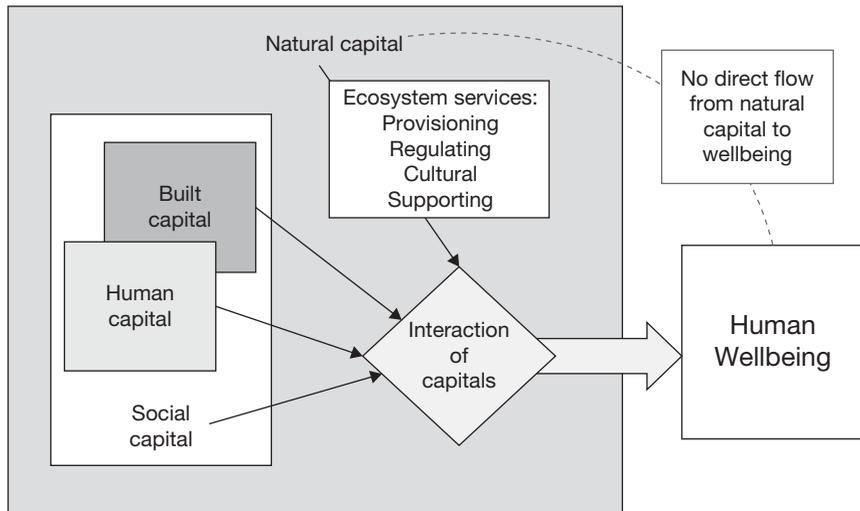
Figure 18.1 Human wellbeing depends on interactions among all four types of capitals. The benefits flow, in the form of ecosystem services that humans enjoy from natural capital, is therefore indirect, reflecting that nature is used together with complementary capitals, rather than a direct flow independent of other forms of capital.
Adapted from Costanza, de Groot, et al. (2014).

many of the benefit flows (Stoeckl et al., 2014). Furthermore, in addition to private benefits flowing to individuals, many of the benefits from nature are inherently social. These benefits that are experienced at a community level are often greater than the sum of the benefits experienced separately by individuals (Stoeckl et al., 2018).

More recent developments in conceptualising the relationship between humans and the rest of nature recognise that, in addition to the flow of benefits from nature to people, there is also a reciprocal flow from people to nature. People have long recognised the need to maintain built capital; there is now a growing recognition that the sustainable use of nature requires the same logic be applied to natural capital. Thus, conceptualising a reverse flow of benefits recognises the important role that people play in providing stewardship services in protecting and caring for ecosystems and supporting their ability to provide a sustainable flow of ecosystem services (Costanza et al., 2017; De Groot et al., 2010; Díaz et al., 2015; Pascua, McMillen, Ticktin, Vaughan, & Winter, 2017).

Historically, studies of the nature–human relationship adopted a Western science lens, considering humans and nature to be two separate entities (Haines-Young & Potschin, 2018). This approach is opposed to those that consider humans and the rest of nature as interconnected and inseparable entities (Kenter, 2018; Pascua et al., 2017). Transdisciplinary work with First Nations Peoples recognises that the world views of many indigenous peoples takes a more holistic approach (see Chapter 7, this volume), whereby the benefits from the rest of nature to humans are inseparable from the actions taken by humans to protect

and care for the rest of nature—their stewardship functions (Weir, Stacey, & Youngetob, 2011).

Recent transdisciplinary work extends the conceptual frameworks of the human–rest of nature system to incorporate the additional flows of benefits from human stewardship activities to human wellbeing (see Figure 18.2), irrespective of whether such stewardship activities contribute to increased environmental health or greater flow of benefits from ecosystem services (Stoeckl et al., 2021). This reflects that being involved in nature, and participating in activities on and for the environment, known as 'caring for Country' by the Australian Indigenous peoples, directly improves the wellbeing of those involved (Larson et al., 2020; Stoeckl et al., 2021). Providing environmental stewardship (Molsher & Townsend, 2016) has shown to have similar benefits to those gained from giving and volunteering (Black & Living, 2004; Choi & Kim, 2011). Recognising that people have stewardship obligations over the natural environment implies that they emotionally care, in addition to physically taking care of nature, and both aspects are likely to contribute to life satisfaction directly and also by indirect means, such as by contributing to people feeling that they have free choice and control over the direction of their lives (Sen, 1999), which has demonstrated links to happiness (Johnson & Krueger, 2006). Thus, human–nature links contribute to human wellbeing in many diverse ways beyond the direct flows of ecosystem services from nature that are more commonly considered to comprise nature's contribution to human wellbeing.
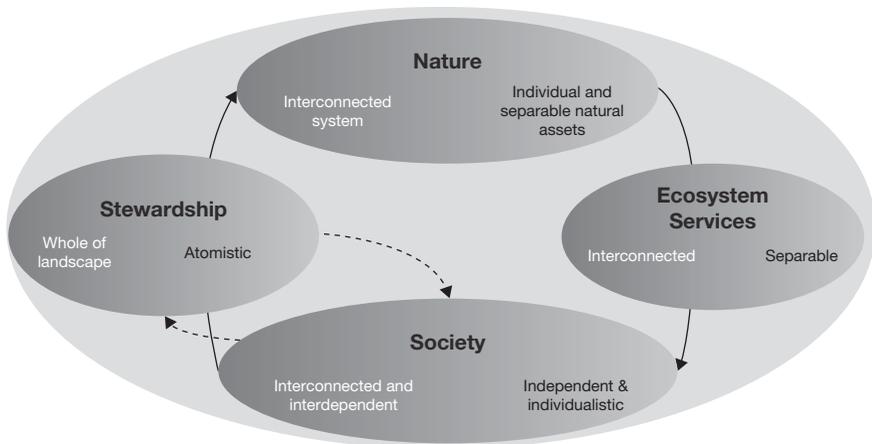

Figure 18.2 Nature and society form a cyclical and integrated system with reciprocal benefit flows from nature to people and from people to nature, plus the flow of benefits to human wellbeing from stewardship activities irrespective of benefits to nature resulting from those stewardship activities. Text on the right (within each oval) reflects that Nature, Society, Ecosystem Services, and Stewardship activities and can be conceptualised as simple and individualistic, while text on the left presents an alternate holistic interconnected worldview.
Adapted from Stoeckl et al. (2021). Figure reproduced under a Creative Commons CC-BY-NC-ND license.

