THE ECONOMIC VALUATION OF ECOSYSTEM SERVICES USING DELIBERATION AS A TOOL FOR VALUE ELICITATION

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JAMES DEREK MARRINER

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SUPERVISORS: PROFESSOR G. FRASER AND PROFESSOR J. SNOWBALL

ABSTRACT

Marine seagrass, *Zostera capensis*, is a highly productive flowering marine seagrass found on the eastern and southern coasts of South Africa and provides a variety of ecosystem services, which include reducing the effects of erosion, trapping nutrients, creating a nursery habitat for fish species and reducing sedimentation. Despite their formal protection status, *Z. capensis* meadows are regressing, often due to anthropogenic influences. Globally, multiple studies have documented the ecological importance of seagrass services, to both humans and nature, but economic evaluations of these services have not been as extensive.

Numerous valuation methods have been used in literature and in practice to value non-market environmental resources and ecosystem services, where results vary. The most widely used non-market environmental valuation method is the contingent valuation (CV) method, which allows for the valuation of environmental resources that are not sold in the market through a stated willingness to pay (WTP) amount, contingent upon a particular scenario. However, the CV method is susceptible to various limitations and forms of bias. As a result, alternative environmental valuation techniques have been reviewed in literature. Deliberation has been suggested as an improved valuation approach to overcome the criticisms of the CV technique, as it increases respondents' understanding and knowledge of the environmental resource under discussion, through the incorporation of debate, discussion, participation and social learning, thereby producing more reliable valuations of non-market environmental resources. The deliberative monetary valuation (DMV) method has been advocated as an important valuation method to achieve more comprehensive and reliable valuations of complex and unfamiliar public goods, such as ecosystem services.

This thesis explored the determinants of WTP for the protection of seagrass, and whether deliberation can be used to supplement findings and values obtained from the individually sourced WTP values. As a result, the study used a dual-method approach to obtain both individual and deliberated WTP values from a range of stakeholders with varied socio-demographic characteristics by using both the CV method and a deliberative focus group, for the ecosystem services that seagrass *Z. capensis* provides to the Knysna community, South Africa.

The results showed that age, education, use frequency and mistrust in local government were determinants in WTP, while deliberative elements uncovered that respondents' knowledge of an environmental resource and a consideration of the valuation scenario were important factors in determining WTP. It was found that 55% of the respondents were willing to pay to conserve the ecosystem services of seagrass in the Knysna estuary through a monitoring programme. Among those

that were willing, the mean WTP amount was approximately R132 per month per household. Although the circumstances in which the deliberative focus group discussion were run were not ideal because of the COVID-19 lockdown, the results showed some interesting potential benefits of using deliberation in complex public good valuation studies.

Key words: DELIBERATION, FOCUS GROUP, ENVIRONMENTAL VALUATION, SEAGRASS

DECLARATION

I, James Marriner, hereby declare that the work on which this thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work or any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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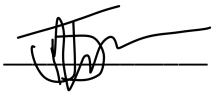
Signature: 

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LIST OF ABBREVIATIONS AND ACRONYMS

CV -	Contingent Valuation
CBD -	Central Business District
DDMV -	Deliberative Democratic Monetary Valuation
DMV -	Deliberative Monetary Valuation
DP -	Deliberative Preferences
GDP -	Gross Domestic Product
GNP -	Gross National Product
KBP -	Knysna Basin Project
MA -	Millennium Assessment
NGO -	Non-Governmental Organisation
NOAA -	National Oceanic Atmospheric Administrations
OLS -	Ordinary Least Squares
PC -	Payment Card
RUT -	Random Utility Theory
SANParks -	South African National Parks
SP -	Stated Preferences
STATSSA -	Statistics South Africa
TEEB -	The Economics of Ecosystems and Biodiversity
TEV -	Total Economic Value
US$ -	United States Dollar
WCG -	Western Cape Government
WTA -	Willingness to Accept
WTP -	Willingness to Pay
WWTW -	Waste-Water Treatment Works
ZAR -	South African Rand

CHAPTER 1:

INTRODUCTION

1.1. Background to the study

All human beings are fundamentally dependent on ecosystems for their livelihoods, welfare and survival (Bunse *et al.* 2015, Fisher *et al.* 2009, Orchard-Webb *et al.* 2016). Ecosystems provide natural contributions and functions to human society, where these contributions have been termed as 'ecosystem services', as first popularised by the Millennium Ecosystem Assessment (MA 2005). Ecosystem services describe the benefits that nature provides to households, communities and economies (Boyd and Banzhaf 2007, Chan *et al.* 2016) through providing goods, services and attributes (Turpie *et al.* 2017). Ecosystem services are critical to the functioning of Earth's life-supporting system and are fundamental to human well-being, health, livelihoods and survival (Costanza *et al*. 2014). Ecosystem services include, but are not limited to, the production of food and water, the control of climate, nutrient cycling and the production of oxygen and materials with which to build shelter (Costanza *et al.* 1997).

There has been an increasingly widespread recognition of the ecosystem services concept globally to make the point that ecosystem services should be recognised as a valuable form of natural capital that contributes to economic capital and human livelihoods and well-being (Potschin and Haines-Young 2016, Turpie *et al.* 2017). Building on this point, ecosystem services provide a 'value' that forms a large, but often hidden, part of the economy (Costanza *et al.* 2014, Farber *et al.* 2002, Small *et al.* 2017). Value, from an environmental economic context, can be associated with ecological value, socio-cultural value, intrinsic value, instrumental value, relational value and economic value (de Groot *et al*. 2002). Through this, value can be expressed via two avenues, that of non-monetary and monetary valuation.

Eliciting a monetary value from an ecosystem service is often a difficult task, as many ecosystem services are not marketed, do not have a direct market value and are inherently free as public goods to society (Bunse *et al.* 2015, Chee 2004). This means that no one owns many of the ecosystem services from which society benefits, and there is little incentive for beneficiaries to sustainably manage ecosystem services (Chee 2004, Palmer *et al.* 2014). Therefore, it is often difficult to value ecosystem services due to of the lack of markets for the goods and services they provide to society.

Economic value and monetary value are values to which society can relate, therefore understanding the economic value of ecosystem services, particularly ecosystem services that do not have a direct material benefit, is important (Costanza *et al.* 2014). There are several motivations in valuing

ecosystem services which include, but are not limited to, policymaking, land-use planning, policy analysis, raising awareness, assisting with the provisioning of natural resources and reducing ecosystem degradation (Bunse *et al.* 2015, Farber *et al.* 2015, Gomez-Baggethun and Ruiz-Perez 2011, Lele *et al.* 2013).

Since ecosystem services are defined as natural capital (Chee 2004), traditional economic analysis has been concerned with direct use values; products that produce tangible benefits. However, economists have broadened their scope to include indirect, option, existence and bequest values of ecosystems, and have subsequently developed several methodologies to value these ecosystem services (Chee 2004, Kaiser and Roumasset 2002). The stated preference method has been the most extensively used valuation method for valuing ecosystem services that do not have a material value (Kenter *et al.* 2017), while the most used valuation method within the stated preference method is the contingent valuation (CV) method.

However, the stated preference method has shown considerable deficiencies in practice (Bunse *et al.* 2015), as it has traditionally focused on *individual* assessments for these ecosystem services. It also ignores the broader, shared and plural values that society places on ecosystem goods and services (Kenter *et al.* 2016). Therefore, an alternative valuation method should be considered to value ecosystem goods and services that take not only individual values into account, but also societal values.

Deliberation has been suggested as a methodology to overcome the shortcomings of individual valuation methods (Kenter *et al.* 2016, Spash 2001). Through this, the deliberative monetary valuation (DMV) methodology has been identified by various scholars and researchers as an improved method to value ecosystem services (Bunse *et al.* 2015, Kenter *et al.* 2016, Spash 2001), thereby overcoming the criticisms of individual valuation methodologies. DMV is an economic valuation method that incorporates participation, reflection, discussion and social learning of environmental and public goods and services into a monetary valuation (Bartkowski and Lienhoop 2018, Kenter *et al.* 2016, Volker and Lienhoop 2016). DMV uses a deliberative approach for environmental valuation that requires participants or stakeholders of the ecosystem good or service under consideration to participate in the DMV process. This allows for a more comprehensive valuation of environmental resources and moves away from individual conceptions of value (Mowat 2019). The use of DMV can create more conducive conditions for the debate of moral, socio-economic and political issues that relate to social and environmental rights, equity and fairness; in addition, it increases the participants' understanding of the environmental good under consideration (Lo and Spash 2013, Orchard-Webb *et*

al 2016). This, in theory, reinforces the validity of the value elicited by the participant (Kenter *et al.* 2016, Mowat 2019).

In a DMV context, Christie *et al.* (2012) noted that no studies of DMV have been conducted in countries with developing economies, including South Africa. However, the application of DMV in countries with developing economies may not necessarily vary significantly from the theory, although it should be undertaken according to the context of the specific study (Christie *et al.* 2012). As DMV is useful in articulating social, economic and political values, conducting a DMV study in a developing country context may be useful in determining the value of environmental goods or services (Christie *et al.* 2012).

However, as important as understanding the value of ecosystem services is, few environmental valuation studies have been conducted in developing countries. This is despite the fact that developing countries harbour most of the world's biodiversity, and that there is often a high dependence on biodiversity for livelihood generation and survival (Kenter *et al.* 2011). Moreover, the valuation of environmental goods and services by using conventional economic valuation techniques, such as the stated preference method, in developing countries is often challenging, where several issues may arise (Lienhoop *et al.* 2015). These include literacy and language barriers, subsistence economies, a lack of familiarity with money and a lack of education and scientific knowledge (Christie *et al.* 2012). Deliberation is an important aspect to consider when attempting to value an environmental good or service in countries with developing economies, as deliberative methods may overcome these issues (Christie *et al.* 2012, Lienhoop *et al.* 2015).

One ecosystem service where DMV could prove to be a particularly useful valuation tool is in seagrass ecosystems. Seagrass *Zostera capensis* is a marine flowering plant found in estuaries along the coast of South Africa and represents one type of ecosystem particularly important to human well-being (Costanza *et al.* 2014, Orth *et al.* 2006). *Z. capensis* provides a variety of indirect ecosystem services (Adams 2016, Dewsbury *et al*. 2016) which include reducing the effects of erosion near coastal settlements, trapping nutrients and organic material, creating a nursery habitat for juvenile commercial fish species and reducing sedimentation (Adams 2016, Dewsbury *et al.* 2016). Seagrass habitats also have a high carbon sequestration rate (Dewsbury *et al*. 2016). Knysna, in the Western Cape province of South Africa, is a stronghold of *Z. capensis*, where it occupies the largest permanent bed of *Z. capensis* in South Africa*,* covering an approximate area of between 350 ha and 390 ha within the estuary (Adams 2016). The Knysna community depends on the abovementioned ecosystem services that *Z. capensis* provides.

This study incorporated a dual-method approach through using both the CV method and a deliberative focus group to investigate whether deliberation may contribute to solving some of the problems associated with the CV method. The CV method was conducted to identify the determinants of respondents' willingness to pay attitudes, and what determined WTP, while the deliberative focus group was conducted to deduce whether deliberation influenced respondents' attitudes and willingness to pay towards the hypothetical scenario.

The study was conducted via the use of an online survey and an online conferencing medium, since the COVID-19 restrictions implemented in South Africa limited social interaction and face-to-face interviews at the time the research was undertaken. It is noted that the original research sought to derive an economic value for the ecosystem services of seagrass ecosystems from a representative sample in Knysna obtained from an in-person focus group using the DMV method. However, due to the restrictions imposed by COVID-19, the study was forced to adapt its original research focus in order to accommodate for these restrictions. Based on this, a new set of goals and aims were developed, which is discussed in the section below.

The shift to an online research format forced the study to adapt its research design and methods. It is noted that the original research design was to produce only a deliberative value for the ecosystem services seagrass ecosystems provide through using a focus group from a representative sample in Knysna. Therefore, the inclusion of the CV method, and subsequent CV questionnaire, was an adapted aspect of the study. The monetary WTP value elicited from the respondents in the CV survey was used as a comparison to the WTP value elicited from the deliberative focus group. Based on this, the monetary values obtained from the CV survey were not used for a policy analysis or a cost-benefit analysis, but rather used as a starting point for a comparison between values elicited from the different non-market valuation methods. A pilot study was not considered necessary for the CV survey.

1.2. Goals of the study

The preliminary goals for this study were contingent on the research being carried out in a face-to-face manner. However, due to the circumstances, and the subsequent restrictions of COVID-19, the study was moved to an online platform. Due to the adjusted methods discussed in Chapter 4, the diversity and the representativeness of the sample were reduced and fewer categories of stakeholders were able to participate in the research. Despite this, a goal and three sub-goals were developed for this research.

a) Main goal

The preliminary goal of this study was to establish the determinants that influence participants' willingness to pay using a dual method approach to an ecosystem service in a South African context.

b) Sub-goals goal

The sub-goals of this project are as follows:

1) To investigate the types of value associated with willingness to pay;
2) To investigate the role of deliberation as an applicable technique to be used to value ecosystem services in a South African context; and
3) To determine the potential of deliberation to improve value elicitation of ecosystem services.

1.3. Rationale

There have been several attempts to economically value seagrass on a global and local scale. Campagne *et al*. (2015) published a paper that valued the goods, benefits and services of seagrass *Posidonia oceanica* in the Mediterranean Sea by using a specifically engineered aggregation method. In addition, there have been several publications of the evaluation of the commercial services that seagrass provides on a global scale, with very few evaluations conducted at a local, specific single species scale.

To the researcher's knowledge, after extensive research, no studies using the DMV method have been conducted in countries with developing economies, including South Africa, nor have CV or DMV studies been conducted to economically value the ecosystem services provided by seagrass in South Africa. This leaves a gap in the research to develop and test a South African site-specific CV survey and DMV focus group to obtain an economic value on the ecosystem services that *Z. capensis* provides to the Knysna community. Through this, the DMV method was used to address the shortcomings of the CVM method in obtaining a value for a hard-to-define ecosystem service. Additionally, the successes and limitations of conducting an online DMV study are of noteworthy importance, as well as the documented findings of the varied results obtained from the CV and DMV methods.

1.4. Dissertation layout

This dissertation consists of six chapters. A brief summary of the contents of each chapter is outlined below. Additional information pertaining to the study is contained in the appendices.

Chapter 1 introduces the project and offers background information of the context of the study. It provides the study rationale, and the aims and objectives of the research. It concludes with the thesis structure.

Chapter 2 presents a review of current literature regarding the concept and importance of ecosystem services and the economic valuation thereof. The chapter discusses two non-market valuation methods used to value ecosystem services; the contingent valuation method and the deliberative monetary valuation method.

Chapter 3 provides details of the context of the study and introduces the ecosystem good under discussion – seagrass *Zostera capensis*. The chapter discusses the ecological traits, geographical distribution and the ecosystem services of seagrass *Zostera capensis.* The chapter then introduces a detailed description of the study site; Knysna, Western Cape, South Africa.

Chapter 4 describes the methods undertaken in this dissertation regarding the online contingent valuation survey and the online deliberative monetary valuation focus group. It discusses the targeted population, the process of data collection and the analysis of results.

Chapter 5 documents the findings of the project. The results obtained from the two methods used in this study – the contingent valuation and deliberative monetary valuation methods – are discussed in detail. Reference is made to literature and past findings.

Chapter 6 concludes with noteworthy findings of the study and presents recommendations for future research.

CHAPTER 2:

LITERATURE REVIEW

2.1. Introduction

Ecosystems provide key market and non-market goods and services that are fundamental to human well-being. Ecosystem services are highly compatible with economic analysis, as the natural environment is a value-generating resource. Therefore, the valuation of ecosystem services plays a significant role in policymaking, land-use planning and raising awareness. However, it is often difficult to value ecosystem services due to an array of market failures or where many ecosystem services are not traded in the market and thus do not have a direct market value.

Conventional methods used to value ecosystem services that do not have a direct market value include the avoided cost, factor income and contingent valuation (CV) methods. However, these methods have shown considerable deficiencies in practice. A new valuation method, the deliberative monetary valuation (DMV) method, has been suggested by various scholars and researchers (Bunse *et al.* 2015, Kenter *et al.* 2016, Spash 2008, Szabo 2011) as an improved method to value ecosystem services that do not have a direct market value. The DMV method incorporates participation, reflection, discussion and social learning about an ecosystem service or environmental good into a monetary value, where, theoretically, the validity of the value derived from this method is increased compared to conventional individual valuation methods.

This chapter reviews the literature behind the fundamental concepts of ecosystem services and the valuation thereof. The determinants of valuation for ecosystem services are also discussed in detail. Finally, it outlines criticisms of conventional ecosystem services valuation methods and offers a novel approach, the deliberative monetary valuation (DMV) method, as an alternative for the monetary assessment of ecosystem services.

2.2. Ecosystem services

All human beings are fundamentally dependent on ecosystems for their livelihoods, welfare, and survival (Bunse *et al.* 2015, Costanza *et al.* 2014, Fisher *et al.* 2009). Ecosystems provide natural contributions and functions to human society. They are characterised by the existence of biotic and abiotic resources, and the interactions between the living and non-living in an environment (de Groot *et al.* 2002). The term 'ecosystem services' describes those services that ecosystems provide to human society and was popularised by the Millennium Ecosystem Assessment (MA 2005). As a result, the ecosystem service concept has made considerable progress in framing core concepts for researchers

and practitioners, where the understanding of how ecosystem services support human well-being has been explored (Small *et al.* 2017). The definitions of the concept of ecosystem services have evolved over time in various publications (Braat and de Groot 2002:5):

- "Ecosystem services are the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfil human life" (Daily 1997:3);
- "Ecosystem services are the benefits human populations derive, directly or indirectly, from ecosystem functions" (Costanza *et al.* 1997:253);
- "Ecosystem services are components of nature, directly enjoyed, consumed, or used to yield human well-being" (Boyd and Banzhaf 2007:619); and
- "Ecosystem services are the aspects of ecosystems utilised to produce human well-being" (Fisher *et al.* 2009:645).

Although these definitions differ, there are similarities in the descriptions. Ecosystem services are the benefits that nature provides to households, communities and economies by delivering goods, services and attributes that are produced through a combination of inputs which directly or indirectly generate utility (Polasky and Sergeson 2009, Turpie *et al.* 2017). As a result, most ecosystem services are considered as public goods (meaning that they are non-rival and non-excludable) or common pool goods (meaning that they are rival and non-excludable), or both (Costanza *et al.* 2014, Kretsch *et al.* 2016). Aesthetic benefits, for example, that are provided by an environmental resource are non-rival in consumption, since many people can enjoy them without affecting the enjoyment of others (Pagiola *et al.* 2004). These terms imply that society, communities and individuals are not excluded from benefitting from ecosystem services (Perman *et al.* 2011). However, due to land ownership and privatisation, ecosystem services may also be considered quasi-public goods (Kretsch *et al.* 2016).

Ecosystem services are critical to the functioning of Earth's life-supporting system and are fundamental to human well-being, health, livelihoods and survival (Costanza *et al.* 2014). If managed correctly and sustainably, ecosystem services yield vital services that contribute to human well-being through the production of goods (for example, seafood and timber), life-supporting processes (for instance, pollination), and life-fulfilling conditions (such as beauty and aesthetic appeal) (Daily 2000). A less degraded or damaged ecosystem would provide better services and benefits than a more disturbed ecosystem (The Economics of Ecosystems and Biodiversity (TEEB) 2010).

Biodiversity offers a wide range of ecosystem services that sustain human well-being and human life (Salles 2011). Several examples of the services that ecosystems provide are the purification of air and

water; moderation of droughts and floods; maintenance of genetic resources; fuel and construction materials; provision of food and other benefits such as cultural, recreational or aesthetic benefits (Millennium Ecosystem Assessment (MA) 2005).

The MA (2005) identified and defined approximately 40 ecosystem services which are further classified into four categories, namely provisioning, regulating, cultural and supporting services (de Groot 2002, Orchard-Webb *et al.* 2016). Provisioning ecosystem services include products obtained from ecosystems, such as food, raw materials and medicinal resources (Harrison *et al.* 2014). Examples of regulating ecosystem services are climate regulation (Atkinson *et al.* 2012) and erosion control. Cultural ecosystem services are the non-material benefits obtained from ecosystems through recreation, spiritual enrichment or aesthetic pleasure (Atkinson *et al.* 2012, Harrison *et al.* 2014). Finally, supporting ecosystem services are the services required to support the production of all other ecosystem services (Harrison *et al.* 2014), examples of which include biomass production, soil formation and nutrient cycling.

There has been widespread recognition of the ecosystem services concept in literature since the 1960s, where Hackbart *et al.* (2017) identified that, between 1960 and 2015, a total of 18,413 articles were published under the theme of 'ecosystem services'. The underpinning rationale behind the increased recognition of the ecosystem services concept was to:

- Make the contributions of ecosystem services more visible (Costanza *et al.* 2014);
- Educate society about humans' reliance on nature and the services that ecosystems provide (Palmer *et al.* 2014);
- Recognise that ecosystem services are a valuable form of natural capital which contribute to economic capital, human livelihood and well-being (Chee 2004, Turpie *et al.* 2017); and
- Demonstrate that the disappearance of biodiversity influences ecosystem functioning, and therefore affects the critical services they provide for human well-being (Braat and de Groot 2012).

The seminal paper by Constanza *et al.* (1997), which highlighted the total value of natural capital and ecosystem services in monetary figures, introduced the ecosystem service concept into the mainstream of debate, criticism, research and development and the usefulness of monetary valuation studies. The ecosystem services concept has therefore contributed to the increased understanding of the relationship between humans and nature (Palmer *et al.* 2014) and has ultimately improved the knowledge of the role that ecosystem services play in society (Costanza *et al.* 2014).

2.3. Economic valuation of ecosystem services

The services provided by ecosystems are vital to the functioning, and growth, of the world's economies (Ferraro *et al.* 2012). Ecosystem services are highly compatible with economic analysis, as the natural environment is a value-generating resource (Badura *et al.* 2016) and a form of a capital asset (Barbier 2007). Barbier (2019) identified that a country's endowment of natural resources, or natural capital, is an essential source of economic growth and human well-being. Economic wealth has three distinct assets; reproducible capital, human capital and natural capital (Barbier 2019, Chee 2004, Mace *et al.* 2015), as highlighted in Figure 2.1.

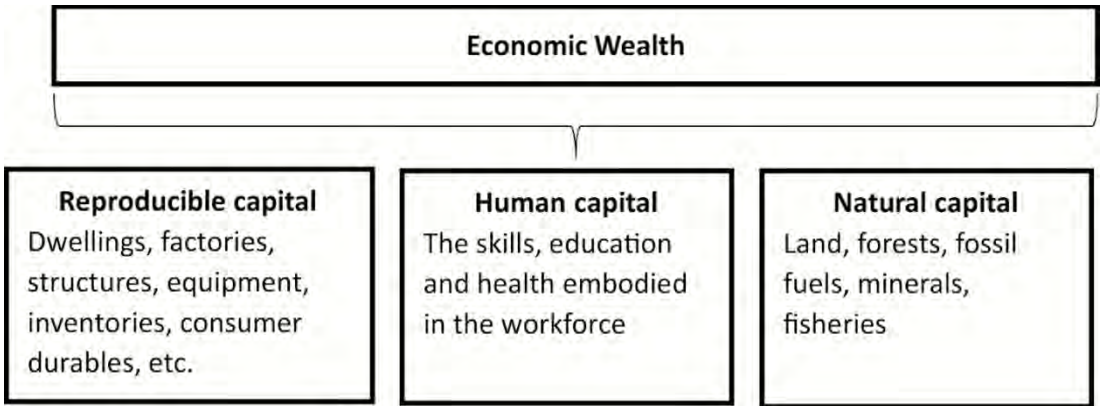

Figure 2.1: The concept of natural capital and economic wealth

Source: Barbier (2019).

The world's ecosystems are capital assets that are considered natural capital (Daily *et al.* 2000, Mace *et al.* 2015). Definitions of natural capital include:

- "Stocks of assets, provided for free by nature which, either directly or indirectly, deliver well-being for humans" Bateman *et al.* (2018:2); and
- "'Natural capital' denotes an economy's environment and natural resource endowment—including ecosystems—that yields a valuable flow of goods and services to human beings" Barbier (2019:17).

Although there are varied definitions of natural capital, the descriptions have similar attributes. The concept of natural capital emerged as a result of economists attempting to make the natural contributions of ecosystem services more visible (Bateman *et al.* 2010, Lele *et al.* 2013). The components of natural capital are biotic and abiotic, where each component interacts with one another to produce ecosystem services that are vital to human well-being (Smith *et al.* 2017). Since ecosystem services are formed from natural capital, they are, therefore, an asset to the economy, one

that produces goods and services over time (Barbier 2007). In this regard, ecosystem services should be treated as a significant asset in the economy and should be valued similarly to other forms of wealth (Barbier 2019, Barbier 2013).

Since the 1960s, there has been an increase in interest in the valuation of the multiple benefits that nature provides to humans (Atkinson *et al.* 2012, Hein *et al.* 2006). A possible reason for the increased interest of the valuation of the ecosystem services concept is the loss or degradation of natural ecosystems and biodiversity over time and, therefore, the loss of ecosystem services (Barbier 2007). Degradation poses a threat of reducing the valuable resources provided by ecosystem services to society (Kumar and Kumar 2008, TEEB 2010), which subsequently has an impact on human well-being and economic welfare (Badura *et al.* 2016). The valuation of biodiversity and ecosystem services makes explicit the fact that biodiversity and ecosystem services are scarce, and that the degradation of these services has a cost to society (Pascual *et al.* 2010).

Understanding the economic value of biodiversity and ecosystem services is necessary for several reasons. One is the perceived 'persuasiveness' of economic language, where conveying the goods and services that the natural world provides in monetary terms is a useful means of communicating the importance of conservation and biodiversity to a broader, global audience (Atkinson *et al.* 2012, Badura *et al.* 2016). For example, Gallai *et al.* (2009) estimated that the value of the services that insect pollinators provide is about US$190[1] billion annually, which was only based upon the benefits of the pollination of crops for direct human consumption. This finding allowed society to compare the importance of ecosystem services to a monetary value. Data gathered from empirical studies of this nature can be used for policymaking, land-use planning and policy analysis (Atkinson *et al.* 2012). By providing site-specific economic estimates of the value of environmental goods and services, managers and policymakers can undertake cost-benefit analyses (Dewsbury *et al.* 2016).

The economic valuation of ecosystem services and their understanding of the monetary value can play an essential role in promoting sustainable use of natural resources (Unsworth *et al.* 2010) through:

1) Justifying conservation decisions in particular places to reduce ecosystem degradation (Ferraro *et al.* 2012);
2) Identifying sources of sustainable financing (Ferraro *et al.* 2012);

[1] US$ - United States of America Dollar

3) Assisting with the provisioning of natural resources and ecosystem services (Bunse *et al.* 2015, Lele *et al.* 2013); and

4) Attempting to correct the failure of markets to ensure efficient allocation of ecosystem services (Farber *et al.* 2002, Pedroso and Kung'u 2019).

Despite the evidence of the importance of ecosystem services, the value of ecosystem services is often undetected in the marketplace (Costanza *et al.* 1997). Since many ecosystem services do not have a direct market value, or do not have a direct material benefit and are inherently 'free' as public goods to society, it is often difficult to attach an economic value to these goods and services (Bunse *et al.* 2015). This is a consequence of an array of market failures which occurs when there is an inefficient distribution of goods and services in the market and results in distorted supply and demand factors, and thus an inability to lead the market into optimal output (Bunse *et al.* 2015). Ecosystem services are a common example of market failure since they are considered public goods.

Ecosystem services that have direct use values, such as the price of timber, are observable in markets, and therefore have exchange values. However, ecosystem services that have indirect use or non-use values, such as a tree limiting the probability and intensity of soil erosion, are not observable in markets and therefore do not have exchange values and are often complex to value (Bunse *et al.* 2015, Kaiser and Roumasset 2002).

Since many ecosystem services do not have a direct market value, many of the benefits derived from these services are subsequently under-priced (Barbier 2007). The undetected market value or the economic invisibility of ecosystem services often leads to a loss of biodiversity and a decline in ecosystem service functioning, which is worsened by short-term ecosystem transformation. For instance, the short-lived ecosystem conversion of clearing mangrove forests for shrimp farming production would reveal positive gross domestic product (GDP), because of the short-term benefits that shrimp production provides (Balmford *et al.* 2002). However, the ecosystem services that untouched mangrove forests provide, such as carbon sequestration, a nursery habitat for fish and storm protection services, are worth 79% more to the economy than the conversion of these forests into shrimp farming (Balmford *et al.* 2002). Unless the benefits from ecosystem services are explicitly measured and valued, these non-marketed goods and services are likely to be ignored in decision-making processes, which may lead to the complete demise of the good or service under discussion (Barbier 2007). Understanding the total economic value for ecosystem goods and services can promote environmental conservation. The concepts of total economic value are discussed further in the section below.

2.3.1. Total economic value

To address the issue of market failure, Costanza *et al.* (1997) measured the local-scale value of ecosystem services of different habitat types per hectare to generate a global estimate of the total economic value of these ecosystem services. They estimated that the value of ecosystem services was an approximately US$33 trillion per annum (Constanza *et al.* 1997), a figure much larger than the global gross national product (GNP) at the time (US$46 trillion when updated to 2011 US$ values) (Polasky and Sergeson 2009). This figure brought the importance of ecosystem services to the foreground, not only concerning the natural resources that ecosystems produce for human consumption, but also the indirect use, non-use and cultural use-value that ecosystem services provide to human society.

However, debate persists on the validity of the values obtained from the Costanza *et al.* (1997) review. For instance, although Toman (1998) acknowledged the importance of the Constanza *et al.* (1997) study in terms of stimulating additional research and debate into the undervalued and underappreciated ecosystem service concept, they highlighted a number of criticisms that the study faced. One criticism that Toman (1998) noted was the methodology used in conducting this research. Toman (1998) cautioned that the value obtained by Costanza *et al.* (1997) reflected the total value of ecosystem services instead of the marginal or incremental value for ecosystem services, through which the study aimed to achieve. This is a "serious underestimate of infinity" (Toman 1998:58).

The economic value of an ecosystem service is based on its use and non-use values which, when combined, determine the resource's total economic value (Bunse *et al.* 2015, Chee *et al.* 2004, Kenter *et al.* 2017, Pascual *et al.* 2010, Perman *et al.* 2011). Figure 2.2 highlights the total economic value (TEV) framework, which attempts to derive the value of all the benefits obtained from a resource. Although the TEV framework varies slightly from analyst to analyst it generally includes three sources of value, namely (1) use-value; (2) option value; and (3) non-use value (Pagiola *et al.* 2004).

Use-value includes subcategories of direct and indirect use values (Boyd and Banzhaf 2007). Direct use values are either consumptive values or non-consumptive values. Consumptive direct use values are the goods or services that society directly derives benefit from an ecosystem service (Badura et al. 2016, Boyd and Banzhaf 2007), an example of which is fish for food consumption. Consumptive direct use values often have a market value attached and possess readily observable market prices (Perman et al. 2011). Theoretically, valuing consumptive direct use-values is straightforward since they usually have observable quantities of products in the marketplace. Non-consumptive direct use values are

not visible in markets but are values from which society directly benefits (Perman et al. 2011), an example of which is a walk on the beach.

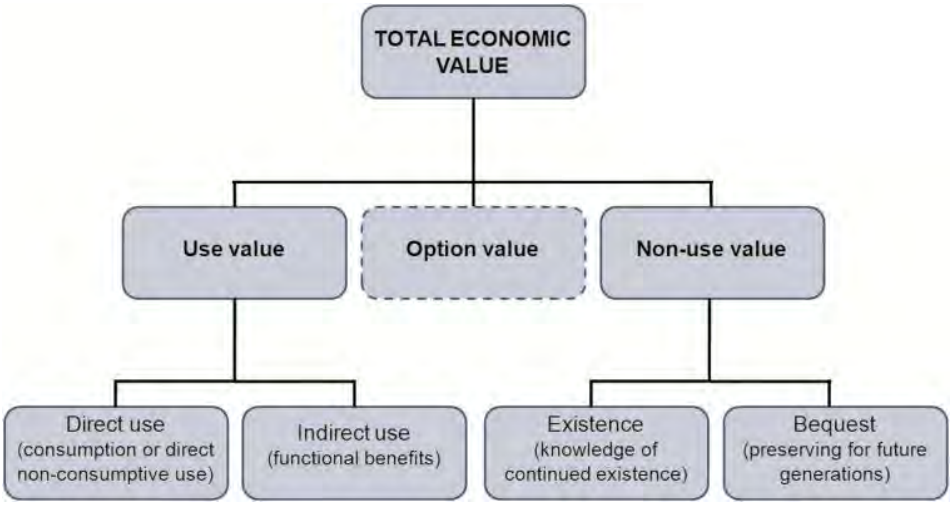

Figure 2.2: The Total Economic Value (TEV) framework

Source: Chee et al. (2004).

Indirect use values are functional benefits and are goods and services from which society does not directly derive benefit. Instead, they provide society with regulatory or provisioning functions (Boyd and Banzhaf 2007, Pagiola *et al.* 2004), such as the roots of a tree preventing soil erosion, water regulation or soil quality. Indirect use ecosystem services are often difficult to measure and translate into a monetary value, and since they do not produce a direct market value, they are often difficult to measure and are inherently 'free' as public goods to society (de Groot *et al.* 2002, Pagiola *et al.* 2004).

The second source of value is called non-use values which refers to the satisfaction and enjoyment that people may experience by simply knowing that a resource exists, even if they may not directly benefit from or use the resource themselves (Boyd and Banzhaf 2007, Chan *et al.* 2016). Non-use values are the benefits individuals may derive from a good or service without directly interacting with it or intending to use it (Perman *et al.* 2011). They are, typically, the most challenging type of value to measure, because they are not reflected in people's behaviour, and are therefore almost unobservable (Pagiola *et al.* 2004). Non-use value exists in two forms; (1) existence value and (2) bequest value, as identified in Figure 2.2.

Existence value is the value of benefits received from an environmental asset's existence alone (Boyd and Banzhaf 2007). For example, individuals may obtain satisfaction from an ecosystem service for its continued existence (Perman *et al.* 2011). Bequest value is the value of satisfaction expressed by

participants through the concern of preserving natural environments for the benefit of future generations (Boyd and Banzhaf 2007, Perman *et al.* 2011).

The third source of value is defined as option value and is derived from preserving a resource for future use (Pagiola *et al.* 2004). In other words, option value is the value that is placed on an environmental good or service for the maintenance of that good or service for use in the future, even though the person may not benefit from it or use it in the present (Pagiola *et al.* 2004). Provisioning, regulating and cultural ecosystem services may all form part of option value.

Although the aspects of TEV are well-defined, the actual process of measuring it is more complicated and an explanation of the valuation techniques used to measure the economic value of ecosystem services is discussed later in this chapter.

2.3.2. Value paradigms

The concepts and methods to value ecosystem services are linked with the economic theory of value (Kenter 2016, Kenter 2017, Salles 2011). However, value can be highly context-dependent, and it is, therefore, necessary that valuation frameworks recognise how different spaces, times, institutions and biological factors all influence value (Badura *et al.* 2016, Kenter 2017). However, understanding the term "value" needs further elaboration, which is discussed below.

In economics, value is associated with trade-offs, choices or opportunity costs which people make concerning what they are willing to give up to obtain something else (Badura *et al.* 2016, Farley 2012), and all decisions that incorporate trade-offs involve valuation (Costanza *et al.* 2014). An object, entity or service, therefore, only has value if an individual who values the entity or service is willing to give up something else to obtain it (de Groot *et al.* 2002). The value of ecosystem services and biodiversity reflects what we, as a society, are willing to trade-off to conserve natural resources (Pascual *et al.* 2010).

The term value has different meanings across space and time (Kenter *et al.* 2015, Kenter 2017) and different dimensions and disciplines (Farber *et al.* 2002). Kenter *et al.* (2015) identified five dimensions of value that are used for value identification, elicitation and measurement (Figure 2.3). The dimensions are (1) value concept, (2) value provider, (3) elicitation process, (4) value intention and (5) value scale. These are highlighted in Figure 2.3, and each dimension is discussed in turn below.

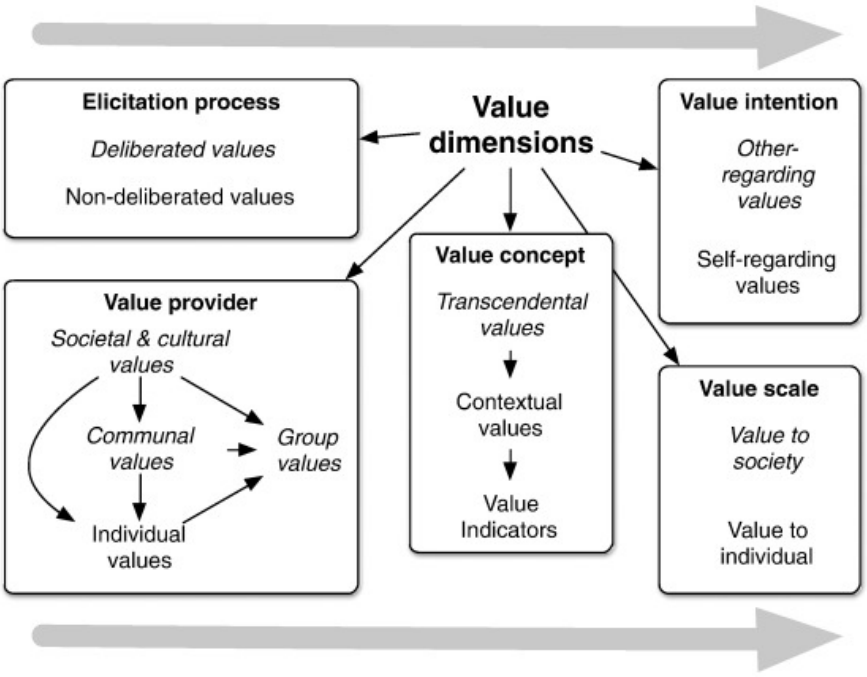

Figure 2.3: Types of value dimensions[2]

Source: Kenter et al. (2015).

