The Grass is Always Bluer

An investigation into the applicability of Market-based Governance for Seagrass in Sweden

David Boyd

Master Thesis Series in Environmental Studies and Sustainability Science,
No 2019:037

A thesis submitted in partial fulfillment of the requirements of Lund University International Master's Programme in Environmental Studies and Sustainability Science (30hp/credits)

LUCSUS
Lund University Centre for Sustainability Studies

The Grass is Always Bluer

An investigation into the applicability of Market-based Governance for Seagrass in Sweden

David Boyd

A thesis submitted in partial fulfillment of the requirements of Lund University International Master's Programme in Environmental Studies and Sustainability Science

Submitted May 14, 2019

Supervisor: Emma Johansson, LUCSUS, Lund University

Abstract

In recent years the concept of "Blue carbon" has brought attention to the importance of Mangroves, Seagrass and Saltmarsh ecosystems in carbon cycles. Concerns over climate change has had countries commit to decreasing CO_2 emissions, often using natural processes to sequester CO_2. This trend has often followed a market approach through creating a monetary value and market for CO_2. This Climate Finance strategy is now starting to be applied to Blue Carbon ecosystems however, seagrass is underutilised, and it is rarely used in developed nations. As such, this paper aims to test the applicability of such a governance model in this context, using Sweden and the management of seagrass ecosystems as a case study.

This was assessed using a qualitative literature synthesis and frameworks developed from Wunder's (2015) definition for Payment for ecosystem services (PES) and the concept for Loss and Damage applied to the Swedish context. This study found that market-based governance of the seagrass species *Zoestera Marina,* through the monetary value of its CO_2 sequestration, fisheries enhancement, and coastal erosion protection services, has potential within a Swedish context. Specifically, the use of the Voluntary carbon market (VCM) is found to be the most applicable strategy. Furthermore, through applying seagrass ecosystems services to the Loss and Damage concept, it is shown that conserving and restoring such an ecosystem can reduce Loss and Damage from climate change.

The use of the VCM approach as a basis for a demonstration project to improve management strategies and best practice is proposed. The use of the Loss and Damage concept as justification for this is suggested. The issues surrounding the concept of market based environmental governance are addressed and whether or not they apply in this case is discussed. Finally, further research regarding the application of this mode of governance on seagrass is discussed.

Keywords: Blue carbon, Seagrass, Sweden, Payment for ecosystem services, Loss and Damage, coastal management, market based environmental governance

Word count: 13 342

Acknowledgements

Firstly, I would like to thank my supervisor Emma Johansson and my group members Will Baigent and Rasmus Larsen. For great advice and support through a difficult process.

I would like to thank Chad Boda for taking the time to have several productive meetings with me and providing me with excellent guidance.

I want to also thank my mother Eílis Boyd for reading through my final draft and my sister Úna Boyd for putting up with my insane late night ramblings.

I also want to thank all of Batch 21 for a fantastic two years and proving how brilliant they all are throughout the long and arduous final weeks. Special shout out to the late night/ early morning crew Halley Rainer and Jens Schubert, as well as Anna Stephens for providing intense moral support via food.

Finally, my deepest thanks go to the coffee machine in the LUCSUS kitchen. The true hero in the darkest hours.

Table of Contents

1 Introduction

In recent years the role played by vegetated coastal ecosystems in carbon sequestration and storage has captured global attention (Nellemann et al., 2009). Through storing carbon in the plants and in the soil of these ecosystems, they create significant carbon sinks that rival that of terrestrial forests, that until recently have been ignored in global carbon budgets (Duarte et al., 2010; McLeod et al., 2011). Under the term "Blue Carbon" attention is being brought to the ability of these ecosystems to contribute to global climate change mitigation (Duarte et al., 2013b; Murray, 2012). These ecosystems include mangroves, seagrasses, and saltmarshes, and are spread widespread throughout the world. However, many of these ecosystems are being degraded and lost at an accelerating rate (Pendleton et al., 2012), with approximately a third of global coverage already lost (Waycott et al., 2009). This process has been driven by human activities such as pollution, dredging and eutrophication (Short et al., 1996), as well as climate change (Short & Neckles, 1999; Smale et al., 2019).

An increasing sense of urgency has now been brought to the issues surrounding climate change. Highlighted by the alarming reports from the IPCC (Intergovernmental Panel on Climate Change), stating that CO_2 emissions need to be drastically reduced to avoid global warming of 1.5°C above pre-industrial levels, in order to avoid impacts such as extreme weather events, sea level rise, and biodiversity loss (IPCC, 2018). Organisations like the United Nations Framework Convention on Climate Change (UNFCCC) and events such as the signing of the Paris agreement on climate change have had countries commit to decreasing their CO_2 emissions, as well as sequestering carbon through their natural ecosystems. Carbon sequestration policy mechanisms have so far mainly focused on forestry, through approaches such as REDD+ (Evans, 2012). This trend has often followed a market approach, creating a monetary value for CO_2, with the aim of creating a profit incentive that pushes for maximising the carbon sequestration potential of these ecosystems. This Climate Finance strategy is now starting to be applied to Blue Carbon ecosystems (Herr & Landis, 2014), with its ability to contribute to reducing CO_2 emissions and environmental goals such as SDG 14.

Attention is also being brought to the opportunity that coastal ecosystems present for nation's nationally determined contributions (NDC) related to the Paris agreement (Herr and Landis, 2016). However it should be noted that this has been overlooked in the European Union's (EU) NDC agreement and in Swedish National carbon inventory (European Parliment and the Council of the European Union, 2003; Swedish Environmental Protection Agency, 2018; UNFCCC, 2015a). This seems to be a clear oversight considering the potential for Sweden and the EU to contribute to their climate change mitigation activities through the inclusion of blue carbon ecosystems.

As Sweden is a Baltic state and in the Baltic Sea the seagrass species *Zostera Marina (Z. Marina)* is widespread, there is a clear opportunity for the application of blue carbon, considering the growing interest in the carbon sink ability of seagrasses (Boström et al., 2014; Ruiz-Frau et al., 2017). However, as a blue carbon ecosystem, seagrass has often been underutilised and the entire concept is rarely applied in developed nations (Wylie et al., 2016). As such, this paper aims to test the applicability of such a governance model in this context, using Sweden and the management of seagrass ecosystems as a case study.

Sweden was chosen since it is considered a critical case by Flyvbjerg (2006) the purpose of which is:

“To achieve information that permits logical deductions of the type, “If this is (not) valid for this case, then it applies to all (no) cases.” (Flyvbjerg 2006 pg.230)

Sweden was considered a critical case due to the significant presence of a blue carbon species (i.e. the seagrass *Z.marina*) in Swedish jurisdiction and the environmental challenges in Sweden that are relevant to its management. Namely, coastal defence concerns, emission reduction targets and coastal environmental objectives (Commission on Climate and Vulnerability (Sweden), 2007; Swedish Environmental Protection Agency, 2016). As all of these services can be valued, this opens up the possibility of introducing market-based mechanisms of environmental governance to promote seagrass conservation and restoration via the concept of PES. This would tie into Sweden’s Environmental objectives, as well as aims of developing the marine sector through the sustainable use of marine resources (Berggren and Liss Lymer 2016) under the EU Blue Growth Strategy (Commission 2013). Furthermore, the basis for market-based governance is already present in Sweden with the monetary valuation of ecosystem services being a popular strategy for informing policy decisions. For example it is used to assess priorities between different policies, help decision making with land-use or to communicate the value of a specific ecosystem (The Swedish Environmental Protection Agency 2018). It has also been used for conservation purposes, with a payment scheme being used to protect carnivores in Northern Sweden (Zabel and Holm-Muller 2008). Finally, experiments in the carbon finance have been carried out in Sweden, as such this concept has been recognised as a potential tool for environmental governance. A good example of this is the Carbon trading scheme experiment set up in by Sveaskog (a nationally owned forestry company) in Övertorneå municipality (PwC 2013).

Based on this background, this research is based on the following questions:

1. What structure would blue carbon governance take in the Swedish context?
2. Can a value be ascribed to seagrass ecosystem services through the Loss and Damage concept?

1.1 Position within Sustainability science

Sustainability Science is a solution orientated approach (Clark and Dickson, 2003) that utilises interdisciplinarity to integrate different spheres of knowledge to create a more holistic understanding of a topic (Spangenberg, 2011). This is carried out with the objective of creating knowledge that is that is salient, credible and legitimate (Cash et al., 2003). In testing the applicability of market-based governance for seagrass this study takes an interdisciplinary approach, through describing the natural science basis of the ecosystem being discussed and discussing a method of governance based around economic theory. The main theme of ecosystem services is an interdisciplinary concept in itself with Schröter et al. (2014 pg. 519) describing it as a concept that

"embraces ecological, economic, and social mechanisms and as such connects the environmental system with politics and decision-making."

Thus, the approaches used in this study are described under the term sustainability science.

2 Background

Here background information is presented that is relevant to the research topic. The first section is a brief outline on the biology of seagrass, as it is necessary to understand how the plant operates to appreciate how it performs ecosystem services. This is followed by an overview of the concept of blue carbon, this is done to illustrate the definition of the term, what it entails and how it can be beneficial to society. Finally, the scope was narrowed to the specific region relevant to the question and the blue carbon species present in its waters.

2.1 Seagrass

Seagrasses are a type of flowering plant that grows in marine and estuarine environments, they are the only flowering plants that are found in the sea with over 50 species spanning 4 families with the genera *Thalassia, Posidonia* and *Zostera* making up the majority of the world's seagrass (den Hartog & Kuo 2006). Seagrasses are widespread throughout the world (Fig. 1) with Antarctica being the only continent from which they are absent (Short, 2013). They are found in coastal waters where they grow in soft substrates (Short, 2013) and spread using specially evolved marine seeds, however they also carry out an asexual reproduction strategy using rhizomes to spread their coverage in the immediate area. Through this they from large meadows with seagrass "beds", where there is a significant amount of below ground biomass binding the soil together (Marbá et al., 2006).

