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Ecosystem Services in the Wet Tropics: A Literature Review and Economic Valuation

Alyson Cheney
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Ecosystem Services in the Wet Tropics: A Literature Review and Economic Valuation

By Alyson Cheney

Project Advisors: Natalie Stoeckl and Michelle Esparon, James Cook University

Townsville, Australia

Academic Director: Tony Cummings

Home Institute: Connecticut College

Majors: Environmental Studies and Economics

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ISP Ethics Review

(Note: Each AD must complete, sign, and submit this form for every student's ISP.)

The ISP paper by Alyson Cheney (student) does conform to the Human Subjects Review approval from the Local Review Board, the ethical standards of the local community, and the ethical and academic standards outlined in the SIT student and faculty handbooks.

Completed by: Tony Cummings

Academic Director: Tony Cummings

Signature:

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8.0 Abstract

1.1 Executive Summary

The present study can be broken down into two sections. First, it created a literature review on the current body of knowledge regarding ecosystem services in the Australian Wet Tropics World Heritage Area. The second portion of the study was an economic valuation determining how much residents that live in the Wet Tropics value the benefits provided to them through ecosystem services. The literature review found that there were large gaps in the present body of knowledge. Biophysical studies made up the vast majority of the literature and very few ecosystem service economic valuations have been carried out for the WTWHA prior to this study. The valuation used residents' importance scores (Esparon et al 2014) along with a calculated sum of direct and indirect values to determine an ecosystem service 'worth' for the region. The study concluded that residents valued the ecosystem services provided for by the WTWHA at a value greater than \$2.69 billion per annum. The study is intended to be used as a rationale to increase funds for conservation in the region on the premise that the area benefits its residents far more in a conserved state than in a degraded one.

1.2 Key words: Ecosystem Services, Economic Valuation, Australian Wet Tropics, Literature Review

1.3 Abbreviations

CICES: Common International Classification of Ecosystem Services

WTWHA: Wet Tropics World Heritage Area

GBR: Great Barrier Reef

WTMA: Wet Tropics Management Authority

2.0 Introduction

2.1 Ecological economics and ecosystem service background:

Economics and ecology have long been used in conjunction. Both fields look at the big picture of how systems work in a holistic and systematic way (Costanza et al, 1997). This inherent nature of the two fields has made them very compatible for use together. With increasing global degradations, the field of ecological economics has become highly interested in the valuation of ecosystem services and how current and future environmental degradations may alter these values (Hein et al, 2006). From an economic perspective these ecosystem services are defined as any contributions that ecosystems make to human well being (Haines-Young and Potschin, 2013). This view takes into account not only the biophysical natural services, but additionally values cultural services as well.

Ecosystem services can be divided into categories of provisioning, regulating/maintenance, and cultural services. Provisioning services include all nutritional, material and energy outputs from a system. This includes services that provide food, water and other physical resources. Regulating/ maintenance services as defined by the Common International Classification of Ecosystem Services (CICES) are “all the ways in which living organisms can mediate ..the environment” to alter human well being (Haines-Young and Potschin, 2013). This category can further be divided down into regulating services and supporting services. In this case regulating services include the benefits human receive from carbon sequestration, flood mitigation, water filtration and erosion control just to name a few. Regulating services tend to be associated with the traditional natural services the science community establishes as services or functions. Supporting services on the other hand include the benefits associated with

refugia, pollination and biodiversity. The last category is cultural services these services are the most self explanatory and encompass all ways in which an ecosystem's animals, landscapes, or other factors preserve or shape a culture as well as affect the mental well being of people who associate with the ecosystem. Although there are a variety of ways to identify and categorize the many benefits ecosystems provide people with, the use of the CICES is, arguably, one of the more common methods. This is perhaps because it maps directly to concepts familiar to biophysical scientists and also maps to concepts more familiar to economists including notions such as 'use' and 'non-use' values (Haines-Young and Potschin, 2013).

2.2 Ecosystem service valuations background

Ecosystem service valuation studies basically try to assess the benefits and costs that ecosystem services provide for the people that live in, visit, or have cultural ties to a given ecosystem, using money as the metric of assessment (Pagiola, 2004). The idea behind valuation is to sum the benefits of the services and attempt to measure them through the creation of a representative monetary value. Valuation studies are of great importance to a variety of groups. They can be used by conservation agencies to stress the importance of services in a given area in a way that policy makers, landholders, and businesses can understand. In general, valuation is thought to assist in improving human decisions regarding ecosystems (Farber et al, 2002). There are some contrasting viewpoints on the need for valuation. Some people view valuations as accepting that biological degradation is inevitable rather than establishing that degradation is inherently wrong (Ehrenfeld, 1988). On the other hand however to not value it could be construed as assuming an ecosystem is without value, which valuations prove is inherently not the case. Additionally with natural resources that are important for economic development,

but often face low regulations on extraction, valuations reiterate that management is needed to prevent degradation of resources for future generations enjoyment as well as growth. The thought here is that valuations allow for measuring ecosystem services and thus improve our ability to properly manage them (Sukhdev, 2011). Improving management is a primary goal of valuation, but recently with the future expected degradations associated with climate change, increasing funds for conservation is becoming a priority for valuation researchers.