The 'value concepts' dimension highlighted in the figure shows three primary descriptions of value; (1) *transcendental*, (2) *contextual*, and (3) *indicators* (Kenter *et al.* 2015). Transcendental values are the guiding principles and life goals that shape society's everyday lives, such as honesty, security, harmony with nature and enjoyment (Kenter 2016, Kenter 2017, Kenter *et al.* 2015). Transcendental values help define contextual values which are dependent on a specific context, such as judging whether the protection of a wetland is more important than developing the land around it (Kenter 2017). Lastly, value indicators provide a measure of the importance of something that is expressed in monetary or non-monetary terms (Kenter *et al.* 2015).

[2] *Notes: The bold titles indicate non-mutually exclusive dimensions of value. The phrases in italics indicate shared societal values. The arrows within the boxes indicate the directions of influence between the different types of value. The arrows above and below the figure indicate that the 'elicitation process' and the 'value provider' dimensions of value influence what value types are expressed along with the 'value concept', 'value intention' and 'value scale' dimensions.*

The 'value provider' dimension identifies four types of value providers which are defined as societies, communities, ad-hoc groups and individuals (Kenter *et al.* 2015). Societies share *cultural* and *societal values* which may be considered as shared principles and virtues (Kenter *et al.* 2015). Communities are not homogenous and, within them, there is a wide range of social groups that express *communal values.* Additionally, there are ad-hoc groups that are associated with research, examples of which are focus groups, discussion groups, participatory mapping and citizen juries (Kenter *et al.* 2015). Lastly, individuals are also value providers.

The 'elicitation process' dimension seeks to distinguish between *deliberated and non-deliberated values* (Kenter *et al.* 2015). This distinction is vital to note. For example, Kenter *et al.* (2015) suggested that the process in which value is elicited may provide significantly different monetary and non-monetary values. These may occur through (1) individual values; (2) deliberated individual values; and (3) deliberated group values. They identified that deliberated individual values often fall between deliberated group values and non-deliberated values (Kenter *et al.* 2015).

The 'value scale' is the distinction of the extent of value; either that of *individual* or *social value* (Kenter *et al.* 2015). The 'value intention' dimension relates to *self-regarding* or *other-regarding* values (Kenter *et al.* 2015). Self-regarding values relate to one's life enjoyment, for example, whereas other-regarding values may refer to that of future generations' value.

The focus of the value of ecosystem services is undertaken through the neoclassical economic valuation framework in which an object, entity or service is assigned a value based on what will be exchanged in return (Spash 2007). In the neoclassical economic valuation framework, the focus of the valuation of ecosystem services is on *individual* contextual values (Kenter 2017). The valuation of ecosystem services relies on the assumption of the utilitarian framework; that the utility an individual derives from a good or service is dependent on that individual's preferences (Chee 2004, TEEB 2010). The utilitarian framework attempts to measure the specific utility that an individual derives from a particular good or service, then aggregates the values across all individuals by allocating an equal weighting (TEEB 2010). The utilitarian framework attempts to measure all ecosystem service values in monetary terms to provide a standard metric to express the value of the benefits derived from the ecosystem services (TEEB 2010).

Fundamental to the natural capital concept is the creation of markets, where natural resources can be bought and sold in ways that will both be sustainable to the natural resource stock, while also generating financial returns for investors (Fletcher *et al.* 2018). In neoclassical economic theory, market prices provide a measure, or estimate, of the relative strength of different goods and services

that satisfy consumer preferences (Bunse *et al.* 2015). Consumer preference, in a neoclassical framework, is considered to be individual preference, where an individual is assumed to make choices via an expression of preference, and where the individual is assumed to maximise their utility (Spash 2007). In this regard, market prices are exchange values that reflect the value, and the valuation of goods and services, that an *individual* makes (Bunse *et al.* 2015). However, if no market exists for the goods or services under discussion, the values of these goods or services can be derived from similar or hypothetical markets (Badura *et al.* 2016). The implementation of the contingent valuation method in this scenario is useful since the method can value goods and services that are not reflected in a market price, which is discussed further in the section below.

2.3.3. Non-market valuation methods

To achieve a value for the environment, different valuation methods are applied to various environmental goods and services. The indicator of value that is most commonly applied are a good's market price (Badura *et al.* 2016), examples of which is the market price of fish or timber. This environmental valuation method is commonly referred to as the market-based method, which uses market prices to value goods and services.

However, when a market price does not exist for a good or service, different methods are sought to record a value. Environmental economists have developed a range of methods that are used to estimate the economic value for non-marketed ecosystem goods and services (Bunse *et al.* 2015). These are broken down into two categories; the revealed preference and stated preference methods (Kenter *et al.* 2011, Perman *et al.* 2011, Tietenberg and Lewis 2020). The revealed preference method draws on observations of consumer behaviour in existing markets (Bunse *et al.* 2015, Snowball 2007), while the stated preference valuation approach is used to assign a monetary value to ecosystem services when observable behaviour is unavailable.

a) Revealed preferences

The revealed preference method is used to estimate direct and indirect use values that are observable (Perman *et al.* 2011). Under the direct method, market prices and simulated market methods are used to infer value through direct observation or simulation (Parkin 2010).

Under indirect methods, the two main revealed preference methods that are used to derive a value for environmental change are the travel cost and hedonic pricing methods (Bunse *et al.* 2015, Tietenberg and Lewis 2020). The travel cost method is used to estimate use-value and it applies a quantitative estimation of the demand for visits to a location and compares the demand to the actual price of a visit, where the travel cost acts as a proxy for the site value (Randall 1994). The second

revealed preference method is the hedonic pricing method which estimates the amount that an environmental good or service adds to property values in the surrounding area (Monson 2009) and is used to value direct use and indirect use-values.

However, the revealed preference method cannot measure non-use values (Figure 2.2), since revealed preferences measure only actual behaviour and expenditures concerning market values (Pascual *et al.* 2010, Tietenberg and Lewis 2020). Revealed preference methods *infer* a value, rather than *estimate* it (Tietenberg and Lewis 2020). This is where stated preference methods are necessary.

b) Stated preferences

The second category of environmental valuation methods are stated preference (SP) methods. Compared to the revealed preference methods, SP methods are used when the value of an ecosystem service is not directly observable, such as the value of preserving an endangered species (Tietenberg and Lewis 2020).

SP methods use a survey technique based on hypothetical or constructed markets (Snowball 2007) and are used to derive a willingness to pay (WTP) value for the marginal improvement of an environmental resource, or a willingness to accept (WTA) value as compensation for avoiding a marginal loss of environmental change (Tietenberg and Lewis 2020). The WTP and WTA values are not related to market values but are contingent upon a scenario for the environmental resource or ecosystem service under discussion (Kanya *et al.* 2019, Pedroso and Kung'u 2019, Perman *et al.* 2011). The foundations of WTP are discussed in further detail in Section 2.4.1.

The most widely used stated preference technique is the contingent valuation (CV) method (Carson 2012, Perman *et al.* 2011). The CV method is a survey-based valuation method that attempts to assign a monetary value to an environmental good or ecosystem service. It is achieved by asking questions that relate to WTP for gaining environmental goods or services, or WTA compensation for losing environmental resources (Perman *et al.* 2011).

The CV procedure is based on hypothetical markets in which respondents are asked to manifest their preferences through a questionnaire, interview or survey (Chee 2004). The method allows for the assignment of economic values to the benefits society derives from a good or service (Kanya *et al.* 2019). The CV method involves using data from a carefully formulated questionnaire, survey or interview in which respondents express their preferences in the form of willingness to pay or willingness to accept bids (Lo and Jim 2015). It considers goods or services that do not have a market value, or which the revealed preference method cannot measure (Kanya *et al.* 2019, Palmer and Snowball 2009).

Given the nature of this study and its objectives, the CV method was deemed the most appropriate valuation method. The following section discusses the CV method further, detailing its limitations, application and the foundations of utility theory on which the willingness to pay method is based.

2.4. Contingent valuation method

As alluded to in the previous section, the CV method is the most widely used valuation technique to estimate the economic value of ecosystem services, especially the value of non-use and non-market goods and services (Carson *et al.* 2001, Moore *et al.* 2011, Perman *et al.* 2011, Tietenberg and Lewis 2020, Whittington *et al.* 2012). Since this method can measure both non-use and use-values which the revealed preference method cannot measure, it is of importance in this dissertation, since it can be used to estimate the value of public good ecosystem services, such as those provided by seagrass ecosystems. Seagrass ecosystems were introduced in Chapter 1, and Chapter 3 provides a detailed description of the context of the research, with specific reference to seagrass.

This section discusses the practical underpinnings of the contingent valuation method in a valuation study. It also addresses the process of data collection and potential sources of bias within the CV method.

2.4.1. Foundations of willingness to pay

Economic value, using the CV method, is estimated in terms of one of four measures:

1) Respondents' maximum willingness to pay (WTP) to receive an increase or improvement in the provision of a good or service (Carson *et al.* 2001);
2) Their maximum WTP to prevent a reduction in such a provision (Badura *et al.* 2016);
3) Respondents' minimum willingness to accept (WTA) compensation for a decrease of the good or service (Perman *et al.* 2011); and
4) The amount that respondents are WTA to forego a welfare gain from the increased provision of such a good or service (Badura *et al.* 2016).

Whether the willingness to pay (WTP) or the willingness to accept (WTA) format is used in a study is dependent on the ecosystem service under discussion (Carson *et al.* 2001). All four of the measures of WTP or WTA discussed above can be used in a CV study, provided that the respondents find the hypothetical market credible (Badura *et al.* 2016). The National Oceanic and Atmospheric Administrations (NOAA) Panel Report does not, however, recommended the use of the WTA format in SP studies (Arrow *et al.* 1993). This is because WTA amounts are not subject to budget constraints,

meaning that the respondent may elicit a WTA amount that is not a realistic value given their budget constraints (Arrow *et al.* 1993). Therefore, only the WTP format is discussed further in this study.

The WTP method reflects the preferences that respondents express in hypothetical markets and are used to determine the value for a good or service that cannot be valued through revealed preference methods. The WTP method is based on a theory of choice behaviour, known as random utility theory (RUT), which explains the choice behaviour of humans (Louviere *et al.* 2010). It is this choice behaviour that assumes that people have 'utility' which cannot be observed by researchers (Louviere *et al.* 2010). RUT assumes that individuals make rational choices based on their existing preferences to maximise their utility (satisfaction) (Cascetta 2001).

2.4.2. Determining variables of WTP

In CV studies, there are standard elicitation methods used to determine WTP values from respondents (Balistreri *et al.* 2001, Tian *et al.* 2011). The NOAA Panel Report (Arrow *et al.* 1993), and other authors (Arin and Kramer 2002, Lindsey and Holmes 2002, Oh and Hong 2012, Rowlands *et al.* 2003, Turpie 2003), drew on several categories that help in the interpretation of WTP factors. Several variables that have the potential to influence WTP are:

1) Socio-economic variables of the respondent, such as education level, income and gender (Oh and Hong 2012);
2) Prior knowledge of, and interest in, the environmental good or service (Turpie 2003);
3) Environmental views and attitudes (Rowlands *et al.* 2003); and
4) Trust in government (Oh and Hong 2012).

There are many social and economic factors that may influence WTP. Studies that have produced noteworthy results are discussed below, while Chapter 4 discusses which WTP determinants were included in the context of this study.

Economic theory assumes a positive correlation between WTP and income (Moffat *et al.* 2011). Higher household or individual income is often associated with higher levels of the *ability* to pay (Daly *et al.* 2015), which results in higher WTP amounts compared to lower-income households. For instance, a WTP study conducted in Ghana for invasive seaweed management found that household income levels influence WTP amounts, where higher household income levels were associated with higher WTP amounts (Ofori and Rouleau 2020). Although households with higher incomes tended to state higher WTP values, Baumgärtner *et al.* (2016) found that, as a percentage of household income, lower-

income households tended to state higher WTP amounts. This means that lower-income households state a higher proportion of WTP relative to income than higher-income households.

Education is also a variable that influences respondents' WTP. Higher levels of education are noted to positively correlate to higher levels of environmental awareness (Arin and Kramer 2002, Halkos and Matsiori 2012, Lindsey and Holmes 2002, Risen *et al.* 2017, Rowlands *et al.* 2003), which results in the willingness of the respondent to contribute to conservation efforts. For instance, Lindsey and Holmes (2002) in a study of the implementation of marine protected areas in Vietnam, found that respondents with higher levels of education had increased awareness of environmental issues, as well as higher WTP amounts for environmental protection. Arin and Kramer (2002), in a study on divers' WTP for visiting marine protected areas in the Philippines, found that WTP values increased with increasing years of tertiary education.

Knowledge of the environmental good or service being valued and interest shown towards the environment are variables that are positively correlated to WTP, highlighted in a study by Turpie (2003) on the value of biodiversity in South Africa. The study concluded that, as the knowledge score associated with the environmental good under consideration increases, so does the mean WTP amount (Turpie 2003).

The use frequency of an environmental resource also influences WTP. For instance, Daly *et al.* (2015) reported that the more frequently respondents utilised a marine protected area in Mozambique, the lower WTP values were. Daly *et al.* (2015) used a user fee levy per visit as the payment vehicle for the study, which showed that the more frequently respondents utilised the marine protected area, the less they were WTP. This was consistent with diminishing marginal utility. Conversely, Schindler *et al.* (2018) reported that an increase in the frequency of use in green spaces in Belgium resulted in higher incidences of respondents being willing to pay for the benefits provided by green spaces. Schindler *et al.* (2018) used local annual taxes as the payment vehicle. Therefore, the payment vehicle was a flat rate, where diminishing marginal utility was not present. Caula *et al.* (2009) and Leng and Lei (2011) also found a similar relationship in WTP and the frequency of the utilisation of environmental resources to Schindler *et al.* (2018). These confounding findings in literature give reason to believe that the frequency of use of an environmental resource does not necessarily correlate to higher levels of WTP, but rather that underlying socio-demographic or context-dependent variables, such as the proposed payment vehicle or hypothetical scenario, may influence respondents' WTP.

The level of interest a respondent showed in nature also had a positive correlation with WTP, where higher interest levels were associated with higher WTP values (Turpie 2003). This finding correlates

with the study conducted by Ofori and Rouleau (2020), where the authors concluded that the attitudes shown towards the environmental good under discussion had a significant influence on WTP throughout all income levels, where the greater interest in the environmental management project corresponded to higher WTP amounts. Environmental concern also had a positive relationship with WTP (Torgidou *et al.* 2006).

However, regarding the knowledge of the environment and environmental interest variables, it should be cautioned that the results obtained from these variables may be complex and challenging to accurately measure (Daly *et al.* 2015). This is due to the yea-saying behaviour, and the warm-glow effect respondents may demonstrate (Daly *et al.* 2015), which are further discussed in Section 2.4.2.

In addition, since these variables are often measured through self-reported answers, the responses are based on subjective evaluations (Garcia and Gustavson 1997). Therefore, the answers respondents provide may be under or over-exaggerated (Garcia and Gustavson 1997). To avoid bias in this regard, Spash (1997) and Whittington and Pagiola (2012) both recommended a dual measurement approach. Firstly, the participants were asked to rate their environmental awareness using a Likert scale (Spash 1997). Secondly, the participants were asked follow-up questions based on the responses provided on the Likert scale. This dual measurement approach increased the validity of the answers provided.

Age and gender variables are also known to influence WTP characteristics (Rowlands *et al.* 2003). Regarding the former, Halkos and Matsiori (2012) and Wan *et al.* (2017) learnt that age had a negative effect on WTP values. They found that, as age increased, respondents were less likely to contribute due to the need to spend more on health or economic dependence after retirement (Halkos and Matsiori 2012). Concerning gender, Dupont (2004) indicated that women generally state lower WTP values than men. Although age and gender are not often significant determinants of WTP (Arrow *et al.* 1993, Daly *et al.* 2015, Dupont 2004), it is useful to include these variables in WTP studies as a point of reference.

One variable that negatively influences WTP is a lack of trust in government (Chen and Hua 2015, Hong and Oh 2006, Jones *et al.* 2008, Oh and Hong 2014, Powe *et al.* 2006), which may be especially important if the CV scenario is to be implemented by government, and/or the payment vehicle is a form of tax. In a study on WTP for improved air quality in subway stations, Hong and Oh (2006) noted that a lack of trust in government negatively influenced respondents' WTP. It was found that, although approximately 90% of the respondents agreed that there was a need for improved air quality, only 40% of them were WTP towards the proposed initiative. Public goods, such as environmental goods and ecosystem services, usually fall under the responsibility of governments (Chen and Hau 2015) or

government-endorsed authorities. Mistrust in government may be the result of a history of poor administration, poor implementation or corruption (Chen and Hau 2015). In WTP studies, an increase in the mistrust shown towards a government agency is often correlated to protest bids, zero-bids or lower WTP estimates than expected (Chen and Hau 2015, Oh and Hong 2012).

A protest bid, or a protest response, is defined as a scenario(s) in which participants reject some aspect of the valuation scenario (Szabo 2011) or fail to express preferences consistent to economic theory (Lo and Jim 2015). Protesting is characterised by respondents electing a zero WTP bid or expressing an unwillingness to pay towards the contingent market, even when they do have positive values for the good in question (Chen and Hua 2015, Mitchell and Carson 1989, Szabo 2011). Genuine zero bids, however, are not considered protest bids, as they can be linked to the inability to pay towards the hypothetical scenario, or a lack of any positive value associated with the good or service, rather than protesting against the scenario (Bernath and Roschewitz 2008). Genuine zero bids can be discovered through debriefing questions to determine the underlying reasons for the zero WTP bid (Bernath and Roschewitz 2008).

Large proportions of protest bids in CV surveys may threaten the validity and reliability of the valuation estimates provided by the respondents (Jorgensen *et al.* 1999). In biodiversity valuation studies, average protest bid responses were recorded to be in the region of 21%, as noted in a meta-analysis by Meyerhoff and Liebe (2010). Reasons explaining protest behaviour include variables such as a lack of information pertaining to the study, personal interests, ethical and moral beliefs and institutional distrust (Jorgensen *et al.* 1999, Spash 2006, Szabo 2011). Protest bias may occur in CV studies when respondents may oppose or disapprove of the survey and therefore fail to place a bid, respond with an invalid but positive bid, or respond with a zero bid (Halstead *et al.* 1992).

2.4.3. Limitations of the CV method

Although the CV method is the only method that can measure all of the values in the TEV framework (Bunse *et al.* 2015), as well as being considered the most commonly used valuation technique, debate persists on the validity and reliability of the method (Arrow *et al.* 1993, Atkinson *et al.* 2012, Carson *et al.* 2001, Chee 2004). The method is often regarded with reservation since it is not based on market behaviour (Chee 2004).

The NOAA Panel Report addressed three pertinent limitations of the CV method (Arrow *et al.* 1993). First, the panel noted that the WTP estimates are often overstated and unreasonably large. An obvious overstatement or understatement of a WTP value challenges the validity of CV studies (Arrow *et al.*

1993). In support of the criticism, Chee (2004) highlighted that respondents often overstate WTP values to encourage the preservation of the area, good or service under discussion.

Respondents may also be "free riders" meaning that, due to the hypothetical nature of CV markets, respondents understand that they will not have to pay the value they state in the WTP study (Snowball 2007). Therefore, respondents may overstate WTP in the hope that they will benefit from the public good provided without having to pay fully for it (Snowball 2007). Furthermore, respondents may not have considered their budget constraints, and may therefore not be making a sensible or realistic market decision based on the WTP value they elected (Snowball 2007).

In contrast to the limitation the NOAA panel highlighted above, respondents may understate the WTP estimate (Chee 2004). Respondents may act strategically – which is coupled with strategic bias – when asked to estimate a WTP value. Strategic bias may materialise when the participants deliberately misrepresent their preferences, elicit a biased value or provide a biased answer to influence the results of the study (Carson 2012, Tietenberg and Lewis 2020). Strategic bias is a problematic source of bias, as it is difficult to detect in CV studies (Chee 2004). Respondents may, therefore, understate WTP values to minimise the possibility of the value stated being brought into policy through a user-charge, tax or levy, which would force the respondent to pay the amount they elected (Chee 2004).

The second concern of the CV method the NOAA Panel Report addressed was the difficulty in the assurance that the respondents have comprehensively understood and assimilated the issues highlighted in the survey (Arrow *et al.* 1993). In theory, the CV method applies to a wide range of ecosystem services, notably in estimating the non-use value of ecosystem services (Atkinson *et al.* 2012). In practice, the results obtained from the CV method are reliable when the respondents have clear prior preferences for the good or service under discussion, or when the respondents are able to discover economically consistent preferences within the time frame of the survey (Atkinson *et al.* 2012). However, when this is not the case, the results obtained from the study may be unreliable or invalid.

Such issues often occur when individuals have little or poor understanding of ecosystem services (Atkinson *et al.* 2012) and, as a result, they may be constrained in their value elicitation (Pedroso and Kung'u 2019). In this regard, a challenge of the CV method is to provide sufficient information to the respondents so that they have a clear and logical understanding of the ecosystem service under discussion without being too simplistic or biasing the respondents' preferences (Carson 2012, Pedroso and Kung'u 2019), thereby influencing the validity of the results. Information bias may occur in CV studies when the participants are asked to value a good or service in which they have little to no

experience or knowledge. This may cause the participants to state a value based on false perception. Visual aids (Labao *et al.* 2008), presentations (Bartowski and Lienhoop 2018, Spash 2008) and group discussions between respondents and researchers (Kenter 2017, Lienhoop *et al.* 2015) – a topic that is further discussed in Section 2.5 – may reduce uncertainty and unfamiliarity of the good or service under discussion (Tietenberg and Lewis 2020).

The third difficulty the NOAA Panel Report listed was the assurance that the respondents' elected WTP values are based on the issues highlighted in the survey, rather than expressing values of public-spiritedness, or the "warm glow" of giving (Arrow *et al.* 1993). Chilton and Hutchinson (2000) made a note of the fact that respondents often treat the WTP value they elect to that of a charitable donation, where a "moral satisfaction" or a "warm glow" feeling is achieved. If a "warm glow" response is recorded, the WTP response should not be considered as a reliable WTP estimate (Chilton and Hutchinson 2000).

Furthermore, the limited time frame allocated to CV surveys may influence the respondents' reflection and engagement of the topic under discussion, which in turn may affect the WTP estimate they elect (Bunse *et al.* 2015, Macmillan *et al.* 2002). A typical CV survey or interview has a time frame of between 10 – 30 minutes (Macmillan *et al.* 2002) or 15 – 20 minutes (Lo and Spash 2013). It is prejudicial to expect respondents in a CV survey or interview to research their welfare trade-offs and underlying preferences and form and state a WTP value in a limited time frame (Lo and Spash 2013, Macmillan *et al.* 2002).

Insensitivity to the scope of the study is also an issue in CV studies (National Research Council 2005). Scope insensitivity arises when the WTP for an environmental resource is not valued relative to its magnitude. For instance, if the value estimated for protecting 100 and 1 000 hectares of mangroves were statistically identical, the study would indicate a lack of sensitivity to scope (Diamond and Hausman 1994, National Research Council 2005). This is because it is expected that respondents would pay more for the larger protection programme, holding all other variables constant. Boyle *et al.* (1994) found that WTP estimates were not sensitive to whether 2 000, 20 000 or 200 000 birds were preserved from an oil spill. This ultimately reduced the validity of the values elicited, since it was expected that the larger number of prevented bird deaths should be valued higher than the prevention of the lower number of bird deaths. To address issues of scope insensitivity, a variety of scope tests can be conducted.

2.4.4. Questionnaire design and sources of bias

The CV method makes use of a survey, questionnaire or interview technique to elicit value from respondents. Typical surveys require the respondent to answer a series of questions relating to the ecosystem service (Perman *et al.* 2011) and a CV questionnaire or survey is often divided into four sections (adapted from Snowball 2007);

1) A section on use values, information about the frequency of visits and purpose of visits;
2) A section covering non-use values, information on opinions and knowledge of ecosystem service, recreational activities performed at the site and perceived benefits that the ecosystem service provides;
3) A section on the valuation of the ecosystem service which includes the WTP question itself, information on the ecosystem service, a hypothetical scenario to be valued, the payment vehicle and payment amounts. The participants are also asked debriefing questions as to why they opted for the value they were willing or unwilling to pay; and
4) A section about the socio-demographic information regarding the participants' age, gender, household income, education level, ethnicity, language and occupation.

In a CV study, the respondents are required to state a WTP value contingent on the hypothetical scenario presented. The hypothetical nature of CV studies may result in hypothetical bias (Hensher 2010). This source of bias occurs when the hypothetical scenario presented to the participants is not specific or is unrealistic (Hensher 2010, Loomis 2011). Due to the hypothetical nature of the CV method, the participants are confronted with a contrived set of choices, rather than an actual, real-life set of options. This, as well as the fact that the participants will not have to pay the value they elicit, may prompt the participants to elect ill-considered answers. This is where hypothetical bias may influence respondents WTP bids. Hypothetical bias is the difference between hypothetical and actual WTP (Mitchell and Carson 1989). The effects of hypothetical bias decrease when the participant is more familiar with the scenario and the ecosystem service under discussion (Loomis 2011).

The WTP value that respondents elect is paid towards a hypothetical vehicle, known as a payment vehicle. The payment vehicle provides context for payment in which respondents hypothetically pay for the environmental good in question (Perman *et al.* 2011) and is defined as a once-off payment or a recurring charge per month or year, such as an increase in tax, commodity price increases, admission fees or donations (Lienhoop and MacMillan 2007). The realism of a payment vehicle should be

carefully considered, as it is necessary for the validity of WTP estimates in CV studies (Campos *et al.* 2007).

Ivehammar (2009) argued that the payment vehicle proposed in a CV study should be one to which all respondents are liable, as it reduces the strategic behaviour of the respondents electing an unrealistic WTP amount. If the payment vehicle is voluntary, such as a donation (Perman *et al.* 2011), the respondents may have an incentive to exaggerate their WTP estimates and bias results (Ivehammar 2009). However, the respondents may also be averse to paying towards a payment vehicle in which they are liable, such as a tax (Dziegielewska and Mendelsohn 2005, Lienhoop and MacMillan 2007). These factors are known as payment vehicle bias, which may arise when respondents react negatively to the payment vehicle of the valuation scenario under discussion (Tietenberg and Lewis 2020), which may cause the respondents to respond with either a zero bid, or a lower bid than their actual willingness to pay (Dziegielewska and Mendelsohn 2005, Lienhoop and MacMillan 2007).

To obtain a value from respondents, value elicitation methods are used. Regularly used value elicitation methods in questionnaires and surveys include the bidding game, open-ended, dichotomous choice, and payment card techniques (Tian *et al.* 2011). The bidding game method involves the interviewer asking the participant a sequence of questions with an associated bid value. The participants are required to state whether they would be WTP a certain amount. Based on their response, the amount is bid up or down to determine the maximum WTP of each respondent. (Perman *et al.* 2011).

The open-ended question method leaves the WTP value open to the participants, merely asking them statements such as “What is your maximum WTP for this ecosystem service?” (Perman *et al.* 2011). The open-ended method is useful in WTP elicitation projects as it does not provide an indication or cue on the worth of the ecosystem services, but instead allows the participants to value the ecosystem services on their own accord (Perman *et al.* 2011). It also eliminates starting point bias. Starting-point bias may arise in survey instruments in which a participant is influenced by the predefined range of WTP possibilities presented to them, or when the good or service under discussion is poorly defined or not distinctly perceived by the respondents (Bhatia 2005). The range of the WTP possibilities may affect the answers elicited by the participants. For example, a range of ZAR0 – ZAR100[3] may produce different valuation results than a range of R10 – R100, even if there are no responses in the R0 – R10 range in the first case.

[3] ZAR - South African Rand, hereafter abbreviated to R.

A study by Bhatia (2005) on the WTP for mosquito nets in India identified a clear presence of starting point bias. The study found that respondents who were offered a lower WTP bid (Rs50[4]) were willing to pay Rs51 for a mosquito net compared to the respondents who were offered a higher WTP bid (Rs100) were willing to pay Rs65 (Bhatia 2005). The study identified that respondents who were exposed to higher starting bids quoted higher willingness to pay values compared to respondents who were presented with lower starting bids. However, a notable limitation of the open-ended method is that it is often challenging for participants to provide a WTP estimate for the ecosystem services under discussion, especially if they are not familiar with the "good" being "sold" (Arrow *et al.* 1993). Therefore, it is unlikely that the respondent will provide a reliable valuation (Arrow *et al.* 1993).

The dichotomous choice method asks participants whether they are willing to pay an amount presented to them for the conservation, utilisation, maintenance or restoration towards an environmental good or an ecosystem service (Snowball 2007). The participants are requested to answer either 'yes' or 'no' to the value presented, based on their budget constraints and attitudes toward the ecosystem services under discussion. The dichotomous choice method can be further divided into the single-bounded dichotomous choice and the double-bounded dichotomous choice (Tian *et al.* 2011). The single-bounded dichotomous choice method asks the participants a 'take-it-or-leave-it' question, where the participants are required to simply answer 'yes' or 'no' (Tian *et al.* 2011). The double-bounded dichotomous choice method asks the participants a 'take-it-or-leave-it' question, but with a follow-up question based on the answer the participants provided. A limitation to the dichotomous choice method is starting-point bias; that the final WTP amounts elicited by the participants are dependent on the starting, or initial amount presented to them (Snowball 2007). Despite the starting-point bias limitation, the dichotomous choice method is the most used method to derive a WTP value from participants (Perman *et al.* 2011, Tian *et al.* 2011).

The payment card (PC) method offers a method of increased efficiency over the dichotomous choice method (Kerr 2000). A payment card presents participants with a card with a range of different monetary values (Kanya *et al.* 2019, Perman *et al.* 2011). The participants are requested to place a tick next to the value that they would be willing to pay and a cross against the values they would be unwilling to pay (Kanya *et al.* 2019, Perman *et al.* 2011). The payment card has the benefit of revealing the whole choice of values to the participant, which may be an essential determinant of bid accuracy (Snowball 2007) as it avoids starting point bias that is present in the bidding game method (Yang *et al.* 2012). In addition, the PC method has proven to provide conservative estimates of WTP estimates

[4] Rs - Indian Rupee.

elicited by respondents in CV studies compared to the bidding game and open-ended formats (Thur 2010). The PC method has also been noted to reduce non-response rates and lower instances of protest bids (Thur 2010), as discussed in Section 2.4.2.

2.4.5. Data collection

Most CV studies are conducted via face-to-face interviews and surveys, as recommended by the NOAA Panel Report (Arrow *et al.* 1993). However, when this format is unavailable, researchers are compelled to implement different formats of CV surveys, one of which is an online survey (Canavari *et al.* 2005, Nielsen 2011, Windle and Rolfe 2011).

The Internet has become an increasingly popular data collection method for the contingent valuation method in environmental economics (Lindhjem and Narvud 2011). Online surveys have varied benefits, such as the fact that they can be administered rapidly at low cost and can reach a large audience. They also allow for graphic supplements and ensure the privacy of responses provided by the respondents (Nielsen 2011). In terms of the WTP valuation estimate provided by the respondents, Nielsen (2011) and Windle and Rolfe (2011) both found that there was no statistically significant difference between WTP values provided by either method. This means, holding other variables constant, that the WTP values provided in Internet CV surveys should not be different to WTP values provided in face-to-face surveys.

While online CV surveys have varied benefits, there are criticisms associated with this format (Wilde and Rolfe 2011), one of which is the issue of coverage and sample error, where the intended or representative sample is not reached since not all participants have access to the Internet (Canavari *et al.* 2005, Nielsen 2011). A lack of Internet coverage from the intended sample can reduce the response rate of the study. This was found in Canavari *et al.* (2005), where a lack of Internet access in the sample country had a response rate of only 6% compared to Nielsen (2011), where their response rate was about 40% in a country with higher access to the Internet.

Regarding socio-demographic factors, Nielsen (2011) and Lindhjem and Narvud (2011) both noted differences in socio-demographic characteristics between the two sample methods. Nielsen (2011) found that respondents who participated in the Internet CV survey had, on average, more years of education than the respondents who participated in the face-to-face CV survey. In this regard, the population with a lower level of education was likely to be underrepresented in the sample (Nielsen 2011).

Regarding respondent income, Marta-Pedroso *et al.* (2007) found that respondents who participated in the Internet study had a higher average income compared to those in the face-to-face method.

Despite the differences in education and income, other socio-demographic characteristics such as age and gender, however, did not vary significantly throughout the sample methods (Lindhjem and Narvud 2011, Nielsen 2011).

Given these factors, using the Internet in CV surveys is not significantly different or less reliable than using face-to-face interviews as a CV method (Lindhjem and Narvud 2011). However, coverage and representativeness concerns about Internet use in CV studies should be carefully considered.

2.5. Deliberative methods in environmental decision-making

Where the CV method may be a suitable method for valuing high experience, use-value goods, the further one moves to goods that are poorly understood and that have indirect or non-use values, the more likely it is that problems may be encountered (Atkinson *et al.* 2012). The implementation of deliberation has been suggested as a solution to the problem of valuing low experience goods and services (Christie *et al.* 2012). Deliberative valuation approaches integrate discussion and careful thought with participants before participants elect a WTP value (Bartkowski and Lienhoop 2018). Deliberation encourages conversation and debate between participants, whereby the understanding of the ecosystem services under consideration is enhanced (Bartkowski and Lienhoop 2018). Deliberative processes allow for an interplay between different stakeholders regarding their thoughts and opinions about the matter under discussion (Kenter *et al.* 2016, Szabo 2011), as well as allowing an interplay between different dimensions of value and equity (Mowat 2019). Engaging in a group discussion is a useful tool to make participants more aware of, and familiar with, the ecosystem service they have been asked to value (Kenter *et al.* 2015), which, theoretically, improves value validity (Vargas and Diaz 2017).

A deliberative study conducted by Kenter *et al.* (2016) in the United Kingdom for a proposed marine protected area campaign found that even the participants who were more familiar with marine habitats than the general public – namely scuba divers and sea anglers – lacked clearly-defined preferences when it came to determining a value for the cultural ecosystem services obtained through marine protected areas. However, these participants were able to develop preferences through group discussion and deliberation (Kenter *et al.* 2016). The general public also increased its understanding of marine protected areas through deliberation (Kenter *et al.* 2016).

The use of deliberative valuation methods allows for more comprehensive valuations of ecosystem services, as indirect use and non-use ecosystem services are often challenging to articulate and value (Kenter 2017). Deliberative processes provide participants with information about the topic at hand and offer a space in which to learn and share thoughts concerning the good or service under

consideration (Mowat 2019). The next section discusses a deliberative valuation method used to assign value to the ecosystem goods and services.

2.5.1. Deliberative monetary valuation

The deliberative monetary valuation (DMV) method has been recommended by various scholars and researchers as an improved method to value non-use ecosystem goods and services (Bunse *et al.* 2015, Kenter *et al.* 2016, Spash 2008, Szabo 2011). Spash (2007:691) defined the DMV method as:

- "[The] use of formal deliberation concerning an environmental impact to express value in monetary terms for policy purposes".

DMV is an economic valuation method that incorporates participation, reflection, discussion and social learning from a diverse range of respondents who benefit from, or utilise, environmental goods and services, into a monetary value (Kenter *et al.* 2016). The method combines stated preference methods with deliberative techniques (Szabo 2011), where respondents explore values and preferences of environmental change through a process of deliberation (Kenter 2017). It was developed as a response to the limitations of the individual WTP contingent valuation method (Arrow *et al.* 1993, Carson *et al.* 2001, Chee 2004), as well as to provide an estimate of value for public ecosystem goods and services that do not have a market price (Szabo 2011).

DMV combines economic, social and political processes to value the benefits derived from ecosystem services through an adaptation of the stated preference method to improve value reliability and validation (Bunse *et al.* 2015, Kenter 2017, Lo and Spash 2013). The distinct characteristic differentiating DMV and other conventional environmental valuation methods, such as the standard, individual WTP method, is the incorporation of deliberative elements, such as permitting participant interaction, allowing time for discussion and providing detailed information to participants (Bunse *et al.* 2015). The first empirical environmental valuation study that used a deliberative element was one conducted by Macmillan *et al.* (2002) where the proposed deliberative element was a market stall approach. The market stall approach provides participants with adequate time and sufficient information for them to effectively determine a WTP value, a setting in which in-depth discussions can take place, and an opportunity for the participants to ask questions before they state a WTP amount for the environmental resource under discussion (Macmillan *et al.* 2002). This approach involved a deliberative meeting attended by participants (Bunse *et al.* 2016, Macmillan *et al.* 2002) and included:

1) A presentation covering relevant background information for the proposed project;
2) An explanation of the valuation scenario and the proposed payment vehicle; and

3) An allocated time allowance for the participants to interact with each other through discussion, and sufficient time for participants to engage with the topic under discussion.