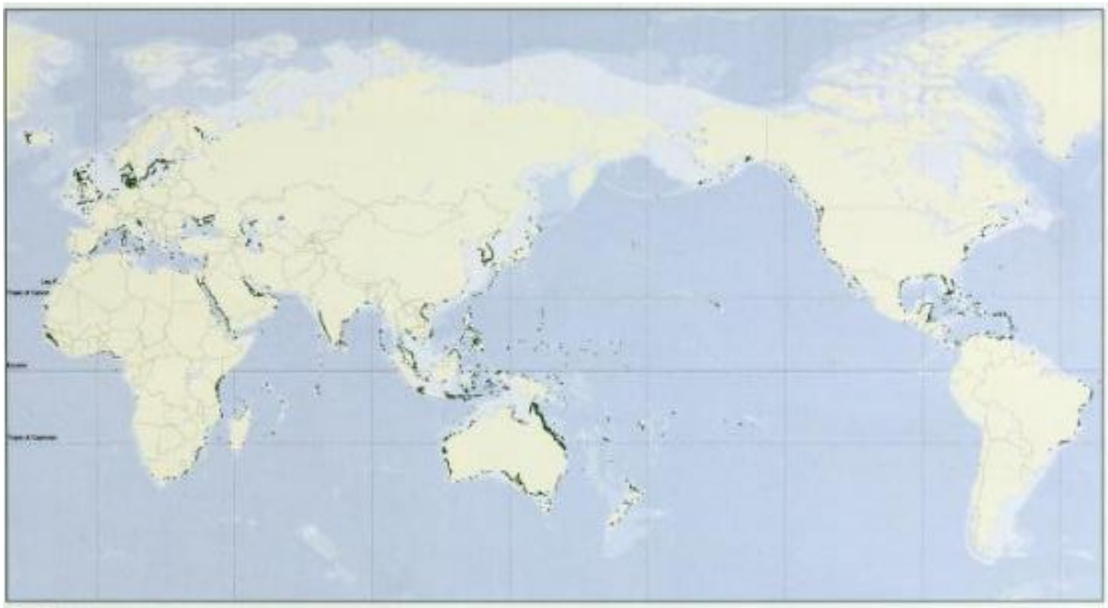

Figure 1: Global distribution of Seagrass species. Adapted from World Atlas of Seagrasses by E.P Green and F.T Short, 2003, p. 22

It is the formation of large meadows that make seagrasses ecosystem engineers. This is due to the effects they have on the biogeochemistry of an area, which is carried out through influencing carbon and nutrient flux via sedimentation and photosynthetic production (Marbá et al., 2006). They also influence coastal processes through reducing water flow velocity and binding sediment with a below ground root structure, thereby reducing erosion (Bos et al., 2007). These processes have brought attention to seagrass' use for climate change mitigation and adaptation through sequestering carbon and sediment accumulation (Duarte et al., 2013b). Furthermore, seagrasses are foundational species, as their large meadows create an important habitat that many species rely upon and thus, they have a key role in increasing local biodiversity levels and providing nursery habitats for many fish species (Hejnowicz et al., 2015).

2.2 Blue carbon

2.2.1 Definition and Origin

Blue carbon is defined as the coastal carbon sequestered and stored by ocean ecosystems (Alongi, 2018). The term originates from a rapid response assessment carried out in 2009 by the United Nations (UN) agencies, United Nations Environmental Programme (UNEP), Food and Agriculture Organisation (FAO) and United Nations Educational Scientific and Cultural Organisation (UNESCO), that was driven by concerns raised by climate change (Nellemann et al., 2009). This report brought to attention the critical role coastal ecosystems play in the global carbon cycle and was carried out to complement the carbon accounting carried out by the IPCC for earth's atmosphere and terrestrial biomes (Alongi, 2018).

The reason for this accounting is the climate change concerns that are most recently highlighted in the IPCC's special report on the impacts of global warming of 1.5°C (IPCC, 2018). Addressing the GHG emissions driving this warming are discussed and attention is brought to the various potential impacts, such as increased extremes in weather, sea level rise and biodiversity loss. In 2013, the IPCC extended its methodological guidelines to include coastal systems within National Greenhouse Gas Inventories (IPCC, 2013). This essentially recognised blue carbon ecosystems and the important role they play in carbon cycles, and thus how conserving and restoring these ecosystems can influence climate change.

2.2.2 Significance of Blue Carbon Globally

Blue carbon ecosystems are primarily mangroves, saltmarshes and sea grasses, and combined these ecosystems have a global coverage of approximately 49 million hectares (Pendleton et al., 2012). This area is just a fraction of the size of earths forests, yet due to the efficiency of blue carbon systems carbon sequestering (with a range of 18 – 1713 gC $m^{-2}yr^{-1}$ compared to 0.7 – 12.1 gC $m^{-2}yr^{-1}$ in forests), their global significance to the carbon cycle is comparable (McLeod et al., 2011). However, it should be noted that these estimates have large uncertainties due to difficulties in accurately assessing the full global extent of these ecosystems and the dynamic variable nature of their sequestration rates (Duarte, 2017). Furthermore, there are other processes that may be contributing to these ecosystems sink capacity that are not accounted for such as export into deep sea sediments (Duarte & Krause-Jensen, 2017)

As the importance of blue carbon ecosystems in earths carbon cycle have become increasingly highlighted, there is a growing interest in utilising these habitats as a carbon sink to mitigate climate change (Duarte et al., 2013b; Howard et al., 2017b; Marbà et al., 2015). This is compounded by the fact that across the world these habitats are at risk with nearly a third of global coverage already lost (Waycott et al., 2009) and this decline is accelerating (Pendleton et al., 2012), driven by human disturbances such as pollution, dredging and eutrophication (Short et al., 1996), as well as climate change (Short & Neckles, 1999; Smale et al., 2019). This is of particular concern from a climate change perspective as the destruction of these habitats allows the for the release of the stored blue carbon, with an estimated 0.15- 1.02 Pg of CO_2 being released annually (Pendleton et al., 2012).

These ecosystems are highly effective at storing carbon due to high levels of primary productivity which stores carbon in the structures of the plant itself and due to the plants taking suspended particles of organic matter out of the water and burying them in the sediment (Duarte, Middelburg, & Caraco, 2005). This happens due to the plants canopy slowing water flow causing particles to drop into the sediment and the plants roots structures then preventing resuspension(McLeod et al., 2011). This creates a layer of organic carbon that is constantly accumulating and due to the anaerobic conditions present cannot be respired into CO_2 (Duarte et al., 2013a). This is why the destruction of these habitats causes CO_2 to be released, as the loss of the below ground plant material causes the sediment to be resuspended in the water column where it can be respired aerobically causing the release of carbon dioxide (Pendleton et al., 2012).

Furthermore, storage of carbon in these sediments has an extra benefit in that it is very long term. In fact, it is along millennial scales and thus allows for large sinks to be built up (Duarte et al., 2005) Also, these ecosystems not only provide a service in terms of carbon sequestration but often provides many other co-benefits from their role in providing habitats for different species critical to fisheries, for stabilising coastal sediment preventing erosion and buffering pollution (Barbier et al., 2011).

Within this blue carbon concept seagrass is significant contributor with an estimated global reservoir of 4.2 and 8.4Pg carbon (Fourqurean et al., 2012). While it is not as an effective a sink as mangroves or salt marshes, it compensates with through its relatively large global coverage of between 35 0000- 60 0000km^2 (Duarte, 2017) sequestering between 0.014–0.0828 Pg C yr^{-1} (Howard et al., 2017b). While this area is large compared to other blue carbon ecosystems, it should be noted that it corresponds to only 0.1 – 0.2% of the sea floor (Röhr et al., 2016).

Considering the significance of these blue carbon sinks, the concept of blue carbon is rising in popularity. With powerful global actors such as the International Union for the Conservation of Nature, Conservation International, European Union, and United Nations, all being involved in initiatives and partnerships promoting blue carbon (The Blue Carbon Initiative, GEF Blue Forests, Blue Natura). As such it is becoming highly relevant in policy as a strategy for mitigating against climate change.

2.3 *Zostera marina* and Sweden

Of the different seagrass species *Z. marina* is one of the most widespread. It is found in temperate northern latitudes where it plays an important role in cycling nutrients, acting as a habitat and a food source for various species thus increasing biodiversity (Larkum et al., 2006). However, in the 1930s a slime mould infection known as the Wasting disease caused a catastrophic decline in the North Atlantic with 90% of *Z.marina* dying.

The species is dominant in the Baltic Sea where it historically has been used for fuel, insulation, roofing material, bedding and fertiliser (Short, 2013). This area was strongly affected by the Wasting disease (Rassmussen 1977), and suffered large declines in population, with some areas losing up to 100% of coverage (Berglund et al., 2018). While recovery did seem to occur, declines became an issue again with the rise of eutrophication (Boström et al., 2014), for example the current distribution of seagrass in Denmark is still only 20-25% of historic levels (Frederiksen et al., 2004). Currently *Z.marina* covers between 1 480 – 2 100km^2 of the Baltic Sea but issues with stressors such as reduced light levels, overfishing and nutrient pollution remain, causing further decline (Boström et al., 2014).

Considering this large-scale decline and the positive benefits from eelgrass habitats, it seems natural that attempts of restoration should take place. Indeed, restoration projects of *Z.marina* species have had success in the US, with 1700 ha being restored in the Virginia coastal reserve (Orth and McGlathery, 2012). Furthermore, these restored seagrass habitats also contribute to store blue carbon with the meadows sequestering carbon at a rate of 36.68 g Cm^{2}yr^{-1} after 10 years, with this rate expected to be comparable to natural meadows after 12 years (Greiner et al., 2013). There are other examples of restoration around the world, with an important trend noted by van Katwijk et al., (2016), where the larger the restoration project the more successful it tends to be as it can utilise the positive feedback mechanisms inherent within seagrass systems to enhance their propagation.

Despite its large decline, *Z. marina* in the Baltic sea is still a significant blue carbon sink with an estimated organic carbon pool of 6.98 and 44.9 t Cha^{-1} (Röhr et al., 2016). The amount of carbon stored in different areas varies greatly and is driven by environmental variables such as sediment type, salinity, water depth and light availability (Dahl et al., 2016; Eriander et al., 2016; Röhr et al., 2018). This variability happens with multiple species worldwide and is a problematic when trying to asses blue carbon sinks of eelgrass, as it creates significant uncertainties that will need to be addressed by collecting more data (Duarte, 2017; Duarte et al., 2013a; Lavery et al., 2013; Röhr et al., 2018)

When we consider what this means for Sweden, we must first look at their ambitious Environmental objectives (Swedish Environmental Protection Agency, 2016). Firstly, in the goal "Reduced climate impact" there is the extremely high reaching objective of reaching zero net emissions of greenhouse gases by 2045 (Ministry of the Environment and Energy, 2018), part of which aims to use forests to sequester CO_2. Secondly there is the goal "A balanced marine environment, flourishing coastal areas and archipelagos", which aims to ensure that the North and Baltic sea have a sustainable productive capacity and to preserve biological diversity. Furthermore, we must consider the risk that a changing climate poses to the Swedish society in terms of coastal erosion and negative impacts on the fishing industry with potential loss of key economic species such Cod in the Baltic Sea (Commission on Climate and Vulnerability (Sweden), 2007)

When looking at the historical coverage of seagrass in Sweden it can be seen that current coverage is 58% lower than it has been in the past (Baden et al., 2009). However, efforts have been made towards restoring *Z.marina* in Swedish waters and there have been successes using a shoot transplantation method in shallow water and seed planting in deeper habitats (Eriander et al., 2016; Infantes et al., 2016). This has important implications as we have shown that seagrasses such as *Z.marina* has properties that allow it to sequester and store significant amounts of carbon, enhance biodiversity and subsequently stocks of valuable fish species. As well as binding coastal sediment and reducing wave action thus countering coastal erosion. As such the impact such restoration techniques have in relation to Swedish Environmental policy goals is clear.