MEASURING THE CONTRIBUTION OF THE REST OF NATURE TO HUMAN WELLBEING: THE LIFE SATISFACTION APPROACH

A wide range of research methodologies have attempted to measure the strength of the relationships among natural capital, ecosystem services, and human wellbeing. Such work recognises that understanding and quantifying the potential impacts of natural capital and ecosystem services on wellbeing and estimating the value of the benefits provided (either in monetary or relative terms) contributes to resource allocation decisions and improved public policy. Various proxy measures have been used to represent wellbeing (Costanza, Kubiszewski et al., 2014; Dolan, Peasgood, & White, 2008), including

1. subjective measures (discussed further below);
2. objective measures, including those based upon adjusted economic indicators such as the Genuine Progress Indicator (GPI) (Kubiszewski et al., 2013); and
3. composite measures that combine both types of measure.

Self-reported measures of overall life satisfaction or subjective wellbeing (SWB) assume that people are able to evaluate their own level of wellbeing and the quality of their lives (Diener, Suh, Lucas, & Smith, 1999). SWB can serve as a proxy for the economist's concept of utility (Kristoffersen, 2010). In this chapter, we focus on empirical studies seeking to understand the factors influencing subjectively measured wellbeing using one specific methodology: the life satisfaction (LS) approach. Simplistically, LS researchers ask questions such as 'How satisfied are you with your life as a whole?', and responses are then regressed against a variety of other factors. The coefficients of the equations provide information about the marginal contribution that these factors make to overall LS (or utility). The terms 'LS', 'happiness', and 'SWB' tend to be used interchangeably in the literature (Easterlin, 2003), along with the term 'quality of life', however each of these terms is conceptually distinct. Traditionally, the psychology literature distinguishes between the hedonic component (affect) of wellbeing and the eudaimonic component (cognitive evaluations of one's functioning in life) (Deci & Ryan, 2008) (see also Chapters 1, 2, and 3, this volume). While happiness is generally associated with hedonic wellbeing (short-lived emotions), LS is more closely related to cognitive judgements and intrinsic goals (in the Aristotelian tradition) (Engelbrecht, 2009) and has been found to correlate better with other national wellbeing predictors (Helliwell, 2003; Vemuri & Costanza, 2006). However, it has been argued that a composite SWB Index based on both happiness and LS was more reliable than either of its components (Inglehart, Foa, Peterson, & Welzel, 2008). Whilst there is some evidence of a reasonably strong relationship between the different concepts (psychological wellbeing and LS, and psychological wellbeing and positive and negative affect [Diener et al., 1999]), little correlation has been found between individual levels of LS and positive and negative affect (Organisation for Economic Co-operation and Development [OECD], 2013). Within the field of

economics, LS has emerged as the preferred measure although the terms 'happiness' and 'SWB' are also used, and comparisons across the different measures are common in the literature (Engelbrecht, 2009). Other research has explored factors relating to satisfaction with specific domains of life (such as health, community, emotional wellbeing, etc.) and the relationship between these different domains (Cummins, 1996) but without a focus on how these different domains interrelate with the natural environment. Accordingly, while the focus here is on the evidence of links between LS and nature, further research exploring the association between the environment and different domains of wellbeing would also be helpful in improving our understanding of this complex relationship.

It is also important to recognise that the LS approach develops models that test whether there is a statistically significant relationship between LS and the different variables included within the model, and therefore the same caution should be applied when interpreting results of LS analysis as with any other research based on statistical models. That is, the research indicates when correlations are present, but this does not necessarily imply a causal relationship flowing from the variable to LS: it is possible that any identified association could alternatively indicate bidirectional causation or from LS to the other variable, or the apparent correlation could be spurious (e.g., when issues of endogeneity, omitted variables, or confounding variables are present).

The key challenge when using the LS approach for measuring the potential impact of the environment on wellbeing (as proxied by LS) is determining an appropriate proxy variable or variables to represent the role of the rest of nature within the LS model. A key component of this challenge is that humans do not necessarily perceive all the benefits that the rest of nature provides to them. Furthermore, the impacts on LS from the rest of nature are not always positive. Negative impacts can result from environmental degradation such as pollution, where the root cause is human activities, or from natural events such as earthquakes, volcanic eruptions, and extreme weather events, which themselves can be exacerbated (or potentially mitigated) by human intervention.

In summary, it is clear that natural capital is a multifaceted concept that contributes to wellbeing via a range of pathways: benefits can flow directly or via indirect routes, and the full range of benefits are derived through use and nonuse mechanisms, some of which are enjoyed *in situ* while other benefits can be enjoyed remotely. The environment has both stock and flow effects and is a complement to other (built, human, social, and cultural) capitals. The rest of nature can be considered both a 'stock' (a natural asset such as the Great Barrier Reef) and a 'flow' (the range of cultural, provisioning, and regulating ecosystem services that are provided by the Reef). Both stocks and flows contribute to LS separately, and their impacts can either reinforce each other or include trade-offs. It is this complexity of benefit flows combined with the social and interrelated nature of the benefits that generates the challenge in determining an appropriate indicator or proxy to represent the rest of nature: with a simple individual benefit being far easier to measure than complex social benefit flows (Stoeckl et al., 2018).

A number of reviews have looked at the use of LS in general (Ferrer-i-Carbonell, 2012; MacKerron, 2012) and the idea of using it to estimate environmental

valuations (Ferreira & Moro, 2010; Welsch & Kühling, 2009). However, to our knowledge, no previous work has evaluated the relative performance of different proxy measures of nature in studies seeking to explore and explain how they contribute to wellbeing. In the next section, we seek to address this gap and thus provide an evidence base for both policy recommendations and future research opportunities.

METHODOLOGY ADOPTED FOR SEARCHING, CLASSIFYING, AND SYNTHESISING THE CONTRIBUTIONS OF THE REST OF NATURE TO LS

The Search and Screening Process

The target literature was identified via a process that involved systematically searching and screening relevant papers prior to synthesising the results. The Web of Science database was searched at the end of May 2019. The search was restricted to articles published from 1 January 2000 (reflecting that the LS approach is a fairly recent innovation, the use of which has grown substantially over the past two decades) to May 2019 and to articles published in English. Literature was selected based on the following search terms:

- Life Satisfaction OR Subjective Wellbeing OR Subjective Well-being
- Natural Capital OR Ecosystem* (where the * is a wild card implying any suffix).