The incorporation of these deliberative elements is what makes the DMV method distinct from conventional environmental valuation methods (Bunse *et al.* 2016).

The DMV method has been tested by various scholars to derive a value for ecosystem services (Ito *et al.* 2009, Orchard-Webb *et al.* 2016, Szabo 2011, Vargas and Diaz 2016). Through these, empirical evidence supports the use of DMV over conventional WTP methods to derive a value for the benefits that ecosystem goods and services provide to society. Szabo (2011) explored the validity of environmental valuation methods by comparing the DMV method to the WTP method in a study carried out in Hungary on valuing the impact of agricultural activities on biodiversity. They found that the DMV method, through a deliberative forum technique, significantly reduced the ratio of protest responses compared to WTP studies, from a protest bid response of 29% in the WTP survey to 13% in the DMV survey (Szabo 2011). Lienhoop and MacMillan (2007), in a study conducted in Iceland on the costs and benefits of a proposed hydro scheme development in a wilderness area, concluded with similar results to Szabo (2011) in terms of a reduced protest response by participants partaking in a deliberative forum opposed to a standard WTP interview. They found that the protest response rate was 3.8% in the deliberative forum approach compared to 16.1% in the WTP interview approach (Szabo 2011). These findings highlighted that DMV studies improve the validity and reliability of environmental valuation methods as compared to conventional valuation methods such as the WTP method.

The DMV method addresses several of the limitations and sources of bias that are associated with the individual contingent valuation method which, in theory, will assist respondents in producing more valid WTP estimates (Lienhoop and MacMillan 2007). A limitation of the contingent valuation method, as noted in Section 2.4.3, is that respondents involved in environmental valuation assessments often do not have extensive knowledge of the ecosystem services under discussion. Therefore, respondents may produce unreliable or invalid WTP estimates (Arrow *et al.* 1993, Kenter 2017, Pedroso and Kung'u 2019). The DMV method is noted to address this limitation, as it is used to increase the respondents' understanding of the ecosystem services under discussion through the incorporation of debate, discussion, participation and social learning (Bunse *et al.* 2015, Lo and Spash 2013, Orchard-Webb *et al.* 2016).

Kenter *et al.* (2016) presented a mixed-method case study to assess the value of cultural service benefits that are associated with marine protected areas in the United Kingdom. The data for the case

study was collected through two phases. The first phase was an online survey with 1683 participants using a combination of the stated preference method through the contingent valuation technique to establish individual perceptions of value. The second phase was completed through 11 DMV workshops with 130 participants using an adapted CV technique to establish both individual and group values. A total of 95 participants participated in both phases. The results showed that the average WTP value decreased from the online survey (£8.86[5]) to the deliberative workshops (£7.28).

Although the WTP value decreased because of a deliberative workshop, the respondents who participated in both the online survey and the workshops felt substantially more confident that the values elicited in the workshops were a truer representation of value (Kenter *et al.* 2016). When asked about which values should be used for decision making (online survey versus workshop), the participants stated that the workshop data should be used instead of the online survey data. This result highlighted the fact that deliberated valuation methods, such as deliberative workshops through the DMV method, assisted the participants to formulate sound and confident preferences, compared to non-deliberative valuation methods.

While the CV method, using interviews and surveys, allows for quantitative analysis of results, such as participants' attitudes and WTP preferences (Philip and MacMillan 2005), it does not generate qualitative information regarding the context, perceptions and uncertainties that are inherent in valuation exercises (Kenter *et al.* 2014). These factors influence decisions made by the participants. Qualitative information that is collected from deliberative valuation studies usually offers a more detailed explanation of WTP decisions (Kenter *et al.* 2014). This could be accomplished through an examination of the questions the participants asked each other and the researchers, or an interpretation as to why the participants decided on a WTP value decision (Philip and MacMillan 2005).

Philip and MacMillan (2005) used an adapted deliberative contingent valuation technique to assess the perceptions of the public for the control of wild animals in Scotland. The deliberative approach allowed the authors to assess quantitative perceptions of the participants through a contingent valuation assessment, as well as the qualitative perceptions through participatory and deliberative methods. They concluded that the deliberative emphasis on their study allowed them to "canvass and explore the views of ordinary members of the public in a reasoned and rational way" (Philip and MacMillan 2005:272). Since the DMV method can incorporate both quantitative and qualitative

[5] £ - Pound Sterling.

assessments, the qualitative information obtained can be used to supplement the quantitative assessment of a study (Philip and MacMillan 2005). A thematic analysis can be used to analyse qualitative data, exhibited by Kenter *et al.* (2014) where they were able to thematically summarise subjective well-being data, which allowed for an in-depth analysis of ecosystem service values.

2.5.2. DMV in a developing country context

Although empirical DMV studies do occur in literature, most of these studies are from a developed country context. For instance, in this text, DMV studies from Hungary, the United Kingdom and Scotland have been outlined, all of which are developed countries. However, few empirical studies exist for the use of the DMV method in a developing country, or South African, context (Christie *et al.* 2012).

Several aspects make conventional economic valuation techniques problematic when attempting to value an environmental good or ecosystem service in a developing country context (Leinhoop *et al.* 2015). The valuation of the benefits of ecosystem services, using conventional economic valuation techniques such as the stated preference method, in developing countries is often challenging, where several issues may arise (Lienhoop *et al.* 2015). These include literacy and language barriers, subsistence economies, a lack of familiarity of money as an indicator of value, and a lack of education and scientific knowledge (Christie *et al.* 2012). In addition, communities in developing countries often have a limited income and have a high dependence on the environment and ecosystem services (such as the collection of firewood for fuel or subsistence fishing for food). For instance, Dikang and Muchapondwa (2012) highlighted that rural communities in South Africa have a high dependency on natural resources for their livelihoods.

Building on the abovementioned issues when applying an environmental valuation study in a developing country context, Kenter *et al.* (2011) suggested that, in countries with low incomes where people rely on biodiversity, the values expressed in stated preference studies may not truly reflect the value of an environmental good or ecosystem service to their well-being. This limitation could be due to two reasons (Kenter *et al.* 2011):

1) Firstly, the household monetary income of the participants could be much less relative to what they believe is the actual value of an environmental good or ecosystem service to their well-being. This means that, if the participants were to fully consider their budget constraints when eliciting a WTP value for the good or service, the full value of the good or service will not be reflected.

2) Secondly, due to literacy and language barriers, the participants may not consider their budget constraints and may therefore elicit a value that is not a true reflection contingent to their monthly or annual income.

The use of deliberation in environmental valuation studies are a crucial aspect to consider when attempting to value an ecosystem service in countries with developing economies, as deliberative methods may overcome these issues (Christie *et al.* 2012, Lienhoop *et al.* 2015).

Mowat and Rhodes (2020) explored the advantages of incorporating deliberative techniques in environmental valuation studies in a South African context. They established that conventional environmental valuation techniques used to value complex and hard to define environmental resources, such as ecosystem services, are often ill-suited for a developing country, and in particular, a South African context (Mowat and Rhodes 2020). This is due to the multicultural and multi-ethnical attributes that South African society harbours, where its citizens hold a myriad of different beliefs, opinions and perceptions of value (Mowat and Rhodes 2020). Deliberation has the ability to address these inherent complexities within society. Moreover, deliberative approaches allow for a greater inclusion of traditional knowledge and local experience, thereby incorporating a multitude of values in the valuation process (Mowat and Rhodes 2020). Although the Mowat and Rhodes (2020) study was a theoretical study and not an empirical one, it does offer interesting insight into the advantages of using deliberation as a means of value elicitation in a South African context. Added to this, at the time of the publication of this dissertation, there were no known deliberative environmental valuation studies conducted in a South African context, supported by Christie *et al.* (2012).

In an empirical study, Kenter *et al.* (2011) conducted a deliberative study to determine the value people place on ecosystem service benefits in the Solomon Islands. The Solomon Islands are of high biodiversity importance, and the indigenous people rely heavily on biodiversity and ecosystem services the environment provides to sustain their subsistence livelihoods. However, due to logging and mining impacts, the ecosystem services they depend on for survival are in decline. Although Kenter *et al.* (2011) did not directly use the DMV method in this study, they implemented a group-based participatory approach that applied a deliberative workshop with 46 focus groups and 447 participants overall. The deliberative workshop results highlighted that participants were willing to pay, on average, US$73 per annum – approximately 30% of a household's mean annual income – for the improvement in environmental goods and ecosystem services upon which they are dependent (Kenter *et al.* 2011). This showed that the people who participated in the study attributed a large proportion of their annual income for the improvement of ecosystem services, which suggested that they placed a high dependence on the environment. The deliberative focus groups also helped to

overcome several practical challenges associated with environmental valuation exercises in a developing country context, such as illiteracy and language barriers (Kenter *et al.* 2011).

2.5.3. Application of the DMV method

There are two subcategories of DMV; (1) *deliberated preferences* (DP) and (2) *deliberative democratic monetary valuation* (DDMV) (Kenter 2017, Orchard-Webb *et al.* 2016) (Table 2.1). Both subcategories use a deliberative process to provide the participants with knowledge and understanding about the ecosystem service under discussion. The DP approach is designed as an adaptation of the stated preferences method technique (contingent valuation), where the WTP estimates are recorded as aggregated individual WTP values (Kenter *et al.* 2016, Kenter 2017, Orchard-Webb *et al.* 2016). As with conventional stated preference studies, the DP approach assumes that the willingness to pay value elicited by the respondent reflects individual, self-regarding and utilitarian preferences (Orchard-Webb *et al.* 2016). Although the WTP estimates are based on individual values, the DP approach incorporates group deliberation intending to develop robust preferences from the respondents (Orchard-Webb *et al.* 2016). It achieves deliberation through group discussions, focus groups, presentations and respondent participation. Since DMV was developed as an adaptation to the stated preference method, the value obtained or estimated from a DMV study is still a *stated* value, not an *inferred* value.

The DDMV approach considers the valuation of an ecosystem service through a deliberative approach, where participants express a *combined* and *aggregated* value of the ecosystem service under discussion (Orchard-Webb *et al.* 2016). The DDMV approach uses a process of deliberation to establish value for an ecosystem service, where the value elicited from the respondents is a *shared* and *plural* group value for the ecosystem service under discussion (Orchard-Webb *et al.* 2016). It considers the ecosystem service as a public good, whereby all the respondents derive benefit from the ecosystem service. This process differs from the DP approach, which elicits aggregated *individual* values from respondents. Unlike the DP approach, DDMV uses an open-ended valuation format to extract value from the respondents (Orchard-Webb *et al.* 2016). This is because the value assigned to the ecosystem service is a value decided upon by the respondents. Therefore, the use of payment card (PC), bidding game or the dichotomous choice method are not used for the DDMV approach.

There are also several different deliberative components that are used to stimulate information sharing through discussion and debate. A deliberative component is the process in which information about the good or service under discussion is provided to the participants, as well as allowing for a forum for debate and discussion (Bunse et al. 2016). A deliberative component can be a focus group,

structured group discussions, market stall approach, focus groups or a workshop, and they are used to stimulate debate between participants and researchers (Kenter et al. 2016). Each deliberative component is unique to the context in which the study is situated.

Table 2.1: A comparison of approaches used in DMV studies

Identified points of the DMV approach	**DMV valuation tool**	
	DDMV	**DP**
Value elicited	Shared and plural value. Elicited value is a group value.	Aggregated individual value.
Conception of deliberation	Deliberation to inform group value. It considers the ecosystem service as a public good.	Group discussion to inform individual preferences of ecosystem goods and services.
Valuation model required	Open-ended. Value elicited is a group value.	Contingent valuation (CV) method survey.

Source: Adapted from Kenter (2017).

Notes: DDMV – deliberative democratic monetary valuation; DP – deliberated preferences.

Group sizes on average range between 52-109 participants, with a median of 64 participants. The participants are separated into groups, where the group size typically ranges from 10-25 participants (Álvarez-Farizo *et al.* 2009) or 6-20 participants (Bunse *et al.* 2016). The total number of groups is dependent on the total number of participants involved in the study, and the total number of participants in a DMV study varies from study to study.

The length of deliberative meetings generally varies between 1-2 hours (Bunse *et al.* 2016) in which time is granted to the participants to discuss the information with one another. After discussions between the participants, they elicit a WTP or a WTA value, based on the scenario the study presented.

2.5.4. Limitations of the DMV method

As discussed in the previous section, the DMV method aims to create a participatory space for inclusive deliberation. However, there is evidence that the use of small groups in deliberation settings can lead to limitations of the values elicited by participants. These include:

1) Power imbalances where certain individuals either disrupt meeting proceedings, or that participants do not contribute to meeting procedures. This is termed "silent voices" (Spash 2007);

2) A lack of statistical representativeness (Leinhoop *et al.* 2015, Söderholm 2001);

3) The fact that deliberation does not guarantee wise or viable decisions or values given by the participants (Söderholm 2001); and

4) Agreement-seeking valuation methods can influence participant responses (Vargas *et al.* 2016).

Firstly, silent voices may occur in meetings where a single individual, or several individuals, in a group meeting who do not voice their thoughts and opinions may be left unheard (Söderholm 2001, Spash 2007). Spash (2007) termed these individuals as "silent voices". Ranger *et al.* (2016) conducted interviews in their paper where one participant suggested that individuals who have more prominent voices tend to have their voices heard in meetings. Conversely, individuals who are not as dominant tend to be quieter, even if they have valid or noteworthy points to raise. Dominant participants may potentially cause problems in deliberative settings by expressing biased attitudes of WTP values. The use of a skilled and experienced facilitator to coordinate group meetings can mitigate this limitation of DMV studies (Lienhoop and MacMillan 2007). Spash (2007) and Lienhoop and MacMillan (2007) identified that the use of a facilitator is essential to control dominant participants.

Secondly, a lack of statistical representativeness may limit the validity of DMV studies. Leinhoop (2015) and Söderholm (2001) made mention of the fact that the small group size used in DMV studies may not statistically represent the whole population in which the research was conducted. Statistical representativeness is a prerequisite when conducting DMV studies, where the study aims to elect and aggregate individual values, in this case, WTP values (Leinhoop *et al.* 2015). Therefore, a representative sample of participants should be selected to participate in the DMV study.

Thirdly, deliberation conducted in a DMV study does not guarantee that the value elicited by participants will be reliable, usable or viable (Söderholm 2001). The participants may be acting in their self-interest and may elect a WTP value that is not a reliable value, which influences the validity of the value chosen.

Fourthly, group decisions can influence individual perceptions of value (Vargas *et al.* 2016). Although the group valuation approach, termed the DDMV approach (Kenter 2017) has been used by several researchers (Kenter *et al.* 2016, Orchard-Webb *et al.* 2016), Vargas *et al.* (2016) advocated against the use of agreement-seeking valuation methods, for instance, the DDMV approach through conformity. In a deliberative setting, conformity may influence participants to change their expressed attitudes towards a view that is accepted by other participants, even though the participants may not consider the changed attitude acceptable or legitimate. Vargas *et al.* (2016) argued that people change their views in a deliberative setting in an attempt to gain the social approval of others, and therefore, to

affiliate with them. This, therefore, may influence the values elicited in a DMV group setting, as participants may not really be willing to pay the group value, but nevertheless agree with the group value to affiliate with the other participants in the study.

It is with the knowledge of these limitations that a deliberative valuation study should be designed in a way that minimises the effects of the abovementioned shortcomings.

2.6. Objections to valuing ecosystem services

While there have been attempts to estimate the total economic value of ecosystem goods and services over different scales (local, regional, global), there have been criticisms of this approach in economic theory (Badura *et al.* 2016). The concept of ecosystem services, and the valuation thereof, has attracted debate and criticism in literature. Criticism includes:

1) The promotion of exploitative human-nature relationships;
2) The commodification of nature (Lele *et al.* 2013, Schroter *et al.* 2014); and
3) The focus on only instrumental value to humans (Daly 2020).

The purpose of ecosystem services valuation was initially developed to raise public awareness for biodiversity conservation, but the emphasis on this has gradually been eroded (Gomez-Baggethun *et al.* 2010).

An added criticism in valuing ecosystem services is that conventional approaches to estimating economic value involve aggregating the value across all individuals, regardless of the difference in their wealth (Lele *et al.* 2013). In this regard, one Dollar or Rand may be more valuable to one individual than another, depending on their wealth. Added to this, the value an individual derives from an ecosystem service is qualitatively different compared to the value of a market-based commodity (Lele *et al.* 2013). This is because ecosystem services have characteristics of open-access resources, meaning that anyone can benefit from the goods and services provided (Lele *et al.* 2013).

Ecologists have conducted much of the work in valuing ecosystem services, whereby part of the valuation has been inconsistent with fundamental economic principles (Polasky and Sergeson 2009). A notable example can be found in the paper by Constanza *et al.* (1997) which drew attention to the value of ecosystem services but was inconsistent with economic principles. Costanza *et al.* (1997) used WTP values at a local scale to estimate a value for different habitats, on the premise that the habitat under discussion would remain the same in other places around the world. However, scaling up WTP values from a local-scale to a regional or global-scale violates this condition (Polasky and Sergeson 2009). Added to this, if recorded and measured correctly, *willingness* to pay values cannot exceed the

ability to pay estimates of GNP or income. This example highlights the inconsistencies of ecosystem service valuation if economic principles are not followed.

2.7. Synopsis

This chapter reviewed literature pertaining to the theory of environmental valuation and the advantages and disadvantages of non-market valuation methods with a specific focus on WTP and the DMV method. The review of literature assisted in the identification of empirical and theoretical literature that related to the design, application and potential limitations of the environmental valuation methods to be used in the context of this study.

The chapter highlighted that the contingent valuation (CV) WTP method was the most suited method to be used for the valuation of ecosystem services with public good characteristics. The limitations, questionnaire design and forms of data collection associated with the CV method were reviewed, which assisted in the construction of an online CV method suited for the context of this study. In highlighting literature pertaining to the issues of valuing low-experience environmental resources, as well as the limitations associated with the CV method, deliberation as a valuation approach was reviewed and introduced as a method to overcome these associated problems. The application and limitations of the deliberative monetary valuation (DMV) method were reviewed.

The following chapter introduces the environmental resource to be evaluated in this study. Details concerning the site description are also provided.

CHAPTER 3:

RESEARCH CONTEXT

3.1. Introduction

This chapter seeks to examine the context in which this study is situated. The environmental good to be studied in this dissertation is seagrass ecosystems – an ecosystem that is particularly important to human well-being (Orth *et al.* 2006). Seagrass ecosystems provide a range of direct and indirect ecosystem services that benefit human well-being (Costanza *et al.* 2014). The chapter begins by further expanding on the importance of seagrass ecosystems for human well-being, as well as the threats they face on a global scale. The seagrass to be studied in this dissertation, seagrass *Zostera capensis*, is introduced.

The following section discusses the study site in which this research was conducted. The study site – Knysna, South Africa, occupies a stronghold of seagrass *Zostera capensis* (Adams 2016, Claassens *et al*. 2020). A discussion on the abundance and distribution of *Zostera capensis* in South Africa is included and the study site, as well as the inherent threats it faces at a study site-specific scale is included to provide further context in which the study took place. To provide further detail to the study site, the chapter discusses the socio-demographic profile and geographical characteristics of Knysna.

3.2. Seagrass ecosystems

One ecosystem where DMV could prove to be a useful valuation tool is the seagrass ecosystem. Seagrass is a unique marine flowering plant that has adapted to exist fully submerged in the sea (Orth *et al*. 2006) and it has successfully colonised all seas of the earth except for the Polar Regions, occupying hundreds of thousands of square kilometres (Dewsbury *et al*. 2016). In comparison to other significant coastal marine habitats, such as coral reefs and mangrove ecosystems, seagrass exhibits a much more extensive geographical range (Orth *et al.* 2006).

Seagrass ecosystems provide a variety of direct and indirect ecosystem services (Costanza *et al*. 2014). Indirect ecosystem services of seagrass include reducing the effects of erosion near coastal settlements, trapping nutrients and organic material, creating a nursery habitat for juvenile commercial fish species and reducing sedimentation (Adams 2016, Dewsbury *et al.* 2016, Orth *et al*. 2006). Seagrass habitats also have a high carbon sequestration rate (Dewsbury *et al.* 2016). In terms of direct use ecosystem services, seagrass has been used as thatch for housing, fodder for livestock (Orth *et al*. 2006), fuel and fertiliser (Bostrom *et al.* 2014). According to Bostrom *et al.* (2014), the

direct uses of seagrass have reduced since the 1960s, when in Germany, the last seagrass harvester was retired in 1960.

Seagrass does not only provide society with several ecosystem services; it is also vital for surrounding natural ecosystems. Seagrass is a food source for many aquatic animals, including fishes and megaherbivores, such as manatees and sea turtles (Adams 2016, Orth *et al.* 2006). Since seagrass meadows exhibit a wide geographical range, they exist near other crucial marine habitats. The proximity of seagrass beds to these crucial marine habitats, such as coral reefs, salt marshes and mangroves, allows for trophic transfers between these ecosystems that benefit numerous forms of biodiversity (Orth *et al.* 2006). Seagrass habitats also act as biological indicators of marine health (Orth *et al.* 2006).

3.2.1. Economic value for seagrass

There have been several economic valuation studies conducted on seagrass ecosystems. Most of the attention of seagrass valuation has been associated with its contribution to the production of marketable output, such as the commercial value of fisheries (McArthur and Boland 2006, Tuya *et al.* 2014, Unsworth *et al.* 2010). Cullen-Unsworth *et al.* (2014) argue that the economic value for seagrass is mainly because of the fisheries that they support. Therefore, studies attempting to value seagrass ecosystems have often used the amount of fish caught in seagrass meadows to establish value. For instance, Tuya *et al.* (2014) used a market price method by estimating the value of fish biomass caught in seagrass to be €866[6]/ha/year (per hectare per year) on the oceanic island Gran Canaria, bordering Spain.

Several valuation studies have been undertaken to value the non-market goods and services of seagrass ecosystems. Campagne *et al.* (2015) used an aggregation method, including methods such as the damage cost method, production function and market prices, to estimate the value of the ecosystem services of seagrass *Posidonia oceanica* in the Mediterranean Sea. Their results found that the economic value of seagrass ecosystem services ranges between €284 – €514/ha/year. Significantly valuable ecosystem services were gained from the protection from coastal erosion, valued at €188/ha/year, and waste-water treatment, valued at €60/ha/year (Campagne *et al.* 2015).

Although there have been several economic valuation studies conducted on seagrass ecosystems, Borger and Piwowarczyk (2016) identified a lack of studies that use the stated preference method to estimate the value of seagrass ecosystems. To their knowledge, no stated preference studies have been conducted in determining the value for seagrass ecosystems (Borger and Piwowarczyk 2016).

[6] € - Euro.

Moreover, there is a lack of seagrass valuation studies that have been conducted in an African and in particular, a South African context. Himes-Cornell *et al.* (2018) conducted a systematic literature review study on the valuation of salt marshes, seagrass beds and mangrove forests. Of the 32-valuation studies Himes-Cornell *et al.* (2018) identified that were conducted on seagrass ecosystems, only 3% (N=1) of them were conducted in Africa, and none were conducted in a South African context. Most of the studies were conducted in Europe (28%) and Asia (25%) (Himes-Cornell *et al.* 2018).

3.2.2. Seagrass threats

As important as seagrass meadows are to providing ecosystem services to coastal communities, seagrass meadows are under threat on a global scale (Adams 2016, Dewsbury *et al.* 2016, Orth *et al*. 2006). Approximately a quarter of the world's seagrass meadows are endangered or vulnerable due to the decline and destruction of their habitats. The destruction and decline of seagrass meadows are often attributed to anthropogenic influences, although there is evidence of environmental and climatic changes influencing the losses of seagrass meadows (Orth *et al*. 2006). Environmental threats include that of global climate change, where there is evidence of increased sea temperature, rising sea levels and the increased frequency of storms and swells. This has a regional and local effect on water quality, ultimately affecting seagrass meadows due to increased sediment load, contaminants and nutrients (Orth *et al.* 2006).

Anthropogenic threats such as boating, trampling, eutrophication (Mvungi and Pillay 2019), marine construction (Dewsbury *et al*. 2016), development and infrastructure (Campagne *et al.* 2015), overfishing and bait collecting can scar and cause a decline of the seagrass meadows (Adams 2016). Boating and heavy dredging from marine construction can cause damage to seagrass by the boat propellers, bank erosion and scouring from marine vessels (Dewsbury *et al*. 2016). Trampling and bait collecting can alter the ecosystem makeup of seagrass meadows. Overfishing has a cascading effect on seagrass ecosystems, where the removal of larger fish species increases the consumer population of smaller fish species (Dewsbury *et al.* 2016). Smaller fish species feed on epibenthic fauna (Dewsbury *et al.* 2016) which in turn feed on epiphytic algae that exist on the blades of the seagrass. A decrease in epibenthic fauna may increase the abundance of epiphytic algae, which may reduce the amount of light required that reaches the seagrass for photosynthesis (Dewsbury *et al.* 2016). Development and infrastructure do not only cause physical scars on seagrass meadows, but the increased population occupying a coastal area due to development can increase the rate of eutrophication (Campagne *et al.* 2015), which in turn increases algae growth that smothers the seagrass (Adams 2016, Mvungi and Pillay 2019).

A decrease in seagrass meadows' habitat reduces the ecosystem services that seagrass meadows provide to coastal societies (Dewsbury *et al.* 2016). Societal livelihoods, human well-being and the sustainability of coastal societies bear the consequences of a decline of seagrass meadow abundance and distribution across South Africa (Dewsbury *et al.* 2016). The decline in seagrass abundance and distribution will not only affect societal well-being and sustainability, but may also affect local communities' economies; an indirect impact on the local economy through a loss of ecosystem services. Dewsbury *et al.* (2016) explained that the seagrass meadows' ability to reduce the effects of coastal erosion, reduce sedimentation and sequestrate large amounts of carbon might suggest that a reduction of seagrass meadows may harm local and coastal communities' economies. This suggests that, without seagrass meadows providing these supporting, regulatory and provisioning ecosystem services, local coastal economies will be negatively impacted, as they would have to find alternative technologies, structures or functions (Blignaut *et al.* 2014) with which to carry out the services that seagrass provides.

3.3. Site description

The study took place in Knysna, South Africa. Knysna is located along the Garden Route in the Western Cape Province of South Africa and situated approximately 55 km east from the city of George and 33 km west from the city of Plettenberg Bay (Figure 3.1). Knysna has an oceanic climate, with warm to hot summers and mild to chilly winters. The average summer temperature is 24.6^0 C, while the average winter temperature is 16.6^0 C (Human *et al*. 2016). The average yearly rainfall is 748 mm (Harvey 2019) with the highest rainfall occurring from August to October.

The town of Knysna is located adjacent to the Knysna estuary (Harvey 2019). The Knysna estuary and its surroundings are a tourism attraction that draws domestic and international tourists year-round (Harvey 2019, Marker 2003). The Knysna economy is dependent on tourism (Marker 2003), where Mander and Van Niekerk (2013) estimated that approximately 700 000 people visit Knysna annually. The coastal areas of the Knysna estuary are densely populated with suburbs, urban development and the Knysna central business district (CBD) (Marker 2003).

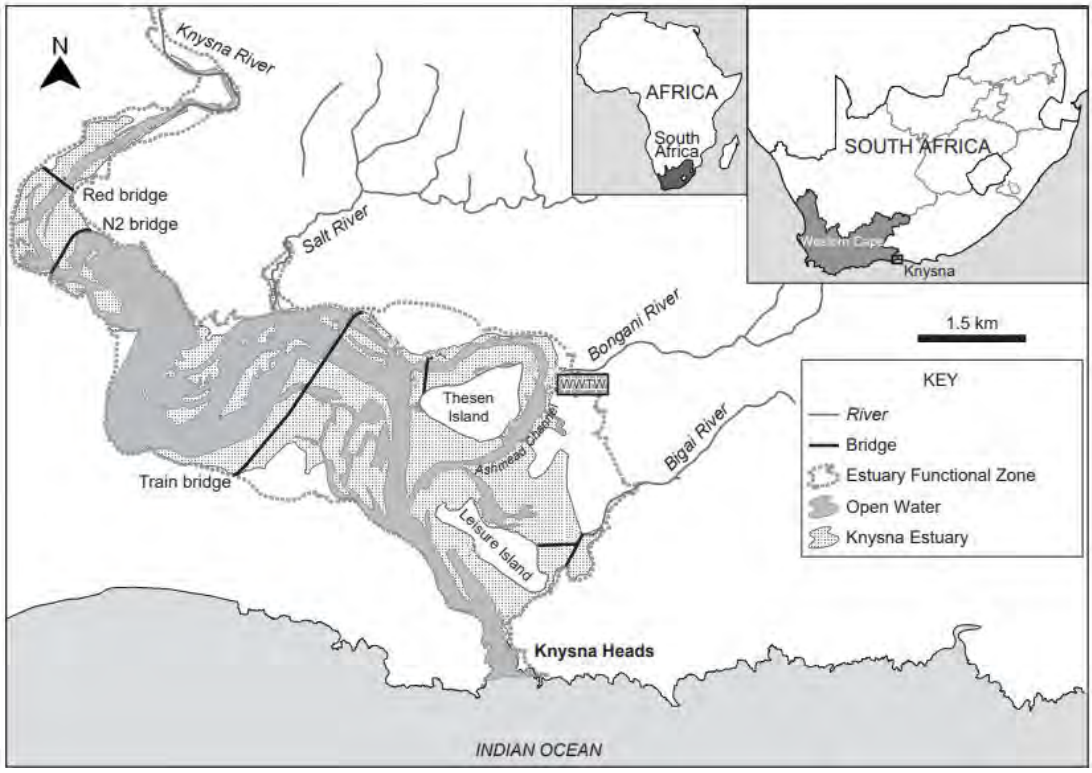

Figure 3.1: Location of Knysna and the surrounding area

Source: Claassens et al. (2020).

3.3.1. Knysna socio-economic profile

In 2016, Knysna had a population of approximately 74 000 individuals made up of approximately 22 000 households (Human *et al*. 2016). The racial demographics of Knysna are 40.9% "Coloured", 36.1% "Black African" and 21.0% "White" (Statistics South Africa (STATSSA) 2019). Afrikaans (51%) is the most spoken home-language, which is followed by isiXhosa (32%) and English (13%). The median age of Knysna residents was 29 years, and the age structure of Knysna residents in 2011 was as follows (STATSSA 2019):

- 24.8% under 15 years old;
- 66.9% between 15 to 64 years; and
- 8.3% older than 65 years of age.

Of the Knysna population, 4% were unschooled, 15% had a highest education level of primary school, 36% had completed some secondary schooling and 36% had matriculated high school (STATSSA 2019). A total of 8% have received an education level higher than secondary school, or tertiary education. Of this population, 4% had completed an undergraduate degree or a

diploma, 3% had completed a post-graduate degree while 1% had completed an alternative form of tertiary education (STATSSA 2019).

Only 26.7% of the Knysna population had access to Internet in 2011, of which 18.5% had Internet access from home, 11.2% from a cell phone and 6.8% from other sources (STATSSA 2019). The unemployment rate in 2016 was 22.1% (Western Cape Government (WCG) 2017). Approximately 26 000 people were employed in Knysna in 2016 (WCG 2017). In terms of yearly income, 16% of the population received no yearly income in 2011, while 21% had a yearly income of between R1 – 19 600 yearly, 54% between 19 601 – R307 600 per year, and 8% had a yearly income of over R307 601 (STATSSA 2019). The average annual per capita income of the Knysna population was R44 256 in 2016 (WCG 2017). However, the Gini Coefficient in Knysna was 0.63, which suggests that there are high levels of inequality in the area (WCG 2017).

The largest employment sectors are wholesale and retail trade, catering and accommodation, which account for approximately 26% of jobs in the Knysna Municipality and contributed to 18.7% of the GDP (WCG 2017). The regional annual GDP of Knysna was R4.19 billion in 2015 (WCG 2017).

Knysna is of both ecological and economic importance. Economically, the estimated economic value of the Knysna estuary includes its nursery habitat for fish species at an estimated value of R167.6 million per annum (Turpie and Clark 2007), its subsistence resource value estimated at R786 500 per annum (Turpie and Clark 2007) and its tourism attributed value of R1 billion per annum (Turpie and Joubert 2005). The collective property value with views over the estuary in 2002 ranged from R1.4 billion – R2 billion (Turpie *et al.* 2002). The ecological importance of the estuary is discussed in the section below.

3.3.2. Knysna estuary

There is an abundance of seagrass *Z. capensis* in the Knysna Lagoon, an estuary that is fed by the Knysna River (Figure 3.1). The estuary covers an area of approximately 1 800 ha, with an average depth of 1.5 metres and a maximum depth of 16 metres. The Knysna estuary is a permanently open estuarine bay (Claassen *et al*. 2020, Human *et al*. 2016) and is biologically rich. It is widely considered as the most crucial estuary in South Africa in terms of ecosystem service provision and conservation importance, where it contains an estimated 42% of all estuarine biodiversity that is found in South Africa (Claassens *et al*. 2020, Human *et al*. 2016, Harvey 2019). Lamberth and Turpie (2003) estimated that the Knysna estuary has a catch size of >250 tons per annum, which suggests that the estuary is biologically rich with fish species.

The Knysna estuary is formally protected under the National Environmental Management Act: Protected Areas Act (Act No. 57 of 2003). The estuary falls under the jurisdiction of the Garden Route National Park which is managed by South African National Parks (SANParks) (Claassens *et al.* 2020). Although the estuary falls under the management of a national park, access to the estuary is not restricted, as the estuary forms part of an open-access national park (Claassens *et al.* 2020). However, SANParks has implemented several restrictions, such as the establishment of bait collection and boating activities exclusion zones, as well as restrictions on recreational and subsistence fishing, which include size restrictions, bag limits and closed seasons (Claassens *et al.* 2020). SANParks enforces these restrictions.

People utilise the Knysna estuary through recreational and subsistence fishing (Napier *et al.* 2009), bait collection (Claassens 2020), tourism (Marker 2003, WCG 2017) and recreational activities which include boating, swimming, sailing and kayaking (Mander and Van Niekerk 2013).

3.4. Zostera capensis

As aforementioned, there are numerous species of seagrass around the world. Seagrass *Z. capensis* is found on the coast of the eastern, southern and parts of the western coasts of southern Africa and is a highly productive flowering marine seagrass (Adams 2016). Its range extends as far as Kenya in the north and Langebaan in the west (Adams 2016). Although *Z. capensis* has a wide geographical boundary, it is listed as vulnerable in the Red Data List of Species (Adams 2016).

Z. capensis is found in many estuaries and coastal shorelines in South Africa, some of which are densely populated with growing communities, towns and cities (Adams 2016). It has a variety of indirect ecosystem services (Dewsbury *et al*. 2016) and is a keystone species within coastal environments, meaning that the health of seagrass meadows directly relates to the health of surrounding ecosystem functions and trophic levels (Adams 2016).

3.4.1. Zostera capensis in Knysna

Knysna has the biggest permanent bed of seagrass *Z. capensis* in South Africa, where it covers an approximate area of between 350 ha and 390 ha (Adams 2016, Claassens *et al*. 2020). Seagrass *Z. capensis* is abundant at both subtidal and intertidal regimes in the estuary. Figure 3.2 highlights the distribution of *Z. capensis* in the Knysna estuary in 2017. It covers approximately 15-20% of the estuary (Department of Water Affairs 2009), which suggests that the ecosystem services provided to the community occur on a large scale throughout the estuary.

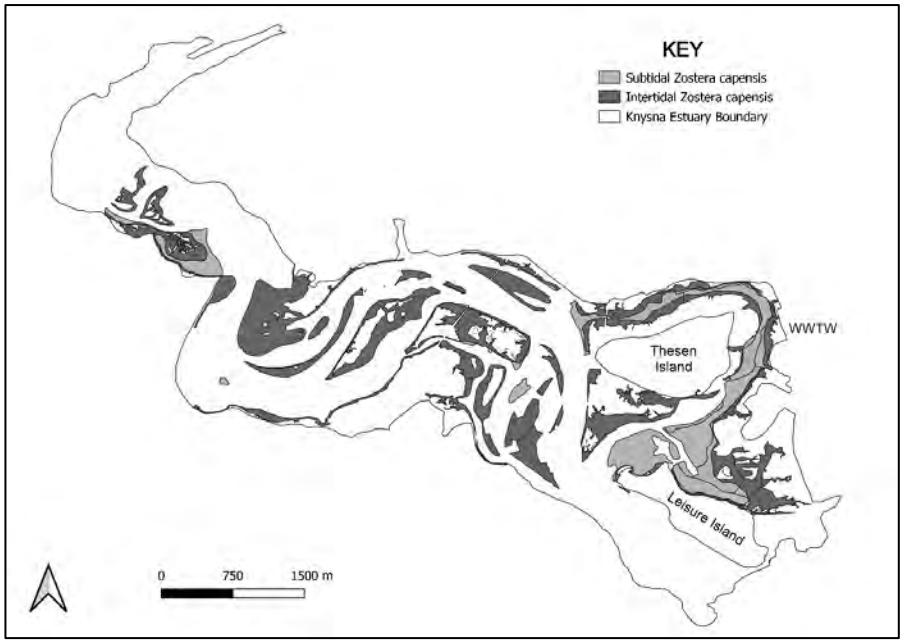

Figure 3.2: Mapped seagrass *Z. capensis* distribution in the Knysna estuary in 2017

Source: Claassens (2019).