3. Conceptual Background

This section presents concepts that are applied in this analysis. Firstly, the concept of market-based environmental governance is introduced and explained. Following this is a section on the concept of blue economy and how it relates to blue carbon, as it is through this concept that market based governance of such coastal ecosystems is often applied. Finally, an overview of the Loss and Damages concept is put forward with an emphasis on the non-economic Loss and Damage and how to value it.

3.1 Market Based Environmental Governance

The question being addressed in this paper is essentially about how one should govern the environment, and the blue carbon paradigm is a method of governance that aims to harness market forces for environmental goals.

Such alternate types of governance are rising in popularity as part of a continuing trend of separating government from governance. This separation is largely due to processes that have been occurring within the recent decades, where neoliberal policies have pushed for a reduction in the role of the state (Young, 2009). Such policies have opened up opportunities for new forms of governance involving different kinds of actors including private actors and civil society. Within this neoliberal approach the idea of using markets for governance has been immensely popular. (Delmas and Young 2009, Evans 2012). For environmental governance, typical top-down government implemented regulation was eclipsed in popularity by what is often termed "New Environmental policy instruments" (Jordan et al., 2003). These are a range of instruments that utilise market forces, such as ecolabels, environmental taxes and tradeable permits.

Negative externalities like environmental degradation are the basis for the use of the markets in environmental governance, as it is believed they are driven by a lack of inclusion of environmental resources in prices. Thus, if these resources are internalised within the market and have a value they will be conserved. In this perspective, environmental resources essentially are suffering from a tragedy of the commons scenario, where a common pool resource is overexploited by users acting in their own self-interest (Hardin, 1968). Within this theory, property rights need to be established, and a market created for the resource where it can be traded as a commodity. Thus theoretically, through market forces the optimal behaviour will be adopted at a minimal cost, as what was a previously free resource now has a monetary value and degrading it will now incur a cost that a rational economic actor will try to avoid if the resource is their property.

This style of market governance has been applied to a whole range of other ecosystem services (ES). This concept arises from the idea of payment for ecosystem services, which is based on calculating a monetary value for the services nature provides to humanity, with the total global value of such services estimated to be $33 trillion per year (Costanza et al., 1997). The idea of ecosystem services and their value first gain traction in policy spheres with the Millennium Ecosystem Assessment (MEA) where they are defined as “the benefits people obtain from ecosystems” (Millennial Ecosystem Assesssment, 2005). This is considered an effective method of bringing attention to the importance of healthy ecosystem within an increasingly neoliberal society, as this translation into monetary value is easily understood in key areas of society, including political and economic spheres. (Gómez-Baggethun & Barton, 2013). This valuation of services provided by nature has been incorporated into market-based schemes where ES beneficiaries make payments that aim to incentivise land users to protect or improve environmental services (Daily, 1997). It is argued that this inclusion of conservation in markets is an important process as it can rectify the shortage of finance being directed towards conservation globally (Huwler et al. 2014).

Payments for ecosystem services (PES) are defined by (Wunder, 2015) as:
“Voluntary transactions between service users and service providers that are conditional on agreed rules of natural resource management for generating offsite services”

These services are extremely diverse but can generally be grouped into 4 categories (De Groot et al., 2002):

- Regulation functions: regulation of essential life support systems e.g clean air, water and soil
- Habitat Functions: creating habitat for biodiversity
- Production functions: Creation of things useful for human consumption e.g food and raw materials
- Information functions: contributions to culture, spirituality and aesthetics

Thus, services that have been incorporated into market-based governance using the payment for ecoservices mechanism are most commonly carbon sequestration, habitats for endangered animals, land scape protection and provisioning of freshwater supplies (Gómez-Baggethun et al., 2010).

The application of this mode of governance to carbon has been immensely popular. This began in the carbon markets developed after the Kyoto agreement, such as the EU Emissions Trading scheme (Grubb & Neuhoff, 2011). This was a "cap and trade" system which put a limit for total CO_2 emissions for industry and divided this total amount into tradable permits for the right to emit CO_2. The aim of the scheme being, that the cost of such permits and the value of being able to sell them would steer companies towards reducing their carbon footprint. Essentially, carbon becomes a good to be purchased on a global market via credits that are produced through emissions reduction or forestry conservation projects (Bumpus, 2015). Currently United Nations Framework Convention on Climate Change (UNFCCC) is the main source of climate mitigation strategies, with its various mechanisms and their associated funds such as, Nationally Appropriate Mitigation Activities (NAMAs) and Reducing Emissions from Deforestation and forest Degradation (REDD+) (Herr et al., 2015). The focus of these projects is to provide a mechanism for developed countries to provide funding for mitigation activities in developing nations though the UNFCCC funds such as GEF Trust Fund or the Green Climate Fund.

Alongside these regulated markets arose an unregulated private market of carbon offset projects, known as the Voluntary Carbon Market (VCM). Here a suite of private companies has developed certification schemes for carbon sequestration projects that allow for the selling of carbon outside of the UNFCCC verification process (Benessaiah, 2012). Currently the amount of carbon being traded on such markets is much smaller than the regulated market and is aimed at companies engaged in CSR activities related to sustainability (Bumpus, 2015).

3.2 Blue carbon within the Blue Economy

The blue economy is a concept driven by the UN sustainable development goals where countries aim to transition from unsustainable economic activities in the ocean, to new industries such as renewable energy, blue biotech and blue carbon (Spalding, 2016). Within this economic context, blue carbon is an ecosystem service that that can be given a value and as such can be put under market-based governance. Due to international efforts to combat climate change, financial mechanisms have been developed by institutions such as the UNFCCC, that aim to encourage the adoption of nature-based solutions by providing compensation in relation to how much carbon is stored or sequestered. Examples of mechanisms that have been developed include REDD+, which is designed to prevent carbon emissions from deforestation in developing countries, and NAMAs which are nationwide climate change mitigation plans (Herr et al., 2015)

Quantifying the monetary value of an ecosystem service and directing finance towards it can be regarded as payment for ecosystem services (Gómez-Baggethun et al., 2010). Within such coastal ecosystem the services provided include those with an established market value such as carbon sequestration and seafood, to more intangible services such as shoreline protection, biodiversity and water quality (Lau, 2013). Unique challenges do exist in implementing PES schemes in marine environments, as is described by Lau, (2013). Firstly, costs can be a challenge when operating in this environment as monitoring can require special techniques and equipment specific to blue carbon ecosystems. Furthermore, enforcing any management strategy can prove difficult due to the large size of the areas being used and the requirement for boats and specialist training to navigate them. Also quantifying services in the marine environment is currently difficult due to limitations in the applicable methodologies available. This creates a lot of uncertainty, as more scientific and economic research will have to be carried out on the different management strategies taking place and quantifying their service delivery though establishing baselines and performance metrics.

However, there is legitimate concern over what is regarded as the commodification of nature, as this only values services that directly impact humans rather than the intrinsic value of nature. There is concern that this would not necessarily lead to healthy biodiverse ecosystems but ecosystems that are carefully managed to maximise their beneficial output at the expense of services that are deemed less valuable or of non-importance to human society (Kosoy & Corbera, 2010).

As was previously discussed the main markets for ecosystems services are the UNFCCC related mechanisms. However, integration of blue carbon projects into such programmes is lacking, despite this, the potential is there, as mangroves can be argued to be forests in REDD+ and NAMAs allow for flexibility in their design (Wylie et al., 2016). Article 6 of the Paris agreement does provide a framework through which blue carbon markets may be developed through international cooperation mechanisms (UNFCCC, 2015b). Firstly, there is direct bilateral cooperation in article 6.2:

"*Parties shall, where engaging on a voluntary basis in cooperative approaches that involve the use of internationally transferred mitigation outcomes towards nationally determined contributions, promote sustainable development and ensure environmental integrity and transparency, including in governance, and shall apply robust accounting to ensure, inter alia, the avoidance of double counting, consistent with guidance adopted by the Conference of the Parties serving as the meeting of the Parties to this Agreement.*" (UNFCCC 2015a pg. 4)

This allows for nations to directly cooperate in the implementation of mitigation strategies. This is done through the transfer of emission reductions to other countries and for the receiving country to include the reductions in their NDCs. This is referred to as internationally transferred mitigation outcomes.

Secondly, there is the sustainable development mechanism in article 6.4:

"A mechanism to contribute to the mitigation of greenhouse gas emissions and support sustainable development is hereby established under the authority and guidance of the Conference of the Parties serving as the meeting of the Parties to this Agreement for use by Parties on a voluntary basis. It shall be supervised by a body designated by the Conference of the Parties serving as the meeting of the Parties to this Agreement, and shall aim to:
1. Promote the mitigation of greenhouse gas emissions while fostering
sustainable development;
2. Incentivize and facilitate participation in the mitigation of greenhouse gas
emissions by public and private entities authorized by a Party;
3. Contribute to the reduction of emission levels in the host Party, which will
benefit from mitigation activities resulting in emission reductions that can also be used by
another Party to fulfil its nationally determined contribution; and
4. Deliver an overall mitigation in global emissions" (UNFCCC 2015a pg. 5)

This allows subnational and private entities to carry out mitigation projects that will also generate transferable emission reductions which can be counted in NDCs. However, these mechanisms are still in their early stages and as such are not fully operationalised (Herr et al., 2017).

To date, the voluntary carbon market has been the most popular funding mechanism for blue carbon projects (Vanderklift et al., 2017). This is when emission reduction credits are sold in non-government regulated markets and is often used by individuals wanting to offset personal emissions or companies with CSR goals related to sustainability, who want to push a green image (Alongi, 2018) or are hedging against potential future compliance obligations (Murray et al., 2011). These markets have been successful at supporting small scale projects and have benefits in that they are more streamlined than the administrative heavy projects such as REDD+, however it should be noted that the credits have a lower value and that this value can be volatile (Wylie et al., 2016)

To combat the issue with the volatile price of carbon credits, strategies are available such as price floors supported by public funds of governments involved (Vanderklift et al., 2017). Another strategy not to focus solely on the carbon sequestration capabilities of such ecosystems but instead to include the full range of ecosystem services and associated co-benefits for local communities. By accounting for such benefits, the value of the credit can increase as well as the appeal to potential investors in VCM who are seeking an investment related with their CSR objectives (Herr et al., 2017).

3.3 Loss and Damage

Loss and damage is a concept that has been adopted by the UN for referring to the impacts on human society from climate change. During the Paris agreement it became an established part of the ongoing climate change agenda, with its inclusion in Article 8 with the statement "Parties recognize the importance of averting, minimizing and addressing Loss and Damage associated with the adverse effects of climate change, including extreme weather events and slow onset events, and the role of sustainable development in reducing the risk of Loss and Damage." (UNFCCC 2015a pg 7)

While there is no accepted official definition for Loss and Damage, a working definition that is commonly used, is that Loss and Damage is the negative effects of climate variability and climate change that people have not been able to cope with or adapt to (Van Der Geest & Warner, 2015). Within this there is an important distinction between Loss and Damage, where loss refers to negative impacts from climate change where there can be no recovery to the original state. Meanwhile damage refers to negative impacts where recovery is possible (UNFCCC, 2012).