2.3 Stoeckl et al. GBR ecosystem service valuation project:

The Great Barrier Reef (GBR) and Wet Tropics World Heritage Area (WTWHA) are areas of particular interest for conservation due to their respective listings as world heritage sites. Many past studies have highlighted that the tourism industry surrounding the GBR and WTWHA are substantial players within the Australian economy (Vogel, unpublished paper). This is in part due to the fact that tourism helps many sectors with secondary benefits and provides substantial domestic employment opportunities (Gutleber, unpublished paper). Although both the GBR and WTWHA are major contributors to the Australian economy, the majority of ecosystem service valuation studies have focused on the GBR.

Although it has always been noted that the GBR has substantial non market value as is shown in both its intrinsic value to the Australian people and in its status as a world heritage listing, a more thorough look into the matter shows us that there is extremely substantial 'value' in the ecosystem services provided. The literary review done by Stoeckl et al looked at the current body of knowledge on the values of ecosystem services provided by the GBR as to highlight all ecosystem services associated with the reef and the ways in which current environmental degradations are affecting these values.

Through the literary review it was found that increasing population growth combined with mining and agriculture activities have increased sedimentation on the reef. This and other environmental degradations decrease the values of the ecosystem services provided by the reef. The study additionally highlighted that the vast majority of discussion and research on the GBR's ecosystem services focused primarily on benefits from tourism and fishing. Through the study it was found that substantial information gaps were present in the current body of knowledge surrounding the values and types of ecosystem services provided by the reef. These information gaps were thought by the researchers to be causing inefficient use of resources (Stoeckl et al, 2011).

Following the literature review the project then focused on determining how tourists and residents in the GBR catchment area valued the ecosystem services provided for by the reef through a large-scale survey project. The survey asked tourists about the importance of goods and services as well as how changes in environmental and market factors would alter their opinion on traveling to the area. Residents were asked the same questions but on how changes in these factors would affect their quality of life (Stoeckl et al, 2013). Both tourists and residents most highly valued having healthy coral, healthy fish, no visible rubbish, presence of iconic marine species, clear water, and healthy wetlands. Tourists said they would be deterred from visiting the region if there were high frequencies of oil spills; murky waters or rubbish was present on the beaches. Tourists were willing to pay, on average about \$14 per visit, and residents were willing to pay, on average, about \$30 per annum, to help fix various environmental problems (Stoeckl et al., 2013; Farr et al., forthcoming). Using the responses to questions about the importance of these factors to overall quality of life, in conjunction with previously published estimates of the total value of tourism in the region (Deloitte Access Economics, 2013), they

estimated the total value of a wide variety of ecosystem services provided by the GBR including industry values, recreational values, Indigenous cultural values, and primary/intrinsic values to be \$16 billion- 20 billion per year (Stoeckl et al, 2013). The study used a whole ecosystem approach to the valuation process, which explains why the estimated value of \$16 billion was much higher than previous valuation studies on the GBR's services. Previous valuation studies were much more limited in what was defined as an ecosystem service and did not include factors such as having undeveloped beaches or preservation of indigenous cultural lands in their valuation process. Past studies also differed in that they focused on expenditure, making them not a uniform comparison to studies operating under a value given methodology (Stoeckl et al, 2014). Currently, the project has moved towards focusing on the valuation of the WTWHA.

2.4 Past valuation studies on WTWHA:

Some previous economic studies have been carried out for the Wet Tropics. For the most part however these studies do not fully cover all the ecosystem services. For instance, Cook and Harrison in their economic evaluation of a proposed long distance walking track study looked at the supply and demand of a long term walking track through the WTWHA. They used marginal costs and the community's willingness to pay to derive the supply and demand for the track. The study estimated the value of the proposed track by estimating how much the proposed track would alter the well being of those who live in and visit the area (Cook and Harrison, 2002). This methodology is congruent with the notion of valuation, but the study only focused on a small sector of recreation and did not touch on provisioning, regulating, or supporting services. Other studies have focused predominantly on the economic contributions of the WTWHA in terms of output, value added, household income, and jobs provided (Gillespie Economics

and BDA group, 2008). Although this sort of study is extremely useful for understanding the contributions made to the national GDP it is not truly an ecosystem service valuation. Other studies have also fallen short on the inclusion of cultural services. In 2004, Ian Curtis- a renowned ecological economist- sought to estimate the value of a broad range of ecosystem services provided by the WTWHA. He found the value of the wet tropics to be in the range of \$188 to \$211 million a year. The most significant ('valuable') ecosystem services contributing to this value were biodiversity and refugia, but few cultural services were included in the study (Curtis, 2004).

Additionally, every year the Wet Tropics Management Authority (WTMA) publishes a state of the Wet Tropics report. These reports historically do an overview of the ecosystem services provided by the area and break them down into categories that mirror the cultural, provisioning, regulating, and supporting services as is found in a valuation study. Although they do not assign values to the ecosystem services, they do acknowledge that they are deeply beneficial to the local community. In terms of market contributions they additionally break down the economic benefits from management and visitation to the WTWHA. These benefits are further broken down into output, value added, household income and the number of jobs provided (WTMA 2008; 2009). These reports are extremely useful for establishing the market benefits of visitation and management and acknowledging the non market values of the ecosystem services provided by the region, but additional numerical valuation of those non-market benefits is still needed in this field.