The publications were initially screened based on Web of Science categories (excluding medical publications clearly focused on the physical and mental health aspects of wellbeing), then screened based on title, then subsequently screened based on abstract, and finally screened based on the full text. At each stage of the screening process papers clearly outside the scope of this study were excluded.

Following screening, 79 publications remained. These identified publications were supplemented by 8 additional publications identified by the authors from prior research, providing 87 eligible publications for critical appraisal and synthesis within this review.

Critical Appraisal and Synthesis

The publications were critically appraised and classified into a number of different themes representing analysis based on different types of environmental/natural capital indicators. Four clear indicator themes emerged from the analysis.

1. *Degree of human intervention* (28 papers): Indicators within this theme captured whether the local environment (neighbourhood, region etc.) reflected a state that had been heavily modified by human intervention

or was in a more 'natural', unmodified condition (e.g., urban/rural, or low population density/high density). Such indicators are simplistic but offer the advantage of being easy to quantify, and the data are easy to find. Measures of transport networks and connectivity were also included in this theme, recognising that the impact of transport networks may be nuanced; they are both an indicator themselves of increased development (hence reducing the 'naturalness; of the environment) but also provide opportunities for urban dwellers to visit more natural environments.

2. *Specific environmental goods and services* (36 papers): Indicators (subjective and objective) within this theme related to specific environmental 'goods' such as coverage of, proximity to, or satisfaction with pleasant places or features (e.g., green space, beach, national park).

3. *Adverse impacts* (40 papers): Indicators within this theme related to specific environmental 'ills', such as objective measures or subjective perceptions of pollution (e.g., air or water pollution) or proximity to somewhere unpleasant (e.g., a hazardous waste facility or polluted river).

4. *Overarching indicators* (24 papers): Indicators within this theme sought to represent the value of or satisfaction with natural capital or ecosystem services more broadly conceived (e.g., natural capital, ecosystem services, and environmental health).

During the appraisal process it was noted that some publications included indicators relating to one theme only whereas others included indicators relating to two or three. Furthermore, a number of the papers included more than one indicator relating to a specific theme. It was also notable that both subjective (based on perceptions) and objective (based on physical measures) indicators were included within a number of these themes, with some publications focusing on objective, others on subjective, and a further set including both subjective and objective indicators. The full list of publications included within this review, analysed by theme, are set out in the Appendix.

RESULTS AND DISCUSSION BY THEME

Summary of the Papers Reviewed

The publications included 65 studies relating to 18 individual countries, with the most highly represented countries being China and Australia. Additionally, 22 studies were based on cross-country comparisons for multiple different countries. Analysis by country is shown in Table 18.1.

The frequency of relevant publications across the years included within the reviewed period increased exponentially. During the first 5 years, only one relevant

Table 18.1 ANALYSIS OF PUBLICATIONS INCLUDED WITHIN THE REVIEW
BY CASE STUDY COUNTRY

Country	Number of papers	% of papers
Australia	13	15
Canada	1	1
Chile	1	1
China	15	17
Ecuador	2	2
Germany	5	6
India	1	1
Iran	1	1
Ireland	4	5
Italy	1	1
Japan	4	5
New Zealand	2	2
Spain	1	1
Switzerland	1	1
Taiwan	1	1
Turkey	2	2
UK	6	7
USA	4	5
Total single-country studies	65	75
Cross multiple countries studies	22	25
Total number of studies	87	100

paper was selected, rising to 13 papers (15% of total) for the second 5-year period, while the third and fourth 5-year periods contained 24 (28%) and 49 papers (56%), respectively (noting that the final period is potentially understated as it only contains 4 years and 5 months of publications) (Figure 18.3). This dramatic growth over time indicates both the increasing use and increasing acceptability of this approach as researchers recognise that it provides a powerful analysis tool.
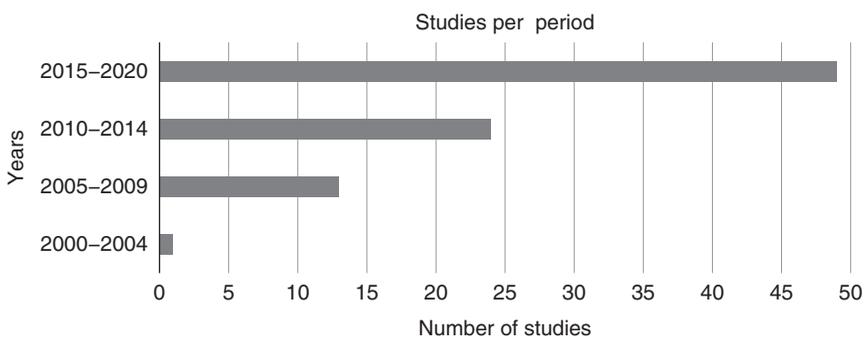

Figure 18.3 Distribution of publications over each 5-year period.

Theme 1: Degree of Human Intervention

Almost one-third of the papers selected for the study, 28 in total, included variables that could be classified as proxies of urbanisation or a degree of human intervention. These variables were further analysed between three subthemes: (1) population density (e.g., people per square kilometre; (2) indication of rural, remote, or far from city centre locations (e.g., distance to city centre; dichotomous variable indicating rural or urban; indicator of residence in either city, town, village or remote area; percentage urban/industrial/commercial coverage of region); and (3) proximity to transport networks (e.g., distance to railway station; indicators of being within a specified distance [say <5 km] from specified facility [say airport, station, main road, etc.]). The relationship between each variable and LS was then ascertained. Some papers included variables from more than one subtheme, and some included a number of different variables from within the transport subtheme, separately testing the impact of different types of transport networks (road, rail, etc). Some papers also include more than one model, with different results depending on the specific functional form of the model; hence one paper may be included in more than one of the groupings. Overall, the impact of 48 different variables from the subthemes is summarised in Table 18.2.

Whilst these types of variables are simple to define and easy to obtain, and consequently are fairly widely included within LS models, they are often found not to have a significant correlation with the respondent's LS. Such measures are too broad and imprecise to enable the effect of living in a natural environment to be determined. Indeed, such measures could be acting as proxies for many factors beyond living in or being connected to the natural world. These variables could also reflect the impacts of some or all elements of physical, social, and financial capital, rendering these variables unsuitable proxies for the benefits we gain from the environment.

Table 18.2 THE NUMBER OF VARIABLES DEMONSTRATING POSITIVE, NEGATIVE, OR NO IMPACT ON LIFE SATISFACTION (LS) OF DIFFERENT VARIABLES INDEXING DEGREE OF HUMAN INTERVENTION.