The implementation of the Loss and Damage concept can be seen through the process of the UNFCCC changing its approach to addressing climate change as described by Roberts and Huq (2015). They show how at first mitigation was the dominant strategy with the Kyoto protocol, showing the widespread reasoning that reducing greenhouse gas emissions to address climate change impacts was feasible and effective. While adaptation was recognised from the early stages, it was not highlighted due to concerns of it overshadowing and reducing commitment to mitigation. However, in 2001 adaptation became more main streamed with increasingly alarming reports from the IPCC highlighting that historic emissions meant that certain impacts were inevitable.

Loss and Damage was first officially used in the Bali action plan (2008) driven by the IPCC's fourth assessment report, which highlighted the limits to adaptation and the impacts from climate change that cannot be avoided. This started the process of developing the concept of "Loss and Damage" and how the UNFCCC can address them. This cumulated at Conference of Parties (COP) 19 in Warsaw, where The Warsaw International Mechanism for Loss and Damage associated with climate change impacts was created.

This Mechanism aims to encourage the use of approaches that will address Loss and Damage caused by climate change through 3 strategies:

1. Enhancing knowledge and understanding of comprehensive risk management approaches to address Loss and Damage associated with the adverse effects of climate change, including slow onset impacts
2. Strengthening dialogue, coordination, coherence and synergies among relevant stakeholders
3. Enhancing action and support, including finance, technology and capacity-building, to address Loss and Damage associated with the adverse effects of climate change, so as to enable countries to undertake actions pursuant to decision 3/CP.18, paragraph 6. (UNFCCC, 2013)

Loss and Damage can also be further sub-categorised into 3 types; avoided, unavoided and unavoidable (Mechler et al., 2019). Here, avoided Loss and Damages are those that were prevented by adaptation and mitigation, and unavoided is where adaptation and mitigation were not attempted due to financial or technical constraints. Meanwhile, unavoidable Loss and Damage is that which adaptation and mitigation would have had no effect on. This is an important element of the concept as it accepts that there are negative effects from climate change that are inevitable due to historical emissions (Huq et al., 2013)

Overall it aims to tackle the impacts of climate change by decreasing avoidable Loss and Damage through mitigation efforts and reducing the impact of unavoidable Loss and Damages through adaptation and risk reduction, as such this approach reinforces both the concepts of adaptation and mitigation (Roberts & Pelling, 2018). While it is important that this international body is providing the impetus for such an approach, it is also crucial that national institutions also take such an approach to addressing climate change (Huq et al., 2013).

One point of interest is that Loss and Damages can be further subdivided into economic and non-economic Loss and Damages. With economic relating to resources, goods and services commonly traded on the market, these can be included easily as they have a monetary value. Non-economic Loss and Damages are essentially everything else that is not traded on the market, their lack of a price and often intangible nature makes inclusion in assessments difficult as there is debate on how they should be valued (United Nations, 2013). This is due to the incommensurability of such values and that the values can be greatly influenced by culture and context (Serdeczny et al., 2016). While there are arguments regarding how these Loss and Damages are impossible to value, within a monetary based governance regime it is necessary to assign them a value. Failure to do so means they are no longer included within the governance system and as such are vulnerable to mismanagement. As a result of this, the field of economics has developed many tools to carry out such valuations such as hedonic pricing or contingent valuation.

Non-economic losses can include different forms of environmental damage and regularly includes biodiversity loss and loss of ecosystem services (Serdeczny, 2019), as damaging such systems has an impact on human wellbeing (Zommers et al., 2016). While there is often difficulty valuing many non-economic Loss and Damages such as cultural values (Serdeczny et al., 2016), there is a well-established practice of putting monetary values on ecosystem services. It is however quite challenging to capture all the value present in an ecosystem and this can lead to negative outcomes (Zommers et al., 2016). An interesting dynamic is at play with these ecosystem services due to the fact that they can be utilised as mitigation and adaptation strategies against Loss and Damages (Van Der Geest & Warner, 2015; Zommers et al., 2016). Thus, by applying the Loss and Damage concept to these ecosystems you can attribute a value to them through the avoided Loss and Damages.

4. Methods

In this chapter, the methods used to answer the research questions of this thesis are described. This thesis takes a multi-method approach to investigate the use of a market-based model of governance on blue carbon ecosystems in a developed-country context. Here Sweden is used as a critical case as it can be argued that this is an ideal setting to test the application of a market governance model on seagrass.

4.1. Methods for Research Question 1 “What structure would blue carbon governance take in the Swedish context?”

Wunder (2015 pg. 241) has defined payment of ecosystem services (PES) as:

"Voluntary transactions between service users and service providers that are conditional on agreed rules of natural resource management for generating offsite services."

By using this definition, key elements of the PES model were identified and defined in order to pose guiding questions for investigating the applicability of the PES governance model for Sweden as a case study (Table 1).

Table 1:Terms taken from PES definition, and associated guiding questions used as a framework to assess potential structures for market based governance of seagrass in Sweden.

Definition terms	**Description**	**Guiding questions**
Voluntary transactions	Can be market based, involve written contract and can be facilitated by an intermediary?	What methods can be used to facilitate transactions?
Service users	May be single entities or government financed. Often brought together by intermediaries.	What actors are users of ecosystem services? Who can act as an intermediary?
Service providers	Effective stewardship of managing Ecosystem service is key requirement.	What actors can be providers of ecosystem services?
Conditional on agreed rules of natural resource management	Conditionality is key element. Compliance is often measured through agreed upon methods of determining ecosystem provision.	How can provision of seagrass ecosystem services be determined
Offsite services	Payment must internalise offsite externalities Services may be bundles.	What value have these offsite externalities? Is bundling possible?

To answer these questions, firstly a qualitative literature and document synthesis took place to gain an understanding of the topics relevant to the guiding questions, and as a source of data to estimate the value of Z.marina's ecosystem services. The literature and document searches were internet-based and carried out using the resources Web of Science and Google Scholar. The literature and documents were surveyed through reading the abstracts/summaries to ensure relevance, and then relevant publications were read in their entirety to extract all the necessary information to gain a full understanding of the topic. During the search process, the literature was organised with the highest cited papers first in order to get high impact papers and authoritative sources for the topics at hand. From these sources, a tracing process was carried out using the literature referenced in them ,to further accumulate relevant information in a "snowballing" effect. This was carried out until a saturation of the relevant knowledge related to each topic occurred. This search process was carried out through the entire research process and the gathered literature was organised by topic and stored digitally.

To answer the questions "What actors can be providers of ecosystem service ", an outline of the coastal zone management structure in Sweden was carried out using the information gained from the literature and document synthesis. This was done to determine what actors have effective stewardship of managing the ecosystem services.

To answer the question "What value have these offsite externalities?", the Dewsbury, Bhat, and Fourqurean's (2016) valuation model for seagrass ecosystems was used as a guide (Fig. 2). As such, the values searched for in the literature were market value of commercial fish, economic effects of CO_2 reduction and coastal property value.

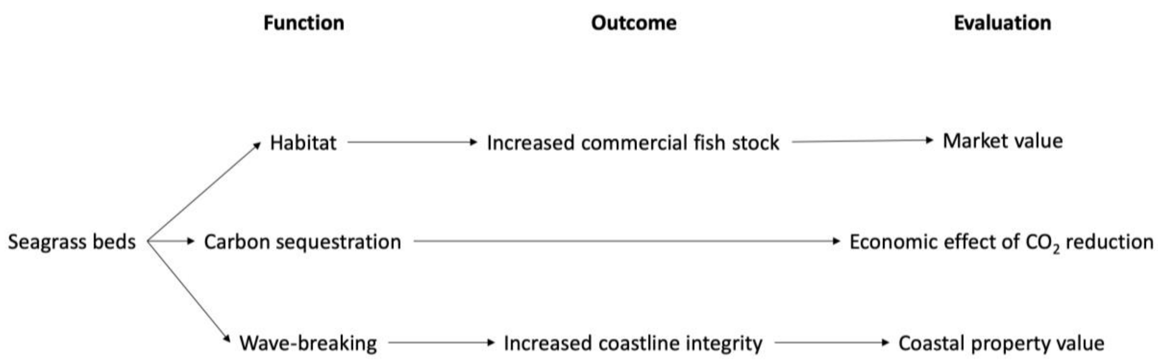

Figure 2: Values used for offsite externalities. Adapted from Dewsbury et al's., (2016) Seagrass Ecosystems valuation model

However, within the literature used to answer this guiding question, different methods of assessing the economic value of carbon were found, such as the Social cost of carbon (SCC), or prices from the EU Emissions Trading Scheme. For effective comparison in this study, it was necessary to unify the economic value of carbon under one value. Here Sweden is a good setting as it already has a well-established carbon tax and thus an indicator for the value place on carbon in Sweden. As such, the cost of carbon used in the studies was substituted with the Swedish carbon tax value to ensure comparability and assess the value specific to Sweden.

4.2 Methods for Research Question 2 "Can a value be ascribed to seagrass ecosystem services through the Loss and Damage concept?"

As has been stated earlier in the thesis, Loss and Damage has been established under article 8 of the Paris Agreement, and as such it is an internationally agreed upon agenda to use mitigation and adaptation techniques to limit the costs incurred by climate change. Using the technical perspective of the Loss and Damage concept (Van Der Geest & Warner 2015), a strong justification can be developed for seagrass conservation and restoration in Sweden. Thus, seagrass services are discussed as ecosystem-based adaptation and mitigation to minimise avoidable and unavoidable Loss and Damage.

A framework was developed (Fig. 3) to assess the applicability of seagrass to this concept in Sweden through using key elements from the Loss and Damage concept.

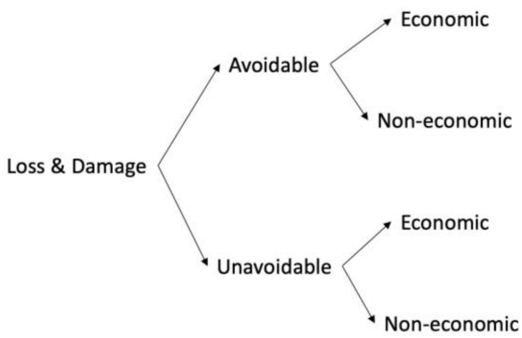

Figure 3: Key elements of the Loss and Damage concept used to assess seagrass (own creation)

Furthermore, the policy document "Sweden facing climate change – threats and opportunities" by the Swedish Commission on Climate and Vulnerability, was used to explore/evaluate/discuss what role that seagrass can play in minimising avoidable, unavoidable, economic and non-economic Loss and Damages of climate change in Sweden.

5. Results

In this chapter, I present the definitions and answers to the guiding questions developed from Wunder's (2015), which answers research question 1: What structure would blue carbon governance take in the Swedish context?