2.5 Importance of study

There are relatively few studies on the non market values of ecosystem services in the WTWHA and there are gaps within the existing studies. This shows that there is still

a need for looking further into the current body of knowledge on ecosystem services as well as a valuation study of those services. It is important to determine the value of the WTWHA as increasing pressures from human population growth and climate change threaten the current composition of the area. A particularly important reason for valuation is that it allows for allocating larger funds for conservation in the area. It also demonstrates to policy makers that the area benefits Australia far more in a preserved state than a degraded one. Valuation also allows for a uniform way of presenting the benefits of an ecosystem to a variety of players and allows for those with government, economics, and science backgrounds to discuss the ecosystem services in the same language so to speak.

2.6 Project goals

The goals of the present study can be broken down into two parts. First, I will create a literature review on the ecosystem services of the WTWHA. This literature review will be used by Esparon, Stoeckl, and Farr in their present valuation study to point out where the holes in the current body of knowledge are. The second part of the study will create a modified valuation. The valuation will be based on data from their WTWHA residents' survey and dollar values from industries to compare the survey scores with.

3.0 Methods

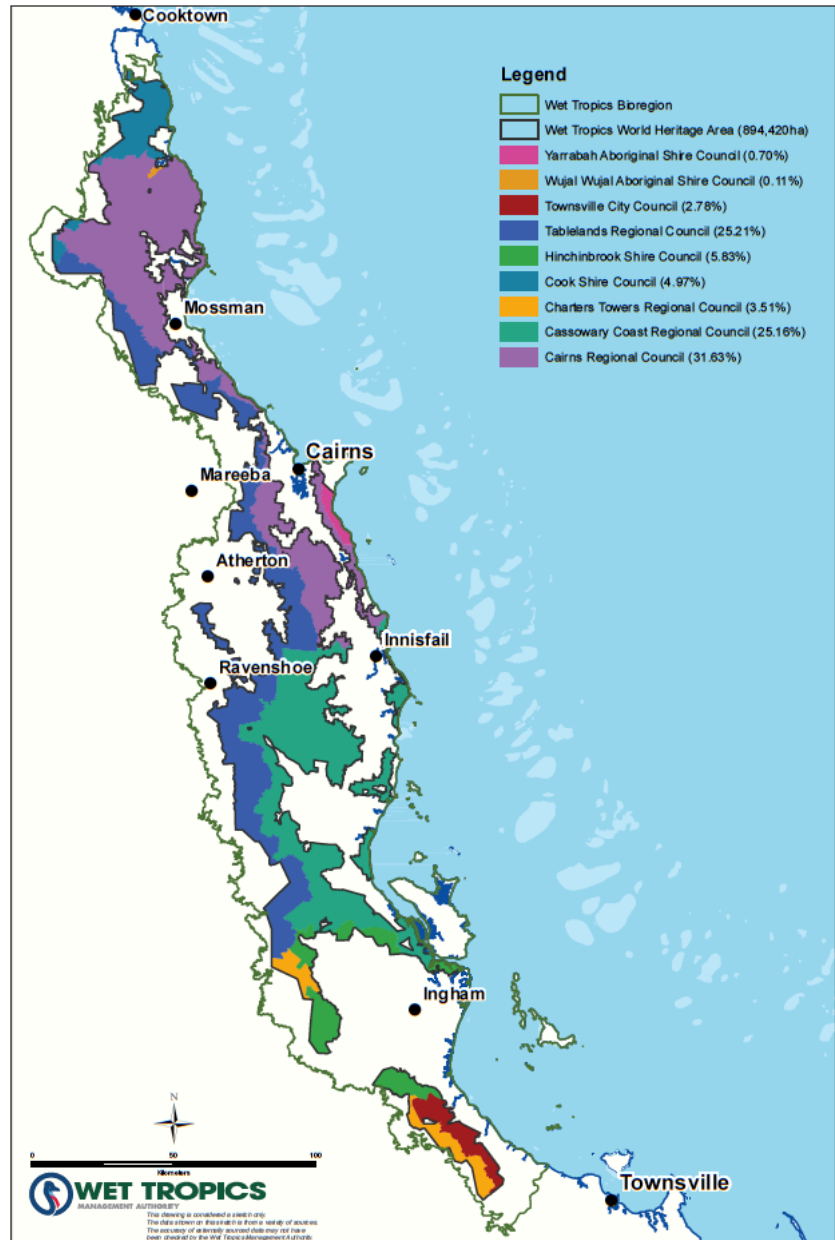
3.1 Wet Tropics Background

The Wet Tropics became a world heritage site in 1988. It was made a world heritage site for meeting four of the world heritage criteria. Firstly it is an area of superlative aesthetic beauty. Secondly, it is representative of the earth's life history seen in the living record of plant evolution. Additionally the area shows on going ecological processes and contains habitats full of biodiversity leading to a strong need for conservation in the area. For these reasons the area was given the title and protection of a world heritage area (WTMA, 2013).