Degree of human intervention subtheme	Impact of variable on life satisfaction as a proxy for wellbeing		
	Positive: Increases wellbeing	Negative: Reduces wellbeing	No significant impact
Population density	2	3	12
Rural, remote, far from city centre	6	5	10
Proximity to transport networks	2	2	6
Total number of variables having this impact on wellbeing	10	10	28

The impact of population density was variable, suggesting that this may be a more important variable at a country scale rather than a regional scale. From the 13 single-country studies, population density had a positive impact on wellbeing in two of those studies (Ambrey & Shahni, 2017; Brereton, Clinch, & Ferreira, 2008) and a negative impact in one (Cuñado & de Gracia, 2012); no significant impact was found in the other 10 studies. For four cross-country studies, population density had no significant impact in two and was found to have a significant negative impact in two others (Maddison & Rehdanz, 2011; Menz & Welsch, 2010).

Measures indicating urbanised or city living compared to more regional or remote lifestyles were also found to have a mixed and frequently insignificant association with LS. Five studies found living in rural/remote locations contributed positively to LS (Ambrey & Fleming, 2012; Kopmann & Rehdanz, 2013; Sasaki, 2018; E. Wang, Kang, & Yu, 2017; Zhang & Wang, 2019) while five found a negative impact (Asadullah, Xiao, & Yeoh, 2018; MacKerron & Mourato, 2009; Requena, 2016; Winters & Li, 2017; Zorondo-Rodríguez et al., 2016). The remaining relevant studies found no significant impact. One study in particular found that the impact of rural residence was highly sensitive to the model specification, as positive, negative, and insignificant impacts were found depending on the form of the model (whether the model included variables indicating respondents' economic position relative to others, whether the model focused on full sample or subsamples selected by income groups), suggesting that the impact of rural or urban location could be mediated by the influences of absolute and relative incomes (Asadullah et al., 2018). Another study used rural/urban indicators (which were all insignificant) but also included dummy variables specifying whether respondents resided in one of the major metropolitan cities (Ambrey & Fleming, 2013). This study found that, compared to living in Sydney (the largest city in Australia), residing in one of the smaller metropolitan areas (Brisbane, Adelaide, Perth, Hobart, Darwin or Canberra) contributed positively to LS, while living in the second largest city, Melbourne, made no significant difference, suggesting that residing in smaller (less urban) rather than larger cities may be beneficial for LS.

The variables representing proximity to transport networks were also found to have highly mixed impacts, potentially due to the clear opportunities for both benefits (in the form of increased connectivity) and costs (noise, congestion, air pollution, etc.) to arise from being in the close vicinity of major roads, airports, etc. Thus, a study investigating regions of European countries found a positive impact from good coverage of roads, rail, and air for northern European countries but not those of central or southern Europe (Kopmann & Rehdanz, 2013). A study in Ireland found benefits from being fairly close to regional (<30 km) and international (30–60 km) airports (Brereton et al., 2008), while an Australian study found being within 5 kilometres of an airport negatively impacted LS (Ambrey & Fleming, 2013) as did being very close to a major road in Ireland (Brereton et al., 2008).

Thus, the relationship between LS and residing in a heavily built environment such as a large city, or a rural location, is unclear, likely due to the many confounding factors that could be having an impact. Some such possibilities are

revealed by research focusing specifically on factors correlating with increased happiness or LS for city residents: for example, indicators of higher human capital have been shown to relate to higher levels of happiness within cities (Florida, Mellander, & Rentfrow, 2013) while larger cities are likely to contribute to longer commute times, which has been shown to reduce LS (Stutzer & Frey, 2008). Furthermore, complex links have been demonstrated between creativity (which itself can be fostered by interactions with nature), human capital, incomes, economic growth, and the aesthetic quality of a location (including natural scenery, parks, and green spaces) within cities, all factors that can impact on LS and which may contribute to the unclear relationship between urban or rural living and LS (Florida, 2014).

The findings from this theme broadly support the conceptual framework developed by Costanza, de Groot, et al. (2014), which proposes that for natural capital to provide human wellbeing benefits such capital needs to be in conjunction with the complementary human, built, and social capitals. High population density and city centre locations with good transport networks provide built capital but are unlikely to have sufficient quantities of natural capital to optimise wellbeing. In contrast, remote areas with low population density are unlikely to have sufficient built capital to enable the more abundant natural capital to be fully enjoyed. This effect may exacerbate differences seen when conducting cross-country comparisons of LS (and contributing factors), particularly between developed and developing countries (which are likely to have lower quality and quantity of built capital per capita). Hence, such variables are shown to have mixed or insignificant impacts on wellbeing and appear to be not overly robust to the precise specification of the model used. Accordingly, these variables appear to be too broad and unfocused to be able to clearly indicate the subtleties involved in the complex benefits flow from natural capital and the services provided by ecosystems.

Theme 2: Enjoyment of Specific Environmental Goods and Services

More than 40% of the papers selected for review, 36 in total, included variables that could be classified as proxies for the enjoyment of specific environmental goods and services. These variables were further analysed between a number of subthemes (Table 18.3) identifying the specific environmental services enjoyed (such as greenspace and urban parks, which were the most widely studied) and whether the variable provided an objective or subjective measure. The significance and direction of the relationship between each variable and LS is summarised in Table 18.3. Some papers included variables from more than one subtheme; thus the impact of 74 different variables across the papers and subthemes have been identified.

The most widely used variables (almost 50% of this theme) related to greenspaces, with a variety of measures used to indicate that natural greenspaces were accessible to those responding to the survey (Table 18.3). Studies that used a form

of greenspace measure to indicate an environmental good found that (proximity to, extent of coverage in local region, use of, or quality of) greenspaces were generally (in 71% of the studies) positively related to LS. However, the relationship is somewhat ambiguous as a number of papers found no significant correlation. Furthermore, three papers found nonlinear or inverted-U shape relationships. A need exists for further research regarding the appropriate functional form of the relationship between greenspaces and wellbeing (linear or otherwise). These findings suggest greenspaces are an example of natural capital contributing to wellbeing as a complement to other capitals, as discussed earlier. That is, accessing greenspace may enhance wellbeing, but are individuals willing and able to access them alone and by foot, or do other factors, such as a need for a car or public transport to access the greenspace play a role as well? And, once there, is their enjoyment enhanced by footpaths, boardwalks, seating areas, etc.? And is their enjoyment enhanced by accessing the greenspace with others (friends, family, etc.)? The complementarity of this example of natural capital and the other capitals (built, social) adds complexity to the task of attempting to separately value the different contributors to overall LS and may have contributed to those studies with nonsignificant findings.