Z. capensis is an ecologically important species, specifically in Knysna, as it provides habitat for the Endangered Knysna seahorse, *Hippocampus capensis* (Adams 2016) and the Critically Endangered false limpet *Siphonaria compressa* (Claassens *et al.* 2020). *H. capensis* is the only seahorse in the world that is known to survive and live in estuaries and is located in only two other locations in South Africa (Adams 2016).

The indirect use ecosystem services that *Z. capensis* provides to the Knysna community are similar to those provided to society on a global scale, as discussed earlier in this chapter. These indirect use ecosystem services, although not always visible, benefit the Knysna community.

3.4.2. Zostera capensis threats in Knysna

As prolific and important *Z. capensis* is to the Knysna estuary, it is under threat due to population increase, growing development and land-use change along the coastline of the estuary (Marker 2003), all of which impact its abundance and distribution (Dewsbury *et al*. 2016, Orth *et al*. 2006). A study conducted by Claassens *et al.* (2020) noted that the ecological health of the Knysna estuary was deteriorating, with specific reference to the displacement and reduction of *Z. capensis* yields.

Knysna has experienced a recent series of recreational and residential developments (Marker 2003, WCG 2017). As a result, ecosystems and habitats in the estuary have been negatively affected (Marker 2003). As mentioned previously, boating and heavy dredging for marine construction can cause damage to seagrass (Dewsbury *et al*. 2016). The Department of Water Affairs (2009) identified, with

a high degree of confidence, that boating activities have damaged *Z. capensis* beds in Knysna. Trampling and bait collecting can alter the ecosystem makeup of seagrass meadows, where evidence in Knysna has shown a decline in the *Z. capensis* meadows as a result of bait collection (Claassens *et al.* 2020). Figure 3.3 highlights the effects of illegal bait digging, which has severely damaged *Z. capensis* beds in the Knysna estuary.

Figure 3.3: Illegal bait digging activity has caused damage to *Z. capensis beds*

Source: Claassens et al. (2020).

The displacement and reduction of *Z. capensis* yields in the Knysna estuary has been primarily attributed to eutrophic conditions in the estuary (Human *et al.* 2016, Pollard *et al*. 2018). Nuisance algae (*Ulva* ssp.) blooms (Figure 3.4 and Figure 3.5), which are an indicator of high nutrient contents (Harvey 2019), can be attributed to creating eutrophic conditions in a waterbody. Nitrogen and phosphorus are nutrients which can be present in water bodies and which promote plant growth (Harvey 2019). If the level of either of these nutrients is only available in low concentrations, then algae growth is limited. Conversely, if these nutrients are available at high concentrations in a water body, plant and algae growth is not limited. The unlimited growth of algae can promote algae blooms, which can create eutrophic conditions (Harvey 2019).

The presence of an algae bloom negatively impacts the underlying vegetation, since the canopy of the algae bloom reduces the amount of sunlight that reaches the underlying vegetation by up to 95%, thereby affecting the ability for plants to photosynthesise (Human *et al.* 2016). An additional impact of an algae bloom is that the underlying vegetation suffers from hypoxia – the lack of oxygen – at

night, which compounds the adverse effects of the health of the underlying or intertidal vegetation (Burkholder *et al.* 2007) (Figure 3.4).

Figure 3.4: Macroalgae covering the Knysna estuary

Source: Claassens (2018).

The Ashmead Channel is a shallow portion of the estuary that separates Thesen Island from the Knysna CBD. The water quality in the Ashmead Channel has deteriorated since 2003, and high concentrations of nutrients have been detected in the channel (Human *et al.* 2016). Studies have identified that the Bongani River and the Knysna Waste-Water Treatment Works (WWTW) are the two likely sources of elevated nutrients in the Ashmead Channel, as compared to the nutrient levels in the estuary further away from the Ashmead Channel (Human *et al.* 2016, Lemley *et al.* 2014).

Human *et al.* (2016) noted that in 2011 there was a fault at the WWTW, resulting in a release of a significant amount of nutrient-rich sludge into the Ashmead Channel, while an additional sewerage leakage event occurred in the summer of 2014/2015 (Allanson *et al.* 2016, Human *et al.* 2016, Pollard *et al.* 2018). This assisted in the growth of an algae bloom which increased turbidity and, as a result, reduced the amount of sunlight that reached the submerged vegetation, including the intertidal seagrass (Figure 3.5). Figure 3.2 highlighted the significance of intertidal seagrass *Z. capensis* in the estuary and in the Ashmead Channel. The elevated amount of nutrients in the channel contributed to an increase in algae blooms which, if sustained, "the functionality of the seagrass ecosystem and its associated services will cease" (Human *et al.* 2016:62).

Figure 3.5: Macroalgae covering seagrass *Z. capensis* in the Knysna estuary

Source: Claassens (2018).

These conditions negatively affected the photosynthesis functions and health of *Z. capensis* (Human *et al*. 2015), where a reduction of the abundance and distribution of *Z. capensis* in the Ashmead Channel was recorded (Allanson *et al.* 2016, Claassens *et al*. 2020, Human *et al*. 2016, Pollard *et al*. 2018). Pollard *et al.* (2018:322) noted that the "[algal] bloom in the Knysna Estuary had a strong negative impact on the Z. capensis beds in this system".

In order to combat the threat of eutrophication in the Knysna estuary, monitoring and evaluation strategies have been suggested. Effective monitoring strategies are said to assist in determining how and why changes in the system occur, which will contribute to effective management and conservation strategies (Claassens *et al.* 2020). By incorporating monitoring practices into management and conservation strategies, seagrass ecosystems within the Knysna estuary may be managed and conserved at a higher standard. Therefore, the abundance, distribution and health of seagrass ecosystems will not be negatively impacted by anthropogenic threats, as mentioned above, whereby the services they provide to coastal communities will remain intact. Through the establishment of an economic value for *Z. capensis* in the Knysna estuary, protection and restoration of *Z.* capensis may be motivated for more strongly and used to justify expenditure on strategies to protect it.

3.5. Synopsis

This chapter researched the literature pertaining to the context of the study; the ecosystem service benefits that seagrass ecosystems provide to coastal communities. The sub-species of seagrass under discussion in this study was seagrass *Zostera capensis.* The threats related to seagrass ecosystems were discussed, where eutrophication was highlighted as a threat. The site description was discussed

with reference to the location – the Knysna estuary – as well as the socio-demographic characteristics of the community that surrounds the Knysna estuary.

The following chapter introduces the research design and methods used in this study to derive an economic value for the ecosystem services that seagrass provides. Details about the methods of data collection and data analysis are also discussed.

CHAPTER 4:

RESEARCH DESIGN AND METHODS

4.1. Introduction

This chapter presents an overview of the research design and the methods applied in this project. The chapter discusses the design of the online contingent valuation (CV) survey that was conducted in this study. The application of the online deliberative focus group that was conducted is discussed in the following section. The scenario, which relates back to the WTP question, is then included.

The purpose for including both the CV and the deliberative focus group in this study was to compare the quantitative and qualitative results from each of the methods. Noteworthy comparisons could be drawn between the CV results where no deliberation between researchers and participants took place, and the DMV method, where participants were able to deliberate and ask questions. This analysis may assist in determining whether deliberation influenced the results. The final two sections of this chapter discuss the proceedings of how the results were analysed, including the details of the ethical clearance that was obtained for this study.

4.2. Data collection

Data collection consisted of two main phases: one online CV survey and one online DMV focus group which was followed by an online DMV survey. The CV survey participants were recruited via email through mailing lists provided by key informants in Knysna. In the recruitment email that was sent to the CV participants, which is attached in Appendix I, the researcher asked whether the participants would be willing to participate in an online DMV focus group. If willingness to participate was shown, the researcher then added the participant to the online DMV focus group list. Therefore, the respondents who participated in DMV focus group were primarily recruited from the CV survey participants.

The data derived from the online CV survey consisted of 100 responses. The sample size for the CV survey was relatively small when compared to studies such as Kenter *et al.* (2016), who interviewed 1 683 respondents using the CV method. However, there has been success in the literature when smaller samples were surveyed. For instance, Szabo (2011), in determining the protest responses recorded in deliberative versus individually sourced values, surveyed 152 respondents through the CV method. Participants in the online CV survey completed the questionnaire via a Google Forms document, and a link to the Google Form was sent in the initial email. The questionnaire took between 10-15 minutes to complete and a copy is attached in Appendix II. The data from each questionnaire

were captured in an Excel spreadsheet for further analysis at the end of the survey day. The participants were not obligated to complete the survey.

The deliberative focus group lasted one hour and was conducted via an online video medium called Zoom (www.zoom.com) and allowed for discussion, debate and preference construction. The proceedings of the online focus group are further discussed in Section 4.6. After the initial presentation and discussion, the focus group required participants to complete a questionnaire comprising 35 questions and took approximately 10-15 minutes to complete. The focus group was video recorded, the purpose of which was to allow for further analysis on the comments and remarks made by the participants when considering the scenario, as well as the questions they asked. Trends, or themes, that were developed within the interactions at the focus group itself were also identified. The video recording was saved on a hard drive and stored.

The participants for the online DMV focus group were recruited from the initial email that was sent to the online CV survey participants. A link for a Zoom meeting was emailed to each participant who indicated interest in the online DMV focus group, but they were not obligated to participate.

Both questionnaires – the online CV survey and the post-focus group discussion questionnaire – used the payment card (PC) value elicitation method to determine a value for seagrass ecosystem services. The PC format is noted to produce more conservative WTP responses compared to the open-ended and bidding game method responses (Thur *et al.* 2010). It also avoids starting point (Yang *et al.* 2012) and protest bias (Thur *et al.* 2010).

So as to achieve the study's first sub-goal, the deliberative focus group made use of the Kenter *et al.* (2016) value dimensions framework, as highlighted in Chapter 2 (Figure 2.3). The value dimensions framework highlighted the types of value associated with value identification, elicitation and measurement. Where applicable, using the Kenter *et al.* (2015) value dimensions framework, this study sought to establish whether deliberation influenced the types of value associated the responses the participants provided.

4.3. Targeted population

The identified stakeholders represented different demographics in terms of age, gender, race, gross monthly income and occupation all of which had a vested interest in the estuary. The stakeholder groups comprised of:

- Scientific services;
- Ratepayers' association;
- Homeowners' association;

- Municipal environmental managers from the Knysna Municipality;
- SANParks representatives;
- Boating and tourism representatives;
- Recreational boaters and fishers; and
- Subsistence fishers.

The initial targeted population for the online CV survey was set at 50 participants (sample size N=50) which represented stakeholders with various socio-demographic characteristics of the Knysna population. Key stakeholder groups were identified through discussion with researchers in Knysna. However, the actual size that was obtained in the CV survey was 100 respondents (N=100), which exceeded the expected sample size.

Based on the response rate from the CV survey, the aim was to include approximately 20 participants (N=20) in the online DMV focus group which was decided upon through discussion with the key informants and researchers in Knysna, as well as taking literature from Lienhoop *et al*. (2015), Spash (2007) into account. However, the sample size for the DMV survey was less than expected, where the DMV focus group recruited ten respondents (N=10). It is noted that the original research was designed to accommodate an in-person deliberative workshop to include as wide a range of different key stakeholders as possible. However, the COVID-19 lockdown made this type of research impossible, thus necessitating the shift to an online focus group format, the implications of which are discussed in Chapter 5. Added to this, the implications of COVID-19 did not allow for much scope for preliminary focus groups to be run, therefore negating the opportunity for a pilot study to be conducted.

A Knysna based research group – the Knysna Basin Project (KBP) – assisted with the recruitment of and communication with the stakeholders, as well as provided key advise in the construction of the payment vehicle and the hypothetical scenario. The KBP (www.knysnabasinproject.co.za) had established relationships across a variety of associations within the Knysna community and were of paramount importance in the assistance of the construction of the hypothetical scenario and payment vehicle. Through this, they were able to assist in obtaining the contact details from the abovementioned associations. The selection of participants was done through stratified random sampling.

Ethical clearance was obtained by the Rhodes University Ethical Standards Committee and is further discussed in Section 4.8. The participants were not paid or compensated for participating in the study.

4.4. The CV method design

The online CV survey was designed to elicit individual responses and individual WTP values from participants without the option of deliberation, therefore obtaining non-deliberated values from the value dimensions framework (Kenter *et al.* 2015). The literature identified the stated preference valuation method as a method that can be used to derive a WTP value for non-use and indirect use ecosystem services (Carson *et al.* 2001, Moore *et al.* 2011, Perman *et al.* 2011, Tietenberg and Lewis 2020, Whittington *et al.* 2012), through which the contingent valuation (CV) method was decided as the appropriate method to elicit an individual WTP value. The CV method, through a WTP approach, was adopted for this study for three reasons:

1) It is less cognitively demanding for respondents compared to the willingness to accept (WTA) method;
2) The NOAA panel supports the use of the WTP method to value public and non-use value goods and services (Arrow *et al.* 1993); and
3) It is an effective method to estimate non-use values.

The survey was administrated through a Google Forms document (Appendix II), which was sent to the participants via a mailing list. On receipt of the survey, the participants were able to open the survey and answer the questions in the document. On completion of the survey, the participants directly submitted the survey on Google Forms, which was automatically saved on Google Drive. Access to the responses from the participants was limited to the research team. The responses were anonymous, and the survey was optional. Once all the responses were recorded on Google Drive, the data were exported to an Excel spreadsheet for further analysis.

As per the value dimensions framework (Kenter *et al.* 2015), the CV survey sought to obtain non-deliberated values from the "elicitation process" dimension, as well as individual values from the "value provider" dimension. Based on this, the responses obtained could be assessed against other value dimensions from the deliberative focus group.

4.4.1. CV questionnaire design and content

The questionnaire was designed after a consideration of literature (Atkinson *et al.* 2012, Bartkowski and Lienhoop 2018, Christie *et al.* 2012, Kenter *et al.* 2016, Szabo 2011) and consultation with a key stakeholder in Knysna – a member of the Knysna Basin Project – pertaining to the structuring, the type of questions asked and the amount of information provided to the respondents. Based on this information, a questionnaire was formed that allowed the respondents to answer the questions with sufficient information and within the standard time frame of a CV survey of between 10 – 15 minutes

(Lo and Spash 2013). A challenge in developing CV questionnaires is the amount of information provided to the participants. The literature noted that the CV method, typically, provides less information than deliberative valuation methods. As such, this challenge was taken into account in the formulation of the CV questionnaire.

As discussed in Chapter 2, there are four stages in designing a CV questionnaire (Snowball 2007). The first section of the questionnaire was to determine the frequency of visits to the location of the environmental good that provides the ecosystem services under discussion, the purpose of the visits, and the use-values the participants obtained from the environmental good. For instance, one question in the survey asked the participants how often they made use of the estuary.

The second section of the survey was used to determine the non-use values, information of opinion and knowledge of the environmental good of the participants, as well as knowledge on the ecosystem service that the environmental good provides. Since the CV survey was administrated before the online DMV focus group, the participants who took part in the online CV survey had not yet had the opportunity to partake in the online DMV focus group, which consisted of an information generating presentation of the ecosystem service benefits that seagrass provides. Therefore, questions in the online CV survey asked participants about their knowledge of the term 'ecosystem services', if they were able to identify seagrass and their knowledge of nature. These questions were asked to discern the level of self-rated confidence the respondents had in identifying the environmental resource under discussion, since knowledge of the environmental resource under discussion, and interest in nature, often correlate to positive WTP decisions (Turpie 2003). For instance, one question the participants were asked in the online CV survey was:

> *"What is your knowledge of the natural environment and how nature can benefit your livelihood?"*
>
> *1 2 3 4 5*
>
> *No knowledge* ⟶ *Very knowledgeable*

The third section of the CV survey was used to elicit the participants' WTP values for the environmental good in question. Before the monetary elicitation question, the participants were provided with a short definition of the term 'ecosystem services' and what seagrass ecosystems were. This helped the participants frame the context of the study. A scenario was provided, which explained the context of the valuation question (discussed in Section 4.4.2). The scenario was associated with a real-life event; that of a eutrophication event in the Knysna estuary in 2011 (Human *et al*. 2016). Since the eutrophication event occurred in Knysna, the participants may have had first-hand experience of its

occurrence. The scenario included the effects that eutrophication had on seagrass ecosystems and coastal livelihoods. The effects of eutrophication were discussed in detail in Chapter 3.

Once the participants had covered the scenario question, they were asked to provide a willingness to pay for the monitoring of the Knysna estuary to improve seagrass habitats. The costs and benefits for paying for a conservation agency to monitor the estuary were mentioned in the survey. For instance, the respondents were asked:

> *"Monitoring the estuary will likely yield greater ecosystem service benefits that seagrass provides. Considering your budget constraints, what is the maximum amount of money (in ZAR) that your household would be willing to pay per month for monitoring practices in Knysna estuary?"*

As identified in the above question, the participants were requested to consider their budget constraints before eliciting a value via a payment card. The values were provided in South African Rand (ZAR) and they ranged from R0 – R1 500, and the centre value was R75. There was an option to state a value for above R1 500, which was depicted as "Above R1 500". There was also an option for the participant to state another value, which was depicted as "Other".

Follow-on questions were asked to determine whether the non-willingness to pay responses were based on respondents' inability to pay towards the scenario, whether they were genuine zero-bidders, or whether the respondents elicited protest bids (Bernath and Roschewitz 2008). The follow-on questions included a list of options from which the respondents could choose:

a) "I do not think that paying a tax will make a difference to the state of the estuary";

b) "Currently, I cannot afford to pay extra taxes";

c) "I do not use the estuary; therefore, I do not think that I should pay for it";

d) "Other people or organisations should fund monitoring practices"; and

e) "Other".

It is noted that no option was given for reasons based on mistrust of the Knysna Municipality or monitoring services as a hypothetical scenario (Appendix II). Instead, an "Other" option was provided in which the respondents were able to contribute additional reasons. Following the literature (Cho *et al.* 2005), if respondents who selected (a) or who gave a reason related to a rejection of the payment vehicle or some other aspect of the study in (e) were classified as protest bidders.

The last section of the online CV survey was to establish the socio-demographic and socio-economic characteristics of the participants. The participants were asked questions regarding their age, home

language, their education level and household income. It is important to note that, in all the questions in this section, an option of "I would prefer not to answer" was provided.

4.4.2. Hypothetical scenario

The following scenario was presented to the respondents in both the online CV survey and the online deliberative focus group, thereby ensuring that participants responded to the same scenario. As with the CV questionnaire design, the scenario was developed through a consideration of literature (Allanson *et al.* 2016, Claassens *et al.* 2020, Human *et al.* 2016, Pollard *et al.* 2018), as well as consultation with key stakeholders in Knysna through the Knysna Basin Project. Reference to literature is made throughout the scenario to support the fact that the scenario was developed through scientific reasoning. The scenario is discussed below:

Following literature discussed in Chapter 3, in 2011 and 2014, leaking sewage from the Knysna Waste-Water Treatment Works (WWTW) was reported to have seeped into the estuary (Human *et al.* 2016, Pollard *et al.* 2018). Despite the other pressures associated with the loss of seagrass in the Knysna estuary (such as bait collection and coastal development), the consultation with the KBP determined that the sewerage leak from the WWTW was the most appropriate scenario to include in the hypothetical scenario. The sewage polluted the water in the estuary, particularly in the Ashmead Channel where the WWTW is located (Human *et al.* 2016). The sewage increased the toxicity of the water, which caused algae to grow on the surface of the water. This resulted in less sunlight reaching the seagrass that grew beneath the surface of the water. This process is known as eutrophication. Before the leakage took place, the health and abundance of the seagrass in the Ashmead Channel was stable (Figure 4.1). However, because of the sewage leak, a significant amount of seagrass died (Human *et al.* 2016) (Figure 4.2)[7]. Human *et al.* (2016) found that the cover of seagrass *Z. capensis* in 2015 had decreased significantly since 2011, while the abundance of algae had increased. This fact, supplemented by photographs of the actual loss of seagrass in Figures 4.1 and 4.2 (Pollard *et al.* 2018), highlighted the extent of the decrease of seagrass coverage and the loss of its associated ecosystem services (Human *et al.* 2016).

[7] The photographs were included in the scenario to visually display the extent of damage that the leaking sewerage from the WWTW caused to the seagrass bed in Knysna.

Figure 4.1: Site A; an almost pure stand of *Z. capensis* in Knysna, Nov. 2014

Source: Pollard et al. (2018).

Although the seagrass recovered from the leakage in 2011, another sewage leakage from the WWTW could mean that seagrass may no longer continue to grow in the Ashmead Channel. If seagrass does not grow in the Ashmead Channel, the ecosystem service benefits that seagrass provides will be lost. If the eutrophic conditions in the Knysna Estuary persist, seagrass ecosystems, and its associated services, will cease (Human *et al.* 2016).

A solution to ensure that such leaks do not occur in the future is to put in place proper checks and monitoring procedures at the sewage works. Human *et al.* (2016) noted that seagrass has the potential to recover and grow back in the absence of an algal covering, which will maintain the ecosystem services associated with the seagrass. Research has found that regularly checking, documenting and monitoring the discharge regulations of the WWTW holds the sewage works liable to adhere to operational standards, therefore reducing the potential occurrence of another leakage (Claassens *et al.* 2020, Harvey 2019), which may halt non-compliant discharges from the WWTW into the estuary. Monitoring the state of the estuary will assist in ensuring that the estuary is in a healthy and functioning state, which will contribute to the maintenance of ecosystem services (Claassens *et al.* 2020).

The Knysna Municipality was identified as the hypothetical payment vehicle in this study, since it would ensure that all the respondents would be liable to pay a tax, as noted in the literature (Ivehammar 2009). The funds collected from a monthly tax would be ringfenced and distributed to a non-governmental organisation (NGO) conservation agency. This would ensure that the respondents would still be liable to pay a tax, but it would also ensure that the funds would be distributed to the correct agency. Since an NGO cannot enforce respondents to pay a monthly or annual levy or tax, the

funds paid towards the NGO may be considered as a donation, through which respondents may exaggerate their WTP (Perman *et al.* 2010).

Figure 4.2: Site A; the loss of *Z. capensis* caused by eutrophication, July 2015

Source: Pollard et al. (2018).

The literature noted that respondent may be averse to paying towards a government agency (Dziegielewska and Mendelsohn 2005, Lienhoop and MacMillan 2007). In order to accommodate for potential mistrust shown towards a government agency, but also to ensure that the WTP amount elicited by the respondent reflected their true preferences and not simply a donation, a payment vehicle of this nature was formed. The NGO would be responsible for checking the operational standard of the WWTW, as well as documenting and monitoring the state of the estuary.

There are costs and benefits associated with paying an organisation to monitor the state of the estuary, as well as the discharge from the WWTW. Table 4.1 below shows these costs and benefits and the contents of which was described to the participants to assist them in their decision-making process.

The benefits of paying an organisation to monitor the compliance of water discharge from the WWTW and the state of the health of the estuary are twofold. Firstly, the intensity and probability of effluent leakages will likely be minimised, and secondly, the estuary will continue to function in a healthy state. Controlled discharge from the WWTW will likely not damage seagrass habitats and, therefore, the services that the seagrass supplies will not be diminished. These services may reduce the impact of coastal erosion, provide a nursery habitat for juvenile fish species, reduce water sedimentation and increase CO_2 sequestration, all of which, if maintained, will positively impact the Knysna community.

However, paying to monitor the regulations of the discharge of the WWTW have financial implications, the first of which is the obvious cost paid by the residents of the Knysna community, which will reduce the amount of money that they would have available for other goods and services. The other cost is that the NGO may impose a limited access policy to the estuary, in certain places or defined times, to allow for the seagrass habitats to recover. A limited access policy may include restrictions on bait digging, boating activities, and the fish bag (amount of fish caught) in the estuary during certain times of the year. This initiative may impact users' recreational and subsistence activities in the estuary, but it will ultimately benefit the biodiversity and natural habitat of the estuary.

Table 4.1: The costs and benefits of paying to maintain ecosystem services

Costs	**Benefits**
A reduction in the amount of money used to spend on other goods and services. The amount is dependent on the willingness to pay value elicited.	Possible decrease in coastal erosion. The roots of *Z. capensis* hold soil together and therefore reduce the potential of erosion.
The possible implementation of a limited access policy. This is to ensure that the seagrass beds are given enough time to recover from potential damages.	Likely increase in fish abundance and diversity, due to the nursery habitat functions of the seagrass meadows.
Probable seasonal restrictions on bait digging. Restrictions may be implemented on the location, and scale of bait digging.	Potential reduction of water sedimentation. Seagrass beds can trap sediment. This will potentially make the water clearer.
Possible seasonal restrictions on fish bag (amount of fish caught). Cascading effect of fish feeding. This may increase the quantity of algae in the estuary.	An increase in CO_2 sequestration. Since *Z. capensis* takes in a lot of carbon, a maintained bed of seagrass may reduce the amount of carbon in the atmosphere, compared to an unmaintained seagrass meadow.
Potential boating restrictions. Restrictions on the location and speed of boating activities may be implemented to reduce the impact on seagrass.	A potential increase, or maintenance, in the abundance of wild fauna and flora, including the endangered Knysna seahorse.
	The aesthetic appeal of the estuary and the surrounding environment is likely to be sustained. Therefore, the number of tourists is unlikely to be impacted. This means that the revenue from tourism will be maintained. The housing market is also unlikely to be impacted.

Based on the scenario discussed, the participants were asked to state a willingness to pay for monitoring practices to be implemented in the estuary. Monitoring practices will likely reduce the occurrence of another sewerage leak, which would maintain the ecosystem services provided by seagrass which in turn would benefit the Knysna community.

4.5. Deliberative focus group design

The implementation of a deliberative focus group allowed for an investigation of whether deliberation influenced respondents' answers when compared to the CV survey. The deliberative focus group was established following literature, which followed the structure of a deliberative monetary valuation (DMV) method framework (Bunse *et al.* 2016, Macmillan *et al.* 2002) regarding:

1) A presentation on background information for the proposed project;
2) An explanation of the valuation scenario and payment vehicle;
3) Time for participants to interact with one another and the research team; and
4) A platform for value elicitation.

As per the value dimensions framework (Kenter *et al.* 2015), the deliberative focus group sought to obtain, individual values from the "value provider" dimension through a deliberative format, otherwise referred to as deliberated values from the "elicitation process" dimension. The purpose of obtaining individual values was due to the fact that this research used the deliberated preferences (DP) approach to obtain value, as noted in Chapter 2 (Kenter *et al.* 2016, Kenter 2017, Orchard-Webb *et al.* 2016), therefore mitigating the need for consensus between respondents.

The original venue decided upon to host the focus group was the South African National Parks (SANParks) boardroom on Thesen Island, Knysna (Figure 3.1 in Chapter 3 provides a visual representation of the location of Thesen Island in Knysna). However, due to COVID-19 restrictions implemented in South Africa, the focus group method approach was adapted to an online medium.

The focus group was conducted through an online video medium application called Zoom. The focus group lasted approximately one hour and was facilitated by the research team. The research team encouraged discussion and debate between the participants, which ensured that all participants were provided the opportunity to voice their value, thoughts and opinions freely, which allowed for a neutral stance as to negate the limitations of focus groups noted in Chapter 2. The focus group commenced as soon as all stakeholders were present on the video application.

During the introduction, the research team introduced the purpose and intention of the focus group. After this, the research team presented information to the participants in the format of a PowerPoint presentation which is attached in Appendix IV. The presentation was delivered in English.

The presentation covered the attributes of the seagrass *Z. capensis*, including its distribution, the importance of the ecosystem services it provides, and the threats that impact its abundance and distribution. The objective of the first session was to increase, or assist in, the participants' knowledge of ecosystem services, how coastal communities benefit from them and the importance of seagrass

Z. capensis as a keystone species. The literature noted that presentations in deliberative valuation studies are used to provide detailed information to respondents (Bunse *et al.* 2015, Kenter *et al.* 2016) pertaining to the environmental good under consideration and the context of the study. In particular, Szabo (2011) noted that the use of deliberation can be used to address the lack of information provided in CV studies. Therefore, the knowledge that the participants gained from the presentation, in theory, was used to increase the validity and accuracy of the values stated by the participants (Bartowski and Lienhoop 2018, Spash 2008).

The participants were encouraged to ask questions on the topics with which they were unfamiliar or if more clarity was needed on a slide or subject. To avoid information bias in the presentation, emotive images and language to convince participants of a point of view were not used. The presentation noted the benefits, as well as the disadvantages of paying to conserve *Z. capensis,* which was highlighted in Table 4.1 above. For example, one benefit was that an increase in *Z. capensis* would yield a reduction in the probability and intensity of coastal erosion occurring. Conversely, paying to conserve *Z. capensis* would cost the respondents financially, ultimately reducing the amount of money they had to spend on other goods and services.

The Zoom focus group made use of polls to allow the respondents to easily and voluntary interact. The poll questions were based on multiple choice and allowed the respondents to answer questions anonymously. The list of all the poll questions is attached in Appendix V. An example of a poll question that the respondents were asked was:

> *In the online survey, about 92% of the participants stated that they thought it was important to monitor the estuary. Why do you think so many people in Knysna were keen to implement the monitoring programme?*
>
> *a) It's a practical way to ensure that the estuary is in a functioning state.*
>
> *b) I think that it is the best measure to help protect seagrass now.*
>
> *c) I can't think of any other option that could be used to protect seagrass.*
>
> *d) I do not like the monitoring idea: I think there are other options that haven't yet been considered.*

Once the polls were completed by all the respondents, the researcher shared the results after which the respondents were encouraged to ask questions which encouraged debate and discussion.

Power imbalances and silent voices, that were noted in Chapter 2, often impact the proceedings and subsequent results of a DMV focus group. To avoid power imbalances, the research team requested that the respondents did not speak over each other and, if a respondent had a question or comment,

that they raise their hand, ask verbally, or type a comment into the comment section of the Zoom meeting. The research team assisted in monitoring the typed comments (in the "chat" area) and raised hands (an electronic function indicating that the respondents wanted to speak) to ensure that all the respondents who wanted to contribute were able to do so.

4.5.1. DMV questionnaire design and content

After the presentation and discussion groups, the participants were presented with a questionnaire, which was in alignment with the CV method questionnaire format that was discussed in Chapter 2. Although the questionnaire for the online focus group followed the same format as the online CV survey, some of the questions in the two surveys differed. However, the fundamental questions, for example, the monetary elicitation questions, were asked in both questionnaires. The questionnaire was divided into four sections:

1) A section on use-values from the Knysna estuary;
2) A section on non-use values obtained from the Knysna estuary;
3) A section on value elicitation that included a WTP question; and
4) A section on the socio-demographics of the participants.

Although the questionnaire was provided to the participants after the respondents had deliberated through the focus group, the answers obtained were individually completed and were anonymous. Since the online CV survey obtained individual WTP values, the online DMV focus group also obtained individual WTP values from the participants. Therefore, and in accordance with the literature (Kenter 2017, Orchard-Webb *et al.* 2016), this study obtained individual WTP values through the *deliberated preferences* (DP) approach, instead of the *deliberative democratic monetary valuation* (DDMV) approach. The purpose of including a questionnaire after the online DMV focus group was to allow for a comparison of results of a non-deliberated CV survey compared to a CV survey that had a deliberative process and to avoid any bias, because of group pressure, associated with requiring the group to agree to one WTP amount.

The first section of the questionnaire asked participants a series of questions concerning their utilisation of their Knysna estuary, including the use values, either consumptive or non-consumptive, relating to the utilisation of the estuary. The participants were asked questions based on how often they accessed the estuary and why they accessed it. This allowed the researcher to determine which respondents utilised the estuary and for what purpose (use values).

The second section of the questionnaire involved asking respondents questions concerning their knowledge of ecosystem services, the benefits of conserving biodiversity and seagrass ecosystems in

Knysna. The purpose of this section was to assess the participants' knowledge of natural resources prior and post-presentation. A Likert scale was used. One of the questions the respondents were asked was:

> *"How much, if at all, do you think that your knowledge about ecosystem services and the benefits nature provides to human livelihoods has changed since the presentation?"*
>
> *Please circle the value you to which you agree.*
>
> *1 2 3 4 5*
>
> *I still have many questions ⟶ I understand much better*

The third section of the questionnaire was formed to elicit the participants' WTP value for monitoring seagrass health within the Knysna estuary. The participants were presented with a scenario, which was discussed in Section 4.4. The same scenario that was used for the online CV survey was used for the online DMV focus group. Based on the scenario, the participants were required to determine a monthly WTP value, which would translate to a tax levy that would be paid to the Knysna Municipality.

A tax was used as the payment vehicle as all stakeholders would be liable to pay the tax. The participants were reminded about their budget constraints before they were presented with the payment card. The respondents were given the option to state a WTP zero-bid. The participants were asked:

> *"Monitoring the estuary will likely yield greater ecosystem service benefits that seagrass provides. Considering your budget constraints, what is the maximum amount of money (in ZAR) that your household would be willing to pay per month for monitoring practices in Knysna estuary?"*

After the participants stated their WTP on the payment card (PC), the questionnaire asked a series of follow-up open-ended and closed questions to allow the participants to clarify the choice of their WTP value. The follow-up questions increased the validity of the responses, and it provided an opportunity for the participants to justify their choice (Whittington and Pagiola 2012).

Value elicitation was done through a PC format, which was the same value elicitation process as the online CV survey. The PC had 18 cells with a range of values from R0 to R1 500. The centre value was R75. The participants were required to select a WTP value, ranging from R0 – R1 500, an option for a value of over R1 500, presented as "Above R1 500", as well as an option for another value on the payment card, presented as "Other value".

The fourth section of the questionnaire collected the participants' socio-demographic and socio-economic characteristics. The questionnaire asked respondents to provide information on their age, gender, education level, current occupation and household income. The questionnaire included a confidentiality clause, which stated that all information supplied remained strictly confidential and that no personal information would be shared in the published report. Respondents were also reminded that they had the right to omit any questions they did not wish to answer, as required by the Rhodes University Ethical Standards Guidelines.

Potential sources of bias, as covered in Chapter 2, were addressed in the questionnaire. First, starting point bias was addressed using PC format. The use of the PC format is noted to reduce starting point bias. Information bias was mitigated using an information generating DMV focus group, where participants gained knowledge about the environmental good under discussion – seagrass ecosystems – and the ecosystem service benefits it provides through a presentation and discussion. Third, hypothetical bias was mitigated since the hypothetical scenario presented to the participants was based on a real-life occurrence of eutrophication, which was realistic and specific to the context of Knysna. Lastly, the possibility of protest bias was reduced since empirical DMV studies suggest that there is a lower potential of respondents electing a protest vote compared to traditional CV studies (Lo and Jim 2015).

4.6. Analysis of results

The study obtained two sets of results; one set of results from the CV survey and one set of results from the deliberative focus group. The results were analysed separately, and the following sections discuss the analysis of each dataset in turn.

4.6.1. CV survey analysis

The results obtained from the CV survey were first analysed through descriptive statistics, and thereafter through an econometric regression. The descriptive statistics analysis allowed for an analysis of the data by reviewing trends in the data, where patterns were observable from the dataset. The data were analysed through the mean, mode and median as well as minimum and maximum values. Descriptive statistics allowed the data to be measured through central tendency and variability.

The data were graphed and tabulated for it to be analysed efficiently. This allowed the researcher to identify the different characteristics of the sample in terms of the characteristics that influenced willingness to pay amounts. Through this, themes were identified.

A correlation matrix was generated to determine the correlations between variables. The results from the correlation coefficient are tabulated and are attached in Appendix VI. A summary of the coding used for the correlation analysis is attached in Appendix IX. All the respondents' responses were included in the analysis. Where possible, correlations between variables were identified and discussed throughout Section 5.2.

The econometric analysis used for the CV dataset was through an ordinary least squares (OLS) regression, run through an econometric programme called E-Views. The regression included all the data obtained from the CV survey, where it tested the determinants that influenced the respondents' willingness to pay amount.

Statistical analyses were performed to quantitatively determine the main characteristics of the dataset through an OLS regression to investigate the determinants that influenced the respondents' willingness to pay. The OLS model was chosen as the statistical analysis model as it was the model that showed the best fit with the data set in terms of the significant variables tested. A binary logit and a log distribution model were also run. The dependent variable was the WTP amount elected by the respondent, which was coded as ranked non-binary numerical data as the actual WTP value (in ZAR) that a respondent elicited, and 0 if not WTP. The independent variables used in the regression were separated into binary and non-binary variables. The remaining variables and coding attributes are highlighted in Appendix X.

To test the correlation of the variables, an adjusted R-squared test was performed, while the Durbin-Watson test was conducted to test for autocorrelation. The F-statistic, using the probability of the F-statistic, was performed to test the validity of the null hypothesis. The results that were obtained from performing an econometric regression meant that the data were analysed statistically, which supported the findings obtained from the descriptive statistical analysis.