The area is made up of 894,420ha, most of which is public land that is held by national park tenure. It

is 450 kilometers in length and it extends from just south of Cooktown to the north of Townsville (Figure 1). Figure 1 shows the boundaries of the WTWHA as well as the major governing bodies.

Figure 1: WTWHA major governing bodies



3.2 Literature review methods

The study was broken down into two sections. The first 3 weeks of the study were spent carrying out a literature review on the ecosystem services of the Wet Tropics. The literature was collected through a variety of sources including peer reviewed journal, Wet Tropics anthologies, Wet tropics management reports, and JCU academic papers.

Literature that did not focus solely on the Wet Tropics was omitted from the review.

The literature review was compiled using similar methods to Stoeckl et al 2011. In their literary review of ecosystem services provided by the GBR they broke ecosystem services down into the four categories established by the CICES of cultural, provisioning, regulating, and supporting services. Cultural services were further broken down to include recreation/tourism, Australian icon, research/education, aesthetics, heritage/spirituality/customs, and sense of place. Provisioning services were limited to food/water, pharmaceutical products, genetic resources, agriculture, and cloud stripping. Regulating services were broken down into the subcategories of carbon sequestration, flood mitigation, ground water recharge, pest control, carbon/water cycles, climate regulation, and erosion control. The subcategories of supporting services included habitat/refugia, ecosystem health/resilience, pollination, biodiversity, soil creation, a nutrient cycling.

Upon initial research, it became clear that much of the literature on the topic was centered on climate change and management. For this reason two additional categories of management of services and threats to services were added to the study. The subcategories within management included conservation/resources, cultural management,

and management for scientific research. Threats to services were broken down into land use, climate change, deforestation/agriculture, and biodiversity loss.

If the literature discussed more than one service it was listed under all relevant categories. Within this process, literature was additionally sorted into categories of

biophysical studies, Indigenous studies, background studies, and economic/valuation studies. It was noted if the study was a report, peer reviewed journal article, or an essay/ chapter. The set up of the categories and organization for the literature review can be seen in Table 3. The literature review was unexhausted and the study does not claim to be a collection of all of the literature on the topic but rather a representation of the current body of knowledge

Benefiting either directly or indirectly from the jobs & incomes created by:
The tourism industry
The mining industry
The agricultural industry
Other industry/sector (e.g. fishing, retail, education etc.)
Being able to access the rainforest via:
Walking tracks &/or dirt roads
Bitumen roads & bridges
Rail/Skyrail
Being able to:
Learn more about a unique & ancient Australian environment
Hear from Aboriginal people about their sense of place (culture & country)
Go on rainforest walks
Visit waterfalls &/or swim in clear, clean rivers/streams/waterholes
See iconic species in the wild (e.g. cassowary, kangaroos, rattle birds, etc.)
Relax and/or reflect in a natural environment
Enjoy uncrowded camping & picnic areas
Enjoy the scenic beauty & peacefulness of the rainforest (sights, sounds & smell)
Having:
Healthy native plants & animals (e.g. free from diseases, pests & weeds)
Beautiful undeveloped scenery to look at
Two world heritage sites side-by-side (i.e. the WTWHA and the GBRWHA)
Protecting:
Places that have Aboriginal cultural values
Places that have other cultural values (e.g. European/Asian)
The WTWHA either for its own sake or for future generations (even if you have never been there & never plan to go)
Being able to:
Spend time with friends & family
Enjoy city-entertainment (e.g. spending time at cafés, museums, etc.)
Have some 'control' over what is happening in your life
Join in community activities (e.g. attend cultural/environmental festivals)
Knowing that:
Friends & family are healthy & safe
Good quality roads, hospitals, schools, etc. are there if need be

Table 1: Values under assessment by residents (Esparon et al, 2014)

that illuminates the present holes in the body of knowledge.

3.2 Valuation methods

The last week of the study was spent carrying out a valuation – using information from multiple sources. The stages of the past sources methods as well as my own additions and calculations can be explained in the following steps:

1) Esparon et al (2014) designed a survey to collect information about how ‘important’ people felt a variety of different things were to their overall quality of life. Table 1 shows the factors upon which residents were asked to ‘value’ in the study (Table 1). They were asked to value them on a scale of -2 showing unimportance to +2 showing very

Society	Environment	Access to nature	Culture	Industry	City
1.72	Average Importance score for the group:				0.15
1.47	0.97	0.95	0.71		
Friends and family being safe (.857)	Undeveloped scenery to look at (.842)	Bitumen roads (.796)	Hearing from Aboriginals about their culture (.855)	Tourism industry (.783)	Enjoying city entertainment (.655)
Good quality roads and hospitals (.743)	Healthy native plants and animals (.784)	Walking tracks (.664)	Preserving Indigenous culture (.784)	Importance of the mining industry (.737)	
Spending time with family and friends (.744)	Enjoying the scenic beauty and peacefulness (.699)	Rail and skyrail (.580)	Learning about a unique environment (.726)	Importance of agricultural industry (.858)	
Having ‘some’ control of one’s life (.588)	Preserving for future generations (.720)		Protecting other cultures (.562)	Importance of other industries (.829)	
	Two WHAs side by side (.725)		Participating in community activities (.595)		
	Being able to relax and reflect (.666)				
	Iconic land species (.634)				
	Rainforest walks (.601)				
	Waterfalls and clear clean rivers (.538)				
	Uncrowded camping and picnic areas (.508)				

(in brackets) = Factor loading

important.