A similar pattern is seen when other proxy variables are considered. Approximately half have a positive relationship to LS, with no significant relationship being found in the rest. Similar nonlinear or complementary factors may apply to these other variables as to those discussed regarding greenspace.

Ambrey and Fleming (2011a) incorporated a number of variables representing a range of different coastal and inland water-based 'goods' in combination within their study, reflecting proximity to coasts, lakes, rivers, and creeks, and found a mix of relationships with wellbeing. Specifically, the relationship of proximity to rivers was negative, proximity to lakes was not significant, and proximity to coastal areas and creeks was found to be significantly positive. This study does not provide insights into potential reasons for these different associations, and there is not a large enough body of research into the impact of water-based environmental goods to be able to draw conclusions here. Potentially, the mixed findings could reflect trade-offs between benefits from proximity to water (such as attractive views, opportunities for leisure and fishing) and adverse outcomes such as risks of flooding or the presence of mosquitos. There is a growing interest in the use of water environments, or 'blue space', to promote human health and wellbeing (Britton, Kindermann, Domegan, & Carlin, 2020; Garrett et al., 2019; Wheaton, Waiti, Cosgriff, & Burrows, 2020). However, further research is recommended to understand the apparent mix of effects on wellbeing resulting from blue spaces.

The list in Table 18.3 includes a number of subjective variables measuring respondents' perceptions rather than objective measures: perceived amount of greenspace and urban parks, subjective quality or satisfaction with greenspace, and perceived increase in native forest cover. Generally, these subjective variables were positively correlated with LS (e.g., Ambrey & Fleming, 2013), which is consistent with other research, such as that which has shown self-reported attributes of greenspaces are associated more clearly with neighbourhood satisfaction than

Table 18.3 THE NUMBER OF VARIABLES DEMONSTRATING POSITIVE, NEGATIVE, OR NO IMPACT ON LIFE SATISFACTION OF DIFFERENT VARIABLES INDEXING DEGREE OF OPPORTUNITIES FOR ENJOYMENT OF ENVIRONMENTAL GOODS AND SERVICES

Enjoyment of environmental goods and services subtheme	Impact of variable on life satisfaction as a proxy for wellbeing		
	Positive: Increases wellbeing	Negative: Reduces wellbeing	No significant impact
Proximity to greenspace and urban parks	6[a]	0	3
Coverage of greenspace and urban parks	14[a]	1[b]	3
Use of greenspace and urban parks	1	0	2
Perceived amount of greenspace and urban parks	1	0	0
Subjective quality of, or satisfaction with, greenspace and urban parks	3	0	1
Proximity to coast or beach	10	0	4
Proximity to lake, river, water, brook, creek	2	1	6
Coverage of wetlands	0	0	3
Proximity to national park	1	0	2
Coverage of national park, reserve, protected area, forest etc	3	0	3
Perceived increase in native forest cover	1	0	0
Subjective scenic amenity or landscape quality	2	0	1
Total number of variables having this impact on wellbeing	44	2	28

[a]Some studies have found a significant nonlinear (inverted U-shape) relationship, with greenspace area (one study) and distance from greenspace (two studies) having a positive impact on wellbeing to a certain point, beyond which further increases in greenspace area/distance from greenspace having a negative impact (Ambrey & Fleming, 2011a; Bertram & Rehdanz, 2015).

[b]One study found the relationship to be negative and significant in the nonlinear model, but nonsignificant in the linear model (Kopmann & Rehdanz, 2013).

is physical reality (Hur, Nasar, & Chun, 2010). Subjective measures generally (not just in relation to the environment) have been found to correspond more strongly with self-reported subjective wellbeing or LS than objective measures (Cummins, 2000), and there can be discrepancies between subjective and objective measures, for example, between respondents' satisfaction with urban green areas and open space (Ma, Dong, Chen, & Zhang, 2018) and objective environmental indicators such as hectares of greenspace per capital within respondents' local region (Ambrey & Cartlidge, 2017), as has been noted in the literature (Kothencz & Blaschke, 2017). Moreover, respondents' perception of same size green spaces differ depending on their types: biodiversity, presence of old trees, density of trees, and the presence of recreational areas (Aoshima, Uchida, Ushimaru, & Sato, 2018).

Overall, the findings from this theme again broadly support the conceptualisations from Costanza, de Groot, et al. (2014). Environmental 'goods' contribute to wellbeing, particularly from the provision of cultural ecosystem services, such as leisure and recreation services, and the more spiritual services enjoyed from being 'close' to nature whether enjoyed directly *in situ* or more remotely. However, such benefits reduce as the distance from nature increases, implying reduced ease of access and increased need for the complementary built and human capital to facilitate the enjoyment of the natural benefit.

Theme 3: Adverse Impacts Arising from Specific Environmental 'Ills'

Approximately half (47%) of the papers selected, 40 in total, included variables that could be classified as proxies for the adverse consequences that result from environmental problems such as pollution and degradation of the environment. These variables were further analysed between the different types of pollution or other problems, including air pollution, water pollution, and proximity to landfill sites, amongst others (Table 18.4). Two papers included variables that, while pollution-related, in fact measured efforts to reduce pollution levels (i.e., indicators of efforts to reverse the impact of the environmental 'ill'); as these measures view pollution via a different lens, they have been shown separately (Table 18.5). Consideration was also given on whether each variable provided an objective or subjective measure of the issue, with these two types of measures shown separately within the table. As for other themes, the significance and direction of the relationship between each variable and LS was identified and summarised. Some papers included variables from more than one subtheme; thus the impact of 78 different variables across the papers and subthemes has been summarised in Table 18.4, plus two variables measuring reduced pollution are shown separately in Table 18.5 (i.e., 80 different variables in total related to this theme).