4.6.2. Deliberative focus group and survey analysis

Since the DMV section of this study was separated into two sections, two analyses were conducted. The data were first analysed through a thematic analysis. A thematic analysis was conducted on the qualitative responses provided by the respondents in the DMV focus group. After the thematic analysis, the data obtained from the online DMV online survey were analysed through a descriptive statistics analysis.

The online DMV focus group was recorded, which allowed the responses to be transcribed into an Excel spreadsheet, coded and sorted based on the video recorded data. The responses were abbreviated into shorter phrases – the quotes obtained from the respondents were shortened – and the data were sorted into themes and subthemes based on the response provided. Within each of the

subthemes, the positive and negative opinions the respondents provided relating to the themes were sorted into “positive dimensions” and “negative dimensions”. The results obtained from the thematic analysis were used to compare against, as well as to support, findings obtained from the CV regressions.

4.7. Research Ethics

Ethical clearance was required for the focus group conducted with various stakeholders in the Knysna community. The Rhodes University Research Ethics Policy, as set out in the Rhodes University Higher Degrees Guide and the Rhodes University Ethical Guidelines for Human Subjects, was adhered to. Ethical Clearance was approved for this study, and the Rhodes University Ethical Standards Committee Review Reference number is 2020-1333-3380. The Ethical Clearance letter is attached in Appendix VII.

4.8. Synopsis

This chapter discussed the methods that were carried out on the two valuation questions: the contingent valuation survey, and the deliberative monetary valuation focus group and survey. The process of data collection was discussed, with reference to the adapted online survey and communication mediums used for this study. The targeted population intended for the study, and the subsequent recruitment strategies, were mentioned.

The processes of data analyses were examined. The research team elected to perform a statistical OLS regression in conjunction with a generated correlation matrix to analyse the CV survey data. Concerning the deliberative focus group, descriptive statistics and a thematic analysis were specified for data analysis. The next chapter provides an interpretive analysis and discussions of the key research findings for both the CV survey and the deliberative focus group.

CHAPTER 5:

RESULTS AND DISCUSSION

5.1. Introduction

This chapter describes the characteristics of the sample and the results obtained from the contingent valuation (CV) survey and the online deliberative (DMV) focus group survey. The results chapter is divided into two sections. The first section describes the results obtained from the online CV survey, and the second section describes the results derived from the online DMV survey and focus group.

It is important to note that the results discussed below are seen in the context of the study's broader limitations. One being that, as a result of the COVID-19 lockdown, in-person focus group discussions were not possible, thus necessitating the move to an online questionnaire and follow-up focus group and this medium of communication may have skewed the data. A notable limitation of using the Internet in valuation studies is the issue of coverage and sample area, where the intended sample is often not reached since not all participants have access to the Internet (Canavari *et al.* 2005, Nielsen 2011). The limitations of this study are further expanded upon in Chapter 6.

5.2. Contingent valuation survey results

The first section of this chapter analyses the socio-demographic characteristics of the CV survey respondents, and these features are illustrated in Table 5.1. The section then discusses responses provided by the respondents based on the online CV survey. Significant and noteworthy results and features are brought to attention throughout this section, which concludes with a statistical analysis using an ordinary least squares (OLS) regression of the results. The CV survey highlighted the non-deliberated values associated with the Kenter *et al.* (2015) value dimensions framework. The responses obtained from this section were based on a non-deliberated framework.

5.2.1. CV survey demographics

One of the consequences having to move the survey online was that the sample was not representative of the Knysna population.

Table 5.1: Socio-economic and demographic characteristics of the CV survey

Socio-demographic characteristics		**N**	**%**
Age	18-30	8	8
	31-40	7	7
	41-50	18	18
	51-60	23	23
	61-70	29	29
	> 70	15	15
Gender	Female	58	58
	Male	41	41
	I would prefer not to answer	1	1
Language	Afrikaans	11	11
	English	87	87
	German	1	1
	isiXhosa	1	1
Highest level of education	Apprenticeship or short course	4	4
	Diploma or degree	39	39
	Grade 12/matric completed	7	7
	I would prefer not to answer	2	2
	More than one diploma or degree	29	29
	Professional qualification	17	17
	School (no matric)	2	2
Occupation	I would prefer not to say	2	2
	Retired	45	45
	Other	2	2
	Unemployed	3	3
	Working	48	48
Household income	R2 000 - R5 000	1	1.06
	R5 001 - R10 000	3	3.19
	R10 001 - R15 000	11	11.70
	R15 001 - R20 000	9	9.57
	R20 001 - R30 000	7	7.45
	R30 001 - R40 000	9	9.57
	R40 001 - R50 000	9	9.57
	> R50 000	18	19.15
	I would prefer not to say	27	28.72

Of the sample reached, the highest proportion of respondents from the online CV survey were between the ages of 61 – 70 years old (29%) (Table 5.1[8]). This was followed by the age group 51-60 (23%). Figure 5.1. shows the distribution of age in the sample.

[8] Since the data in Table 5.1 were categorical data – some of which had inconsistent ranges – capturing the standard deviation of the data proved to be very difficult which provided skewed data.

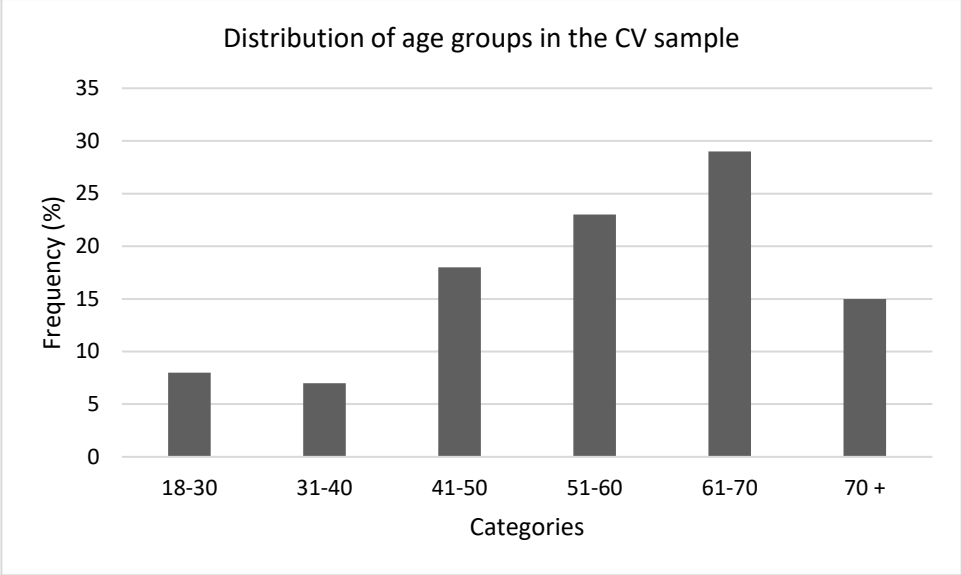

Figure 5.1: Age distribution of CV sample

Literature noted that the older a respondent, the less likely that they were willing to pay (Halkos and Matsiori 2012). In the context of this study, 67% of the respondents were over the age of 50 years old, and of these 44% were over the age of 60 years old. Although Halkos and Matsiori (2012) did not provide a specific age as to when the WTP started to decrease, their results showed a negative relationship between age and WTP. Based on the age categories of this study when compared to the age categories of the Knysna population, this study represented an older population (STATSSA 2019). Taking this into account, along with the findings from Halkos and Matsiori (2012), the respondents' WTP may be negatively influenced. In contrast to Halkos and Matsiori (2012), the correlation matrix of this study (Appendix VI) did not demonstrate a significant relationship between age and WTP.

Most of the respondents in the online CV survey indicated that they were female (58%). As noted in Chapter 2, the age and gender of respondents often prove significant factors for determining WTP. Concerning the gender variable, Dupont (2004) suggested that females generally state lower WTP values than males. Since this study had a female representation of 58%, WTP values may, too, be negatively influenced. As in the case of the correlation between age and WTP, the correlation matrix (Appendix VI) did not show a significant relationship between gender and WTP.

English (87%) was the most frequently spoken home-language in the online CV survey while there was one isiXhosa home-language speaker. Eleven percent of respondents indicated that their home-language was Afrikaans and an interesting home-language identified in the online CV survey was German (n=1). Besides Afrikaans, English, German and isiXhosa, no other languages were identified. These results differ from the broader Knysna population, where the most spoken home-language was noted to be Afrikaans, the second isiXhosa, and the third most spoken language was English (STATSSA

2019). In this regard, the Afrikaans and isiXhosa speaking populations were underrepresented in this study, and while the English-speaking community was overrepresented.

In terms of the highest level of education achieved, the highest proportion of the respondents stated that they had completed one diploma or degree in the CV survey (39%) and the second-highest percentage was more than one diploma or degree (29%) obtained. Based on these figures, approximately 68% of the sample population had completed a tertiary academic qualification, which differs from the education statistics identified in Chapter 3. According to the Knysna education statistics (STATSSA 2019), approximately 11% of the Knysna population had completed an education qualification higher than secondary school, which is significantly lower than the 68% identified in this sample. Therefore, the sample of people who had completed an education level of higher than secondary school is likely to be overrepresented in this study. Figure 5.2 shows the distribution of education groups across the CV sample.

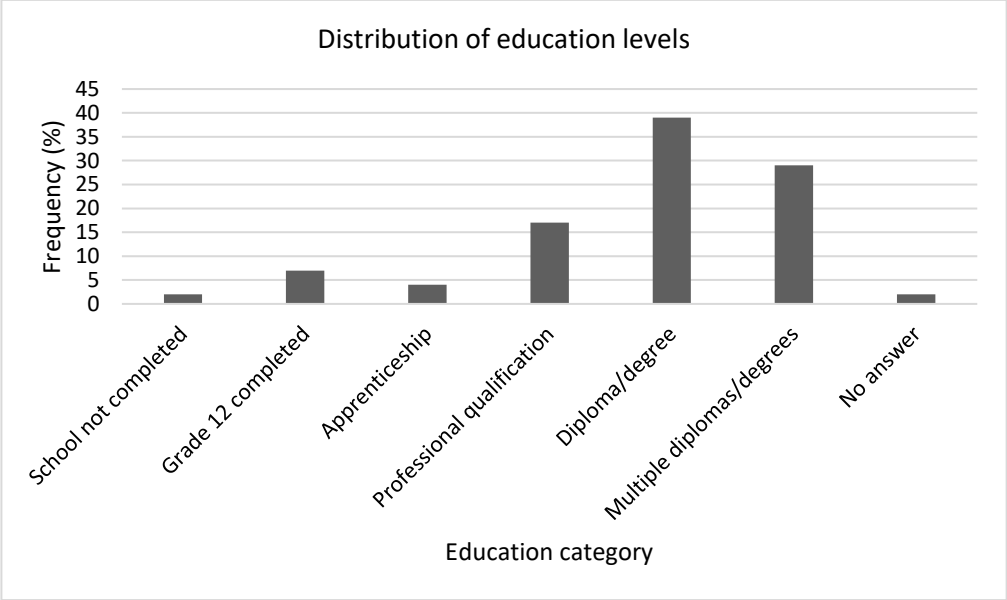

Figure 5.2: Education distribution of CV sample

An overrepresentation of respondents with a tertiary qualification may be an influencing factor when determining WTP. According to literature (Lindsey and Holmes 2002, Rowlands *et al.* 2003), education was found to have a positive relationship with WTP, where an increase in the number of education years was often correlated to an increase in WTP values a respondent stated (Arin and Kramer 2002).

The remaining responses of highest education level achieved were a professional qualification (17%), Grade 12/Matric completed (7%), an apprentice or short course (4%) and secondary education where matriculation was not achieved (2%). According to the education statistics of the Knysna population, approximately 37% of the population had not completed secondary school (STATSSA 2019) which is

significantly higher than the 2% of respondents recorded in this study. Based on this, it is likely that the population that has not completed secondary school was underrepresented in this study.

Most of the participants indicated that they were employed (48%) while the number of retired respondents was the second-highest category (45%). A high number of retired respondents correlates to the age of the respondents identified in this sample. Three (3%) respondents stated that they were unemployed in the CV survey. This figure is lower than the unemployment rate of 22.1% in the general Knysna population (STATSSA 2019), which suggests that the unemployed people were underrepresented.

Regarding household income, 29% of respondents in the CV survey indicated that they would prefer not to disclose their income. There were also six cases of missing data. Literature suggested that income is often used as a variable when determining WTP values (Moffat *et al.* 2011) in that higher incomes are often attributed to higher WTP values (Ofori and Rouleau 2020). However, since almost 30% of the sample did not disclose their income, using income as a determinant of WTP may prove difficult in this study.

Of the remaining 71% of the sample that responded to their monthly household income, the most frequent monthly household income was R50 000 or more per month (19.15%) and the next most frequent income range was between R10 001 – R15 000 per month (11.7%). The Knysna population per capita yearly income was R44 256 (WCG 2017). Since the survey asked the respondents to state their *household* monthly income, as opposed to *per capita* income, a comparison to the annual per capita income of the Knysna population was difficult. The Knysna income statistics also reported per capita income on a yearly basis, as opposed to a monthly basis as per the question in the survey. However, the results surmised that the sample represented a higher income group that the overall Knysna population. Figure 5.3 shows the distribution of income ranges obtained from the CV sample.

Based on the results discussed above, the sample demographics of the CV survey suggested that this sample represented the older, English-speaking, higher income and educated citizens rather than the general Knysna population. This is noted as a source of bias and a limitation of this study, as the sample in this study was not a representation of the socio-demographics in Knysna (STATSSA 2019). This can largely be attributed to the move to conducting online research for the questionnaires and a follow-up focus group meeting.

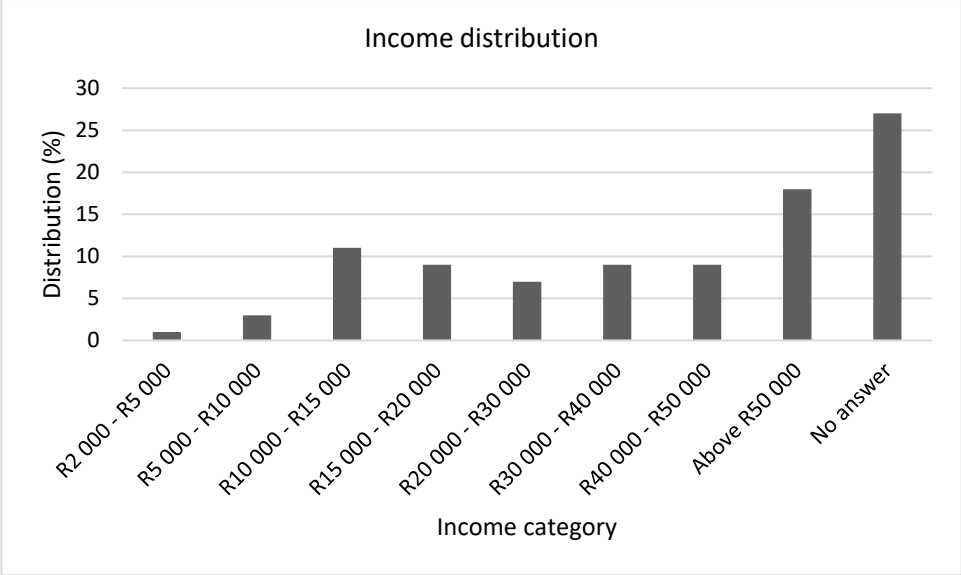

Figure 5.3: Income distribution of CV sample

5.2.2. Activities in Knysna

Respondents in the CV survey were asked questions regarding their utilisation of the Knysna estuary. Out of a sample of 99 respondents, 93% stated that they made use of the estuary. The omitted response was due to missing data. Figure 5.4 highlights their responses. The results show that the modal frequency for the utilisation of the estuary was for aesthetic pleasure (66%), followed by land-based (64%) and recreation (48%) activities. Several examples of responses recorded for the “Other” category were: “Occasional visits to the Heads and yacht club”; “Enjoying sunsets and beach walks”; and "[Conducting] water bird surveys".

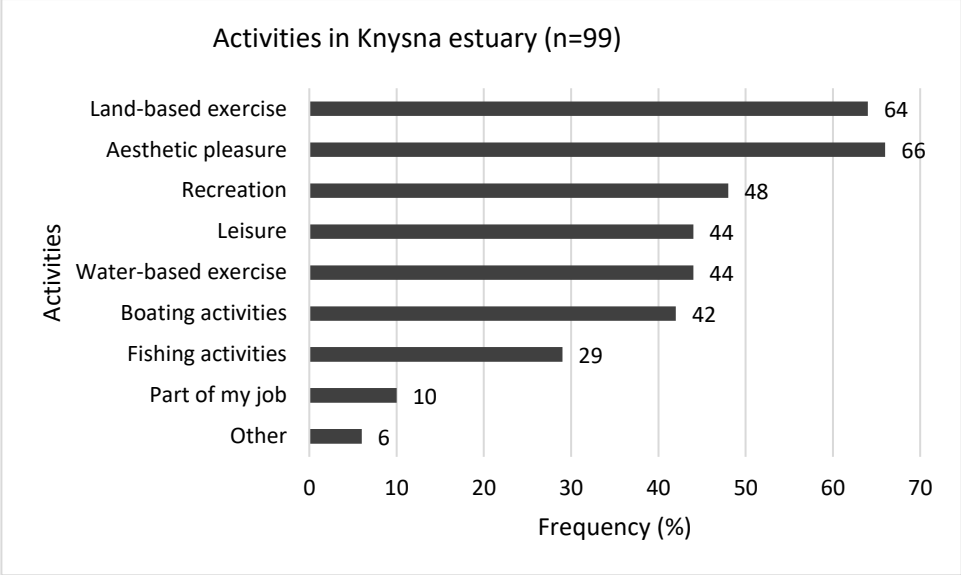

Figure 5.4: Activities in the Knysna estuary

Note: Respondents could indicate multiple uses, therefore percentages do not equal 100.

The purpose of asking the participants about their utilisation of the estuary was to ascertain the use values associated with the Knysna estuary, and to assimilate the foundations of the total economic (TEV) framework discussed in Chapter 2 (Pagiola *et al.* 2004). In the context of this study, two sources of value were identified. First was non-consumptive use-value (Perman *et al.* 2011), which included activities such as land-based and water-based exercise, boating activities and recreation, aesthetic pleasure and leisure. The second source of value was consumptive use-value (Badura *et al.* 2016, Boyd and Banzhaf 2007), which included activities such as fishing. The estuary was utilised in various ways, where most of the use-values associated with the utilisation of the estuary were non-consumptive use-values. Although raised in the online CV survey (Appendix II), issues related to the indirect use-values that seagrass ecosystems provide (Adams 2016, Dewsbury *et al.* 2016, Orth *et al*. 2006) were not surveyed.

A correlation matrix (Appendix VI) was generated from the survey data in accordance to the guidelines discussed in Chapter 4. The results from the correlation matrix analysed numerous relationships, one of which showed a moderate positive correlation between non-consumptive use and frequency of utilisation of the estuary (0.46). This relationship alluded that an increase in the frequency of use of the estuary resulted in an increase in the non-consumptive values of the estuary.

Further analysis was conducted to examine whether different socio-economic variables influenced the use activities of the estuary. In Table 5.2, data from the two most frequent occupation categories – from the retired and employed sample – were compared and two distinct differences were identified. Firstly, most of the retired respondents (84.44%) stated that they utilised the estuary for aesthetic

appeal, where only 56.25% of the employed sample utilised the estuary for aesthetic appeal. Secondly, 60% of the employed sample utilised the estuary for recreation, which was almost double that of the retired sample (35.56%).

Besides these two findings, and despite the large number of retired respondents in this sample, the findings show that, for the most part, the use activities between the occupation groups do not differ significantly. Therefore, the bias of having many retired participants in this study was not significantly affected by the use activities.

The use activities of the estuary were further analysed in terms of income categories and Table 5.3 describes the activities in the estuary that were separated amongst income groups. The data only included the use activities of that part of the sample that disclosed a monthly household income and, since 29% of the sample did not disclose their income, the results in this table may be skewed.

Table 5.2: Relationship between estuary utilisation and occupation

Activity	Occupation	
	Retired (N=45) (%*)	**Employed (N=48) (%*)**
Fishing	14 (31.11)	15 (31.25)
Water-based activities	18 (40)	23 (47.92)
Aesthetic appeal	38 (84.44)	27 (56.25)
Land-based activities	28 (62.22)	33 (68.75)
Leisure	18 (40)	23 (47.92)
Boating	20 (44.44)	21 (43.75)
Work related	2 (4.44)	8 (16.67)
Recreation	16 (35.56)	29 (60.42)
Other	4 (8.90)	2 (4.17)

*Note: * Percentage calculated from use activity divided by number of respondents. Therefore, it does not equal to 100.*

The data were organised into income categories[9], which included lower, middle- and higher-income groups. The use activities that the respondents elicited were computed according to their income. The results show that income did not significantly influence the use activities associated with the estuary, besides for two distinct findings. The first finding was that 62.96% of higher-income households utilised the estuary for boating activities, which was more than double the use frequency of middle- and lower-income households. This may be due to the excess expendable income available to purchase and utilise motorboats that higher-income households possess. The second finding was that lower-income households utilise the estuary more for aesthetic appeal (80%) than the other income categories. However, besides these two findings, there was no distinct difference between use-values and income categories in this study.

5.2.3. Knowledge about and interest in the environment

In this section, the respondents were asked questions regarding their knowledge of the natural environment and seagrass ecosystems. The purpose of asking these questions was to determine the level of knowledge that respondents had of the natural environment, and whether the level of knowledge obtained from the respondents resulted in a change in the WTP value estimated by the respondents. As identified in Chapter 2, higher WTP values tend to be associated with higher levels of environmental awareness (Ofori and Rouleau 2020, Turpie 2003).

[9] It is noted that the income categories for the study sample do not represent the income categories of the Knysna population at large.

Table 5.3: Relationship between the utilisation of the estuary and income categories

Activity	Monthly household income**		
	Higher-income (N=27) (%*)	**Middle-income (N=25) (%*)**	**Lower-income (N=15) (%*)**
Fishing	11 (40.74)	7 (28)	6 (40)
Boating	17 (62.96)	7 (28)	5 (33.33)
Recreation	14 (51.85)	10 (40)	8 (53.33)
Aesthetic	15 (55.56)	13 (52)	12 (80)
Leisure	12 (44.44)	8 (32)	7 (46.67)
Land	16 (59.26)	12 (48)	9 (60)
Water	15 (55.56)	14 (56)	5 (33.33)
Job	0	4 (16)	4 (26.67)
Other	1 (3.70)	2 (8)	0

*Note: * Percentage calculated by dividing activity by number of respondents. Therefore, total does not equal 100. ** Income categories: higher-income R40 001 – >R50 000; middle-income R15 001 – R40 000; lower-income R2 000 – R15 000.*

A notable limitation of the CV method discussed in Chapter 2 was that, if respondents do not know the good or service they were being asked to value, the WTP amounts they state may not be reliable (Arrow *et al.* 1993, Atkinson *et al.* 2012, Carson 2012). Therefore, in asking questions related to their knowledge under which the study is situated serves as an indicator towards the WTP responses discussed later in the text.

a) General awareness and interest in nature

The respondents were asked whether they had previously heard of the term "ecosystem services" and it was ascertained that more than half of the sample (52%) had not. Since the context of the study was situated on the ecosystem services provided by seagrass to the Knysna community, this finding was of importance, as it demonstrated that more than half of the sample were not familiar with a main driver of the study. This finding was corroborated by the limitation of CV studies, where participants are often under-equipped to answer valuation questions based on unfamiliar or complex environmental resources (Arrow *et al.* 1993, Atkinson *et al.* 2012, Carson 2012).

The respondents were asked self-rated questions based on their familiarity with seagrass ecosystems and their knowledge of nature. They were asked to rate how confidently they would be able to identify the plant seagrass on a scale of 1-5, with one being not confident and five very confident. The results showed that the modal frequency of confidence for identifying seagrass was one (23%); which was equated as not confident. This was followed by a confidence rating of four (22%) and a confidence rating of two (20%). Only 19% of the respondents stated that they were very confident (a rating of five) that they were able to identify the plant seagrass. Despite 85% of the respondents stating that

they had heard of seagrass, almost half (43%) of the respondents had a self-rated identification of two or less for seagrass, suggesting that the respondents were not knowledgeable of the environmental resource under discussion in the study. The reduced number of the respondents' ability to recognise or identify an environmental resource is similar to the results obtained from the WTP study of fynbos by Turpie (2003), where the study found that, although 72% of the sample stated that they had heard of fynbos, only 41% were able to confidently recognise the plant.

The respondents were then asked about their knowledge of the natural environment, and how nature can benefit their livelihoods through rating their level of knowledge of the natural environment on a ranking scale of 1-5 with one being not knowledgeable and five very knowledgeable. Forty-two percent of the respondents rated their knowledge of the environment a value of four; which was equated to reasonably knowledgeable. A further 19% rated their knowledge of the environment at five, which equated to very knowledgeable. Therefore, almost two-thirds (61%) of the sample had a high self-rated knowledge of the environment. Based on this finding, a sample that demonstrated a high rating of environmental awareness should correlate to positive WTP. Turpie (2003), once more, found that 36% and 15% of their sample had an active or passionate interest in nature, respectively.

b) Utilisation of the estuary

The respondents were asked how often they utilised the estuary. The results showed that the modal frequency of the extent that the estuary was utilised was 2-3 times per week (24.74%). This was followed by once a month (19.15%), while every day and once every two weeks had the same response rate (15.46%).

Cross-tabulation was used to compare the respondents' confidence in identifying seagrass and their knowledge of nature to the use frequency of the estuary. It was expected that the more frequently the respondents utilised the estuary, the more likely they would be able to identify seagrass confidently, and the more likely they would have a high rating of their knowledge of nature. Table 5.4 shows a cross-tabulation of the sorted and averaged responses provided by the respondents, concerning the frequency of use of the estuary, self-rated confidence in identifying seagrass and self-rated knowledge of nature.

The results show that the highest average for the confidence in identifying seagrass was 3.91/5 for respondents who stated that they used the estuary five or more times a week. This was followed by a rating of 3.2/5 for respondents who stated that they utilised the estuary every day. The lowest confidence for identifying seagrass was a rating of 1/5, which was provided by the respondents who stated that they never used the estuary. As expected, the higher the frequency of estuary utilisation, the higher the value of confidence for identifying seagrass. These variables, however, showed a weak

positive correlation between the utilisation of the estuary, and the confidence a respondent had in identifying seagrass (0.20) (Appendix VI). A weak positive correlation suggested that the utilisation of the estuary does not necessarily increase the ability and confidence of respondents to identify seagrass.

As expected, results show that the more frequently the estuary was utilised, the more knowledgeable respondents rated their environmental knowledge. The results show that the highest average for a respondent's knowledge of the natural environment was from respondents who utilised the estuary every day (4.2). This was followed by respondents who utilised the estuary five or more times a week (3.91). The lowest rating of the knowledge of the natural environment was from respondents who never used the estuary (3).

Using the correlation matrix from Appendix VI, a weak positive correlation (0.29) was determined between the utilisation of the estuary and the knowledge of nature respondents manifest. This suggests that an increase in the usage of the estuary would yield a moderate positive increase in the respondents' self-rated knowledge of nature.

Table 5.4: Knowledge about and interest in the environment

Use frequency	**N**	**Identify seagrass confidence average (1-5)***	**Knowledge of nature average (1-5)****
Every day	15	3.2	4.2
Five or more times a week	11	3.91	3.91
2-3 times a week	24	2.75	3.71
Once a week	10	2.8	3.53
Once every two weeks	15	2.93	3.4
Once a month	18	2.89	3.5
Never	4	1	3

*Notes: * Averaged ranking scale; 1 not confident; 5 very confident. ** Averaged ranking scale; 1 not knowledgeable; 5 very knowledgeable.*

Table 5.4 above shows that respondents who stated that they never used the estuary exhibited the lowest rating in both their confidence for identifying seagrass, as well as the lowest rating for their knowledge of ecosystem services. This finding is supported by literature (Tietenberg and Lewis 2020), where the effects of hypothetical bias decrease when the respondent is more familiar with the environmental good or service under discussion. To discern whether these findings are statistically significant, a regression was conducted which is discussed in Section 5.2.6.

Although the variables between the utilisation of the estuary and the identification of seagrass and knowledge of nature do not hold strong correlations, a moderate positive correlation (0.50) was identified between the self-rated confidence of identifying seagrass and the knowledge of nature

(Appendix VI). This means that, holding all other variables constant, an increase in the confidence a respondent elicits in identifying seagrass showed an increase in the knowledge of nature stated by the respondent. Turpie (2003) also found a positive correlation between the knowledge of the environmental resource under discussion and the respondents' interest in nature.

5.2.4. Valuation scenario

The respondents were provided with a short text of the definition of ecosystem services, what seagrass ecosystems were and a hypothetical scenario, which was discussed in Chapter 4. The respondents were then asked several questions about the scenario, including a WTP question. The *a priori* expectations were that:

1) The greater concern a respondent elicited of the effects of eutrophication on seagrass health, the higher the WTP response would be; and
2) The higher the importance rating provided by the respondent for monitoring practices, the higher the WTP response would be.

The first question the respondents were asked related to their concern for the damage caused to the seagrass by leaking sewerage, on a scale of 1-5, with one being little concern and five being great concern. This question was asked to determine whether the reason behind a respondent being willing to pay was based on a genuine value, or the warm glow effect (Arrow *et al.* 1993). The results (illustrated in a cross-tabulation table in Table 5.5) show that 70.70% of the respondents stated a concern of five, which was followed by a value of four (23.23%). It is noted that zero respondents stated a value of one. Therefore, approximately 94% of the respondents stated a concern value of four or above, which suggested that the respondents were highly concerned about seagrass being damaged by leaking sewerage.

The second question asked the respondents to rate their opinion on the importance on the monitoring of the estuary to assist with seagrass health (Table 5.5). The question asked the respondents to rate the level of importance of monitoring on a scale from 1-5, with one being not important and five being very important. The results show that 74.49% of the respondents stated an importance value of 5 for monitoring practices to be conducted in the estuary for seagrass health, and 17.32% stated a value of four. Therefore, approximately 91% of the respondents stated a score of 4 or above for the importance of monitoring practices to be conducted in the estuary.

Table 5.5: Valuation scenario ratings

Rating	Concern that seagrass was damaged (n=99) (%)	Importance of monitoring practices (n=98) (%)
1	0	0
2	2.02	2.04
3	4.04	6.12
4	23.23	17.34
5	70.70	74.49

The correlation matrix (Appendix VI) highlighted a strong positive correlation (0.67) between the concern a respondent expressed towards seagrass damage and the importance of monitoring. This correlation is significant, as it indicated that the scenario – that of monitoring services in the Knysna estuary to reduce the effects of eutrophication on seagrass – showed some validity in that the respondents who expressed great concern for the damage of seagrass caused by eutrophication also rated a high importance value for monitoring services to be conducted.

The next question that the respondents were asked was the valuation question. The respondents were provided with the following question before they answered whether they were willing to pay an additional tax:

> *"Monitoring practices conducted in the estuary will likely reduce the probability of another sewerage leak from occurring. This may assist with seagrass health, and therefore the ecosystem service benefits that they provide. Keeping in mind that this is based on a hypothetical scenario, as well as considering your budget constraints (i.e. your household expenditure and other things you may want to spend the money on), would your household be willing to pay an additional monthly tax to the Knysna Municipality for monitoring practices to be conducted in the estuary? The tax would be ring-fenced (made sure that the money will not be used for anything else) and the proceeds would go straight to the NGO."*

Although 94% of the respondents stated a concern value of four or above for the damage that leaking sewerage has on seagrass (Table 5.3), and 91% of the respondents stated a value of four or above for the importance of monitoring practices to be conducted in the estuary (Table 5.5), just over half (n=56) of the respondents stated that they would be willing to pay an additional monthly tax to fund monitoring services in the Knysna estuary to reduce the effects of eutrophication on seagrass (n=100). The *a priori* expectations were that, since a large percentage of respondents provided high values of concern and importance for the damage of seagrass and monitoring respectively, there would be a higher WTP response. This finding contradicts the findings in Togridou *et al.* (2006), where they

reported that higher levels of concern expressed by respondents resulted in higher incidences of WTP responses.

Other environmental valuation studies found higher WTP responses, such as 76% in Turpie (2003), 72% in Lo and Jim (2015) and 70% in Enriquez-Acevedo *et al.* (2018). In comparison to these environmental valuation studies, this study has a relatively low WTP response.

The respondents were asked a question regarding their opinion on whose responsibility it was to ensure that the estuary is managed sustainably in Knysna (Table 5.6). Since the ecosystem services that seagrass provides to the Knysna community are public goods (Costanza *et al.* 2014, de Groot *et al.* 2002, Kretsch *et al.* 2016, Pagiola *et al.* 2004), the opinion on the responsibility of managing the public good has been noted to impact respondents' WTP (Jorgensen *et al.* 2001). The results were tabulated along with the response of whether respondents were willing to pay for monitoring practices.

The results indicated that 49% of the respondents stated that government-endorsed environmental management organisations should be responsible for managing the estuary. Lo and Jim (2015) found a similar result, where 75% of their sample believed that the government should be responsible for protecting the environmental public good under discussion in their study. Since seagrass – and the associated ecosystem services – in the Knysna estuary is a public good, the findings in this study corroborate with the findings by Lo and Jim (2015), where most of the respondents in both samples believed that government agencies should be responsible for managing public goods.

Of the total that thought it was the responsibility of government-endorsed environmental organisations to manage the Knysna estuary, 57.14% of these respondents stated that they would not be willing to pay a tax for monitoring practices. Concerning the correlation between these variables, a moderate negative correlation (-0.26) was identified, meaning that, if respondents were of the opinion that government-endorsed agencies should manage the estuary they were less likely to be WTP (Appendix VI).

Table 5.6: Opinion of the responsibility for managing the estuary and willingness to pay

Responsible party	**N**	**WTP Yes (%)**	**WTP No (%)**	**Correlation**
Government-endorsed organisations	49	42.86	57.14	-0.26
Non-government-endorsed organisations	9	77.78	22.22	0.05
The Knysna Municipality	22	63.64	36.36	0.08
The residents of Knysna	9	88.89	11.11	0.21
All the above	9	66.67	33.33	0.07
Other	2	0	100	-0.16

Jorgensen *et al.* (2001) cautioned that opposition in WTP might be due to the perceptions of the respondents regarding the conservation or management of public goods. They suggested that respondents may not be willing to contribute additional funds for public good improvements because they believe that the government should be responsible for managing that resource (Jorgensen *et al.* 2001). The Knysna Municipality was the second most frequently stated responsible organisation for managing the estuary and had the second-lowest positive WTP bids (63.64%) after government-endorsed organisations (42.86%). The Knysna Municipality is an entity of the government, so the findings of Jorgensen *et al.* (2001) in terms of the fact that WTP bids may be affected by the opinion that the government should manage public goods also holds true in this regard.

The respondents who were not willing to pay were asked several follow-on questions to determine the reasons. Following literature (Cho *et al.* 2005) and the guidelines in Chapter 4, protest responses and genuine zero-bidders were sorted. As discussed in Chapter 2, protest bids are cases where the respondent rejects some aspect of the valuation scenario, which includes a dislike of the payment vehicle, a lack of information about the study, or the contingent valuation scenario itself (Spash 2007, Szabo 2011, Tietenberg and Lewis 2020). Based on this, a low WTP response could be associated with the respondents' rejection of the payment vehicle, the hypothetical scenario or, alternatively, a genuine zero bid elicited by the respondents (Spash 2007, Szabo 2011, Tietenberg and Lewis 2020).

Of the 44 respondents who stated that they were not willing to pay a tax for monitoring practices to be conducted in the estuary, 46% believed that they already paid too much tax. Nine percent of the respondents believed that other people or organisations should be responsible. These zero bid responses were considered to be genuine zero bids.

Of the potential protest bidders, respondents stated their reasons for their non-willingness to pay response in the option "Other". Thirty-four percent believed that paying a tax would not make a difference to the state of the estuary, thus rejecting the valuation scenario. A further 25% of the respondents criticised the Knysna Municipality for the mismanagement of funds as their response for an unwilling to pay, thus rejecting the proposed payment vehicle. Two responses related to the criticism of the Knysna Municipality were:

> *"It is unlikely that the money raised will be used effectively for the purpose intended but will be swallowed up in administrative costs"; and*
>
> *"If funds were paid to the Muni' (even if ring-fenced) due to the corrupt way tenders and projects are issued, the project would not achieve its intended goal".*

Another 14% believed that monitoring services might not be the correct strategy for ensuring the health and maintenance of seagrass ecosystems in the estuary. One respondent stated:

"Monitoring does not equal action".

Therefore, 17 (36%) of the respondents credited their non-willingness to pay response as mistrust in either the payment vehicle or the hypothetical scenario.

These variables correlated to the "mistrust" variable used in the correlation matrix, coded as 1 if the reasons for the WTP response indicated a rejection of the scenario or the payment vehicle. A moderate negative correlation between WTP and mistrust (-0.51) was reported. This correlation suggested that an increase in mistrust in the payment vehicle (a monthly tax paid to the municipality) or the hypothetical scenario (monitoring services) correlated with a decrease in the respondents' willingness to pay any amount toward the proposed monitoring service.