The application of seagrass ecosystem services in relation to key concepts from Loss and Damage are thereafter described in order to answer research question 2: Can a monetary value be ascribed to seagrass ecosystem services through the Loss and Damage concept”

5.1 Research question 1: What structure would this form of governance take?

Definition term 1: Voluntary transactions

Guiding question: *What methods can be used to facilitate transactions?*

Markets can provide an effective means of facilitating a transaction between users and providers of ecosystem services in a PES scheme. Currently the only truly applicable markets to this case would be carbon markets. The vast majority of such carbon is traded through the UNFCCC-related mechanisms such as the clean development mechanism or REDD+ (Herr et al., 2015). However, these markets cannot be applied in this case as they are targeted toward conservation and restoration in developing nations (Alongi, 2018). As such, the main option would be the Voluntary Carbon Market. However, for a PES scheme, full market integration is not necessary and in fact government financed PES schemes are the dominant structure used globally (Wunder, 2013). Using this method, the transaction would take place as part of a government programme with the government representing the users (e.g. population within a jurisdiction), and the providers (e.g. private individuals with secure property rights over areas of seagrass) voluntarily partaking.

Definition term 2: Service users

Guiding question (1/2): *What actors are users of ecosystem services?*

- The fishing community
- County administrative boards
- Global community

The fishing community is an actor within marine Swedish management whose concerns focus around access to fishing resources (Swedish Agency for Marine and Water Management, 2015). The previously discussed habitat and production functions of seagrass play an important role in maintaining fish stocks and thus makes the fishing community a service user. Furthermore, coastal infrastructure associated with the industry can be threatened by sea level rise and coastal erosion, the discussed regulatory function of seagrass in sediment accretion resulting in coastal defence properties is another service this user avails of.

In areas where coastal erosion and sea rise is a problem, coastal property owners would be availing of seagrasses coastal defence services as it is the private property owner who is responsible to take financial action to protect their property from coastal erosion (Policy Research Cooperation, 2009). Thus, such actors are users of seagrass' regulatory function in sediment binding and accretion.

County administrative Boards are subnational government bodies appointed by the government and tasked with fulfilling national policy goals for their counties (Swedish Environmental Protection Agency, 2017). Considering Sweden's climate goals regarding zero net CO_2 emissions, County administrative boards would be users of the regulating service of carbon sequestration in seagrass habitats.

As climate change is a global phenomenon with CO_2 emissions not having a specific local effect but instead driving large scale changes in climate through the warming of the planet's atmosphere, it can be argued that the global community are users of seagrasses carbon sequestration service.

Guiding question (2/2): *Who can act as an intermediary?*
Local municipalities may act intermediary for all users of all ecosystems in their jurisdiction, through providing a financing system for potential providers to voluntarily adhere to.

Definition term 3: Service providers
What actors can be providers?

- County administrative Boards
- Municipalities
- Coastal property owners

The governance of coastal areas has a clear hierarchical structure (Fig. 4) with the bulk of spatial planning being the responsibility of the municipalities (Policy Research Cooperation 2009). In relation to erosion, all coastal protection measures are to be initiated and financed by landowners, however municipalities often coordinate these actions (Policy Research Cooperation, 2009).

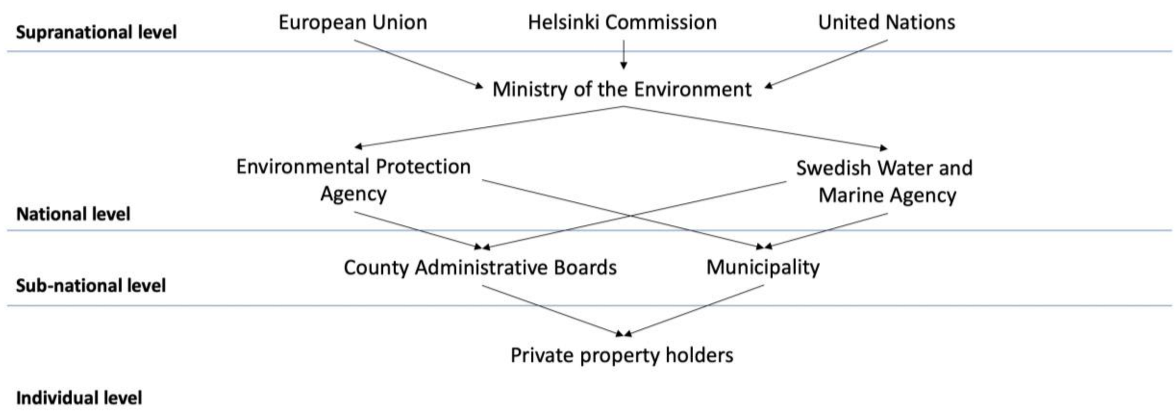

Fig.4: Structure of Swedish coastal management (own creation)

However, environmental protection is the responsibility of Country administrative boards (CAB) and municipalities. CABs are appointed by the government and tasked with fulfilling national policy goals for their counties (The Swedish Environmental Protection Agency 2017). Meanwhile municipalities are responsible for administrating local public tasks and services, they also have an elected council that creates committees to deal with various areas such as the environment (The Swedish Environmental Protection Agency 2017).

The actions of these Boards are co-ordinated by the Swedish Agency for Water Management (SwAM) and the Swedish Environmental Agency (SEPA) (Grip and Blomqvist, 2018). SEPA is responsible for surveying protected areas, managing lists and registers of protected areas, acquiring and managing parcels of land and water that the state designates for conservation purposes. As well as coordinating property investigations, border work, valuation and negotiation. SwAM is responsible for producing advice and guidelines, coordinating national inventories and investigations in relation to the marine environment. Municipalities are also free to create marine protected areas and are responsible for the management of any they create (Dahl et al., 2016).

On a national level, environmental objectives are decided by the Swedish national Government and it is the duty of the Ministry of the Environment to enact them via the appropriate agencies. While Sweden can set its own national environmental objectives, many of these objectives come about due to inter-governmental organisations and agreements such as the Helsinki Commission or EU maritime strategy.

As the responsibility for protecting marine areas is that of the Country administrative boards (CAB) (Grip and Blomqvist, 2018) and municipalities (The Swedish Environmental Protection Agency, 2017), it is clear that they both can act as providers of ecosystem services. Considering they have jurisdiction up to 12 nautical miles from their coast (Swedish Agency for Marine and Water Management, 2015), the majority of suitable habitats for seagrass are within their sphere of influence. Therefore, both actors do have the ability to set up a conservation project funded by a PES mechanism. Worth noting is the fact that In Sweden private property can include water 300m from the shoreline (Grip 2018). As such this opens up the potential for private actors to set up a PES scheme using seagrass conservation and restoration in their property, although it would be extremely limited in scale.

Definition term 4: Conditional on agreed rules of natural resource management
Guiding question: *How can provision of seagrass ecosystem services be determined?*

Direct measurement of service provision can be difficult. With carbon there are difficulties in relation to lack of data and variability in storage and sequestration rates and these are problematic for valuing ecosystem service (Macreadie et al., 2014). As PES schemes are reliant on as accurate valuations as possible, it would be necessary to carry out rigorous estimations of the carbon sequestration rates and the size of the carbon sink in the area where the PES is being applied (Gallagher, 2017).

In terms of the impact of fisheries provision, fisheries science can be applied to measure for increases in fisheries yield and local stock condition (Lau, 2013). However, problems may arise with attributing any increases to seagrass conservation. Coastal defence services can be attributed through the applications of experimental data and modelling on seagrasses ability to reduce current velocity, dissipate wave energy and stabilise sediment however again data would need to be site specific (Ondiviela et al., 2014).

Due to the difficulties discussed in direct measurement of provision proxies are often used in PES. In this case estimations for each service can be provided for in terms of per hectare seagrass and thus the total area of seagrass conserved and the increase in area via restoration can be used as a proxy for the provision of these resources.

Definition term 5: Offsite services

Guiding question (1/2): *What value have these offsite externalities?*

Table 2:Summary of results to Defintion term 5, guiding question 1 " What value have these offsite externalities?"

Seagrass	Nursery function	Comercial fish	Market value SEK 3200 yr^{-1}
	Carbon sequestration	-	Economic effect of CO_2 Sequestration: SEK 2890 $ha^{-1}yr^{-1}$ Restored Sequestration (after 10 years): SEK 433 $ha^{-1}yr^{-1}$ Sink: SEK 5117 ha^{-1}
	Decreased wave energy	Increased coastline integrity	Coastal property value N/A

Unfortunately, due to data limitations estimations of seagrass sequestration rates and the sink capacity from other areas have to be used. This is problematic as these rates can vary greatly (Dahl, 2017) and as such should be calculated for each individual case (Gallagher 2017).

When we look at a study on the valuation of current seagrass ecosystem services in Sweden (Cole and Moksnes, 2016) we can see that the annual value of seagrass carbon sequestration is SEK 2890 per hectare per year, this is however dependant on estimations of carbon sequestration of seagrass habitats in the UK. Furthermore, this valuation takes into account future losses of seagrass, if successful restoration efforts are implemented this would of course alter the value.

If we consider studies with more local estimates, we can see that the Baltic sea contains up to 1.7-12% of global seagrass blue carbon with the current storage and sink capacity (Röhr et al., 2016), which can be valued of SEK 5117 per hectare in the Kattegat region. Considering the significant amount of the Baltic sea that is under Swedish jurisdiction there is clear potential to capture the value of these ecosystems.

Considering restored meadows, if we use the sequestration rates determined by for restored *Z.marina* meadows in the US, we can see that 336.8 kg of Carbon can be sequestered per year 10 years after restoration (Greiner et al., 2013). As such, a hectare of restored *Z.marina* meadow in Sweden would sequester SEK433 worth of carbon per year. Considering that seagrass has an exponential rate of carbon sequestration that increases rapidly after the 10 year mark (Duarte et al., 2013c), if we take the estimated accumulated carbon per hectare after 50 years, estimated at 177 tonnes *Z. marina* by Duarte, Sintes, et al., (2013) we can see that the value gained using the Swedish carbon tax is SEK 208,860.

In an ecosystem valuation study carried out by Cole and Moksnes, (2016) the value of fish production in Swedish seagrass systems was estimated it to be 3200 SEK per hectare.

Adding value in terms of protection from coastal erosion and sea level rise is much more difficult and context specific as the value of the property on the coast being protected can vary greatly. Unfortunately there is a lacking of information regarding the economic value of seagrasses coastal protection service (Dewsbury et al., 2016; Ruiz-Frau et al., 2017).

Guiding question (2/2): *Can services be bundled?*

Due to the multiple ecosystem services which can be valued coming from this single ecosystem, there is potential to bundle the services into a single credit type, this is possible when taking the Voluntary carbon market approach which recognises co-benefits (Herr et al., 2017; Lau, 2013)These services can also effectively be bundled in a government financed payment for ecosystem scheme by accounting for all their values when negotiating the price.

5.2 Research question 2: Can a value be ascribed to seagrass ecosystem services through the Loss and Damage concept?

Avoidable

Current meadows are an important carbon sink and there is potential for restored meadows capable of sequestering carbon at significant rates (Duarte et al., 2013c; Greiner et al., 2013). This would be a mitigation strategy that protects against avoidable Loss and Damage in a more general nature due to the diverse impact climate change can have.