As can be seen from the analysis within Table 18.4, the topic of air pollution has received far more attention than other topics, with 74% of the variables relating to objective or subjective air pollution. The next most studied topic was water pollution (9%), with the remaining studies covering a variety of different

Table 18.4 THE NUMBER OF VARIABLES DEMONSTRATING POSITIVE, NEGATIVE, OR
NO IMPACT ON LIFE SATISFACTION OF DIFFERENT VARIABLES INDEXING DEGREE
OF IMPACTS FROM ENVIRONMENTAL 'ILLS'

Impact of environmental 'ills' subtheme	Impact of variable on life satisfaction as a proxy for wellbeing		
	Positive: Increases wellbeing	**Negative: Reduces wellbeing**	**No significant impact**
Proximity to landfill or hazardous waste	0	2	3
Objectively measured poor air quality: particulates pollution, and/or emissions of one or more gases	2	33	14
Subjectively measured perceived air pollution	0	7	2
Proximity to polluted river	0	0	2
Objectively measured water pollution	0	1	2
Subjectively measured perceived water pollution	0	1	1
Proximity to invasive species impacted location	0	1	0
Subjectively measured perceived noise pollution	0	1	2
Subjectively measured perceptions of impact of pollution in general	0	1	1
Reported having concerns about ozone layer	0	1	0
Reported having concerns about animal extinctions	1	0	0
Total number of variables having this impact on wellbeing	**3**	**48**	**27**

problems. Overall, the analysis reveals the unsurprising result that, in the majority of circumstances (62%), the presence of pollution or other environmental ills whether objectively or subjectively measured reduces wellbeing. However, this finding does vary if we consider the different types of pollution in more detail. In 69% of the instances where air pollution was the focus, a negative impact

Table 18.5 THE NUMBER OF VARIABLES DEMONSTRATING POSITIVE, NEGATIVE, OR
NO IMPACT ON LIFE SATISFACTION OF DIFFERENT VARIABLES INDEXING DEGREE
OF IMPACTS FROM INDICATORS THAT ENVIRONMENTAL 'ILLS' ARE BEING REVERSED

Impact of reversed indicators within environmental 'ills' subtheme	Impact of variable on life satisfaction as a proxy for wellbeing		
	Positive: Increases wellbeing	**Negative: Reduces wellbeing**	**No significant impact**
% of industrial air emissions that have been treated	1	0	0
% of water discharges that have been treated	0	0	1
Total number of variables having this impact on wellbeing	**1**	**0**	**1**

on wellbeing was found, with most of the balance having no significant impact; however, in two papers, positive impacts were found. Beja (2012), in a multiple-country study, found context in the form of the development state of the country to be important. That is, emissions in developed countries generally reduce wellbeing but can have a positive impact in developing countries, presumably due to links between industrial activity (hence emissions) and income/jobs, which are generally found to benefit wellbeing. Goetzke and Rave (2015), in a single-country study drawing survey participants from across Germany, explained (and supported with econometric analysis) that the positive relationship they found between objectively measured air pollution and wellbeing was due to the air pollution being fully capitalised within the housing market (i.e., air pollution is factored into house prices, with housing in high-pollution areas being cheaper than housing in less-polluted areas, with the consequence that the negative impact of pollution on LS is counterbalanced by the positive effect on LS resulting from cheaper housing). Interestingly, alternate research has found that subjectively measured air pollution (as opposed to objectively measured pollution) is not fully capitalised within the housing market (Rehdanz & Maddison, 2008).

In comparison to the air pollution findings, the non–air pollution variables were found to have an insignificant impact in the majority of cases (55%), and, for those instances where the focus was water pollution, a negative impact on wellbeing was found in only 29% of cases (the remaining 71% showing no significant impact).

Considering the objective (proximity or actual measured pollution) variables compared to the subjective variables revealed little difference, with 62% and 61%, respectively, showing a negative impact on wellbeing.

The variables representing efforts to reduce the various forms of pollution supported the findings from the variables indicating the impact of the pollutions/ills themselves. Increasing the proportion of air emissions that are treated, thus

reducing air pollution, had a positive impact on wellbeing, whereas for water emissions, increasing the proportion treated was not found to have a significant impact. Thus, again, air pollution problems appear to have a greater impact on wellbeing than problems with water quality.

The relationship between perception/awareness of environmental 'ills' and objective indicators, and between perception/awareness and LS, can be summarised as follows:

- Perceived air pollution (e.g., particulates such as PM10 or gases such as nitrogen dioxide [NO_2]) has been found to be strongly negatively related to LS (MacKerron & Mourato, 2009; Rehdanz & Maddison, 2008), as has noise pollution (van Praag & Baarsma, 2005).
- In some cases, the perception of pollution relates strongly with LS while objective measures of pollution do not (e.g., van Praag & Baarsma, 2005).
- Similar strongly negative relationships have been found between environmental awareness (ozone layer depletion, concerns about biodiversity) and LS (Ferrer-i-Carbonell & Gowdy, 2007).
- There is good evidence of a strong correlation between perceptions of air pollution and actual levels of air pollution (Li, Stoeckl, King, & Gyuris, 2017; MacKerron & Mourato, 2009).
- People with personal experience of air pollution (e.g., people with asthma and older people) display a higher sensitivity to the levels of air pollution (Day, 2007).

Overall, this theme clearly indicates that pollution, and environmental 'ills' more generally, have a negative impact on human wellbeing. These findings, in conjunction with the findings from theme 2, suggest a possible adaptation of the framework showing the indirect flows of ecosystem services from nature and involving the complementarity on other types of capitals (Costanza, de Groot et al., 2014). Instead, it appears that while enjoyment of the benefits of nature (ecosystem services) are indeed generally indirect, the reduction in wellbeing from a degraded or polluted environment (itself caused by human activities) may in fact have a direct and adverse impact on human health and wellbeing.

Theme 4: Overarching Measures of Ecosystems and Other Descriptors of Natural Capital

Around one-quarter (28%) of the papers selected for review, 24 in total, included variables that provide a more general or overarching measure of the impact of the environment on wellbeing rather than a specific element of the environment or the type of impact. These variables were further analysed between objective or subjective measures, with subjective indicators being more common within this

Table 18.6 THE NUMBER OF VARIABLES DEMONSTRATING POSITIVE, NEGATIVE,
OR NO IMPACT ON LIFE SATISFACTION OF DIFFERENT VARIABLES INDEXING
DEGREE OF IMPACTS FROM OVERARCHING INDICATORS OF THE ENVIRONMENT
AND NATURAL CAPITAL

Impact of overarching environmental indicators subtheme	Impact of variable on life satisfaction as a proxy for wellbeing		
	Positive: Increases wellbeing	Negative: Reduces wellbeing	No significant impact
Objective measures of natural or less developed environments[a]	14	1	2
Subjective measures of contribution of nature/ ecosystems[a]	5	0	4
Subjective measures indication positive attitude toward conservation or environmental protection[a]	5	0	3
Total number of variables having this impact on wellbeing	24	1	9

[a]In all examples where a variable was measuring a degraded environment or concern about degradation or other problems, then measure reversed for consistency and comparability with other measures.

theme than elsewhere. Some papers included variables from more than one subtheme; the impact of 34 different variables (17 objective and 17 subjective) across the papers and subthemes is summarised in Table 18.6. As can be seen, these variables were found to be significantly and positively associated with wellbeing in a clear majority of cases (70%).