Since the respondents could choose more than one option, several responses overlapped. Therefore, if a respondent stated that they paid too much tax, but also stated a mistrust in the municipality, a mistrust in the effectiveness of monitoring services or that paying a tax would not make a difference to the estuary, they were considered to be a protester. Based on this, a total of 25 (or 56.82%) of the 44 respondents who stated a non-willingness to pay response were considered to be protesters. In relation to the sample as a whole, 25% of the WTP responses were protest responses, which does not differ greatly compared to other environmental valuation studies.

In a meta-analysis, Meyerhoff and Liebe (2010) reported that the mean protest response of 35 environmental valuation studies related to the conservation of nature/biodiversity was 21.04%. Similar protest response means were later reported in Szabo (2011) at 29%. These studies confirm that a protest response of 25% in this study is not significantly higher than reported protest responses in other valuation studies.

5.2.5. Valuation question

This section discusses the values associated with those respondents who stated that they were willing to pay for monitoring practices. The respondents who stated that they would be willing to pay a monthly tax to the Knysna Municipality were asked to answer a series of questions to establish the amount they were willing to pay, as well as their reasons for their stated value.

In the first question, the respondents were asked to state a WTP value for the monitoring of the Knysna estuary. The respondents were reminded of their budget constraints and that the question was based on a hypothetical scenario. Since CV surveys are based on hypothetical markets (Chee 2004, Snowball 2007), the respondents would not be held liable for their preferences. To reduce the effects of hypothetical bias (Tietenberg and Lewis 2020), reminding the respondents about their budget

constraints makes them consider their financial responsibilities before eliciting a WTP value (Daly *et al.* 2015).

The question required the respondent to select a value that their *household* would be willing to pay and not an individual WTP value. The respondents were presented with a payment card with values that ranged from R0 – R1 500. Figure 5.5 highlights the frequency of the values that the respondents elicited. The values elicited were contextual values, as per the Kenter *et al.* (2015) value dimensions framework.

Of the 56 respondents who stated a positive WTP bid for monitoring services, 53 WTP values were provided which are highlighted in Figure 5.5. The values elected ranged from R10 as the minimum value elicited to R500 as the highest WTP per month value elicited. The results show that the modal frequency for the payment amount was R100, where 31% of the respondents elected to pay this value per month. This was followed by WTP values of R50 (24%) and R200 (15%). The mean value elicited was R131.69, where the median and mode values were both R100, respectively. At the time of this study (December 2020), the exchange rate of the United States Dollar to the South African Rand was USD$1 to ZAR15.28.

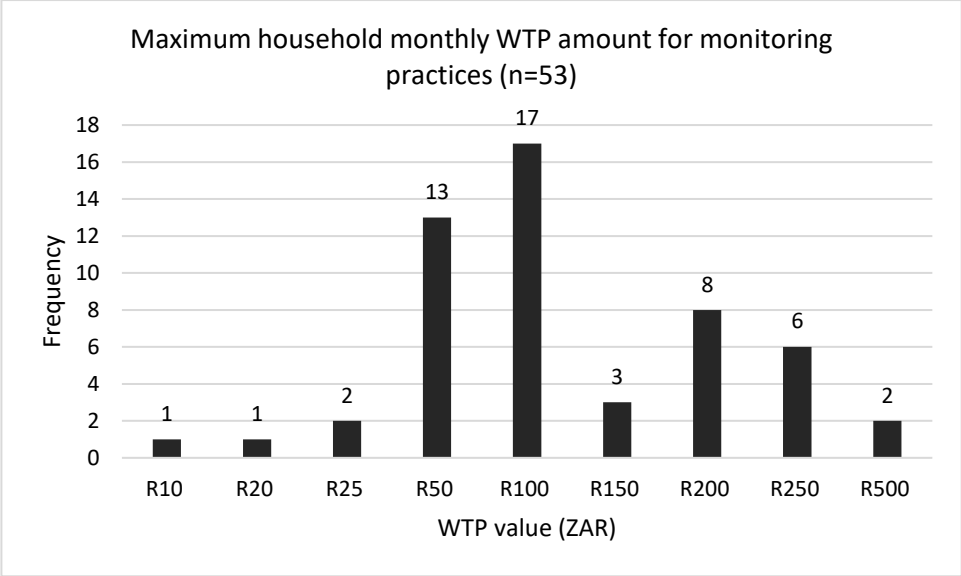

Figure 5.5: Reported maximum WTP amounts and frequency of choices

Note: Zero bids were not included in the figure.

Further analysis of the WTP values was conducted on the relationship that income, education and frequency of use had on WTP values. Table 5.7 shows the relationship between the income categories of the respondents and their stated a WTP value. The data shows that, in general, as the household income level increased, the approximate proportion of income the respondent stated they were willing to pay decreases. Considering this, although the mean WTP for the income category of R2 000

– R5 000 was R50, the WTP value in proportion to their income was 1.4%. This is compared to the mean WTP value of R122.91 for the income category of above R50 000, where the proportion of WTP to income was only 0.24%. The findings of the current study are congruent with literature in that both studies found, although respondents with higher household incomes often state higher WTP values, the proportion of the WTP amount in relation to their income is often lower than households with lower household incomes (Baumgärtner *et al.* 2016).

Table 5.7 also shows the range of the WTP bids per income category. As shown in Figure 5.5, the range of WTP bids ranged from R10 to R500. By showing the range of the WTP bids elicited, warm glow and unrealistically high WTP bids could be identified. A warm glow bid, in the context of this table, was a WTP bid that was unrealistically high compared to the mean WTP, which could skew the results. The two values of R500 were identified as warm glow bids (Figure 5.5), since these values were double that of the next greatest value elicited.

Table 5.7: Relationship between income and willingness to pay

Income category	**N**	**Maximum WTP (ZAR) (protest bid removed)**	**Minimum WTP (ZAR)**	**Mean WTP (ZAR) (protest bid removed)**	**WTP as percentage of HH income ****
R2 000 - R5 000	2	50	50	50	1.4
R5 000 - R10 000	2	50	50	50	0.67
R10 000 - R15 000	7	200	20	131.42	1.05
R15 000 - R20 000	4	100	10	52	0.30
R20 000 - R30 000	4	200	50	150	0.6
R30 000 - R40 000	9	500* (250)	25	147.22 (103.15)	0.42 (0.30)
R40 000 - R50 000	5	250	50	130	0.29
Above R50 000	11	250	25	122.91	0.24
No answer	9	500* (250)	50	155* (116.67)	*n/a*

*Notes: * Identified warm glow bid; ** To calculate the WTP percentage of household income, the household income categories were aggregated, then divided by the mean WTP values.*

Several characteristics influenced the WTP amounts. Table 5.8 highlights the relationship between education and willingness to pay. The table shows that, on average, the higher the education level of the respondent, the higher the WTP amount elected. For instance, an education qualification of more than one diploma or degree had an average WTP amount of R158, whereas an education level of school without matriculation had an average WTP amount of R100. This finding was supported by literature, where multiple studies (Ofori and Rouleau 2020, Risen *et al.* 2017, Wan *et al.* 2017) found that an increase in the number of years in education, in general, increases the WTP bid. To validate

this finding, the data were tested through a regression to determine whether the variables were statistically significant. This is further discussed in Section 5.2.6.

Table 5.8: Relationship between education and reported WTP amounts

Education level	N	WTP No (%)	WTP Yes (%)	Mean WTP (ZAR)*
I would prefer not to answer	2	50	50	50
School (no matric)	2	0	100	100
Grade 12/matric completed	7	57.14	42.86	120
Apprenticeship or short course	4	50	50	60
Professional qualification	17	47.37	52.94	122
Diploma or degree	39	61.54	38.46	111.66
More than one diploma or degree	29	27.59	72.41	158

*Note: * Mean WTP values were calculated by aggregating only positive WTP responses per education level category. Results in table only include WTP values of those who indicated WTP.*

Regarding the frequency of use of the estuary and WTP, the literature identified confounding results. Figure 5.6 shows that there were higher incidences of a respondent being willing to pay the more often they utilised the estuary. The findings obtained in this study are congruent with the findings in Caula *et al.* (2009), where they found that an increase in the frequency of use of an environmental good also increased the willingness to pay amount associated with the good.

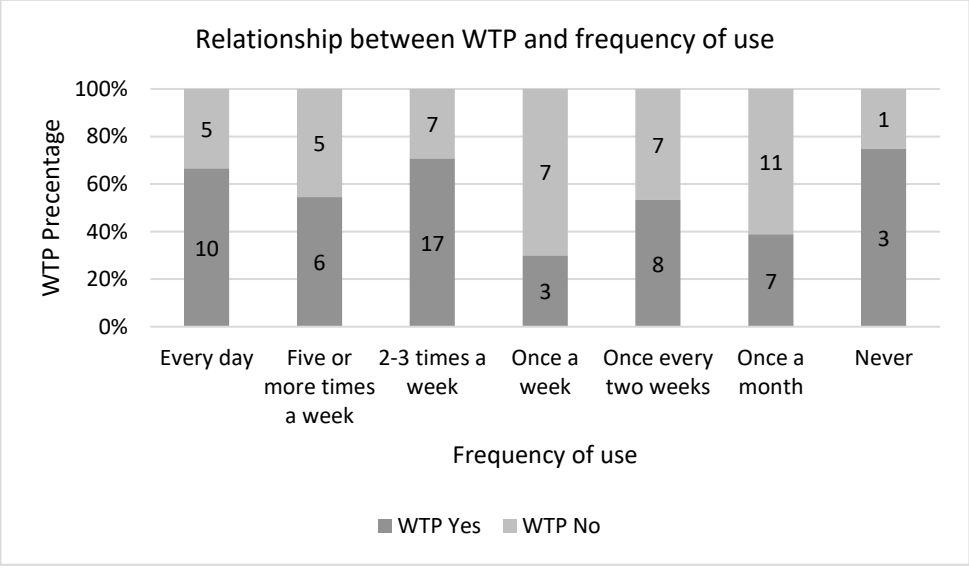

Figure 5.6: Variation in WTP and frequency of use of the estuary

Figure 5.7 shows the different WTP averages associated with the utilisation of the estuary. A trend line was included in the dataset, which shows that, on average, as the utilisation of the estuary increased, so did the WTP amounts the respondents selected. This finding is correlated to the findings in Figure 5.6, which suggested that, as the frequency of use increased, so did the WTP response.

Figure 5.7 shows that respondents who stated that they utilised the estuary every day were willing to pay, on average, R93.75 per month towards the monitoring programme. This is compared to respondents who stated that they utilised the estuary only once a month were willing to pay, on average, R44.12 per month for the monitoring programme. This finding is consistent with Caula *et al* (2009), Leng and Lei (2011) and Schindler *et al.* (2018), who identified that an increase in the frequency of utilisation of the environmental resource under consideration resulted in greater WTP values. This finding is discussed further in a statistical analysis in Section 5.2.6.

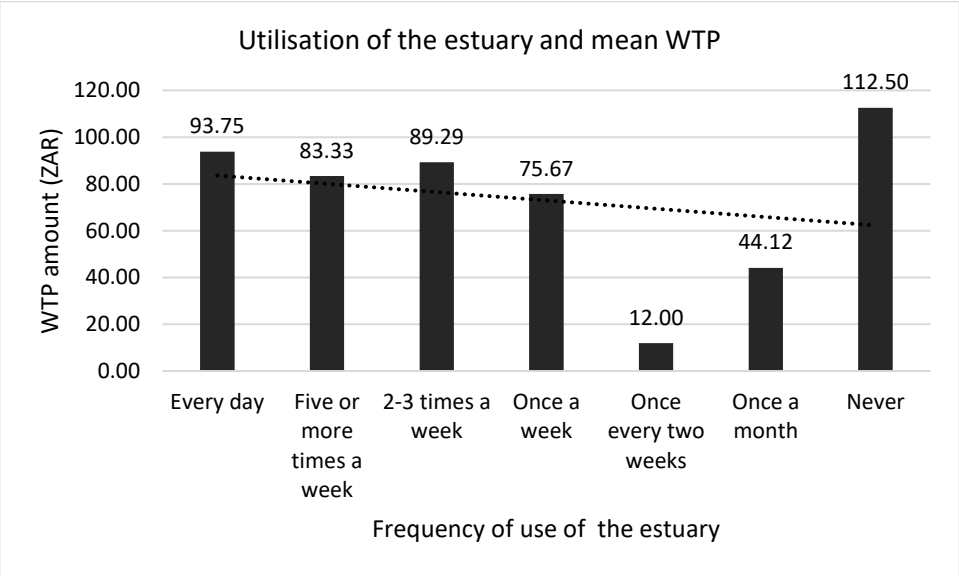

Figure 5.7: Utilisation of the estuary associated with WTP amounts

Note: Zero bids were included in the results.

As in Table 5.7, there were discrepancies with this dataset. There was a weak positive correlation between the utilisation of the estuary and the respondents' willingness to pay any amount (0.12). This may be due to a notable discrepancy in the data where respondents who said that they never used the estuary, stated that they were willing to pay the highest amount for monitoring services, at a mean amount of R112.5 per month. Hypothetical bias may have influenced these respondents to state an unrealistic WTP amount for monitoring services. Alternatively, the people who did not utilise the estuary expressed high non-use values of the estuary, such as bequest and existence value (Boyd and Banzhaf 2007, Perman *et al.* 2011), and therefore were willing to pay higher amounts than those individuals who utilised the estuary. A limitation of this study was that bequest and existence values were not explored.

The respondents were then asked a follow-on question to determine their reason for selecting the WTP amount. Table 5.9 highlights the results, where a noteworthy result was over 10% of the responses from this question were from the category "It was a random amount". In this regard, there

is credible evidence of hypothetical bias, where the hypothetical scenario presented to the respondent was not realistic, and therefore the respondent stated a value which cannot be justified. If hypothetical bias was evident in this study, then the WTP value elected may not be valid (Tietenberg and Lewis 2020). However, on the other hand, the remainder of the responses (about 90%) in Table 5.9 indicated that the respondents had rationally considered the scenario, as well their budget constraints, by electing a valid motive for their WTP elicitation. This may suggest that, for the most part, hypothetical bias may not have influenced respondents' WTP amounts.

Table 5.9: Elaboration on WTP amount selected

Why did you choose this amount? (N=56)	**%**	**Mean WTP (ZAR)**
If everyone in the municipality paid this amount, I think it would cover the expenses of this initiative	44.64	104.0
It is the most I am willing to spend on environmental issues	3.57	200.0
It is the most I can afford to pay based on my budget constraints	32.14	172.8
It was a random choice	10.71	100.0
The amount is an accurate representation of the value that I perceive seagrass ecosystem services to have	1.79	100.0
The impact of eutrophication on the seagrass may impact my livelihood, so this is the amount I agreed upon	1.79	100.0
Other	5.36	*n/a*

Taking into account the socio-economic characteristics of the sample – a mostly English-speaking, highly educated and high mean monthly income population – and the socio-demographics of the Knysna population in Chapter 3, a mean monthly WTP value was calculated to accommodate for the sample used in this research. The value was calculated from data obtained in Chapter 3 by multiplying the number of Knysna households by the percent of which were classified as higher income residents, which was then multiplied by the median WTP value from this study. The WTP value from this sample was equated to be R374 000 per month for monitoring services for households that had similar socio-economic characteristics to those in this study. Therefore, if only the individuals with similar socio-economic characteristics in the Knysna community paid the median amount, R100 per month, then R374 000 would be raised for monitoring services within the Knysna estuary. This value can be used for a cost-benefit analysis.

5.2.6. Statistical analysis of willingness to pay

There were 96 observations used for this regression. It is noted that four observations were omitted, because of missing data, from the regression, which may have had a resultant impact on the final findings of the regression. The OLS regression was performed to interrogate the relationship between

the determinants that influenced the respondents' willingness to pay (Equation 5.1). The following model was run:

$$Yi = \beta 0 + \beta 1X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5 + \beta 6X6 + \beta 7X7 \quad (5.1)$$

where *Yi* = WTP amount (ZAR per month); *β0* = constant; *β1X1* = education level; *β2X2* = age; *β3X3* = confidence in identifying seagrass; *β4X4* = knowledge of ecosystem services; *β5X5* = use frequency; *β6X6* = non-use value; *β7X7* = mistrust. The results of the OLS regression are tabulated in Table 5.10 and are discussed below[10].

Concerning the statistical testing, the probability of the F-statistic was highly significant (at the 1% level), meaning that the model was significant overall, which explained that the independent variables were effective in explaining the dependent variable. The model also ran a Durbin-Watson test, which had a statistic value of 1.9. A value close to two, in this case, 1.9, means that there is no autocorrelation present in the regression (Oliver and Gujarati 1993). The model had an adjusted R-squared of 0.14. This means that the independent variables that were used in this model are associated in explaining 14% of the variation of the willingness to pay values for monitoring services that were used in for this study.

The regression was divided into three main categories. The first dealt with the individual characteristics with the variables of education and age. The second covered the respondents' environmental knowledge, with the variables relating to the confidence in identifying seagrass and the respondents' knowledge of ecosystem services. The third category considered use variables, with the use frequency of the estuary and the non-use values respondents obtained from the estuary. A variable labelled "mistrust" was also included in the regression.

The regression results showed that, holding other variables constant, there was a positive significant (at the 5% level) relationship between WTP value and education (Table 5.10). This explained that an increase in one level of formal education was associated with an increase of R14.85 in WTP value, holding all other variables constant at their mean. This finding was also supported by literature, where it was identified that education often positively affects willingness to pay amounts (Arin and Kramer 2002, Ofori and Rouleau 2020, Risen et al. 2017).

[10] It is noted that only the CV survey sample was included in the OLS statistical regression due to the fact that the DMV sample size was too small to be statistically analysed. This will be further expanded upon in the following section.

Table 5.10: Regression results of OLS model on WTP determinants (n=96)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	86.32225	54.31371	1.589327	0.1156
Education	14.85731	7.759429	1.914743	0.0588**
Age	-10.93294	6.597761	-1.657068	0.1011*
Identify seagrass	3.401174	7.755333	0.438559	0.6621
Knowledge of ES	-16.04743	11.60690	-1.382577	0.1703
Use frequency	10.15771	5.819072	1.745589	0.0844*
Non-use value	-27.98585	22.45063	-1.246551	0.2159
Mistrust	-82.82657	25.30893	-3.272623	0.0015***
Adjusted R-squared	0.145342			
Prob(F-statistic)	0.003591***			
Durbin-Watson stat	1.907297			

*Notes: Significant: * at the 10% level; ** at the 5% level; *** at the 1% level.*

Concerning the age of the respondents, despite the relationship shown between age and WTP in the correlation matrix (Appendix VI), a statistically negative significant (at the 10% level) relationship with WTP value was identified in the OLS regression. The relationship showed that an increase in one level of a respondents' age group was associated with a decrease of R10.93 in WTP, holding all other variables constant with their mean. This finding was corroborated by Halkos and Matsiori (2012) where they found that increasing age resulted in diminishing WTP bids. Wan *et al.* (2017) also alluded that younger people were more likely to be supportive of spending additional income on an environmental protection programme compared to older people.

The independent variable for the confidence in identifying seagrass showed a positive, but highly insignificant relationship (0.66) with the amount that a respondent was willing to pay. A weak positive correlation between confidence in identifying seagrass and the utilisation of the estuary was noted above (Appendix VI). This result, as with the correlation matrix, was not expected. It was expected that, as the confidence in identifying seagrass increased, so would the WTP amount associated with monitoring services to protect the seagrass. This was due to the respondents knowing what the environmental good or service was for which they were paying to protect and monitor. The literature identified that, the more a respondent knew about the environmental good or service they were asked to value, the more likely they were to be willing to pay for the protection of the good or service (Daly *et al.* 2015, Turpie 2003).

As with the independent variable of identifying seagrass, the independent variable of the knowledge of the term ecosystem services also showed an insignificant positive relationship (0.17). This, too, was not expected in this regression. It is noted that the rating values that the respondents provided (Table 5.5) for their confidence for identifying seagrass and their knowledge of the term ecosystem services were self-rated. Since the ratings were based on a subjective evaluation, they may not depict the

respondents' actual ability to identify seagrass or knowledge about ecosystems services. Although this study adapted suggestions by Spash (1997) and Whittington and Pagiola (2012) regarding adopting a dual measurement approach of using a Likert rating scale and asking follow up questions, the answers may still yield under-or over-exaggerated responses (Garcia and Gustavson 1997).

The use frequency of the estuary had a significant positive relationship with the WTP amount (at the 10% level). A weak positive correlation of these variables in the correlation matrix was noted above; however, with the implementation of an OLS regression, it was found that there was a significant positive relationship between these variables. The relationship explained that an increase of one level in the use frequency of the estuary was associated with an increase of R10.15 in WTP a respondent elected, holding all other variables constant at their means.

This finding is consistent with Caula *et al.* (2009), Leng and Lei (2011) and Schindler *et al.* (2018) who indicated higher WTP value incidences the more frequently an environmental resource was visited or utilised. In this regard, underlying context-dependent variables, such as the proposed payment vehicle or hypothetical scenario, can influence the relationship between WTP and the frequency of use of an environmental resource.

The most notable statistically significant regression result was a negative (at the 1% level) relationship between WTP amount and the "mistrust" variable. It is noted that this variable was defined as the mistrust that the respondents showed towards the municipality (the payment vehicle), or towards monitoring (the contingent valuation scenario) as a viable solution to protect seagrass ecosystems in their responses as to why they were willing to pay or not for the seagrass monitoring programme. Respondents who indicated mistrust of one of these aspects of the scenario reduced WTP by an average of R82.83, holding all other variables constant at their means. The importance of this finding highlights that mistrust in either the payment vehicle (a monthly tax paid towards the Knysna Municipality) or the monitoring programme itself, or both, influenced the respondents' willingness to pay amounts.

Incidences of mistrust in governmental institutions have been reported in Knysna. According to local news reports (Ramphele 2018, Sgqolana 2020), there have been "allegations of fraud, corruption, financial maladministration and malpractice within the Knysna Municipality" (Sgqolana 2020). The literature also discussed that mistrust in governmental institutions influences WTP (Chen and Hua 2015, Hong and Oh 2006, Jones *et al.* 2008, Oh and Hong 2014). Although none of these studies gave exact values regarding the decrease in the WTP amount when mistrust in government existed, Hong and Oh (2006) did suggest that an increase in one level of mistrust in the government resulted in a decrease of more than half the WTP amount for the proposed project. In this regard, this study's mean

WTP was R131.69, and an increase in one level of mistrust resulted in a decrease of R82.83 – more than half of the initial average WTP amount – in a respondent's WTP amount, a similar result to Oh and Hong (2006).

5.3. Deliberative focus group results

The deliberative focus group results were obtained from two sources: firstly, from an online deliberative focus group meeting with ten participants, and secondly from an online survey with the same ten respondents who participated in the online focus group. The implementation of deliberative focus groups followed the structure of a deliberative monetary valuation (DMV) method framework (Bunse *et al.* 2016, Macmillan *et al.* 2002), where the deliberative processes sought to determine the impact of *deliberated values* in the "Elicitation process" of the Kenter *et al.* (2015) value dimensions framework (Figure 2.3). This was used as comparison to the *non-deliberated values* that were tested in the CV survey.

As a result of the COVID-19 lockdown, this study did not meet the guidelines regarding a representative and statistically significant sample size (Leinhoop *et al.* 2015, Söderholm 2001). Theory suggested that sample sizes in DMV studies typically range between 52-109 participants (Bunse *et al.* 2016), comprising multiple focus groups or workshop groups ranging between 10-25 participants (Álvarez-Farizo *et al.* 2009).

This study comprised ten participants who were invited to participate in the deliberative focus group after completing the online CV survey. The focus group was conducted via an online video medium, where a presentation was shared with the respondents and time was allotted for questions and discussion.

Although the DMV focus group used in this study may not have been large enough to provide valid and reliable WTP estimates as compared to other empirical DMV studies (Kenter *et al.* 2016, Philip and MacMillan 2005), it offers qualitative data that can be useful in interpreting the results of the larger online survey. The smaller sample size obtained in the DMV sample is a notable limitation of this study, and is further discussed, with recommendations, in Chapter 6.

The results from the focus group were analysed through a qualitative thematic analysis assessment, and the results obtained from the follow-up online DMV survey were analysed through a summary statistics analysis. The following sections analyse and discuss the socio-demographic characteristics of the sample, the thematic analysis of the deliberative focus group, and the questionnaire responses. The objectives of these sections were to compare the responses of the DMV survey to the CV survey, to determine whether the deliberative discussion within the group influenced respondents' answers.

5.3.1. Focus group demographics

This section discusses the socio-demographic characteristics of the ten respondents who participated in the DMV online focus group all of whom also completed the follow-up DMV online survey, which was completed after the focus group participation.

Most of the respondents were 70 years or older, while the remainder were between the ages of 41 and 50. Just over half of the respondents in the DMV survey were male. Almost all the respondents were English home language speakers, and one respondent was an isiXhosa home language speaker. There were no Afrikaans home language speakers, so this population was underrepresented in relation to Knysna demographics (STATSSA 2019). The modal frequency of the monthly household income in the DMV study was between R20 000 – R30 000.

In terms of occupation, half of the respondents stated that they were employed and just under half of the sample said that they were retired. Many of the respondents stated that they were actively involved in the management or conservation of the estuary, where a few respondents were active members of government-endorsed and privately endorsed conservation agencies in Knysna.

More than half of the respondents had a diploma or degree as their highest level of education. The remaining respondents had more than one diploma or degree. All the respondents who participated in the DMV focus group had completed some form of tertiary education. These statistics differ from the Knysna population, where it was noted that only 8% of the Knysna population had completed a higher level of education than secondary school (STATSSA 2019). Since all the respondents had completed some sort of tertiary education, and many of them were involved in conservation or management roles in the estuary, it may be surmised that the DMV sample formed an expert group, rather than being generally representative of the population.

The use of expert stakeholder focus group discussions is often part of environmental valuation studies. However, they represent one stakeholder group, rather than combining the experience and view of multiple stakeholder groups. Despite this, the use of an expert group in deliberative studies is used to enhance the respondents' knowledge about the environmental resource under discussion, even for respondents who are well-acquainted with the resource. For example, Kenter *et al.* (2016) surveyed participants who were well-acquainted with marine habitats – scuba-divers and sea-anglers – to determine a value for the cultural ecosystem services obtained through marine protected areas. They found that deliberation was an effective means of value formation around complex and hard to define environmental resources, such as ecosystem services, even for participants who were well-acquainted with the environmental resource under discussion, in this instance, scuba-divers and sea-anglers (Kenter *et al.* 2016).

Due to the differences of the sample sizes for the CV and the deliberative survey, a quantitative comparison between the two samples proved difficult. Despite this, a qualitative comparison between the sample was conducted, where two differences between the samples were noted.

The first difference is that the entire sample of the deliberative focus group had completed some form of tertiary education. This is compared to the CV sample, where 68% of the sample had completed some form of tertiary education. The higher level of education in the deliberative sample does not only give reason to suggest that the deliberative focus group formed part of an expert focus group, but also that the answers provided may be based on a more educated response.

The second difference is the age of the respondents in each method. While the average age of the respondents cannot be calculated, it is noted that the deliberative focus group had an older sample represented than the CV survey. The implications of such are that the older a respondent, the lower the WTP value they tend to state compared to younger respondents. This could have an implication of the final WTP values obtained from the surveys.

5.3.2. Thematic analysis of the focus group

A thematic analysis assessment was carried out on the qualitative data from the focus group discussion. As alluded to Section 5.2.6, the DMV sample was size too small for a statistical regression to be conducted. As such, an alternative means of analysing the data was sought through a thematic analysis. Four themes and 11 sub-themes were identified through the group discussions, and the thematic analysis is attached in Appendix VIII. The sub-sections that follow discuss key findings within the themes.

a) Rejection of payment vehicle

The first theme concerned the payment vehicle used in the scenario. The payment vehicle used was a monthly tax paid to the Knysna Municipality towards monitoring services. During the focus group discussions, four notable sub-themes regarding the payment vehicle came to attention. The first sub-theme concerned municipal tax – the payment vehicle used for this study. The respondents suggested that, although a municipal tax as a payment vehicle ensured that residents are liable to pay towards monitoring services, they cautioned against using a tax as a payment vehicle. Respondents felt that taxpayers were already over-burdened, referring to taxpayers as being “bled dry”.

Based upon this response and the summarised responses in the thematic analysis, there is evidence that the respondents may have been averse to the payment vehicle, thus demonstrating that payment vehicle bias may have influenced the results in this study (Tietenberg and Lewis 2020). A tax was used as a payment vehicle as all respondents would be liable to pay the tax. An unwillingness to pay towards

municipal or government tax is not novel to this study as the use of tax as a payment vehicle has shown several shortcomings in literature. In a pilot study in determining an adequate payment vehicle for their research, Lienhoop and MacMillan (2007) found that tax was an unpopular payment vehicle for participants, where the participants felt that the general public should not be liable to pay extra tax. Dziegielewska and Mendelsohn (2005) found a similar trend, where respondents were also averse to tax as a payment vehicle.

Since taxes are controlled by governmental authorities, there may be a concern as to whether the authority would use the money collected for the stated purpose. Recent news articles regarding accusations of corruption and maladministration within the Knysna Municipality (Ramphele 2018, Sgqolana 2020) give reason to support the respondents' opposition to using tax as a payment vehicle.

b) Mistrust in local government

The aforesaid concerns relating to the rejection of the payment vehicle may correlate to the theme "Management agencies" in the thematic analysis (Appendix VIII). This theme summarised the positive and negative dimensions associated with the different agencies that may, hypothetically, be responsible for managing the effects of eutrophication in the Knysna estuary. A subsequent sub-theme entitled "Knysna Municipality" was identified in the thematic analysis as a potential management agency. The Knysna Municipality sub-theme was brought to attention as it linked back to the hypothetical scenario of this study – a payment of tax paid to the Knysna Municipality which would be ring fenced and distributed to a local NGO, who would in turn use it for the proposed monitoring programme. It emerged in the focus group that, although the Knysna Municipality had access to resources to conduct conservation strategies, there were notable concerns about entrusting the funds collected from the tax into their care.

One concern noted the Knysna Municipality was already responsible for the management of the waste-water treatment works (WWTW), and that therefore, the respondents felt that it was not necessary to further finance the same management authority. An additional concern was that respondents were not confident that the funds collected would actually be used to fund the monitoring system proposed. Respondents stated that they were not willing to pay towards a government entity; the Knysna Municipality.

A mistrust in local government authorities has been found in other studies. Mistrust in local government was found to increase the occurrence of protest responses in a variety of other studies (Chen and Hua 2015, Hong and Oh 2006, Jones *et al.* 2008, Oh and Hong 2014, Powe *et al.* 2006). These findings may help to explain the high proportion of protest votes; those respondents who cared about the environment and expressed concern about ecosystem services in the lagoon, but who were

not willing to pay towards the monitoring programme described in the contingent valuation scenario. Using Chen and Hau (2015) as a reference, mistrust in government may result from a history of maladministration or corruption.

c) Misinterpretation of the context of the study

Prompted by the remarks against the use of a municipal tax as a payment vehicle, other forms of payment vehicles were discussed and proposed within the context of this study. In a deliberative study conducted by Szabo (2011), alternative payment vehicles pertaining to the context of the study were discussed within the deliberative focus group. This showed that deliberative processes were useful in not only uncovering the value associated with hard-to-define environmental goods, but also different payment vehicles pertaining to the study.

The second payment vehicle sub-theme was a "user pays" levy which is a levy charged only to those who make use of the estuary. A concern was raised that it is challenging to monitor a "user pays" levy. Since the Knysna estuary is an open-access park – meaning that anyone can utilise the estuary at any time – there are no control points ensuring that users pay to utilise the estuary (Claassens *et al.* 2020). The second concern was that the respondents felt that it was inequitable to expect users with different socio-economic characteristics to pay the same levy. For example, a respondent stated that there was a high population of lower-income subsistence fishers that fish in the estuary. Although these individuals were not included in this study – a noted limitation of a lack of statistical representativeness (Leinhoop *et al.* 2015, Söderholm 2001) – respondents in the focus group noted that individuals with lower incomes should not be liable to pay the same rate as users with higher incomes for similar use activities. Thus, although it was not possible to include the lower income subsistence fisher stakeholders in the focus group discussion, their position was considered as part of the deliberations, which alludes to the fact that the respondents were considering *other-regarding* values – the consideration of the values of other users who benefit from the environmental resource (Kenter *et al.* 2015). This highlights that there was a shift from self-regarding to other-regarding value in value intention, as well as a shift from individual values to social values on the value scale (Figure 2.3) (Kenter *et al.* 2016). This may offer support for the DMV approach, which argues that individual utility theory may not be sufficient to explain the values associated with environmental resources.

The third concern was that the ecosystem services provided by seagrass do not only benefit people who directly utilise the estuary, but that the wider community also benefits indirectly from these services, since the ecosystem services seagrass provides are a public good (Costanza *et al.* 2014, Kretsch *et al.* 2016). Therefore, a user pays levy would only account for the payments from the people who directly utilise the estuary and who directly benefit from the ecosystem services seagrass

provides, and would exclude the people who indirectly benefit from the ecosystem services that seagrass provides. The broader Knysna community that indirectly benefits from the seagrass ecosystem services, such as coastal erosion control and carbon sequestration (Adams 2016, Dewsbury *et al.* 2016, Orth *et al*. 2006), would therefore not be liable to pay for these services if a user pays levy was chosen as the payment vehicle.

This concern may be coupled with the tourism levy sub-theme. Using a tourism levy as a payment vehicle would limit the fee paid towards monitoring services to tourists. This, like the user pays levy, would exclude the rest of the Knysna community from paying a fee towards monitoring services that improve ecosystem services, even though tourists are not the only group to benefit from the ecosystem services seagrass provides.

In this respect, although the respondents identified alternative payment vehicles and discussed positive and negative dimensions associated with them, they may have misinterpreted the scope of the WTP study, where they valued the Knysna estuary as a single entity and did not take the ecosystem services seagrass provides into account (which is a sub-component of the value of the estuary). For example, respondents made statements such as:

> *"There is a need to have an understanding of the value of the Knysna estuary and how it benefits the Knysna community", and*
>
> *"People do not understand the value of the Knysna estuary as an asset".*

These statements suggest that the respondents considered the Knysna estuary a *single entity*, rather than identifying the specific ecosystem service benefits derived from seagrass ecosystems located *within* the estuary. Although the respondents stated that the deliberative focus group enhanced their understanding of the ecosystem service under discussion – as per suggestions in literature (Bartkowski and Lienhoop 2018, Kenter *et al.* 2016) – issues pertaining to the hypothetical scenario may have influenced the respondents' WTP choices.

In this regard, the respondents may have misunderstood the scope of the scenario as referring to the value of the whole estuary, rather than considering the value of protecting seagrass within the estuary only. This is known as scope insensitivity which, although is not a sign of an unsound study, does raise issues regarding the validity and reliability of the WTP values elicited (Diamond and Hausman 1994). Literature discussed that it was expected that people would pay more for larger scale projects, holding other variables constant (National Research Council 2005). Based on this, if respondents misinterpreted the scope of the study by valuing the whole estuary instead of the benefits that an environmental resource provided within the estuary, it is likely that the WTP values provided would be lower if the scope of the study was properly considered.

The deliberative focus group was useful in uncovering alternative payment vehicles that the respondents thought may have been used in the context of this study. Although the payment vehicle used for this research was established through scientific literature and consultation with key stakeholders, the discussion of alternative payment vehicles proved to be an interesting finding. It showed that, through discussion and debate, respondents were able consider additional information pertaining to the context of the study; something in which the CV method cannot measure.

d) Concerns with monitoring services proposed in CV scenario

Regarding the conservation strategies theme, the thematic analysis identified three resultant sub-themes. The conservation strategies theme was of importance, as it discussed the positive and negative dimensions of not only the proposed scenario in this study, but also the dimensions for other proposed conservation strategies that may have been used instead. The first was monitoring services – the hypothetical scenario originally used in the context of this study. Respondents brought attention to the fact that, although monitoring is a valuable and proactive tool for conservation, without end goals and outcomes, monitoring is futile. One respondent stated:

> *"Monitoring is like driving whilst looking in the rear-view mirror; if you don't know where you are going, it doesn't help very much".*

This statement, supported by the negative dimensions of monitoring in Appendix VIII, suggested that the monitoring strategy proposed in this study may not have been aligned with the expectations of the Knysna community. The respondents may have rejected the proposed hypothetical scenario as being ineffective in achieving seagrass ecosystem health, which may have resulted in some respondents, who do have positive values for ecosystem protection, registering a zero WTP response. A limitation of this study may have been that the hypothetical monitoring scenario was not adequately discussed, leaving room for ambiguity.

5.3.3. Focus group survey responses

This section summarises the responses obtained from the online survey that the respondents who participated in the online focus group discussions completed.

a) Knowledge and interest in nature

In terms of the information generation section of the survey, the respondents were asked to rate their level of knowledge of the natural environment on a ranking scale of 1-5 with one being not knowledgeable and five very knowledgeable. Almost all the respondents stated that their knowledge of the natural environment was at a rating of four or higher. Half of the respondents stated that the online focus group discussion enhanced their understanding of the way in which nature benefits

human livelihood. Additionally, all the respondents stated that they knew what the term "ecosystem services" meant, where seven respondents stated that the DMV focus group enhanced their understanding of the term.