Economic: Economic Loss and Damages from climate change faced by Sweden are due to the impacts of: increased flooding and landslides on infrastructure, increased fires on forestry, increased pests in agriculture, nutrient pollution of water supply, migration of fish stocks, increased temperature on health, increased storm frequency on infrastructure.

Overall these Loss and Damages are valued at 1 065 – 1 800 billion SEK.

*Noneconomic***:** Non-economic Loss and Damages from climate change faced by Sweden are due to the impacts of: Changing composition of terrestrial biodiversity much of with has an associated cultural value, massive shifts in the structures of marine ecosystems changing species and increasing algal blooms, nutrient leeching ruining freshwater quality in river and lakes.

Unavoidable

As unavoidable Loss and Damages are due to historical emissions and cannot be mitigated against, seagrasses role would be in adapting to them and as such is more site specific.

Economic: Coastal areas in the south of Sweden will be threatened by sea level rise and coastal erosion with an estimated 150 000 buildings susceptible to sea level rise of 88cm with an estimate cost of 30 to 110 billion SEK by 2100

Conserving and restoring seagrass can be used to minimise this Loss and Damage through its coastal defence properties.

Non-economic: Climate change will impact the biodiversity of the marine ecosystems, conserving and restoring seagrass can reduce this Loss and Damage as seagrasses are important habitats and foundational species.

Table 3: Summary of results for Research Question 2: Can a value be ascribed to seagrass ecosystem services through the Loss and Damage concept?

<table>
<tr><td rowspan="4"><u>Loss and damage</u></td><td rowspan="2"><u>Avoidable</u>
Diverse range of impacts associated with climate change</td><td><u>Economic</u>
• Flooding & Landslides
• Forest fires
• Agricultural pests
• Degraded water supply
• Degraded fish stocks
• Temperature impacts on health
• Storm frequency and intensity
Valued at 1 065 – 1 800 billion SEK.</td></tr>
<tr><td><u>Non-economic</u>
• Shifts in culturally valuable biodiversity
• Shifts in marine ecosystem structures
• Degraded water quality in lakes and coasts</td></tr>
<tr><td rowspan="2"><u>Unavoidable</u>
Coastal threats driven by historical greenhouse gas emissions</td><td><u>Economic</u>
• Coastal erosion
• Sea level rise
Valued at 30 to 110 billion SEK by 2100</td></tr>
<tr><td><u>Non-economic</u>
• Shifts in biodiversity of Marine systems</td></tr>
</table>

6. Discussion

Here the results of the investigation are interpreted with regard to the overarching aim of the investigation. The implications of the findings are then discussed regarding debates within the field of PES and sustainability science and their applicability to the case.

6.1 Interpretation of Results

From the results it can be seen that the most applicable provider for seagrass related ecosystem services would be the sub-national government bodies, Municipalities and County Administrative Boards. While it is possible for private property to be held in the sea, the limitation of 300m from the shore makes it negligibly small compared to the 12 nautical miles from coast that the subnational government bodies have jurisdiction over. This then rules out the government being an intermediary for users.

It should be noted that the fishing community and watershed users can also be considered providers. However, they do not hold any property right over seagrass areas which is a stated weakness in many PES schemes (Börner et al., 2017). Instead they would provide the ecosystem services through minimising their environmentally damaging actions. Thus, both actors were excluded from the providers section in this study, as this can compromise effective stewardship of the ecosystem services (Wunder, 2013).

Due to municipalities being the only effective providers, this limits the methods through which the transaction can take place. Largely as it rules out the opportunity for a government financed structure.

Due to the diverse range of users and the multiple ecosystem services provided, establishing a market for the basis of the voluntary transaction is the most effective option. Currently the only option for this is the voluntary carbon market. There is a possibility for a negotiated PES mechanism between municipalities and coastal property owners for the service of coastal defence, as it is the coastal property owners that are financially responsible for this. While there is a current lack of valuation of the current coastal defence service in the literature, what can be done is to look at the projected unavoidable economic Loss and Damages due to coastal erosion and sea level rise of 20 to 110 billion SEK by 2100 (Commission on Climate and Vulnerability (Sweden), 2007). This highlights the economic severity of this issue and as such suggests that such PES scheme may be feasible. However, it would be limited in scope to coastal areas of high financial value.

In summary the most applicable mode of implementing market governance for seagrass in Sweden would be through using the VCM to carry out transactions, thus the general public would be users and the County Administrative Board or Municipality would act as providers. This would be conditional on the provision of seagrasses carbon storage sink services which provide offsite benefits for climate mitigation. These off-site services included within the price through the process bundling. This finding matches with that of (Hejnowicz et al., 2015).

6.2 Implications of Results

The fact that the VCM is the only available market has implications for the application of market-based governance in this case, as it's prices are volatile and the market is relatively small (Benessaiah, 2012; Vanderklift et al., 2019). Considering the high costs (0.44M and 1.73M SEK per hectare) of restoration estimated by the Swedish Water and Marine agency (Moksnes et al., 2016), this could be a serious issue.

However, the VCM has advantages in low transaction costs, regulatory flexibility, and being easily accessible by the public. Due to this, it can be an effective method for funding small scale projects (Grimsditch et al., 2013), the capacity here could be enough for a development of a demonstration project. Through such a project different methods can be tested, policy gaps identified and tools developed to cope with encountered challenges (Vanderklift et al., 2019). This would fit with the objective of blue carbon demonstration projects as described in Herr et al's., (2012 pg.17) blue carbon policy framework:

"Field-based demonstration projects are urgently needed to: demonstrate the viability of Blue Carbon activities, including the science, policy and potential financing mechanisms; develop and refine methodologies; and build capacity in target countries".

One option for the implementation of such a project could be the establishment of a special biotope area for seagrass. However, this is a limited approach due to that these areas are quite small at 20 hectares (Swedish Agency for Marine and Water Management, 2015) and thus has little potential for restoration projects. Sweden does have an extensive network of marine protected areas whose management strategies align with the blue carbon objectives of restoring and conserving seagrass (Swedish Agency for Marine and Water Management, 2015), as such it should be a consideration that any project could be integrated within the design of these marine protected areas (Howard et al., 2017a).

Such a demonstration project could have a more global value considering the widespread distribution of *Z.marina.* Using the value of seagrass in the Swedish context as motivation for a flagship project that can be used as proof of concept and a blue print for other regions. This could be an effective way of expanding seagrass conservation globally as part of network of demonstration projects, with the target of developing a larger scale market. Considering the current push to use nature based solutions to address the various challenges faced by society, including climate change (Walters et al., 2017), it is clear that such seagrass projects would be a policy tool that is relevant to many national agendas.

While these findings indicate that market-based governance of seagrass has limited potential to generate any significant level of conservation and restoration in Sweden it is worth noting the potential implications of Article 6 in the Paris Agreement (UNFCCC, 2015b). As was discussed earlier in this thesis, article 6.4 describes the mechanism for public and private entities to carry out climate mitigation strategies that can contribute to a nations NDCs. While current options for market governance of seagrass are limited in their ability to contribute on any scale, due to the drawbacks of the VCM, a future national carbon offset market based on UNFCCC regulation may be much more effective. This further highlights the value of potential demonstration projects, as well-established projects would be better positioned to take advantage of these mechanisms once fully developed.

6.3 Concerns associated with market-based governance

6.3.1 Data limitations

It needs to be considered that the application of such finance mechanisms to blue carbon ecosystems is still in its infancy and certain developments need to take place before large scale finance can take place. Issues include developing reliable carbon accounting for investors to know rates of survival and carbon accumulation, if they are to fully understand the level of risk and their potential return on investment (Gallagher, 2017; Vanderklift et al., 2017). This would allow for the identification of the most effective areas to conserve, however this does bring forward one of the limitations of market governance, where small sinks and areas of low sequestration rates may be overlooked due to their lack of commercial value. Furthermore, these measurements of carbon storage and sequestration are not only important for identifying areas for blue carbon initiatives but need to be carried out regularly throughout the duration of any blue carbon project if it is to be part of a carbon offset scheme or included in national inventories.

With seagrass habitats, calculating this data can be complicated due to the carbon being stored in soil, this means that intensive site sampling may need to occur to ensure accurate measurements (Murray, 2012). Additionally, estimating seagrass coverage is difficult due to the limitations of remote sensing technology detecting submerged plants (Ruiz-Frau et al., 2017).

Furthermore, there are other hurdles to developing official offsets. Namely addressing additionality, permanence and leakage (Murray, 2012; Ullman et al., 2013). Additionality is the proof that the reduction in carbon emissions would not have happened independently of the blue carbon project. Leakage is when projects simply cause carbon emitting activities to move elsewhere, meaning no net reduction in carbon emissions has actually occurred. Permanence is the measure of how long the carbon will actually be sequestered after the offsets are sold. Considering the previously discussed declining coverage of seagrass, the fact that no carbon emitting activity is being addressed and that seagrass is a proven long term sink, addressing these requirements should be straight forward in the Swedish context.

Worth noting is how this evaluation of market-based governance highlights the key element property rights play in designing PES and the problems it causes with coastal ecosystems. Due to these ecosystems being in the sea they are generally part of national jurisdiction and not owned privately. Thus, government bodies are usually the only feasible providers. Thus, this limits the choice of PES design.

6.3.2 Social concerns over commodification of nature

When discussing such market-based governance of the environment it is important to address many of the social issues that are associate with the topic. One major issue is that of dispossession and commodification of nature (Kosoy and Corbera, 2010). This is often described as the process of “green grabbing”, where the valuation of natural services and their integration in markets is driving appropriation of land around the world and in many cases displacing local communities or negatively affecting their livelihoods (Fairhead et al., 2012). This problem is further compounded by the fact that it is wealthy actors that are acquiring this land and thus the process is driving inequality as natural capital is accumulated in the hands a wealthy few, especially between the global north and south (Mcafee, 2012). Bumpus (2015) describes how this issue is prevalent in the international carbon markets described in this paper. He discusses how such markets are criticised for neo-colonial practices and dispossession of rights through selling cheap carbon compensation credits produced in the global south to buyers in the global north. Finally, this approach is criticised as it does not try to address the underlying causes of environmental degradation, namely the current capitalist global system (Arsel and Büscher, 2012) but rather maintains a business as usual approach.

Concerns about this neoliberalism of nature within the blue economy paradigm are highlighted by Barbesgaard, (2018). The main concern raised here is the process where powerful actors are taking control of aquatic resources while using the aims of combating climate change or preserving biodiversity to legitimise their actions. This is often referred to as ocean grabbing, where the well-established process of land grabbing is applied it to the ocean. Furthermore, he raises issues regarding the market logic of payment for ecosystem services, if the idea is to pay ecosystem users not to carry out destructive processes then by following neoliberal logic, investors will try and maximise the efficiency of conservation per invested capital. As such, small scale and low profit industries will be targeted by these schemes, meaning that the larger scale, highly destructive industries that produce huge profits will not be addressed (Mcafee, 2012). This will severely limit the conservation value of such schemes, while potentially exacerbating the negative social impacts.