A diverse range of objective measures indicating a more natural environment were included and could be broadly categorised into a number of types including (1) values attributed to natural capital using World Bank wealth accounts; (2) values based on different indices (Normalised Difference Vegetation Index [NDVI]; diversity index; biocapacity index; environmental sustainability index; and ecosystem services production index); (3) counts of plant species, animal species, or crop species in a particular region; and (4) footprint measures (carbon footprint, ecological footprint, and impact of land use). Whichever type of measure was used, these objective variables were virtually always positively linked to wellbeing (in 82% of cases).

The subjective measures have been subdivided into two distinct categories. First were those measuring perceived benefits from or satisfaction with the environment, which were generally measured on a 1–5, 0–5, or best to worst type scale. Specific examples include 'perceived contribution of nature to wellbeing', 'perceived value of ecosystem services', a variety of satisfaction/dissatisfaction measures such as 'perceived satisfaction with the environment/nature', and 'perceived severity of environmental issues/worries'. Such measures were fairly evenly split between having a positive impact or no significant impact on LS, with a slight majority (56%) finding positive impacts. Studies using wider response scales (0–10) gave more positive impacts than those with narrower response scales (1–3) and intermediate response scales (0–5, 1–5) indicating a mix of significant and insignificant findings, perhaps indicating that fairly wide scales should be used to ensure that different attitudes can be differentiated. The second category described as subjective measures related to positive attitudes toward the environment, conservation, and environmental activism, which were found to be positively related to wellbeing 63% of the time. Of the variables found to have a positive relationship, three indicated that higher satisfaction with conservation activities was associated with improved wellbeing, while a fourth variable—namely, being concerned about the environment—was associated with lower wellbeing. The fifth variable is more complex, being a measure of activism. The question posed was 'Have you ever reported a situation that caused pollution?', with an affirmative 'yes' answer to the question being related to increased wellbeing; this indicates that the respondent must have encountered pollution (otherwise there would be nothing to report), but the act of taking action against the problem (reporting it) was sufficient to enhance wellbeing, rather than the pollution itself suppressing wellbeing, thus affirming the importance of people feeling they have the freedom to exercise control over their life and situation, as found in studies in many different contexts (e.g., Inglehart et al., 2008; Sen, 1999). This accords with findings from recent research, which found that those whose response to climate change was described as 'eco-anger' were prompted to take individual action which itself was related to improved mental health and wellbeing (reduced depression, anxiety, and stress), while alternate emotional responses to climate change classified as 'eco-depression' or 'eco-anxiety' were found to reduce the likelihood of the person taking individual action and were related to poor mental health outcomes (Stanley, Hogg, Leviston, & Walker, 2021).

The various indicators of environmental quality and its contribution to human wellbeing support the frameworks proposed by Costanza, de Groot, et al. (2014) and also that of Stoeckl et al. (2021). Not only does the environment itself contribute to wellbeing, but being actively involved in conservation/stewardship activities also contributes to wellbeing. Similarly, protests against environmental degradation or activities promoting conservation also contribute to human wellbeing even if such activities result in no direct benefits to nature

itself (supporting the feedback loop from stewardship activities directly to societal wellbeing).

SUMMARY

This review sought to assess the relative abilities of variables based on different proxy measures of nature to explain variations in human wellbeing. The results revealed that simple and easy-to-obtain measures such as population density (theme 1) are too broad and unfocused to provide meaningful information regarding the complex relationship between humans and the rest of nature. Hence, more specific variables are required, with variables relating to access to specific environmental goods/services (theme 2) and to more overarching measures of natural capital (theme 4) generally related to improved human wellbeing, while exposure to environmental ills (theme 3) were generally found to directly reduce human wellbeing, perhaps through a combination of health and aesthetic impacts.

The insights from this review lead to a number of policy recommendations, the adoption of which could contribute to improved human wellbeing as follows:

- *Increase access to green space.* However, important questions remain regarding by how much and how close this access needs to be (linking to further research requirements below). It seems likely that a nonlinear, 'limiting factor' formulation is needed: that is, developing indicators and models that reflect that the impact of increasing green space on wellbeing will vary depending on the green space originally available and may also need to incorporate 'tipping points' at which level further increases in green space may have little impact on wellbeing or even change the direction of impact (see Chapter 21, this volume).
- *When developing policies to promote the use and enjoyment of nature, it is important to consider the complementary built, human, and social capital requirements* in addition to (but not as a replacement for) the extent and quality of the natural capital itself.
- *Reduce pollution!* It is very clear that environmental degradation and pollution in general, and air pollution in particular, whether perceived or measured objectively, have a very clear adverse effect on human health and wellbeing.
- *Increase opportunities for people to be involved in conserving and managing the natural environment*, as these types of stewardship activities provide multiple benefits including benefitting nature, benefitting humans by improving the flow of benefits back to humans from nature, and benefitting human wellbeing directly from their stewardship activities.

Future research recommendations generated from this work include the following:

- Further exploration of the nonlinearity of relationships between the correlating factors and wellbeing—particularly of environmental goods and services—is required to improve our understanding of how improvements to the environment may enhance wellbeing. Specific questions include gaining a better understanding of how much and what quality of environmental services are sufficient to optimise wellbeing benefits
- Further exploration of methods by which the complementarity of use of natural capital with other capitals can be reflected within the LS model
- Additional research to incorporate spatial and temporal scales and variations within the models
- Give consideration to additional moderators or potentially confounding factors that could usefully be built into future research models
- Further exploration of the reciprocity between stewardship/looking after nature, improved flow of ecosystem services, and improved human wellbeing, seeking to create a sustainable human–rest of nature system encapsulated by the Australian Indigenous motto 'healthy people, healthy country'.