A reason for the enhanced understanding of the term ecosystem services and knowledge of nature's benefit to humans was due to the topics covered in the presentation. The presentation highlighted nature's benefit to humans, with specific reference to the ecosystem services concept, and the importance of seagrass ecosystems. Bartowski and Lienhoop (2018) and Spash (2008) supported the use of presentations to enhance the respondents' understanding of not only the ecosystem service under discussion but also the broader context in which the study is situated. The presentation is attached in Appendix IV.

The respondents were asked to rate how confidently they were able to identify the plant seagrass on a scale of 1-5, with one being not confident and five very confident. All the respondents gave a rating of four or five for their confidence to identify seagrass. This suggested that these respondents were more confident in identifying seagrass than the overall CV sample population which had a mean identification rating of 2.78 out of five. A possible reason the DMV population had a higher confidence in identifying seagrass was due to the use of visual aids of seagrass *Zostera capensis* in the presentation. Half of the respondents stated that the presentation increased their ability to identify seagrass. The use of visual aids of the ecosystem service under discussion has been noted to reduce uncertainty and unfamiliarity of the ecosystem service under discussion (Labao *et al.* 2008).

These findings are of importance. Literature and theory note that one advantage of using DMV is that it increases the understanding of the ecosystem service under discussion (Atkinson *et al.* 2012, Bunse *et al.* 2015, Pedroso and Kung'u 2019). This was accomplished by presenting information related to the study to the respondents, as well as allowing an opportunity for debate, discussion, participation and social learning. These results suggested that, even for relatively highly educated respondents who were familiar with the resource under discussion, the additional discussion and information that was provided via a DMV workshop improved their understanding of the valuation scenario and potentially lead to more reliable results. This gives reason to suggest that the incorporation of a deliberated focus group may yield positive results in a developing country context.

This addresses a notable limitation of the CV method, where respondents who participate in a CV study often do not have a grounded knowledge of the environmental good under discussion leading to the possibility the valuation answers they provide being unreliable (Arrow *et al.* 1993, Kenter 2017, Pedroso and Kung'u 2019).

b) Willingness to pay

The respondents in the online focus group were presented with the same valuation scenario as those in the online CV survey (Appendix III). It is acknowledged that due to the small sample size associated with the deliberative focus group, reliable assessments of WTP cannot be made. However, this section serves as an indicator of what the WTP responses were for the deliberative focus group.

Of the respondents who participated in the DMV focus group follow-up survey, half stated that they would be willing to pay for monitoring services in the Knysna estuary, and half stated that they were not. The mean WTP value elicited from five respondents was R110 per month for the monitoring services. Overall, WTP values ranged from a minimum value of R50 to a maximum value of R150 per month. The mean WTP value for the DMV survey was a value less than the R132 mean from the CV survey. As with the CV survey, the deliberative focus group found that the respondents elicited contextual values, as per the Kenter *et al.* (2015) value dimensions framework.

Kenter *et al.* (2016) found that WTP values often decrease from online SP surveys compared to the DMV surveys. They established that the lower WTP value in the DMV survey was largely due to the participants having more time to think about the scenario and form preferences about specific parameters of the scenario (Kenter *et al.* 2016). In this study, the mean WTP values obtained post the focus group discussion were lower than the CV survey, which was found in Kenter *et al.* (2016). However, that sample size was too small for these results to be valid and reliable.

Additionally, the DMV survey had a proportionally older sample of respondents than in the CV survey. Chapter 2 addressed the scenario that age had a negative effect on WTP, where older respondents were less likely to be WTP (Halkos and Matsiori 2012).

However, of the respondents who gave a WTP value post the focus group discussion, three stated that their new elected value was higher than their initial value. This is similar to a study conducted by Lienhoop and MacMillan (2007), who found that approximately 40% of the respondents who participated in a DMV market stall study changed their WTP values. When asked to provide an explanation, all three respondents stated that the focus group assisted them in making more informed WTP decisions. Kenter *et al.* (2016) found that respondents who participated in both a non-deliberated survey and a DMV survey felt that the value they elicited in the DMV survey was a more accurate amount. This was because they felt that the DMV workshop had assisted them in formulating sound preferences based on the scenario at hand. While the present study sample size was too small to draw firm conclusions, the results do give some indication that the DMV process could help to elicit more valid and reliable valuations for complex public goods, like ecosystems services.

Of the respondents who stated that they were unwilling to pay any amount, a series of follow-on questions were asked to establish their reasoning. The DMV focus group established two factors that affected respondents WTP. The first was that monitoring requires objectives and goals for the monitoring programme to be effective. The second was that the payment vehicle – a monthly tax paid to the Knysna Municipality – was received negatively. The questions the respondents were asked synthesised these factors into the question below:

> *If the monitoring practice implemented in the Knysna estuary was to meet an end goal (i.e. the results obtained are to be used to assist policymaking and management of the estuary), and if payment towards the monitoring was paid directly to the monitoring organisation, do you think that your household would be more willing to pay a monthly amount to the monitoring organisation?*

The purpose of the question above was to discern whether the payment vehicle (monthly tax) and the hypothetical scenario (monitoring services) played a role in the high proportion of those who had an unwillingness to pay in both the CV and DMV surveys. Two respondents stated that they would be WTP for the proposed above-mentioned valuation question if the effectiveness of the monitoring system, and the allocation of the funds to this project could be guaranteed. The WTP values for this valuation question were R100 and R200 respectively, a mean of R150. The remaining respondents stated that they were not WTP for the proposed above-mentioned valuation question, but would rather support other management services of the estuary, such as:

> *"Support those groups that research the wellbeing of the lagoon and take heed of their advice",*
>
> *"Fix sewerage systems, stop rampant development, tax the people who are contributing to sewerage in Knysna", and*
>
> *"[Knysna Municipality] needs to run the WWTW efficiently".*

The purpose of asking this question was to determine whether other strategies to reduce the effects of eutrophication on seagrass may be preferable to the respondents.

5.4. Synopsis

This chapter analysed and described the results of the contingent valuation survey, the deliberative focus group meeting and follow-up questionnaire. The preliminary analysis of the characteristics of the population in both the CV survey and the deliberative focus group found that the sample comprised of mainly older, English-speaking, higher income individuals who had a higher education level compared to the general Knysna population. These characteristics were likely because of the

employment of an online communication medium, thereby resulting in a misrepresentation of the Knysna population.

Despite these limiting factors, the results of the CV survey determined that, on average, respondents were WTP R132.04 for monitoring services to protect seagrass ecosystems in the Knysna estuary. Various variables that influenced WTP were found throughout the Chapter and were supported by an OLS regression. Variables such as use frequency and education positively influenced WTP, while the respondents' age and mistrust in local government or monitoring services negatively influenced WTP. The deliberative focus group results, through a thematic analysis, supplemented the findings obtained in the CV survey.

Key findings in the deliberative focus group were that respondents felt that the payment vehicle and monitoring services may not have been adequate for this study, that there was mistrust in local government authorities and that respondents may have misinterpreted the context in which the study was based. The deliberative focus group was useful in complementing the findings obtained in the CV survey. The focus group discussion also demonstrates some of the difficulties in using hypothetical scenarios to value complex public ecosystem services goods, even amongst highly education people who were familiar with the research context.

The next chapter concludes with key findings obtained from the study and provides a detailed discussion on the limitations associated with the study. Recommendations for future research and policy implications are also discussed.

CHAPTER 6:

CONCLUSION AND RECOMMENDATIONS

6.1. Introduction

All humans are dependent on ecosystem services and, if managed correctly and sustainably, ecosystem services contribute to human well-being, health and livelihoods. Determining the economic value for environmental resources and ecosystem services can play an essential role in promoting the sustainable use of natural resources, can assist with the reduction of ecosystem degradation and can ensure that the benefits derived from ecosystem services are not lost. However, determining the value of environmental resources using traditional environmental valuation methods, such as the stated preference method, has inherent challenges, since they do not consider the broader, shared and plural values that society places on ecosystem goods and services.

Developing countries harbour a significant amount of the environmental resources upon which communities and households have a high dependency. However, determining the value of ecosystem services using conventional economic valuation techniques such as the stated preference method in a developing country context is often challenging due to literacy and language barriers, subsistence economies, unfamiliarity of money and a lack of education and scientific knowledge. Deliberation, through the deliberative monetary valuation (DMV) method, has been put forward as a method to overcome these challenges to derive reliable and valid monetary estimates for the value of ecosystem services using the willingness to pay (WTP) method. However, despite the acclaimed success of obtaining more reliable values using the DMV method, this study rather opted to determine whether deliberation can improve the value elicitation process of ecosystem services.

The goal of this study was to investigate the determinants that influence participants' willingness to pay for public ecosystem services using a dual method approach in a South African context. In addition to this goal, the study had three sub-goals which were:

1) To investigate the types of value associated with willingness to pay;
2) To investigate the role of deliberation as an applicable technique to be used to value ecosystem services in a South African context; and
3) To determine the potential of deliberation to improve value elicitation of ecosystem services.

To address the goals of the research, the study implemented a dual-method approach, using a non-deliberated CV survey followed by a deliberative focus group. The initial intention for this study was to conduct a face-to-face deliberative workshop with 20 stakeholders of the Knysna estuary who

represented a diverse range of socio-demographic characteristics. However, due to the circumstances and the subsequent restrictions of the COVID-19 lockdown, the study was moved to an online platform. Therefore, the study was required to adapt the research design and methods to accommodate a move to online research and these are discussed in this section.

As stated in the section above, this study used a dual-method approach to discern the determinants that influence WTP values and responses for the ecosystem services that seagrass provides to the Knysna community. It used a CV survey and a deliberated focus group following the DMV method framework to obtain WTP values and assess the responses associated with the knowledge and understanding of hard-to-define ecosystem services, such as seagrass *Zostera capensis*.

The CV survey elicited non-deliberated responses from the respondents using an individual online anonymous WTP survey sent to the respondents via a Google Forms document through a mailing list, which received 100 responses. Following the CV survey, a deliberative online focus group of a sub-sample of respondents in the original survey was conducted, which had ten participants. A follow-up anonymous online survey was sent to the focus group participants after the deliberative meeting. The analysis methods for the CV survey included summary statistics and an ordinary least squares (OLS) regression, while the deliberative focus group data were analysed through a thematic analysis.

A mean value of R132.04 per household per month was recorded for the CV survey, which resulted in a total of R374 000 per month paid by higher-income households within Knysna for monitoring services in the estuary. The WTP value from the deliberative focus group was R110 per household, per month. However, as a result of the online medium, the sample size used for the deliberative focus group was not large enough to produce significant statistical values. Therefore, a quantitative and reliable assessment on the differences in WTP values was not possible, where the study sought to rather determine whether deliberation could be used as a means to improve the responses obtained from conventional valuation methods.

6.2. Summary of results

Both the CV survey and the deliberative focus group produced interesting results. Concerning the principal goal of the study, the results from the CV survey found that education level, age, use frequency of the estuary and mistrust of the municipality were all significant determinants of WTP. The deliberative focus group found that the knowledge obtained about an environmental resource through deliberation, and the consideration of the valuation scenario, such as the payment vehicle and the hypothetical scenario, were important determinants that influenced the respondents' WTP.

Regarding the first sub-goal, using the Kenter *et al.* (2015) value dimensions framework (Figure 2.3), the study found that different types of value – non-deliberated and deliberated – influenced WTP

responses, where the CV investigated individual WTP and the deliberative focus group investigated individual WTP after a deliberative discussion. Evidence from the focus group found that the respondents considered the values of other users who were not represented, thereby considering social WTP through deliberation, as compared to the CV survey where social value was not considered, which was not uncovered in the CV survey. This could be linked to a shift from individual to social value on the value scale (Figure 2.3), as well as a shift from self-regarding to other-regarding values (Kenter *et al.* 2015). Only contextual values (Figure 2.3) were identified in both the CV survey and the deliberative focus group.

The second sub-goal found some evidence that deliberation was an interesting technique to be used to value ecosystem services in a South African context. Research to the study found that South Africa, and in particular Knysna, has a wide range of socio-demographic characteristics, such as differences in income and education. The study conducted research on a homogenous sample in Knysna, that represented largely a white, older, more educated, and wealthier sample compared to the broader Knysna population. The analysis of the deliberative focus group found that even highly educated respondents who were familiar with the environmental resource under discussion increased their understanding of seagrass ecosystems and the term ecosystem services, which are important determinants for producing valid and reliable WTP estimates. While, although South African is defined as a developing country, the study sample did not represent that of a developing country. Despite this fact, the results highlighted above may prove useful in a South African context, where a lack of literacy and scientific education may hinder the success of conventional valuation techniques in producing reliable WTP values. This study showed that, through deliberation, an increase in the understanding of hard-to-define public goods, such as ecosystem services, was useful.

However, the evidence presented also showed that the process of deliberation may not be an applicable method to value hard-to-define ecosystem services in a South African context. Despite the fact that a higher educated sample improved their understanding of a hard-to-define ecosystem service through deliberation, a less educated sample, such as the case of the general population in South Africa, may not have as much success in improving their understanding of ecosystem services. This was proven through the fact that a highly educated sample, in the deliberative focus group, misrepresented the context of the study, by valuing the Knysna Estuary as a single entity, opposed to the seagrass ecosystem services found *within* the Knysna Estuary. This showed that the process of deliberation may not be an applicable technique to be used with a more uneducated sample, such as with a South African context. Further research on the processes of deliberation in a South African context with a represented sample would be useful.

Regarding the study's third sub-goal, the research showed that the process of deliberation was a useful technique for value elicitation for a hard-to-define ecosystem service. Despite the issues of a lack of a representative sample in a South African context, the implementation of the deliberative focus group provided useful results in interpreting the usefulness of deliberation as a tool for value elicitation. The results from the CV survey found that a large proportion of the respondents were unfamiliar with seagrass ecosystems and the term ecosystem services. This highlighted that these respondents had hazy preferences when determining a value for the benefits seagrass ecosystem services provided. In contrast, the deliberative focus group highlighted that most of the respondents who participated in the deliberative focus group felt that the presentation enhanced their understanding of the term ecosystem services, nature's benefit to humans, and their confidence in identifying seagrass. These results suggested that even for relatively highly educated respondents who were familiar with the environmental resource under discussion, the application of deliberation improved their understanding of the scenario, which, was not uncovered in the CV method. This showed that deliberation was had the potential to uncover findings that were not observed in the CV method, as well as provide a platform for preference construction, thus highlighting the usefulness of using deliberation of a valuation technique.

Added to this, the findings discussed above were supported in the literature (Bunse *et al.* 2015, Lo and Spash 2013, Orchard-Webb *et al.* 2016) where an increase in the knowledge of hard-to-define public goods, for example, such as ecosystem services, resulted in more reliable responses compared to conventional valuation methods. This highlighted that deliberation can be used as a tool to increase the respondents' knowledge of complex environmental resources, which in turn can result in more reliable responses.

Although addressing the goals of the research, the study also produced other significant results. Regarding the socio-demographics of the sample, the CV survey revealed that the sample represented an older, English-speaking, highly educated and high mean monthly income population. These characteristics emphasised the fact that the sample did not represent the socio-demographic and socio-economic characteristics of the broader Knysna community. This was primarily attributed to the move to an online medium of data collection.

However, despite the homogeneous sample used for this study, the socio-demographic variables of the sample that were used in this research were useful in explaining the determinants of WTP in the CV survey. For instance, the CV survey uncovered a significant relationship between respondents' education level and WTP, which explained that an increase in one level of education resulted in an increase of R14.85 in WTP value. This finding was of importance, as it correlated to other environmental valuation studies regarding an increase in education and WTP value (Arin and Kramer

2002, Ofori and Rouleau 2020, Risen *et al*. 2017). The respondents' age also had a significant relationship with WTP, where an increase in one level of age resulted in a decrease of R10,93 in WTP; a finding also supported by the literature (Halkos and Matsiori 2012, Wan *et al.* 2017). However, due to the small sample size represented in the deliberative focus group, a quantitative and reliable assessment of the monetary values elicited proved difficult. Future research would be beneficial in determining the monetary value of ecosystem services using deliberation from a larger sample group.

In terms of the utilisation of the estuary, the results found no significant difference between respondents' occupation or income and the estuary utilisation activities. This finding was used to explain that, despite the study representing a relatively older and retired sample, the utilisation activities did not differ to that of the employed population. This reduced the bias of an older sample representing the study.

Additionally, results pertaining to the utilisation of the estuary found that respondents who visited the estuary more frequently displayed higher self-rated levels of confidence in identifying seagrass as well as higher levels of environmental knowledge than respondents who visited the estuary less frequently. This finding was used to support those obtained regarding the WTP amounts for monitoring services to protect seagrass from eutrophication, where the results showed that respondents who utilised the estuary more frequently displayed not only higher WTP frequencies, but also higher mean WTP amounts compared to respondents who utilised the estuary less frequently. This finding was supported by the OLS regression performed, where a statistically significant increase in one level of the use frequency of the estuary resulted in an increase of R10,16 of the respondents' WTP amount. These findings suggest that the respondents who utilised the estuary on a more frequent basis were not only more confident in identifying the environmental resource under discussion, but were also more willing to pay to protect the environmental resource.

There were 56 respondents – out of 100 – who expressed a positive WTP for monitoring services in the Knysna estuary. Of the 44 who were not WTP, 25 were considered to be protest bids – a rejection of some aspect of the valuation scenario or failure to express preferences consistent with economic theory (Lo and Jim 2015, Szabo 2011). A protest response of 25 did not differ significantly from other environmental valuation studies identified in the literature (Meyerhoff and Liebe 2010, Szabo 2011). The protest response was useful in unpacking the reasons regarding respondents' unwillingness to pay, even when their responses to other questions in the survey indicated positive values associated with, and concern about, ecosystem services. Such responses were explained by mistrust in the project's hypothetical scenario or in the payment vehicle. This finding was supported by the OLS regression, which identified a statistically significant relationship at the 1% level, that mistrust of one

of the aspects of the scenario reduced WTP by an average of R82.83, holding all other variables constant at their means.

The determinants that influenced WTP in the CV survey were further expanded upon in the deliberative focus group. The results obtained were useful in explaining the determinants of WTP that the respondents displayed through a thematic analysis, which identified four themes and 11 subsequent sub-themes. Using these themes as a foundation, key findings relating to the determinates of WTP were identified.

The thematic analysis exhibited that, even though the deliberative focus group largely represented a homogeneous sample, the respondents took consideration of the other user groups who benefit from the ecosystem services of seagrass, but who were not represented in the focus group into account. This highlighted that, although the respondents who participated in the focus group were required to consider their WTP values on an individual basis, they might have considered the social value of the ecosystem services that seagrass provides when stating WTP. This correlated to the WTP amount elicited by the respondents in the deliberative focus group, which was a mean value of R110 per household per month; a value lower than the mean WTP from the CV survey. A lower WTP value exhibited from the focus group results might have been a result of the respondents considering the social value of user groups with different socio-economic characteristics.

These findings brought attention to the fact that deliberation, in this study, considered the values of other user groups, termed *other-regarding* values by Kenter *et al.* (2015). Based on this, if conducted at a larger scale, deliberation, through the DMV method, might be useful in uncovering different dimensions of value which could be useful in a South African context, and which traditional valuation methods cannot detect.

Deliberation also brought other issues associated with the implementation of the study into account, one of which was that respondents were averse to the payment vehicle associated with the study; that of a monthly tax paid to the Knysna Municipality. Despite acknowledging that tax as a payment vehicle made people liable to pay towards the scenario, the respondents also alluded to the fact that taxpayers already pay too much tax, and therefore cautioned against its usefulness as a payment vehicle in the context of this study. While the payment vehicle used in this study was, admittedly, imperfect, the construction of it was in alignment with literature, and it was the most favoured payment vehicle discussed in the focus group.

The thematic analysis also uncovered that the respondents might have misunderstood the scope of the valuation scenario, as the respondents were observed discussing the value of the estuary as a whole as opposed to the value of the ecosystem services that seagrass provided within the estuary. If

the scope of the study had been accurately understood, the WTP values elicited might have been lower, as the literature alluded (Diamond and Hausman 1994, National Research Council 2005).

These findings brought to the forefront that deliberation assisted the participants to genuinely consider the payment applications associated with the study. Deliberation allowed the respondents to carefully consider the vehicle and the hypothetical scenario of the study, which, if conducted at a larger scale, would yield more reliable and valid WTP values compared to traditional valuation methods.

6.3. Implications of the findings and recommendations for future research

The dual-method approach was advantageous in showcasing the usefulness of employing deliberation as a tool for decision-making, as compared to standard non-deliberated stated preference studies. In this study, deliberation uncovered findings that were not detected in the CV survey. For instance, the use of deliberation allowed the respondents to consider alternative payment vehicles, conservation strategies and management agencies that could be useful in the context of this study. It also allowed for a discussion on the positive and negative elements associated with the scenario with which they were presented.

In addition, the focus group also proved its usefulness in increasing the respondents' knowledge of complex and hard-to-define public goods, such as ecosystem services, before eliciting a WTP value, which the CV survey was unable to achieve. This finding is useful for future research, as it can be used to support the reliability and validity of the WTP responses obtained in environmental valuation studies, as supported by the literature (Bartkowski and Lienhoop 2018, Christie *et al.* 2012, Kenter *et al.* 2017, Vargas and Diaz 2017), especially in a developing country context where literacy and language barriers, and a lack of education and scientific knowledge hinder the reliability of conventional environmental valuation methods.

The findings obtained in this study can be used to support the use of deliberation, through newly constructed valuation methods, such as the DMV method, in overcoming the challenges inherent in traditional environmental valuation methods. This gives reason to suggest that the DMV method has the potential to include various user groups to not only uncover the social values associated with the value of ecosystem services, but also to produce more reliable and valid WTP values due to the deliberative element of information generation, and the fact that respondents carefully considered the payment vehicle and the hypothetical scenario before eliciting a WTP value. These findings may assist the application of future research for hard-to-define public goods such as ecosystem services.

However, the potential of deliberation used against large socio-demographic divides was not proven in this study, as the sample for this research represented a homogenous population. Despite the fact

that the results obtained from this research were useful in establishing that deliberation is a useful technique to supplement conventional valuation methods, future research pertaining to conducting deliberative valuation studies should consider a representative sample.

Regarding the online method medium adopted for this study, the CV survey and the deliberative focus group both showed advantageous characteristics in its application. For instance, the CV survey highlighted the ease of recruitment, the inexpensive alternative to face-to-face surveys, and the benefit of complete anonymity as important advantages through using an online survey technique. These advantages ensured that the research could take place in a time where social interaction was limited – as per the case of the COVID-19 restrictions.

Concerning the application of the deliberative focus group, some advantages of conducting online focus group research included the ease of recording of the meeting for future transcribing and coding purposes, the inexpensive application of hosting a focus group as compared to in-person focus groups, and the anonymity of the polls, which perhaps made the respondents more comfortable to answer questions. These advantages provided useful insights into the application of online deliberative focus groups as a means of value elicitation, which could be used to aid future research.

Further research should focus on accommodating a larger sample size that should include a variety of socio-demographic stakeholders. While the online method medium showed considerable advantages, the sample was distorted to only include respondents with access to the Internet (generally, a high income and education group in South Africa). Based on this, the adoption of face-to-face deliberative focus groups or workshops is recommended.

6.4. Limitations of the research

There were, however, limitations associated with this study, one of which was the adoption of an online method approach. Since the survey was only sent to potential participants who had access to a computer, Internet and email service, the survey excluded certain individuals from participating. This was significant in this study, as Chapter 3 identified that about 63% of residents in Knysna do not have access to the Internet. Although the online CV method as the primary source of recruitment and participation in this study was supported by literature and had certain advantages, the sample was ultimately skewed to only include participants with access to the Internet.

Additionally, while the inclusion of the groups who relied on the ecosystem services that seagrass provided for subsistence or income was an initial target of the study, it was not possible to include these stakeholders due to the COVID-19 restrictions. Therefore, the adoption of the online method technique mainly limited the ability for subsistence groups to participate. Based on these factors, although the online medium method had advantages, as discussed in the section above, the sample

in this study was, therefore, not representative of the stakeholder groups in the Knysna community, and the results only included the responses of respondents who did not rely on the estuary for subsistence living.

A challenge that was encountered in the formulation of the CV questionnaire was the amount of information provided to the respondents. The literature noted that it is often a difficult task to provide a sufficient amount of information pertaining to the case study to respondents participating in a CV study (Carson 2012, Pedroso and Kung'u 2019). While the CV questionnaire was developed through a consultation with key stakeholders and a consideration of literature, the amount of information provided to the respondents may have been inadequate, and thus reducing the validity of the results obtained.

Regarding the criticism received about the payment vehicle and the hypothetical scenario, this research did not conduct a pilot study to determine an appropriate payment vehicle or a hypothetical scenario to be used in the context of this study. If a pilot study had been conducted, accusations regarding maladministration and corruption in the Knysna Municipality would have been identified earlier, which may have led the research to adopt an alternative payment vehicle strategy (although alternatives discussed in the focus group were also seen as problematic). Additionally, a pilot study would have been useful in determining an appropriate CV scenario more acceptable to the respondents which, if implemented, would effectively protect the good in question.

However, despite the lack of a pilot study when conducting this research, this study is, in essence, a pilot in itself. The study noted that this was the first known deliberative study to value seagrass ecosystem services in South Africa. Based on this, there was a limited amount of literature on the formulation of a deliberative environmental valuation study in a South African context, even without the implications associated with the COVID-19 pandemic. Future research may consider the limitations associated with this research.

6.5. Concluding remarks

The application of a dual-method approach proved to be a successful technique in supplementing individually conceived WTP values and responses of a complex environmental resource. Deliberation was shown to be advantageous in uncovering findings that were not observed in non-deliberated valuation methods, which should be considered for future research on the valuation of complex environmental resources. The study showed that deliberation was a useful valuation method to value hard-to-define ecosystem services, such as the benefits of seagrass ecosystem services.

While the deliberative process was valuable in uncovering the findings that were not observed in the CV survey, the process of deliberation in a South African context proved to be difficult. This was evident due to the socio-demographic divide between the sample used in the deliberative focus group, compared to the socio-demographic characteristics of the South African population at large.

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APPENDIX I: RECRUITMENT EMAIL

I am an Environmental Economics Masters student at Rhodes University, and I am currently conducting research into the value that seagrass provides the residents of Knysna. I am contacting you to respectfully ask if you would be willing to participate in my research project, thereby contributing to my post-graduate studies. I hope you don't mind me emailing you. I obtained your contact details from Louw Claassens, the previous Programme Director of the Knysna Basin Project, as she believes that you can provide valuable input for my research project.

I am currently in the data collection phase of my research, which requires me to conduct a survey with as many stakeholders of the Knysna Lagoon as possible to assess the attitudes and perceptions of the value of environmental services that you enjoy in Knysna. Your survey responses will be of great help to my Masters research, as well as furthering research into seagrass ecosystems in general in the Knysna Lagoon.

The survey should take you between 10-15 minutes to complete. If you are willing to take part in the survey, please click here and you will be redirected to a Google Forms document.

There is a second part to my data collection phase, which involves a one-hour online focus group presentation and discussion (conducted via Zoom), which is an optional follow-on to the survey. It will begin with a presentation by me about seagrass ecosystems and their importance, which will be followed by an open discussion. The proposed date for the focus group is the evening of Thursday 23rd of July 2020. If you are also willing to take part in the focus group, please reply to this email so that I can send you the details.

As with all research projects, ethical clearance is required before a project can commence, and my research project has been approved by the Rhodes University Ethical Standards Committee (contact person: Mr Siyanda Manqele s.manqele@ru.ac.za).

All responses obtained will be used purely for academic research and will be kept completely anonymous and confidential.

If you know of anyone else who may be interested in participating in this research, kindly put them in contact with me or, alternatively, please forward their contact details to me.

Thank you so much for reading my email and for considering to support my studies by participating in the survey and focus group. Please feel free to contact me with any questions or comments you may have about either my project or your participation.

Kind regards,

APPENDIX II: INDIVIDUAL ASSESSMENT OF SEAGRASS ECOSYSTEMS

Hello! My name is James Marriner and I am a Masters student in the Economics Department at Rhodes University. Please may I ask you to take a few minutes to complete this survey?

I am doing research in Knysna, specifically on seagrass ecosystems. The aim of my study is to determine peoples' perceptions and knowledge on seagrass ecosystems in Knysna, as well as to derive a value for the seagrass ecosystem that may be used for further research and protection of the seagrass habitat.

Please note that this questionnaire is confidential and voluntary, and no one will know your answers besides myself. If you feel like stopping any time during the questionnaire, please feel free to do so. This questionnaire is designed is to obtain your opinion, and there are no right or wrong answers.

As with all research projects, ethical clearance is required before a project can commence. My research project has been approved by the Rhodes University Ethical Standards Committee (contact person: Mr Siyanda Manqele s.manqele@ru.ac.za).

** Required*

1. **Are you 18 or older and willing to complete the survey and take part in the study?**

   **Mark only one oval.*

   ☐ Yes, I consent: Thank you! The survey should take between 10 to 15 minutes to complete. Please click the "Next" button to continue.

   ☐ No, I do not consent: Thank you for your interest. You may close the window now.

SECTION 1: ACTIVITIES IN THE KNYSNA ESTUARY

Thank you for being willing to take part in this survey for my Masters research paper. In this section, I would like to find out more about how you use and may benefit from the Knysna Lagoon. Please note that in this survey, I refer to the Knysna Lagoon as the "Knysna estuary".

2. **How long have you lived or worked in Knysna?**

   Mark only one oval.

   ☐ Less than 1 year

   ☐ 1 - 2 years

   ☐ 3 - 5 years

   ☐ 5 - 10 years

   ☐ 10 - 20 years

   ☐ Over 20 years

   ☐ Holiday homeowner

   ☐ Other:

3. **Do you make use of the Knysna estuary (Knysna lagoon)?**

Mark only one option.

- ☐ Yes
- ☐ No

4. **How do you utilise the Knysna estuary?**

Check all that apply.

- ☐ Fishing activities
- ☐ Boating activities (e.g. skiing, tubing)
- ☐ Water-based exercise (e.g. canoeing, kayaking, stand-up paddling)
- ☐ Leisure (e.g. beaching, sun-tanning)
- ☐ Recreation (e.g. snorkelling, swimming)
- ☐ Part of my job (e.g. research, conservation, tourism)
- ☐ Land-based exercise along and around the estuary (e.g. walking, running, cycling)
- ☐ Part of my job (e.g. research, conservation, tourism)
- ☐ I do not make use of the estuary
- ☐ Not applicable
- ☐ Other

5. How often do you make use of the estuary to fulfil your activity or activities mentioned in the question above?

Mark only one option.

- ☐ Every day
- ☐ Five or more times a week
- ☐ 2-3 times a week
- ☐ Once a week
- ☐ Once every two weeks
- ☐ Once a month
- ☐ Never

6. **How environmentally aware would you consider yourself to be?**

Mark only one option.

	1	2	3	4	5	
Not aware	◯	◯	◯	◯	◯	Very aware

SECTION 2: INFORMATION GENERATION

In this section, I would like to find out more about your knowledge and understanding of ecosystem services and seagrass habitats in Knysna.

7. **Did you know that the Knysna estuary forms part of an open-access national park, managed by SANParks?**
   Mark only one option.

   ☐ Yes

   ☐ No

   ☐ I have heard of it, but I am not completely certain

8. **What is your knowledge of the natural environment and how nature can benefit your livelihood?**
   Mark only one option.

	1	2	3	4	5	
No knowledge	◯	◯	◯	◯	◯	Very knowledgeable

9. **Have you heard of the term 'ecosystem services' before?**
   Mark only one option.

   ☐ Yes

   ☐ No

10. **If you have heard of the term 'ecosystem services' before, please give a brief definition of what you understand it to mean:**

_____

11. **Have you heard of the ocean plant 'seagrass' before?**
    Mark only one option.

    ☐ Yes

    ☐ No

12. **How confidently would you be able to identify the seagrass plant?**
    Mark only one option.

	1	2	3	4	5	
Not confidently	◯	◯	◯	◯	◯	Very confidently

Information for the next section

Please take a moment to read the following information as it will help you formulate your answers for the following section. In the previous section, I asked you if you had heard of the term 'ecosystem services'. Ecosystem services are the varied benefits that nature provides to humans that contribute to human and economic well-being. Examples of ecosystem services may be the roots of a tree preventing erosion, or the pollination of crops by bees.

In Knysna, seagrass habitats are found throughout the estuary. The seagrass that is found in Knysna covers approximately 20% of the Knysna estuary floor. It has several ecosystem services (nature's benefit to humans) that the Knysna community benefit from. The seagrass helps with the prevention of coastal erosion, it creates a nursery habitat for fish species, and it reduces sedimentation which helps with the water clarity. It also has a high carbon sequestration rate, meaning that it holds carbon dioxide from the air. It is also a habitat for the endangered Knysna seahorse.

Image of seagrass

SECTION 3: VALUATION SCENARIO

Please read the following scenario in the box below. There are two figures in this section that you should consider:

The scenario

In 2011, leaking sewage from the Knysna sewerage plant seeped into the estuary which polluted the water in the estuary. This caused algae to grow on the surface of the water, which meant that less sunlight could reach the seagrass that grew underneath the surface of the water. This is known as eutrophication.

Before the leakage took place, the health of the seagrass in the Knysna estuary was stable. Figure 1 shows a healthy seagrass habitat in Knysna. However, as a result of the sewage leak, a lot of seagrass died. Figure 2 shows a loss in seagrass because of eutrophication. The pictures were taken at the same place, but 7 months apart.

Although the seagrass recovered from the leakage in 2011, if there was another sewage leak, it could mean that seagrass may no longer grow in the Knysna estuary. If seagrass does not continue to grow in the estuary, then the ecosystem service benefits that seagrass provide will be lost.

An idea to ensure that such leaks do not happen again in the future is to put in place proper checks and monitoring procedures at the sewage works, as well as the overall state of the estuary. Research has found that regular checks, documenting and monitoring of the sewerage works will mean that regulations and operational standards will more likely be adhered to. This could potentially reduce the occurrence of another leakage. Monitoring the state of the estuary will assist in ensuring that the estuary is in a healthy and functioning state, which will contribute to the maintenance of seagrass ecosystem services.

Money will need to be raised in order to support a monitoring operation such as this. A local non-governmental organisation was identified as the hypothetical responsible organisation for monitoring and documenting the state of the estuary. This organisation is a non-government funded environmental management organisation in Knysna dedicated to marine conservation.

An idea to finance the monitoring procedures proposed by the Knysna Basin Project is through an additional monthly tax paid by residents in Knysna to the Knysna Municipality. The tax will be ringfenced to ensure that the funds will go straight towards monitoring operations at the Knysna Basin Project.

There are costs and benefits associated with paying for an organisation to monitor the state of the estuary. One benefit is that seagrass habitats may not be damaged further. This could have further benefits such as reducing the impact of coastal erosion surrounding the estuary, providing a habitat for fish species, reducing water sedimentation to make the water clearer and it could increase carbon dioxide sequestration. These services that seagrass provide, if maintained, will positively impact the Knysna community.

However, there are costs involved with paying for an organisation to monitor the estuary. One cost is funding the organisation. This cost will reduce the amount of money you will have to spend on other goods and services. Other non-monetary costs that may be implemented are potential restrictions on boating, bait digging and fishing activities to allow for the seagrass to recover.

Based on this scenario, please answer the questions that follow. Please remember that all of the questions in this section are based on a hypothetical scenario, meaning that you will not be held accountable to your answers. All of the information, projects, fund-raising and taxes are hypothetical. The responses obtained in this survey are purely for academic research.

Image of healthy seagrass

Image of damaged seagrass

13. How concerned are you that the seagrass was damaged in the Knysna estuary from the leaking sewerage?
Mark only one option.

	1	2	3	4	5	
Not concerned	◯	◯	◯	◯	◯	Very concerned

14. **How important do you think it is to put in place monitoring practices in the Knysna estuary to assist in seagrass health?**

Mark only one option.

	1	2	3	4	5	
Not important	◯	◯	◯	◯	◯	Very important

15. **Whose responsibility do you think it is to ensure that the environment is managed sustainably in Knysna?**

Mark only one option.

- ☐ The Knysna municipality
- ☐ The residents of Knysna
- ☐ Government-endorsed environmental management organisations
- ☐ Non-government-endorsed environmental organisations
- ☐ Other

16. **Monitoring practices conducted in the estuary will likely reduce the probability of another sewerage leak from occurring. This may assist with seagrass health, and therefore the ecosystem service benefits that they provide. Considering your budget constraints (i.e. your household expenditure and other things you may want to spend the money on), would your household be willing to pay an additional monthly tax to the Knysna Municipality for monitoring practices to be conducted in the estuary? The tax would be ringfenced and the proceeds would go straight to the Knysna Basin Project.**

***** *Mark only one option.*

- ☐ Yes (Skip to question 17)
- ☐ No (Skip to question 21)

SECTION 4: VALUATION QUESTION

In this section, I would like to find out how much your household would be willing to pay per month for monitoring practices to happen in the Knysna estuary.

Please remember that these questions are still based on the hypothetical scenario.

17. **Monitoring the estuary will likely yield greater ecosystem service benefits that seagrass provides. Considering your budget constraints, what is the maximum amount of money (in ZAR) that your household would be willing to pay per month for monitoring practices in Knysna estuary?**

Mark only one option.