These negative social consequences described are of concern to many investors who do not want to damage their reputation by being involved in such activities (Vanderklift et al., 2019). As such, practices such as involving local communities and actors in the development and implementation of projects can help ensure that the community benefits from the project are often implemented. These strategies also have other benefits such as helping prevent leakage, helping the overall success of the project (Wylie et al., 2016).

It can be argued that the case described in this paper is able to overcome most of these social concerns. Firstly, due to the geographical context of Sweden being a wealthy nation in the global North, concerns regarding unbalanced power dynamics associated with global ecosystem markets are unfounded. Within this context, dispossession is of limited concern as marine protected areas are already well-established practice within the Swedish context and the majority of seagrass is found in nationally owned waters. Furthermore, in the case of a national market based on the mechanism put forward in article 6 of the Paris agreement, such market-based governance would result in carbon offsets contributing to the nations NDC, as such there would be no dispossession of the nation's natural capital.

The main concern in this context would be the removal of traditional access rights over areas where conservation and restoration is occurring. This would not affect recreational users due to the Swedish law of Allemansrätten (Swedish Environmental Protection Agency, n.d.), which guarantees the right to public access to all land and marine areas. However, limitations may be imposed on fishing industry due to the discussed impact on seagrass beds, this may be offset by the benefits gained from fishery provisioning services provided by seagrass. Including actors from the fishing industry through participatory processes would be recommended to ensure this negative outcome does not occur.

6.3 Ineffectiveness at promoting conservation

There are also broader issues in the application market-based governance for conservation that need to be considered. While this mode of governance has obvious appeal as a well-designed payment for ecosystem service scheme can be a cost effective way to correct market failures, caution is advised as poorly designed schemes can waste money and result in damaging environmental and social consequences (Börner et al., 2017).

Issues can arise when there is a focus on win-win scenarios of combining conservation and development as it usually leads to ineffective outcomes for both objectives (Muradian et al., 2013). Furthermore, concerns are raised about how the application of economic logic into societies can encourage a shift towards individualism and competition and the erosion of conservation for ethical or social reasons (Gómez-Baggethun et al., 2010)

These negative consequences are highlighted in the seven problems with using payment for ecosystem services to achieve conservation goals brought forward by Redford and Adams, (2009) (Table 4). Here they describe how such an approach has a narrow focus due to its economic and human centric approach and can thus lead to less than favourable outcomes in terms of conservation, either through neglect or mismanagement.

Table 4: Redford and Adams' (2009) critiques of the use of PES for conservation

Critique	**Argument**
Economic logic	That this focus on economic logic will eclipse noneconomic arguments for conservation.
Human focus	This only focuses on ecosystem functions that are positive to human society and that this could lead to processes that have no benefit to humans to be neglected.
No motivation for native species protection	There is an issue that focusing purely on services does not necessarily require native species as many invasive species can fulfil ecosystem services. As such this mode of governance can be ineffective at conserving native species.
Neglecting less monetarily valuable services	There is risk of focus on single services becoming highly valued and so ecosystems will thus be engineered to maximise this service to increase the value. This will not align the profit motive with a healthy ecosystem as the maximisation of single services runs the risk neglecting other processes and thus creating a fragile ecosystem.
Problems with valuation	There are issues with the valuation of services. Firstly, due to ecosystem complexity making many services inherently difficult to value. Furthermore, using this logic, areas located close more to consumers will have a much higher incentive to conserved, while isolated areas run the risk of being neglected.
Welfare implications	Even if ecosystem services that provide the highest revenue are not associated with welfare, this market-based governance will push for them to be prioritised.
Levels of uncertainty	There are a lot of uncertainties involved with climate change and the current flux we see in the natural world, meaning that there is no guarantee that ecosystems will stay in their current form and provide the services they do today. This creates the risk that owners of the services will attempt to keep them in their current location to maintain their revenue flows while at the same time making the ecosystem more fragile.

However, it can be argued that while many of these concerns are pertinent, many are not relevant in this case. In this context there is no focus on a win- win scenario of conservation and development, it is purely focused on environmental conservation as its goal. Issues with the ecosystem services in this case are recommended to bundled which can alleviate problems associated with maximising one service (Kosoy and Corbera, 2010). There is also limited concern about causing a shift in conservation values, due to it being in the context of a Western nation, where valuing ecosystem services can be a method of convincing opponents to nature protection (Schröter et al., 2014). Considering the lack of societal awareness of seagrasses importance (Unsworth et al., 2018), there is a need to communicate the range of services it provides. As such, an argument can be made for assigning a monetary valuation to such services, as it can be an effective way of communicating to a wide range of groups in society (Schröter et al., 2014).

This raises important questions about the global distribution of blue carbon projects, which are skewed toward the Global South. As many of the negative social outcomes associated with market-based governance are most relevant in a global south context (Muradian et al., 2010). As such, why is there not more emphasis on implementing blue carbon based projects in the Global North? As in many regions it is feasible and more socially sustainable.

6.4 Loss and Damage

As can be seen in the results, through applying the lens of Loss and Damage to seagrass in the Swedish context, it is clear that the ecosystem services provided by seagrass fit into key elements of the concept well. If we take a technical perspective on the Loss and Damage concept as described by (Van Der Geest and Warner (2015 pg. 136) as:

” Technical perspectives aim to minimise current and future Loss and Damage by protecting people, properties and ecosystems against climate-related stressors through technical solutions”

We can see how the Loss and Damage concept can be used to develop a strong justification for seagrass conservation and restoration in Sweden. This would be done through defining it as ecosystem-based methods of minimising avoidable and unavoidable Loss and Damage.

An important consideration is how, unlike adaptation and mitigation, this concept has an economic element inherent to it. As such using an ecosystem-based approach within the Loss and Damage concept integrates well with market based environmental governance. As through assessing the effectiveness of seagrasses ecosystem services at reducing economic Loss and Damages a monetary value can be assigned.

Worth noting is that climate change can also directly impact existing seagrass meadows resulting in the loss of their beneficial ecosystem services (Short & Neckles, 1999). Loss and Damage to these ecosystem services would often fall under into the non-economic category, as such services are not traded on the market and are not easily valued monetarily. Thus, including these services within Loss and Damage framework can be challenging. However, to use a blue carbon market-based governance system for seagrass, these services have to be assigned an economic value. Thus, the market-based governance model can integrate economic and non-economic Loss and Damages with regard to ecosystems. Therefore, using market-based approach can encompass a wide range of costs due to Loss and Damage from climate change related with seagrass in Sweden and thus be used to promote its effective governance.

As has been stated earlier in the thesis, Loss and Damage has been established under article 8 of the Paris Agreement and as such it is an internationally agreed upon agenda to use mitigation and adaptation techniques to limit the costs incurred by climate change. Thus, by integrating seagrass ecosystem services within its framework in different national contexts, it can provide a method for justifying seagrass conservation and restoration globally. This is a valuable tool considering the previously described blue carbon policy framework's goal of developing demonstration projects across the world.

6.5 Limitations and future research

This paper was purely exploratory in nature, considering the fact that applying such a market governance approach to seagrass is a relatively novel idea globally and has never been carried out in this region. As such, it was limited in some respects in assessing the potential for market-based governance of Sweden.

The values used in this study for the value of ecosystem services are based on estimates from the literature. While they are from the same species and in as close a geographical location as possible, this is still far from ideal. For example Cole and Moksnes (2016) use sequestration rates from UK and Röhr et al. (2016) estimation for stocks value is in Danish waters. Therefore, the results can only provide rough estimations of the discussed values that may guide further investigation.

To test this mode of governance further, a specific area would need to be chosen and site-specific data collected. For the carbon sequestration function, soil and plant samples would need to be collected in order to calculate the size of the carbon sink and rates of CO_2 sequestration. For the fisheries provisioning service, population counts for juveniles of economically important fish species would need to be carried out. Finally, estimates for the coastal defence service provided by seagrass can be determined by the value of adjacent coastal property and infrastructure.

Considering the findings of this study suggest for the development of demonstration projects, there are going to be a range of technical and social considerations raised that are specific to regional contexts. To address these considerations, it is suggested that sustainability sciences is integrated into the development of any such project. As sustainability science aims to include non-academic actors in the co-production of knowledge (Clark & Dickson, 2003) with an emphasis on participatory processes (Kates et al., 2001). This is relevant as a participatory approach that is inclusive of different stakeholders can ensure the correct strategy is taken to maximise socio-ecological benefits in any development project. Sustainability also includes the formation of networks through which to share this knowledge generated (Kates et al., 2001), this concept links well with the proposal of demonstration projects to develop proof concept, as creating a knowledge sharing network between these projects can help develop effective management strategies and best practices.

7. Conclusions

Using market-based governance mechanisms to restore and conserve the seagrass species *Zoestera Marina* through the monetary value of its CO_2 sequestration, fisheries enhancement, and coastal erosion protection has some potential within a Swedish context. As carbon is the ecosystem service which has been most successfully integrated into markets, blue carbon would be the main avenue though which market-based governance could be applied. However, due to the design of current regulated carbon markets there is no way for the integration of seagrass blue carbon to take place. This is due to the majority of UNFCCC mechanisms being designed to channel funding to the Global South. However, using the Voluntary Carbon Market approach has some potential due to its flexibility and precedent for the use of blue carbon. Furthermore, the incorporation of co-benefits into the VCM can enhance the value of credits on this market and so this method can be used to capture the value of other ecosystem services. However, this approach is problematic due to the volatility of prices that make investment flows uncertain, prices low, and only being successful at a small scale.

There is however scope to use the Voluntary Carbon market funding of blue carbon services as a basis for a development project, to improve management strategies and best practice. This would be of value considering the potential of future national carbon offset markets implemented using the Paris agreement Article 6.4.

Through applying seagrass ecosystems services to the Loss and Damage concept, it is shown that conserving and restoring such an ecosystem effectively minimises Loss and Damage from climate change. Thus, through this technical perspective a strong justification for the conservation of seagrass can be made using established international policy

8 References

Alongi, D., 2018. Blue Carbon Coastal Sequestration for Climate Change Mitigation, Springer Briefs in Climate Studies. https://doi.org/10.1007/978-3-319-91698-9_5

Arsel, M., Büscher, B., 2012. Nature™ Inc: Changes and Continuities in Neoliberal Conservation and Market-based Environmental Policy. Dev. Change 43, 53–78. https://doi.org/10.1111/j.1467-7660.2012.01752.x

Baden, S., Gullström, M., Lundén, B., Pihl, L., Rosenberg, R., 2009. Vanishing Seagrass (Zostera marina, L.) in Swedish Coastal Waters. AMBIO A J. Hum. Environ. 32, 374–377. https://doi.org/10.1579/0044-7447-32.5.374

Barbesgaard, M., 2018. Blue growth: savior or ocean grabbing? J. Peasant Stud. 45, 130–149. https://doi.org/10.1080/03066150.2017.1377186

Barbier, E., Hacker, S., Kennedy, C., Koch, E., Stier, A., Silliman, B., 2011. The value of estuarine and coastal ecosystem services. Ecol. Monogr. 81(2), 169–193.