2) They then used principal components analysis to see which factors ‘grouped’ together. In the groupings, they then compared the ‘average’ importance of each separable group.

Table 2: Residents average importance scores by group (Esparon et al, 2014)

3) One of the separable groups was comprised entirely of things related to ‘the market’ – specifically, the jobs and incomes associated with the tourism, mining, and agricultural industries. The grouping of both market factors and environmental factors as well as their importance scores can be seen in Table 2.

4) I then determined the financial ‘value’ of the industries within the region. The tourism values for expenditure and value added were taken from the Deloitte Access Economics 2013 report (Deloitte, 2013). The mining sector values for expenditure and value added were from The Rolfe et al 2011 study on the economic contributions of resources within Queensland (Rolfe et al, 2011). Noting that mining and tourism only account for 75% of the economic activity in the area, the sum of the direct and indirect values for both of these industries combined were multiplied by 1.25 to encompass the values of industries outside of mining and tourism.

‘Direct’ and ‘indirect’ values were used because the stimulus generated from the economic activities that rely on the WTWHA generate a greater increase in economic gains than is seen in the value of the initial amount of expenditure. This concept is expressed in Figure 2. In this example a tourist spend \$10 at a local grocery store. The owner of the grocery store saves, pays taxes, and purchases foreign goods with \$60 out of

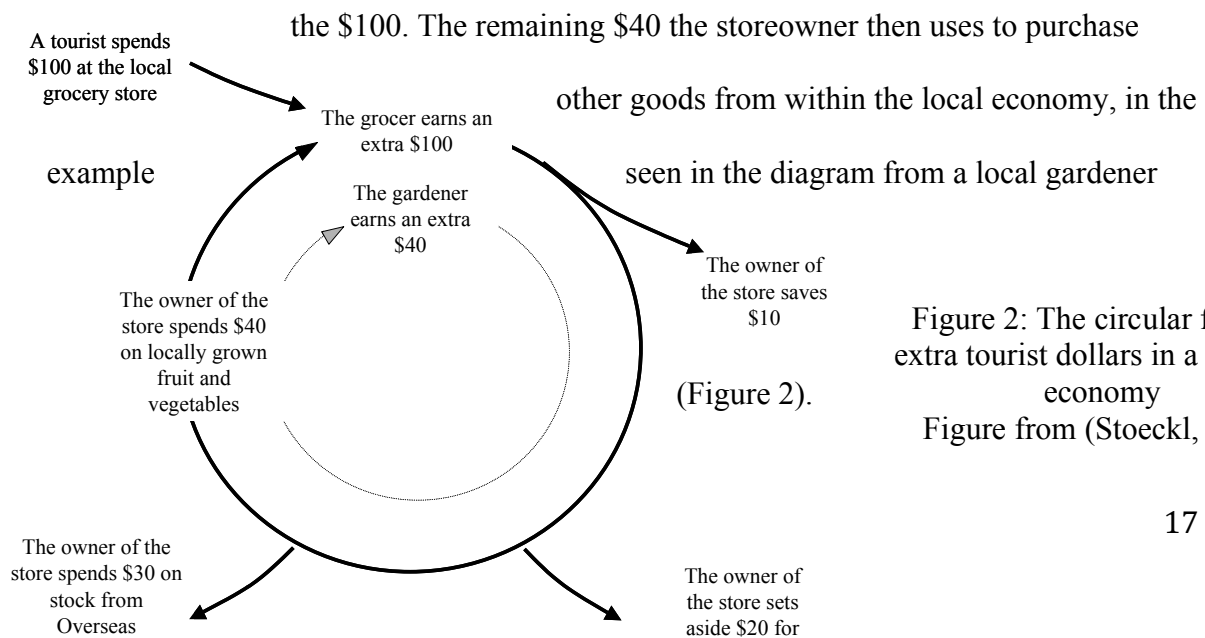


Figure 2: The circular flow of extra tourist dollars in a regional economy
Figure from (Stoeckl, 2010)

In this situation, the initial expenditure is often referred to as ‘direct expenditure’; the ‘extra’ expenditure induced by the process of re-spending is often referred to as ‘indirect’ expenditure, and the fraction, which allows one to estimate total stimulus, is often called ‘the multiplier’. The multiplier was calculated using the following equations:

- Expenditure + value added= total value
- Total value/ expenditure = multiplier

This process of increased regional stimulus from tourism expenditure due to the presence of the multiplier explains why the present study uses both the direct and indirect values to encompass the full economic ‘value.’