Extending this review to also recognise the important impacts of climate and the effects of climate change on wellbeing would also be a valuable contribution to knowledge. There has been limited research on the climate–wellbeing relationship at this stage, which has mainly focused on inter-country comparisons (such as Maddison & Rehdanz, 2011), with one study of local-level influences in Ireland (Brereton et al., 2008). In addition to the impact of climate in isolation, such research would need to recognise that the impact of climate on wellbeing can relate to enjoyment of environmental goods (theme 2); that is, climate appears to influence the way we enjoy greenspaces and natural capital assets (Brereton et al., 2008). Furthermore, climate may also have an adverse impact on wellbeing: research has already indicated the adverse consequences of extreme weather events on LS such as drought (Carroll, Frijters, & Shields, 2009), floods (Fernandez, Stoeckl, & Welters, 2019), and extreme temperatures (Frijters & Praag, 1998). Climate change is the most prominent illustration of a 'reverse ill'; that is, human action negatively impacting on natural capital. Thus further research is needed into how climate interacts with natural and other forms of capital to impact wellbeing.

APPENDIX

Table 18.A1 SUMMARY OF PUBLICATIONS INCLUDED WITHIN THE REVIEW

Publication details	Theme 1: Degree of human intervention	Theme 2: Specific environmental goods or services	Theme 3: Adverse impacts	Theme 4: Overarching measures
Aguado, González, Bellott, López-Santiago, & Montes (2018)	✔			✔
Alfonso, Zorondo-Rodríguez, & Simonetti (2017)		✔		
Ambrey & Fleming (2013)	✔	✔		
Ambrey (2016a)	✔	✔		
Ambrey (2016b)		✔		
Ambrey & Cartlidge (2017)		✔		
Ambrey & Daniels (2017)				✔
Ambrey & Fleming (2014)	✔			✔
Ambrey & Fleming (2011a)		✔		
Ambrey & Fleming (2012)	✔	✔		
Ambrey & Fleming (2011b)	✔	✔		
Ambrey, Fleming, & Chan (2014)	✔	✔	✔	
Ambrey, Fleming, & Manning (2016)				✔
Ambrey & Shahni (2017)	✔	✔		
Aoshima et al. (2018)		✔		
Apergis (2018)			✔	
Asadullah et al. (2018)	✔			
Barrington-Leigh & Behzadnejad (2017)			✔	
Beja (2012)			✔	

Table 18.A1 CONTINUED

Publication details	Theme 1: Degree of human intervention	Theme 2: Specific environmental goods or services	Theme 3: Adverse impacts	Theme 4: Overarching measures
Bertram & Rehdanz (2015)		✔		
Bonini (2008)				✔
Bravi & Sichera (2016)				✔
Brereton et al. (2008)	✔	✔	✔	
Cuñado & de Gracia (2012)	✔	✔	✔	
Diener & Tay (2015)			✔	✔
Dolan & Laffan (2016)	✔		✔	
Dong, Nakaya, & Brunsdon (2018)			✔	
Du, Shin, & Managi (2018)			✔	
Engelbrecht (2009)				✔
Engelbrecht (2012)				✔
Ferrer-i-Carbonell & Gowdy (2007)		✔	✔	
Ferreira et al. (2013)			✔	
Ferreira & Moro (2013)	✔	✔	✔	
Ferreira & Moro (2010)	✔	✔	✔	
Fleming, Manning, & Ambrey (2016)		✔		
Gao, Weaver Scott, Fu, Jia, & Li (2017)		✔		
Giovanis & Ozdamar (2016)			✔	
Goetzke & Rave (2015)			✔	✔
Guardiola & García-Quero (2014)				✔
Inoguchi & Fujii (2009)				✔
Jarvis, Stoeckl, & Liu (2017)				✔
Jones (2017)			✔	
Knight & Rosa (2011)				✔
Kopmann & Rehdanz (2013)	✔	✔		

Table 18.A1 CONTINUED

Publication details	Theme 1: Degree of human intervention	Theme 2: Specific environmental goods or services	Theme 3: Adverse impacts	Theme 4: Overarching measures
Krekel, Kolbe, & Wüstemann (2016)		✔		
Kubiszewski, Zakariyya, & Jarvis (2019)				✔
Kubiszewski, Jarvis, & Zakariyya (2019)				✔
Larson, Jennings, & Cloutier (2016)		✔		
Levinson (2012)			✔	
Liao, Shaw, & Lin (2015)			✔	✔
Liu, Liu, Huang, & Chen (2018)			✔	
Luechinger (2009)			✔	
Ma et al. (2018)	✔	✔		
MacKerron & Mourato (2009)	✔		✔	
MacKerron & Mourato (2013)		✔		
Maddison & Rehdanz (2011)	✔	✔		
Menz (2011)	✔		✔	
Menz & Welsch (2010)	✔		✔	
Moro, Brereton, Ferreira, & Clinch (2008)	✔	✔	✔	
Morrison (2011)		✔		
Orru, Orru, Maasikmets, Hendrikson, & Ainsaar (2016)			✔	
Ozdamar (2016)			✔	
Rajani, Skianis, & Filippidis (2019)				✔
Rehdanz & Maddison (2008)			✔	

Table 18.A1 CONTINUED

Publication details	Theme 1: Degree of human intervention	Theme 2: Specific environmental goods or services	Theme 3: Adverse impacts	Theme 4: Overarching measures
Requena (2016)	✔			
Sasaki (2018)	✔			
Smyth, Mishra, & Qian (2008)		✔	✔	✔
Smyth et al. (2011)		✔	✔	
Tandoc Jr & Takahashi (2013)				✔
Taskaya (2018)		✔	✔	
Tsurumi & Managi (2015)	✔	✔		
Vemuri & Costanza (2006)				✔
Wang & Cheng (2017)			✔	✔
Welsch (2007)			✔	
Welsch (2006)			✔	
Welsch (2002)			✔	
White, Alcock, Wheeler, & Depledge (2013)		✔		
White, Pahl, Wheeler, Depledge, & Fleming (2017)		✔		
Winters & Li (2017)	✔	✔		
Yuan, Shin, & Managi (2018)		✔	✔	
Zhang & Wang (2019)	✔		✔	
Zhang, Liu, Zhu, & Cheng (2018)			✔	
Zhang, Shi, & Cheng (2017)				✔
Zhang, Zhang, & Chen (2017a)			✔	
Zhang, Zhang, & Chen (2017b)			✔	
Zorondo-Rodríguez et al. (2016)	✔			✔

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