☐ R0	☐ R150
☐ R1	☐ R200
☐ R5	☐ R250
☐ R10	☐ R500
☐ R20	☐ R750
☐ R25	☐ R1 000
☐ R50	☐ R 1500
☐ R75	☐ Above R1 500
☐ R100	☐ Other

18. **If you selected 'Other' in the question above, please state the value below (in ZAR). If you did not select 'Other', please disregard this question.**

_____

19. **What are the most crucial reasons as to why you would be willing to pay such a tax? (Choose as many as apply)**

Check all that apply.

- ☐ I will personally benefit from paying a tax
- ☐ It is for a good cause
- ☐ I am concerned that I will lose my livelihood if the seagrass habitat is impacted
- ☐ I am concerned that I will not benefit from recreational activities anymore
- ☐ I am concerned that there will be a loss of biodiversity
- ☐ The environment should be protected for me and future generations
- ☐ It is important that we protect the seagrass habitat not only for ourselves, but also for the natural environment that depends on it
- ☐ Other

20. Why did you choose the amount?

Mark only one option.

- ☐ It is the most I am willing to spend on environmental issues
- ☐ The amount is an accurate representation of the value that I perceive seagrass ecosystem services to have
- ☐ It was a random choice
- ☐ It is the most I can afford to pay based on my budget constraints
- ☐ The effects of eutrophication do not impact my livelihood, so this is the amount I decided upon
- ☐ The impact of eutrophication on the seagrass may impact my livelihood, so this is the amount I agreed upon
- ☐ If everyone in the municipality paid this amount, I think it would cover the expenses of this initiative
- ☐ Other:

SECTION 5: ELABORATION

In this section, I would like to find out why you selected "No" from the previous question.

21. **What was the reason(s) as to why you were not willing to pay a tax to monitor the estuary?**

Check all that apply.

- ☐ I do not think that paying a tax will make a difference to the state of the estuary
- ☐ Currently, I cannot afford to pay extra taxes
- ☐ I do not use the estuary; therefore, I do not think that I should pay to conserve it
- ☐ Other people or organisations should fund the monitoring practices
- ☐ I already pay too much tax
- ☐ I would prefer not to answer
- ☐ I do not understand the goods and services of seagrass ecosystems enough, therefore I am not willing to pay to monitor them
- ☐ Other

SECTION 6: SOCIO-DEMOGRAPHIC INFORMATION

In this section, I would like to find out more about your socio-demographic profile. Please remember that all information given will be kept completely confidential. If you do not feel comfortable answering a question, there is an option for you to select.

22. What is your age?

Mark only one option.

- ☐ 18-30
- ☐ 31-40
- ☐ 41-50
- ☐ 51-60
- ☐ 61-70
- ☐ 70 +
- ☐ I would prefer not to answer

23. What do you identify as?

Mark only one option.

- ☐ Male
- ☐ Female
- ☐ Non-binary
- ☐ I would prefer not to answer

24. What is your home language?

Mark only one option.

- ☐ Afrikaans
- ☐ English
- ☐ Xhosa
- ☐ Other:

25. What is your highest level of education?

Mark only one option.

- ☐ School (no matric)
- ☐ Grade 12/matric completed
- ☐ Apprenticeship or short course
- ☐ Professional qualification
- ☐ Diploma or degree
- ☐ More than one diploma or degree
- ☐ I would prefer not to answer

26. Are you:

Mark only one option.

- ☐ Working
- ☐ Studying
- ☐ Retired
- ☐ Unemployed
- ☐ I would prefer not to say
- ☐ Other:

27. What is your monthly household income after tax (ZAR)?

Mark only one option.

- ☐ Less than R2 000
- ☐ R2 000 - R5 000
- ☐ R5 000 - R10 000
- ☐ R10 000 - R15 000
- ☐ R15 000 - R20 000
- ☐ R20 000 - R30 000
- ☐ R30 000 - R40 000
- ☐ R40 000 - R50 000
- ☐ Above R50 000
- ☐ I would prefer not to say

THANK YOU! THIS IS THE END OF THE SURVEY.

To complete this survey, please click "submit". If there are any questions that you would like to revisit, you may do so. Just a reminder that the responses obtained from this survey will be kept anonymous and confidential.

There is a second part of my research, which involves an online focus group presentation and discussion. This is an optional follow-on to the survey, and it will take place on the 23rd of July 2020. If you are interested in participating in the online focus group, or if you have any questions or comments about the survey, your participation or my project, please email me, I would love to hear from you.

Thank you so much for completing the survey - your input will be of great value!

APPENDIX III: DELIBERATIVE ASSESSMENT OF SEAGRASS ECOSYSTEMS

Hello! Thank you so much for your participation in the online focus group - your input will add great value to my research. As discussed in the focus group, the aim of my project is to assess whether deliberation plays a role in influencing people's choices and decisions.

The questions in this survey were designed around the information provided in the focus group. You may notice that there are several similar questions to the first survey you completed. However, this survey is slightly different, and I will use the results obtained in this survey as a comparison to the first survey.

Please note that this questionnaire is confidential and voluntary, and no one will know your answers besides myself. If you feel like stopping any time during the questionnaire, please feel free to do so. This questionnaire is designed is to obtain your opinion, and there are no right or wrong answers.

* Required

1. **Are you 18 or older and willing to complete the survey and take part in the study?**
   **Mark only one option.*

   ☐ Yes, I consent: Thank you! The survey should take between 10 to 15 minutes to complete. Please click the "Next" button to continue.

   ☐ No, I do not consent: Thank you for your interest. You may close the window.

SECTION 1: ACTIVITIES IN THE KNYSNA ESTUARY

In this section, I would like to find out more about how you use and may benefit from the Knysna Lagoon.

Please note that in this survey, I refer to the Knysna Lagoon as the "Knysna estuary".

2. **Do you make use of the Knysna estuary (Knysna lagoon)?**
   Mark only one option.

   ☐ Yes

   ☐ No

3. **How do you utilise the Knysna estuary?**
   Check all that apply.

   ☐ Fishing activities

   ☐ Boating activities (e.g. skiing, tubing)

   ☐ Water-based exercise (e.g. canoeing, kayaking, stand-up paddling)

   ☐ Leisure (e.g. beaching, sun-tanning)

   ☐ Recreation (e.g. snorkelling, swimming)

   ☐ Part of my job (e.g. research, conservation, tourism)

   ☐ Land-based exercise along and around the estuary (e.g. walking, running, cycling)

   ☐ Part of my job (e.g. research, conservation, tourism)

   ☐ I do not make use of the estuary

   ☐ Not applicable

   ☐ Other

4. **How often do you make use of the estuary to fulfil your activity or activities mentioned in the question above?**
   Mark only one option.

   ☐ Every day
   ☐ Five or more times a week
   ☐ 2-3 times a week
   ☐ Once a week
   ☐ Once every two weeks
   ☐ Once a month
   ☐ Never

SECTION 2: INFORMATION GENERATION

In this section, I would like to find out what impact, if any, the online focus group had on your understanding of seagrass ecosystems and ecosystem services.

5. **What is your knowledge of the natural environment and how nature can benefit your livelihood?**
   Mark only one option.

	1	2	3	4	5	
No knowledge	◯	◯	◯	◯	◯	Very knowledgeable

6. **Do you think that your knowledge of the natural environment, and the way nature can benefit your livelihood, has changed since the first survey?**
   Mark only one option.

   ☐ Yes
   ☐ No

7. **Do you know what the term 'ecosystem services' means?**
   Mark only one option.

   ☐ Yes
   ☐ No

8. **Do you think that the presentation contributed to your understanding of the term ecosystem services?**
   Mark only one option.

   ☐ Yes
   ☐ No
   ☐ Maybe

9. **Based on the information provided in the presentation, how confidently would you be able to identify the seagrass plant?**

Mark only one option.

	1	2	3	4	5	
Not confidently	◯	◯	◯	◯	◯	Very confidently

10. **Do you think that your ability to identify seagrass has changed since the presentation?**

Mark only one option.

- ☐ Yes
- ☐ No
- ☐ It stayed the same

11. **Do you think that your understanding of the ecosystem service benefits that seagrass provides has changed since the first survey?**

Mark only one option.

- ☐ Yes
- ☐ No
- ☐ Other

12. **Considering the ecosystem services that seagrass ecosystems provide, which do you think is the most valuable to your involvement in the estuary?**

Check all that apply.

- ☐ Nursery habitat for fish species (i.e. potentially more fish in the estuary)
- ☐ Decreases coastal erosion (i.e. infrastructure protection)
- ☐ Increases water clarity (i.e. clearer water)
- ☐ High carbon sequestration rate (i.e. potentially cleaner air)
- ☐ All of the above

13. **What was the most noteworthy piece of information that you obtained from the presentation?**

_____

SECTION 3: VALUATION SCENARIO

Please read the scenario below. The scenario is the same as the scenario presented in the first survey. The purpose of including the same scenario in this survey is to assess whether your valuation preferences have changed since the first survey.

Since I do not have access to the individual answers you provided in the first survey, please note that I cannot directly compare the answers you provided in the first survey to the answers provided in this survey. Based on this, please consider the questions in this section as novel, and please answer them based on your knowledge (either gained or sustained) from the presentation.

As with the first survey, all of the questions in this section are based on a hypothetical scenario, meaning that you will not be held accountable to your answers.

The scenario

In 2011, leaking sewage from the Knysna sewerage plant seeped into the estuary which polluted the water in the estuary. This caused algae to grow on the surface of the water, which meant that less sunlight could reach the seagrass that grew underneath the surface of the water. This is known as eutrophication.

Before the leakage took place, the health of the seagrass in the Knysna estuary was stable. Figure 1 shows a healthy seagrass habitat in Knysna. However, as a result of the sewage leak, a lot of seagrass died. Figure 2 shows a loss in seagrass because of eutrophication. The pictures were taken at the same place, but 7 months apart.

Although the seagrass recovered from the leakage in 2011, if there was another sewage leak, it could mean that seagrass may no longer grow in the Knysna estuary. If seagrass does not continue to grow in the estuary, then the ecosystem service benefits that seagrass provide will be lost.

An idea to ensure that such leaks do not happen again in the future is to put in place proper checks and monitoring procedures at the sewage works, as well as the overall state of the estuary. Research has found that regular checks, documenting and monitoring of the sewerage works will mean that regulations and operational standards will more likely be adhered to. This could potentially reduce the occurrence of another leakage. Monitoring the state of the estuary will assist in ensuring that the estuary is in a healthy and functioning state, which will contribute to the maintenance of seagrass ecosystem services.

Money will need to be raised in order to support a monitoring operation such as this. The hypothetical responsible organisation for monitoring and documenting the state of the estuary is a registered and established non-government organisation (NGO) dedicated to marine conservation in Knysna.

An idea to finance the monitoring procedures proposed by the NGO is through an additional monthly tax paid by residents in Knysna to the Knysna Municipality. The tax will be ringfenced to ensure that the funds will go straight towards monitoring operations at the NGO.

There are costs and benefits associated with paying for an organisation to monitor the state of the estuary. One benefit is that seagrass habitats may not be damaged further. This could have further benefits such as reducing the impact of coastal erosion surrounding the estuary, providing a habitat for fish species, reducing water sedimentation to make the water clearer and it could increase carbon dioxide sequestration. These services that seagrass provide, if maintained, will positively impact the Knysna community.

However, there are costs involved with paying for an organisation to monitor the estuary. One cost is funding the organisation. This cost will reduce the amount of money you will have to spend on other goods and services. Other non-monetary costs that may be implemented are potential restrictions on boating, bait digging and fishing activities to allow for the seagrass to recover.

Based on this scenario, please answer the questions that follow. Please remember that all of the questions in this section are based on a hypothetical scenario, meaning that you will not be held accountable to your answers. All of the information, projects, fund-raising and taxes are hypothetical. The responses obtained in this survey are purely for academic research.

Image of healthy seagrass

Image of damaged seagrass

14. How concerned are you that the seagrass was damaged in the Knysna estuary from the leaking sewerage?

Mark only one option.

	1	2	3	4	5	
Not concerned	◯	◯	◯	◯	◯	Very concerned

15. Do you think that your concern for the damage of seagrass from the leaking sewerage has changed since the first survey?

Mark only one option.

- ☐ My concern has increased
- ☐ My concern has decreased
- ☐ My concern has stayed the same
- ☐ Other

16. Do you think that the presentation might have influenced your decision above?

Mark only one option.

- ☐ Yes
- ☐ No
- ☐ Other:

17. **Monitoring practices conducted in the estuary will likely reduce the probability of another sewerage leak from occurring. This may assist with seagrass health, and therefore the ecosystem service benefits that they provide. Considering your budget constraints (i.e. your household expenditure and other things you may want to spend the money on), would your household be willing to pay an additional monthly tax to the Knysna Municipality for monitoring practices to be conducted in the estuary? The tax would be ringfenced and the proceeds would go straight to the Knysna Basin Project.**

***** *Mark only one option*

☐ Yes *(Skip to question 18)*

☐ No *(Skip to question 25)*

SECTION 4: VALUATION QUESTION

In this section, I would like to find out how much your household would be willing to pay per month for monitoring practices to happen in the Knysna estuary. Please remember that these questions are still based on the hypothetical scenario.

18. **Monitoring the estuary will likely yield greater ecosystem service benefits that seagrass provides. Considering your budget constraints, what is the maximum amount of money (in ZAR) that your household would be willing to pay per month for monitoring practices in Knysna estuary?**

Mark only one option.

☐ R0	☐ R150
☐ R1	☐ R200
☐ R5	☐ R250
☐ R10	☐ R500
☐ R20	☐ R750
☐ R25	☐ R1 000
☐ R50	☐ R 1500
☐ R75	☐ Above R1 500
☐ R100	☐ Other

19. **If you selected 'Other' in the question above, please state the value below (in ZAR). If you did not select 'Other', please disregard this question.**

_____

20. Why did you choose the amount?

Mark only one option.

- ☐ It is the most I am willing to spend on environmental issues
- ☐ The amount is an accurate representation of the value that I perceive seagrass ecosystem services to have
- ☐ It was a random choice
- ☐ It is the most I can afford to pay based on my budget constraints
- ☐ The effects of eutrophication do not impact my livelihood, so this is the amount I decided upon
- ☐ The impact of eutrophication on the seagrass may impact my livelihood, so this is the amount I agreed upon
- ☐ If everyone in the municipality paid this amount, I think it would cover the expenses of this initiative
- ☐ Other:

21. Was the value you elected in this survey different from the value you selected in the first survey? *

Mark only one option.

- ☐ Yes, it was a different value (*Skip to question 22)*
- ☐ No, it was the same value (*Skip to question 30)*

SECTION 5: DIFFERENT VALUES ELECTED

In this section, I would like to find out more about why you think that you elected a different value from the first survey.

22. Was the value you selected in this survey higher or lower than the value you selected in the first survey?

Mark only one option.

- ☐ The value I selected in this survey was higher
- ☐ The value I selected in this survey was lower than the first survey

23. If your value was higher in this survey, please consider this question. Why do you think that the value you elected in this survey was higher compared to the value you selected in the first survey?

Check all that apply.

- ☐ The information provided in the presentation helped form my preferences better than the first survey
- ☐ The discussions in the focus group made me realise that I benefit from seagrass more than I originally realised
- ☐ I understand seagrass ecosystems better
- ☐ I understand the term ecosystem services better
- ☐ All of the above
- ☐ Other

24. If your value was lower in this survey, please consider this question. Why do you think that the value you elected in this survey was lower compared to the value you selected in the first survey?

_____

SECTION 6: ELABORATION

In this section, I would like to find out why you selected "No" from the previous question.

25. **If the monitoring practice implemented in the Knysna estuary was to meet an end goal (i.e. the results obtained are to be used to assist policymaking and management of the estuary), and if payment towards the monitoring was paid directly to the monitoring organisation, do you think that your household would be more willing to pay a monthly amount to the monitoring organisation?**
    Mark only one option.

    ☐ Yes (*Skip to question 30)*

    ☐ No (*Skip to question 27)*

26. **If you selected "Yes" from the question above, please consider this question. Considering your budget constraints, what is the maximum amount of money (in ZAR) that your household would be willing to pay per month for the abovementioned monitoring practice in Knysna estuary?**
    Mark only one option.

☐ R0	☐ R150
☐ R1	☐ R200
☐ R5	☐ R250
☐ R10	☐ R500
☐ R20	☐ R750
☐ R25	☐ R1 000
☐ R50	☐ R 1500
☐ R75	☐ Above R1 500
☐ R100	☐ Other

SECTION 7: FURTHER REASONING

In this section, I would like to find out why you selected "No" from the previous two sections.

27. **What was the reason(s) as to why you were not willing to pay a tax to monitor the estuary?**
    Check all that apply.

    ☐ I do not think that paying a tax will make a difference to the state of the estuary

    ☐ Currently, I cannot afford to pay extra taxes

    ☐ I do not use the estuary; therefore, I do not think that I should pay to conserve it

    ☐ Other people or organisations should fund the monitoring practices

    ☐ I already pay too much tax

    ☐ I would prefer not to answer

    ☐ I do not understand the goods and services of seagrass ecosystems enough, therefore I am not willing to pay to monitor them

    ☐ Other

28. **What other strategies (besides monitoring) do you think could be implemented in the Knysna estuary to reduce the effects eutrophication has on seagrass ecosystems?**

_____

29. **Do you think that your household would be more willing to pay an amount to support the alternative strategy you mentioned from the question above?**

Mark only one option.

☐ Yes

☐ No

☐ Other:

SECTION 8: SOCIO-DEMOGRAPHIC INFORMATION

In this section, I would like to find out more about your socio-demographic profile. Please remember that all information given will be kept completely confidential. If you do not feel comfortable answering a question, there is an option for you to select.

30. **What is your age?**

Mark only one option.

☐ 18-30

☐ 31-40

☐ 41-50

☐ 51-60

☐ 61-70

☐ 70 +

☐ I would prefer not to answer

31. **What do you identify as?**

Mark only one option

☐ Male

☐ Female

☐ Non-binary

☐ I would prefer not to answer

32. **What is your home language?**

Mark only one option

☐ Afrikaans

☐ English

☐ Xhosa

☐ Other:

33. What is your highest level of education?

Mark only one option

- ☐ School (no matric)
- ☐ Grade 12/matric completed
- ☐ Apprenticeship or short course
- ☐ Professional qualification
- ☐ Diploma or degree
- ☐ More than one diploma or degree
- ☐ I would prefer not to answer

34. Are you:

Mark only one option

- ☐ Working
- ☐ Studying
- ☐ Retired
- ☐ Unemployed
- ☐ I would prefer not to say
- ☐ Other:

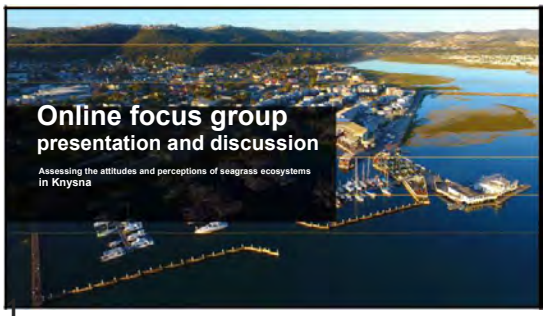
35. What is your monthly household income after tax (ZAR)?

Mark only one option.

- ☐ Less than R2 000
- ☐ R2 000 - R5 000
- ☐ R5 000 - R10 000
- ☐ R10 000 - R15 000
- ☐ R15 000 - R20 000
- ☐ R20 000 - R30 000
- ☐ R30 000 - R40 000
- ☐ R40 000 - R50 000
- ☐ Above R50 000
- ☐ I would prefer not to say

THANK YOU! THIS IS THE END OF THE SURVEY.

To complete this survey, please click "submit". If there are any questions that you would like to revisit, you may do so. Just a reminder that the responses obtained from this survey will be kept anonymous and confidential.



1

A bit about me and my research

Thank you so much for participating in my research thus far – your participation will add great value!

I am a Masters student at Rhodes University, studying Environmental Economics. I have been at Rhodes throughout my university career and I plan to finish my studies at the end of the year.

What I find interesting about this topic is how we as humans are so connected to the natural world. We use and benefit from the environment in numerous ways, some of which aren't visible to us.

This evening I am joined by both of my supervisors: Prof. Gavin Fraser and Prof. Jen Snowball, who are experts in the Environmental Economics field at Rhodes University and in South Africa at large.

2

A few housekeeping points

We will try to keep this presentation as short and concise as possible.

If you have any questions about your participation, please do not hesitate to stop me and ask during the presentation.

We want to try make this presentation interactive – there will be a couple of poll questions. These are anonymous and it will be great to get you input.

Just a reminder that all responses and input provided in this focus group will remain confidential. This focus group is designed to obtain your opinion, and there are no right or wrong answers.

3

My research and your participation

The aim of my research is to determine whether deliberation and information generation (through a focus group) has the potential to influence people's attitudes and perceptions of seagrass ecosystems.

At the end of this focus group I will ask you to complete a questionnaire, similar to the one you completed in the online survey.

It is my aim that you will hopefully learn something new about seagrass ecosystems as well as ecosystem services.

4

5

Ecosystem services

Ecosystems provide natural contributions and functions to human society. Ecosystems provide many of the basic services that make life possible for people.

The term ecosystem services is characterized as the varied benefits that humans obtain from natural ecosystems.

Ecosystem services link humans to nature, highlighting the ways, often small and unnoticeable, in which nature benefits humans.

6

How do ecosystem services impact our life?

Ecosystem services contribute to human wellbeing in many ways:

- Food, water purification and raw materials,
- Flood and erosion control, or plants cleaning the air,
- Bacteria decomposing wastes, pollination, and
- Spiritual and recreational benefits.

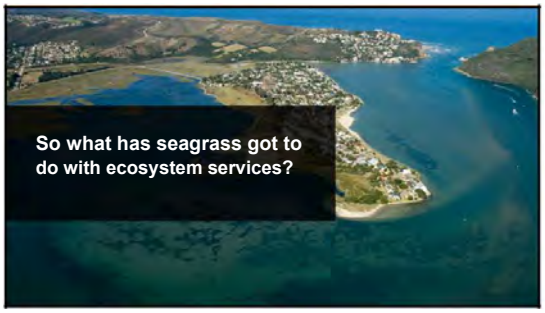
The benefits of ecosystem services are, however, often unquantified and unmeasured. For instance, how do we measure and value the roots of a tree preventing erosion? Without the roots, erosion may cost society money for damage to infrastructure etc.

In asking questions about your willingness to pay (like in the first survey), we can estimate the value of environmental goods and ecosystem services.

7

Poll question

8



9

Poll question

10

Seagrass ecosystems

Seagrass is a unique marine flowering plant that has adapted to fully exist submersed in the sea.

The name seagrass stems from the fact that many seagrass species have long and narrow leaves, and are spread across "meadows" that resemble underwater grasslands.

They are often found in shallow and sheltered coastal waters, such as in estuaries and lagoons.

They are found throughout the world, besides the polar regions, occupying thousands of kilometres.

Seagrass in Knysna

The seagrass found in Knysna is called Zostera capensis, which is a subspecies of seagrass. It is found along the southern and eastern coasts of southern Africa.

Seagrass occupies approximately 20% of the Knysna estuary floor, and are either subtidal, or intertidal.

It is listed as vulnerable in the Red Data List of Species.

Seagrass ecosystem services

Seagrass has a number of ecosystem services (nature's benefit to humans).

Although not always visible, these ecosystem services impact coastal community's livelihoods.

Some ecosystem services are:

- A nursery habitat for juvenile fish species,
- A preventative measure against coastal and wave erosion,
- They help increase water clarity,
- They produce oxygen, and
- They have a high carbon sequestration rate.

13

Seagrass threats

Seagrass have threats that impact its abundance and distribution in a water body.

Some threats are:

- Boating activities,
- Building and infrastructure,
- Illegal bait digging, and
- Eutrophication.

14

Eutrophication

Eutrophication was discussed in the survey as a direct threat to seagrass in Knysna.

Eutrophication occurs when there is an excess amount of nutrients in a water body. The nutrients build up and create a mat-like layer of algae on the surface of the water. This reduces the amount of light that reaches the plants underneath the algae, so the plants cannot photosynthesise, and they often die.

This occurred in Knysna (supported by literature), when sewerage leaked into the estuary and caused some seagrass to die.

15

A solution?

A proposed solution to reduce the effects that eutrophication has on seagrass ecosystems is through monitoring.

Regularly checking and documenting sewerage levels could mean that the regulations and operational standards of the sewerage works will more likely be adhered to. This could potentially reduce the occurrence of another leakage.

The monitoring could be taken a step further, and be used to identify other sources of sewerage and what other drivers could be impacting seagrass.

The hypothetical responsible organisation for monitoring and documenting the state of the estuary is a registered and established non-government organisation (NGO) dedicated to marine conservation in Knysna.

16

Poll question

17

So should I pay to monitor seagrass? Or should I not pay?

There are costs and benefits associated with paying to monitor the estuary.

18

Benefits of monitoring

The ecosystem service benefits that seagrass provide may be advantageous to the Knysna community. Therefore, if a healthy abundance of seagrass is maintained, through monitoring, the ecosystem services will remain.

Monitoring of seagrass could result in:

- A potential reduction in coastal erosion,
- Providing a habitat for fish species,
- Reducing water sedimentation to make the water clearer,
- Increase carbon dioxide sequestration, which could lead to a healthier air quality in Knysna,
- A potential increase, or maintenance, in the abundance of wild fauna and flora, including the endangered Knysna seahorse, and

These services that seagrass provide, if maintained through monitoring, may positively impact the Knysna community.

19

Costs of monitoring

However, there are costs to paying for an organization to monitor the estuary.

The most obvious being a monetary cost. By paying an organization to monitor the estuary, you will not have as much money to spend on other goods and services.

Other costs that may be implemented by the monitoring organization could be non-monetary costs, such as potential boating and fishing restrictions. These may be implemented to allow for seagrass recovery in certain places around the estuary.

20

Poll question

21

Discussion question

One comment that came from the online survey was that monitoring the estuary does not necessarily equate to seagrass being maintained, meaning that nothing may come from the monitoring.

Do you think that other measures could be conducted to help protect seagrass from eutrophication?

Question is open to the floor for discussion.

22

What next?

Do you have any questions or comments about the presentation?

If you would like to go back to anything, please let me know.

A second survey will also be sent to you via email. Please fill this out and submit it. The responses from the second survey will be used as a comparison to the first survey.

Thank you!

Thank you so much for your participation in this focus group – I really appreciate it.

Your input will be of great value to my research!

APPENDIX V: POLL QUESTIONS

1. **In the online survey, the results showed that just under 50% of the participants knew what the term ecosystem services meant. Do you think that your knowledge of ecosystem services has changed since the first survey?**

a) Yes
b) No, I still do not know what the ecosystem services mean.
c) Somewhat, I am happy with the definition term.
d) I knew what it was before I took the survey.

2. **Before we start the section on seagrass ecosystems, have you heard of seagrass before?**

a) Yes
b) No

3. **How confidently would you be able to identify the seagrass plant in a scale of 1 -5 (1 being not confidently and 5 being confidently)?**

a) 1
b) 2
c) 3
d) 4
e) 5

4. **Before the first survey, what did you think seagrass was?**

a) A weed
b) Invasive species
c) A type of seaweed
d) I knew what it was
e) I didn't know what it was

5. **In the online survey, about 92% of the participants stated that they thought it was important to monitor the estuary. Why do you think so many people in Knysna were keen to implement the monitoring programme?**

a) It's a practical way to ensure that the estuary is in a functioning state.
b) I think that it is the best measure to help protect seagrass now.
c) I can't think of any other option that could be used to protect seagrass.

d) I do not like the monitoring idea: I think there are other options that haven't yet been considered.

6. About 55% of the participants said that they were willing to pay a tax for monitoring. However, 92% of participants said that they thought it was important for monitoring. Why do you think that 45% of the participants were not willing to pay a tax?

a) Potential distrust in where the money paid may end up.
b) The amount paid toward monitoring may be used up in administrative costs, where the money may not go the NGO for monitoring practices as intended.
c) That other organizations and stakeholders should rather be responsible.
d) That the money raised should be through another scheme; not through taxes.
e) That the money should rather be paid directly to the NGO instead of being ring-fenced through the municipality.
f) I can't afford to pay extra tax.

7. Do you think that the presentation might have changed your valuation answers to monitoring the estuary, as compared to the first survey?

a) Yes
b) No

APPENDIX VI: CORRELATION MATRIX

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*	*16*	*17*	*18*	*19*	*20*
1. WTP any amount?	1																			
2. Mistrust	-0.511	1																		
3. WTP value	0.665	-0.338	1																	
4. Importance	0.187	-0.115	0.160	1																
5. Concern	0.202	-0.107	0.165	0.666	1															
6. Non-consumptive	0.007	-0.049	0.069	-0.015	-0.014	1														
7. Consumptive use	0.034	0.004	-0.059	0.066	0.095	-0.072	1													
8. Knowledge of nature	-0.062	0.049	-0.089	-0.023	0.131	-0.005	-0.118	1												
9. Gov. responsible	-0.260	0.036	-0.149	0.004	-0.021	-0.098	-0.009	-0.049	1											
10. NGO responsible	0.054	-0.002	-0.016	0.071	0.144	0.189	0.117	0.133	-0.248	1										
11. Knysna Muni. resp.	0.082	-0.048	-0.037	-0.090	-0.155	-0.004	-0.073	-0.189	-0.521	-0.134	1									
12. Residents resp.	0.208	-0.142	0.252	0.114	0.126	0.090	0.184	0.111	-0.308	-0.079	-0.167	1								
13. All of the above resp.	0.068	0.044	0.088	-0.092	0.073	-0.055	-0.047	0.148	-0.308	-0.079	-0.167	-0.099	1							
14. Utilisation of estuary	0.122	-0.103	0.121	0.075	0.208	0.455	0.029	0.292	-0.121	0.222	-0.131	0.174	0.118	1						
15. Identify seagrass	-0.009	0.147	-0.033	0.066	0.213	-0.017	-0.065	0.503	-0.125	-0.019	0.055	-0.059	0.158	0.196	1					
16. Know of ES?	-0.076	0.045	-0.061	-0.095	-0.044	-0.030	-0.085	0.381	-0.101	0.010	0.021	-0.022	0.118	0.052	0.247	1				
17. Education	0.083	-0.014	0.163	-0.001	0.006	0.036	-0.173	0.146	-0.111	0.190	0.032	-0.134	0.121	0.123	0.123	0.049	1			
18. HH income	0.076	-0.031	0.083	0.023	0.080	-0.021	0.044	-0.050	-0.252	0.027	0.145	0.254	0.054	0.100	-0.044	-0.118	-0.073	1		
19. Age	0.030	-0.044	-0.138	0.019	0.079	0.114	0.095	-0.023	-0.138	0.149	-0.045	0.102	0.024	0.155	0.011	0.174	0.067	0.352	1	
20. Gender	-0.049	0.188	-0.025	-0.017	0.117	-0.107	0.045	0.011	-0.053	0.044	0.044	0.091	-0.052	0.047	0.047	0.022	-0.017	0.484	0.319	1

APPENDIX VII: ETHICAL CLEARANCE LETTER

RHODES UNIVERSITY
Where Leaders Learn

Human Ethics subcommittee
Rhodes University Ethical Standards Committee
PO Box 94, Grahamstown, 6140, South Africa
t: +27 (0) 46 603 8055
f: +27 (0) 46 603 8822
e: ethics-committee@ru.ac.za
www.ru.ac.za/research/research/ethics
NHREC Registration no. REC-241114-045

28 April 2020

James MARRINER

Email: g16m0178@campus.ru.ac.za

Review Reference: 2020-1333-3380

Dear Prof Fraser

Title: The economic valuation of ecosystem services using the deliberative valuation method in the context of a developing country

Principal Investigator: Prof Gavin Fraser

Collaborators: Mr. James Marriner, Prof Jen Snowball

This letter confirms that the above research proposal has been reviewed and **APPROVED** by the Rhodes University Ethical Standards Committee (RUESC) – Human Ethics (HE) sub-committee.

Approval has been granted for 1 year. An annual progress report will be required in order to renew approval for an additional period. You will receive an email notifying when the annual report is due.

Please ensure that the ethical standards committee is notified should any substantive change(s) be made, for whatever reason, during the research process. This includes changes in investigators. Please also ensure that a brief report is submitted to the ethics committee on the completion of the research. The purpose of this report is to indicate whether the research was conducted successfully, if any aspects could not be completed, or if any problems arose that the ethical standards committee should be aware of. If a thesis or dissertation arising from this research is submitted to the library's electronic theses and dissertations (ETD) repository, please notify the committee of the date of submission and/or any reference or cataloging number allocated.

Sincerely,

Prof Arthur Webb

Chair: Human Ethics Sub-Committee, RUESC- HE

APPENDIX VIII: THEMATIC ANALYSIS OF THE DELIBERATIVE FOCUS GROUP

Theme	Subtheme	Positive Dimensions	Negative Dimensions
Payment vehicle	Municipal tax	Enforces the community to be liable for payments.	An exorbitant amount of tax already paid; extra taxes said to drain the taxpayer.
	User pays levy	Useful payment strategy to ensure that the individuals who utilise the estuary pay for using it.	Cannot expect people with different socio-economic drivers and use values to pay the same levy amount; challenging to monitor.
	Tourism levy	Tourism linked to boosting the local economy; tourists visit Knysna primarily due to the aesthetic appeal of the estuary.	Tourism already significantly increases the local economy; unfair to expect tourists to pay an additional levy for conservation strategies.
	Donations	Community members are more likely to pay amounts to conservation agencies than forced municipal taxes.	Difficult to control; no one is liable to pay donations.
Conservation strategies	Monitoring	A critical and proactive process for conservation.	Essential to have outcomes, objectives and goals in the monitoring process; monitoring is futile without outcomes; the community is less likely to WTP to support programme without outcomes.
	Restoration	If implemented, restoration could create jobs.	Like monitoring – if there are no outcomes and goals, restoration is futile.
	Education	Educating the community about the value of the estuary to increase values and attitudes towards the estuary.	If the importance of estuary better understood, the community may be more WTP.
Estuarian system	Indirect value	Estuary has a national value; fish nursery habitat in Knysna may impact fisheries in throughout South Africa.	Indirect use values estuary provides often ignored; people unlikely to invest in conserving the estuary if value not understood.
Management agencies	Knysna municipality	Have the resources to conduct conservation strategies.	Local distrust in the municipality to reduce WTP; no accountable authority to taxpayers; unwilling to pay more if there are already established authorities responsible for managing WWTW and conserving the estuary.
	SANParks	Have the experience in conducting conservation strategies in the estuary.	The current monitoring plan is not in a state that provides community and other organisations with goals and outcomes.
	NGO's	People more WTP to local NGO's than government-endorsed agencies.	Often do not have the resources to conduct extensive conservation programmes.

APPENDIX IX: VARIABLE CODES USED FOR THE CORRELATION ANALYSIS

Variable	Variable Coding
WTP any amount	Coded as 1 if WTP was any amount; 0 otherwise.
Mistrust	Coded as 1 if the respondent indicated mistrust in monitoring scenario or the payment vehicle (municipal tax); 0 otherwise.
WTP value	Actual WTP value stated by the respondent; 0 otherwise.
Importance of monitoring	Coded on a ranking scale: 1: Not important 2: Very important
Concern of seagrass damage	Coded on a ranking scale: 1: No concern 2: Very concerned
Non-consumptive use value	Coded as 1 if respondent made use of non-consumptive use values in the estuary; 0 otherwise.
Non-use value	Coded as 1 if the respondent indicated non-use values associated with the estuary; 0 otherwise.
Consumptive use value	Coded as 1 if respondent made use of consumptive use values of the estuary; 0 otherwise.
Knowledge of nature	Coded on a ranking scale: 1: No knowledge 5: Very knowledgeable
Utilisation of estuary	Seven categories: 1: Never 2: Once a month 3: Once every two weeks 4: Once a week 5: 2-3 times a week 6: Five or more times a week 7: Every day
Confidence in the identification of seagrass	Coded on a ranking scale: 1: Not confident 5: Very confident
Heard of ecosystem services	Dummy variable: 1 if heard of ecosystem services; 0 otherwise.
Education level	Six categories: 1: School (no matric) 2: Grade 12/matric completed 3: Apprenticeship or short course 4: Professional qualification 5: Diploma or degree 6: More than one diploma or degree
Household income	Coded as average household income category respondent elicited.
Age	Coded as average age group respondent elicited.
Gender	Dummy variable: 1 if male; 0 otherwise.

APPENDIX X: OLS REGRESSION VARIABLE CODING

Variable	Variable coding
WTP amount	Actual WTP value stated by the respondent.
Age	Six categories: 1: 18-30 2: 31-40 3: 41 – 50 4: 51 – 60 5: 61 – 70 6: Above 70
Frequency of use	Seven categories: 1: Never 2: Once a month 3: Once every two weeks 4: Once a week 5: 2-3 times a week 6: Five or more times a week 7: Every day
Confidence in identifying seagrass	Coded on a ranking scale: 1: Not confident 5: Very confident
Heard of ecosystem services	Dummy variable: 1 if heard of ecosystem services; 0 otherwise.
Non-use value	Coded as 1 if the respondent indicated non-use values associated with the estuary; 0 otherwise.
Mistrust	Coded as 1 if the respondent indicated mistrust in monitoring scenario or the payment vehicle (municipal tax); 0 otherwise.