5) I then compared the ‘average’ importance scores of the environmental grouping-representing ecosystem service benefits- with the ‘average’ importance score of the industry group, to determine how closely their worth would be. In particular I looked to see if the importance of the environmental groupings would be greater than or lesser than in ‘value ’ in comparison to the industry grouping. I then used the calculated sum of direct and indirect values for the WTWHA total industry to establish a relative ‘value’ for the benefits residents receive from the ecosystem services in the area.

4.0 Results

4.1 Literature review

The literature review found substantial gaps in the current body of knowledge surrounding ecosystem services within the WTWHA. Table 3 lists all the literature included by service and topic discussed. From the table it can be seen that the biophysical studies dominate the published literature and that relatively few economic/ valuation studies have been carried out for the region (Table 3).

Table 3: Significant gaps in understanding of ‘values’ associated with the WTWHA.

Table made by Michelle Esparon from data collected by Alyson Cheney (Esparon, 2014)

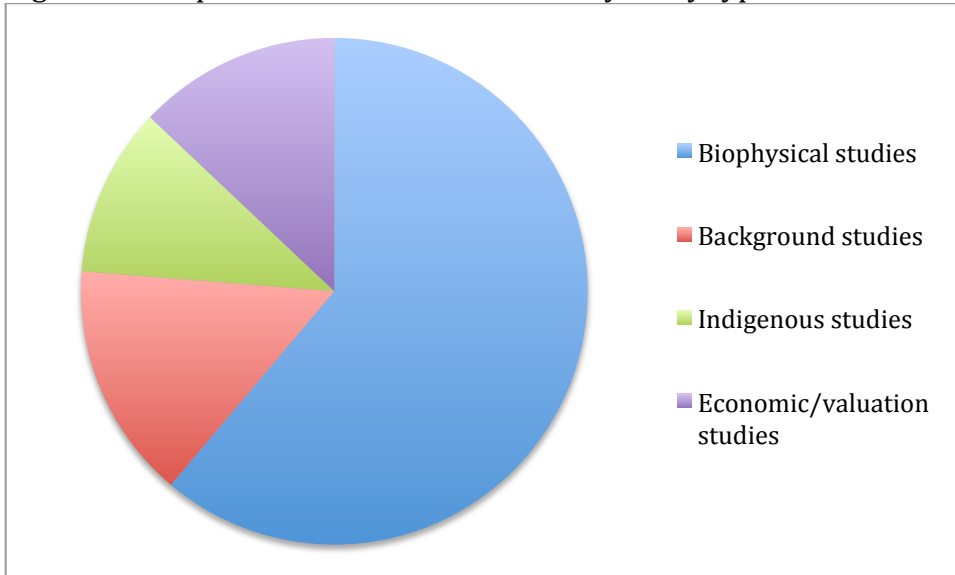
Key: dark green denotes journal articles; medium green denotes books or book chapters; and light green denotes reports.

	Services	Biophysical studies	Background studies	Indigenous studies	Economic/valuation studies
Cultural services	Recreation/Tourism	WTMA (2008; 2010; 2011; 2013) Pert et al. (2010)	Pearce (2008) WTMA (2009; 2010) Carmody & Prideaux (2008, 2011)		Cook & Harrison (2002) WTMA (2009)
	Australian icon		Carmody & Prideaux (2008, 2011)		Gillespie Economics (2008) Curtis (2004)
	Cognitive/Scientific research/education	Stork et al. (2014) WTMA (2008; 2010)		Gratani et al. (2011) WTMA (2010; 2011)	
	Aesthetics	WTMA (2008; 2013) Pert et al. (2010)	Carmody & Prideaux (2008)		Curtis (2004)
	Heritage/spirituality/customs/knowledge systems	WTMA (2008; 2013) Gratani et al. (2011) Hill et al. (1999)	Pearce (2008)	WTMA (2011) Hill et al. (2008) Knudtson & Suzuki (1992) Panell (2008) Pryor (1998)	
	Sense of place	WTMA (2008) Knudtson & Suzuki (1992)	Carmody & Prideaux (2008, 2011) McNaire (1992, 1993, 1996) Bentrupperbäumer & Reser (2002, 2003, 2006)	Hill et al. (2008) Knudtson & Suzuki (1992) Panell (2008) Pryor (1998)	
Regulating services	Food/water	WTMA (2008; 2013)	Curtis (2004)		Curtis (2004)
	Pharmaceutical products	WTMA (2008)			
	Genetic resources	WTMA (2008)			Curtis (2004)
	Agriculture	WTMA (2008)	Curtis (2004)		
	Cloud stripping	McJanet et al. (2008)			
	Carbon sequestration	WTMA (2008) Preece et al. (2012)	Hunt (2008)		
	Flood mitigation	WTMA (2008) Pert et al. (2010)			Curtis (2004)
	Ground water recharge	WTMA (2008)			Curtis (2004)
	Pest control	WTMA (2008)			
	Carbon /water cycles	WTMA (2008) McJanet et al. (2008) Pert et al. (2010) Richards et al. (2003) McKergow et al. (2005) Preece et al. (2012) Richards et al. (2003)			Curtis (2004)
Supporting services	Climate regulation	WTMA (2008) Preece et al. (2012)			Curtis (2004)
	Erosion control	McKergow et al. (2005)			Curtis (2004)
	Habitat & refugia	Hilbert et al. (2007) Pusey et al. (1995) Schneider & Moritz (1999) Hilbert et al. (2001)			Curtis (2004)
	Ecosystem health (resilience)	WTMA (2011) Mackay et al. (2012)			
	Pollination	Boulter et al. (2008)			Curtis (2004)

Management of services	Biodiversity	Catterall et al. (2012) Garnett et al. (2010) Kikkawa (2008) Metcalfe & Ford (2008) Pusey et al. (2008) Mackay et al. (2012) Williams et al. (2008) Pert et al. (2010) Schneider & Moritz (1999) Williams & Bolitho (2003) Stork et al. (2014)	Hunt (2008)	Hill et al. (1999) Hill et al. (2008)	Curtis (2004)
	Soil creation	Rasiah et al. (2004)			Curtis (2004)
	Nutrient cycling	Rasiah et al. (2004) Richards et al. (2003) McKergow et al. (2005)			Curtis (2004)
	Conservation/ Resources	Pert et al. (2012) Waterhouse et al. (2012) WTMA (2013) Hilbert (2010) Stork et al. (2014)	Emtage & Herbohn (2012) Carmody & Prideaux (2008)		
	Cultural			Hill et al. (1999) Panell (2008)	
	Scientific (for research)	WTMA (2010; 2011) Stork et al. (2014)			
	Land-use and its flow on impacts on the GBR (mainly agriculture's use of fertilisers, etc.)	Brodie et al. (2005) Faithful & Finalyson (2005) Shaw et al. (2010) Waterhouse et al. (2012) Rasiah et al. (2004)			
	Climate Change	Hilbert et al. (2001) Hilbert et al. (2007) Hilbert (2010) Shoo et al. (2005) WTMA (2008; 2011) Williams & Bolitho (2003)			
	Deforestation/ agriculture/grazing	Rasiah et al. (2004) Pert et al. (2012) WTMA (2013) Waterhouse et al. (2012)			
	Biodiversity loss	Catterall et al. (2012)			

A total of 56 sources were used and 139 were observed to fit descriptions of the variety of subcategories of ecosystem services. This shows that individual sources often discussed more than one ecosystem service. Biophysical studies made up the bulk of the review, contributing to 61.15% of the literature present in the review. The next largest contributors were background studies contributing 15.11% of the studies in the review. The smallest categories were Indigenous studies and economic/valuation studies making up 10.79% and 12.59% respectively. The distribution of studies found throughout the literature review can be seen in (Figure 3).

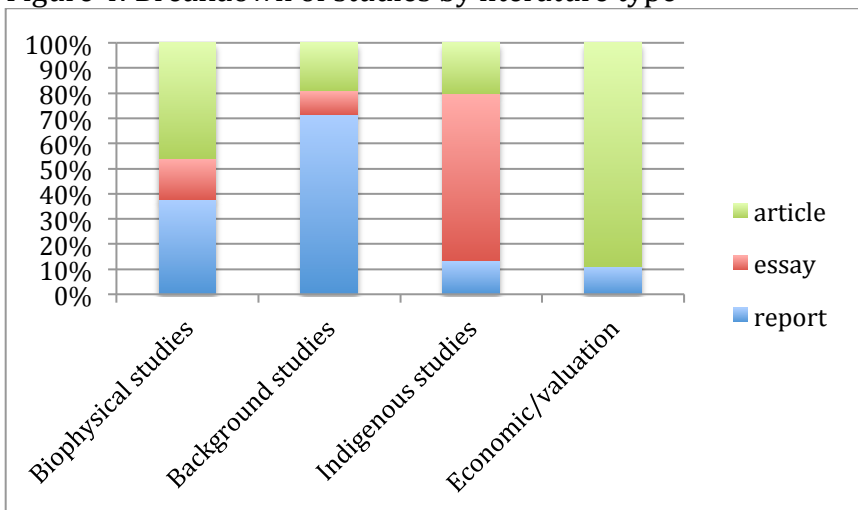
Figure 3: Composition of literature review by study type



Biophysical studies were comprised mostly of articles and reports.

Background studies were strongly dominated by reports where as Indigenous studies were mostly made up of essays and chapters. Economic/valuation studies had no essays and were almost entirely articles. The percentage break up of each study type can be seen below (Figure 4).

Figure 4: Breakdown of studies by literature type



4.2 Valuation

Industry had an importance score of .71 and a total value \$2.69 billion per year. The major contributing sector to this value was tourism. The environment had an importance score of 1.47, which is greater than .71, thus we can say that the value of the ecosystem services to residents in the WTWHA is greater than \$2.69 billion. The value could be as high as \$4.45 billion if there is a linear relationship between importance and monetary value. It could be much greater than

Table 4: Calculation of direct and indirect value

Tourism	
Expenditure	\$2,594.50
Value added	\$1,173.40
Total value	\$3,767.90
Direct and indirect value (millions)	\$1,704.09
Multiplier	1.45226441
Mining	
Expenditure	\$193.40
Total value	\$307.70
Direct and indirect value (millions)	\$59,509.18
Multiplier	1.45226441
WTWHA Economy total estimate	
Tourism	\$1,704.09
Mining	\$446.86
Tourism and Mining (millions)	\$2,150.95
Tourism and Mining (billions)	\$2.15
Remaining sectors estimate (.25x 2.15)	\$0.54
Total economic (billions)	\$2.69

4.45 if the relationship is non-linear and convex such as if monetary value rises exponentially with 'importance'. Additionally it could be less than 4.45 if the relationship is non-linear and concave. We do not have enough information to determine what the relationship is, so are only able to say, that these other values are worth more than 2.69 billion per annum.

5.0 Discussion

5.1 Implications of the study

The literature review showed that there are significant gaps in the present body of knowledge. The largest implication of the these gaps is that far more economic/valuation

research needs to be carried out in order to have a more accurate and thorough understanding of the ecosystem services in the WTWHA. Additionally more background studies and Indigenous studies should be looked into to even out the strong biophysical focus on the topic. Within the background studies and Indigenous studies, there is a strong need for peer review publications to remediate the strong imbalance in regards to the sources of such articles. Although these cultural gaps are clearly present, this study is primarily focused on the implications of the absence of economic and valuation studies within the body of knowledge. The data collected on the literature review in the present study was used in Esparon et al recent publication to reiterate the strong need and uniqueness of their report on the ecosystem service values of the WTWHA to both residents and tourists (Esparon, 2014). In the absence of such information we risk people assuming, even if only by accidental omission, that lack of price is the same thing as lack of 'value'.

As a preliminary reaction to the valuation portion of the study, it appears that much larger funds could go into conservation of the WTWHA. If the site brings residents a benefit that is greater than \$2.69 billion dollars a year in its current state, a strong implication is that in a more degraded state it would benefit its residents at a lesser value. This implication alone allows the valuation to serve as a statement to policy makers and conservation agencies that there is a strong monetary incentive to not allow for further environmental degradations in the area. On a similar note, the study implies that improving the current state of the WTWHA through restoration projects has the potential to increase the value of the area to residents. In terms of allocation of funds for conservation and management, the findings of this valuation also can serve as a statement

that it would be in the people's and thus the governments best interest to spend a much larger sum of money on the environmental upkeep of the region.

5.2 Comparison to other valuation studies

The present study is comparable in framework, ideology, and methodology to the valuation of the GBR seen by Stoeckl and Esparon (Stoeckl, et al. 2014; Esparon et al., 2014). The study differed substantially to the valuation of the WTWHA done by Curtis in 2004 (Curtis, 2004). Curtis's study gave a value of \$188 to \$211 million a year for the area. This is substantially lower than the valuation of the present study. There are three potential explanations to why the values are so different. Firstly, the Curtis study was predominantly focused on biophysical attributes. This could have lead to it potentially omitting values that are more culturally related. Secondly, the methodology of the two studies was vastly different. The Curtis study used a panel of experts to assign values where as the present study looked at the values from the viewpoint of benefits to residents and used known monetary industry values to compare and establish these benefits. Due to the large difference in the set up of the studies, the two studies may not be compatible for comparison. Lastly, the Curtis study was carried out in 2004 where as the present study just occurred in 2014 and the different time frames and different economic conditions present at the times of the two studies serves as a potential reason for the very different outcomes of the valuations. Although the two studies are not entirely comparable, the difference in valuation methods and findings are both interesting and substantial enough to be worth noting.

6.0 Conclusion

6.1 Limitations of current study and future research

The present study was most prominently limited by the time it was carried out in. Using only a month for the study did not allow the literature review portion of the study to be as thorough and all encompassing as was possible. An interesting further research project would be to complete a more extensive literature review on the subject. Additional limitations include that the study only used the importance scores for residents and omitted using scores of tourists thus limiting the accuracy of the valuation.

Other limitations that are more common of valuations in general are that using industry indirect and direct values as a basis for the valuation means that small inaccuracies in the industry values can lead to inaccuracies in the projected valuation numbers. The present study has no reason to believe that the used industry values are inaccurate, but it is something to keep in mind if large economic factors change in the future. A large limitation relating to using a methodology involving importance scores is that it allows for a broad estimate range. Further research determining a methodology that allows for a narrow estimate range of value would be useful to the valuation research community and those who benefit from their work.

For future research, it would be useful to create a study of similar methodology for other world heritage sites in Australia or other world heritage sites globally. It would be interesting to see how residents living in a variety of world heritage areas value the ecosystem services of that location in comparison to other heritage sites. In a similar way the current valuation methodology could easily be applied to other regions with large tourism sectors. For future research once I am back in the States, I am particularly interested in taking the methodology used in this study and applying it to other ecosystems with similar ecotourism intensive economies. For instance, the methodology would be applicable to the Colorado Rockies iconic skiing tourism industry. With climate

change putting increasing pressured on the skiing tourism industry, it could make an interesting study to look at the values that residents and tourists assign the area as well as how increased environmental degradations will alter these values. I feel that using the lessons and methodology learned through the completion of this study will allow me to look into future valuation research on a diverse range of ecosystems.

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