Benessaiah, K., 2012. Carbon and livelihoods in Post-Kyoto: Assessing voluntary carbon markets. Ecol. Econ. 77, 1–6. https://doi.org/10.1016/j.ecolecon.2012.02.022

Berglund, J., Boström, J., Clausen, P., Gamfeldt, L., Gundersen, H., Hancke, K., Hansen, J.L.., Häggblom, M., Højgård Petersen, A., Ilvessalo-Lax, H., Jacobsen, K.-O., Kvarnström, M., Lax, H.-G., Køie Poulsen, M., Magnussen, M., Mustonen, K., Mustonen, T., Norling, P., Oddsdottir, E., Postmyr, E., Roth, E., Roto, J., Sogn Andersen, G., Svedäng, H., Sørensen, J., Tunón, H., Vävare, S., 2018. Biodiversity and ecosystem services in Nordic coastal ecosystems 2. https://doi.org/10.6027/TN2018-532

Börner, J., Baylis, K., Corbera, E., Ezzine-de-Blas, D., Honey-Rosés, J., Persson, U.M., Wunder, S., 2017. The Effectiveness of Payments for Environmental Services. World Dev. 96, 359–374. https://doi.org/10.1016/j.worlddev.2017.03.020

Bos, A.R., Bouma, T.J., de Kort, G.L.J., van Katwijk, M.M., 2007. Ecosystem engineering by annual intertidal seagrass beds: Sediment accretion and modification. Estuar. Coast. Shelf Sci. 74, 344–348. https://doi.org/10.1016/j.ecss.2007.04.006

Boström, C., Baden, S., Bockelmann, A.C., Dromph, K., Fredriksen, S., Gustafsson, C., Krause-Jensen, D., Möller, T., Nielsen, S.L., Olesen, B., Olsen, J., Pihl, L., Rinde, E., 2014. Distribution, structure and function of Nordic eelgrass (Zostera marina) ecosystems: Implications for coastal management and conservation. Aquat. Conserv. Mar. Freshw. Ecosyst. 24, 410–434. https://doi.org/10.1002/aqc.2424

Bumpus, A.G., 2015. Accumulation by Decarbonization Offsets of Carbon and the Governance 84, 127–155. https://doi.org/10.1111/j.1944-8287.2008.tb00401.x

Cash, D.W., Clark, W.C., Alcock, F., Dickson, N.M., Eckley, N., Guston, D.H., Jager, J., Mitchell, R.B., 2003. Knowledge Systems for Sustainable Development. PNAS 100, 8086–8091.

Clark, W.C., Dickson, N.M., 2003. Sustainability science: The emerging research program. Proc. Natl. Acad. Sci. 100, 8059–8061. https://doi.org/10.1073/pnas.1231333100

Cole, S.G., Moksnes, P.-O., 2016. Valuing Multiple Eelgrass Ecosystem Services in Sweden: Fish Production and Uptake of Carbon and Nitrogen. Front. Mar. Sci. 2, 1–18. https://doi.org/10.3389/fmars.2015.00121

Commission on Climate and Vulnerability (Sweden), 2007. Sweden facing climate change - threats and opportunities. https://doi.org/10.1080/0141192940200204

Costanza, R., D’Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., Limburg, K., Naeem, S., O’Neill, R. V., Paruelo, J., Raskin, R.G., Sutton, P., Van Den Belt, M., 1997. The value of the world’s ecosystem services and natural capital. Nature 387, 253–260. https://doi.org/10.1038/387253a0

Dahl, M., 2017. Natural and human-induced carbon storage variability in seagrass meadows.

Dahl, M., Deyanova, D., Gütschow, S., Asplund, M.E., Lyimo, L.D., Karamfilov, V., Santos, R., Björk, M., Gullström, M., 2016. Sediment properties as important predictors of carbon storage in Zostera marina meadows: A comparison of four European areas. PLoS One 11, 1–21. https://doi.org/10.1371/journal.pone.0167493

Daily, G.C., 1997. Nature's services: societal dependence on natural ecosystems. Brittonia 45, 392. https://doi.org/10.2307/2806859

De Groot, R.S., Wilson, M.A., Boumans, R.M.J., 2002. A typology for the classification, description and valuation of ecosystem functions, goods and services. Ecol. Econ. 41, 393–408. https://doi.org/10.1016/S0921-8009(02)00089-7

Dewsbury, B.M., Bhat, M., Fourqurean, J.W., 2016. A review of seagrass economic valuations: Gaps and progress in valuation approaches. Ecosyst. Serv. 18, 68–77. https://doi.org/10.1016/j.ecoser.2016.02.010

Duarte, C.M., 2017. Reviews and syntheses: Hidden forests, the role of vegetated coastal habitats in the ocean carbon budget. Biogeosciences 14, 301–310. https://doi.org/10.5194/bg-14-301-2017

Duarte, C.M., Kennedy, H., Marbà, N., Hendriks, I., 2013a. Assessing the capacity of seagrass meadows for carbon burial: Current limitations and future strategies. Ocean Coast. Manag. 83, 32–38. https://doi.org/10.1016/j.ocecoaman.2011.09.001

Duarte, C.M., Krause-Jensen, D., 2017. Export from Seagrass Meadows Contributes to Marine Carbon Sequestration. Front. Mar. Sci. 4, 1–7. https://doi.org/10.3389/fmars.2017.00013

Duarte, C.M., Losada, I.J., Hendriks, I.E., Mazarrasa, I., Marbà, N., 2013b. The role of coastal plant communities for climate change mitigation and adaptation. Nat. Clim. Chang. 3, 961–968. https://doi.org/10.1038/nclimate1970

Duarte, C.M., Marbà, N., Gacia, E., Fourqurean, J.W., Beggins, J., Barrón, C., Apostolaki, E.T., 2010. Seagrass community metabolism: Assessing the carbon sink capacity of seagrass meadows. Global Biogeochem. Cycles 24, n/a-n/a. https://doi.org/10.1029/2010gb003793

Duarte, C.M., Middelburg, J.J., Caraco, N., 2005. Major role of marine vegetation on the oceanic carbon cycle. Biogeosciences Discuss. 1, 659–679. https://doi.org/10.5194/bgd-1-659-2004

Duarte, C.M., Sintes, T., Marbà, N., 2013c. Assessing the CO2 capture potential of seagrass restoration projects. J. Appl. Ecol. 50, 1341–1349. https://doi.org/10.1111/1365-2664.12155

Eriander, L., Infantes, E., Olofsson, M., Olsen, J.L., Moksnes, P.O., 2016. Assessing methods for restoration of eelgrass (Zostera marina L.) in a cold temperate region. J. Exp. Mar. Bio. Ecol. 479, 76–88. https://doi.org/10.1016/j.jembe.2016.03.005

European Parliment and the Council of the European Union, 2003. DECISION No 529/2013/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 21 May 2013 on. https://doi.org/2004R0726 - v.7 of 05.06.2013

Evans, J.P., 2012. Environmental Governance. https://doi.org/10.1146/annurev.energy.31.042605.135621

Fairhead, J., Leach, M., Scoones, I., 2012. Green Grabbing: A new appropriation of nature? J. Peasant Stud. 39, 237–261. https://doi.org/10.1080/03066150.2012.671770

Fourqurean, J.W., Kennedy, H., Kendrick, G.A., McGlathery, K.J., Apostolaki, E.T., Serrano, O., Marbà, N., Mateo, M.A., Duarte, C.M., Krause-Jensen, D., Holmer, M., 2012. Seagrass ecosystems as a globally significant carbon stock. Nat. Geosci. 5, 505–509. https://doi.org/10.1038/ngeo1477

Frederiksen, M., Krause-Jensen, D., Holmer, M., Laursen, J.S., 2004. Long-term changes in area distribution of eelgrass (Zostera marina) in Danish coastal waters. Aquat. Bot. 78, 167–181. https://doi.org/10.1016/j.aquabot.2003.10.002

Gallagher, J.B., 2017. Taking stock of mangrove and seagrass blue carbon ecosystems : A perspective for future carbon trading. Borneo J. Mar. Sci. Aquac. 1, 71–74.

Gómez-Baggethun, E., Barton, D.N., 2013. Classifying and valuing ecosystem services for urban planning. Ecol. Econ. 86, 235–245. https://doi.org/10.1016/j.ecolecon.2012.08.019

Gómez-Baggethun, E., de Groot, R., Lomas, P.L., Montes, C., 2010. The history of ecosystem services in economic theory and practice: From early notions to markets and payment schemes. Ecol. Econ. 69, 1209–1218. https://doi.org/10.1016/j.ecolecon.2009.11.007

Greiner, J.T., Mcglathery, K.J., Gunnell, J., Mckee, B.A., 2013. Seagrass Restoration Enhances " Blue Carbon " Sequestration in Coastal Waters. PLoS One 8, 1–8. https://doi.org/10.1371/journal.pone.0072469

Grimsditch, G., Alder, J., Nakamura, T., Kenchington, R., Tamelander, J., 2013. The blue carbon special edition - Introduction and overview. Ocean Coast. Manag. 83, 1–4. https://doi.org/10.1016/j.ocecoaman.2012.04.020

Grip, K., Blomqvist, S., 2018. Establishing marine protected areas in Sweden: Internal resistance versus global influence. Ambio 47, 1–14. https://doi.org/10.1007/s13280-017-0932-8

Grubb, M., Neuhoff, K., 2011. Allocation and competitiveness in the EU emissions trading scheme : policy overview Allocation and competitiveness in the EU emissions trading scheme : policy overview. Clim. Policy 3062, 37–41.

Hardin, G., 1968. The Tragedy of the Commons. Science (80-.). 162, 1243–1248.

Hejnowicz, A.P., Kennedy, H., Rudd, M.A., Huxham, M.R., 2015. Harnessing the climate mitigation, conservation and poverty alleviation potential of seagrasses: prospects for developing blue carbon initiatives and payment for ecosystem service programmes. Front. Mar. Sci. 2, 1–22. https://doi.org/10.3389/fmars.2015.00032

Herr, D., Landis, E., 2016. Coastal Blue Carbon Ecosystems in NDCs: Opportunities for Nationally Determined Contributions. Policy Brief. IUCN Washignton, Dc.

Herr, D., Landis, E., 2014. Coastal blue carbon ecosystems. Natl. Wetl. Newsl. 36, 5–7. https://doi.org/http://dx.doi.org/10.2305/IUCN.CH.2015.10.en

Herr, D., Trines, E., Howard, J., Silvius, M., Pidgeon, E., 2015. Keep it Fresh or Salty: An introductory guide to financing wetland cargon programs and projects, Keep it Fresh or Salty: An introductory guide to financing wetland cargon programs and projects. https://doi.org/10.2305/iucn.ch.2014.02.en

Herr, D., von Unger, M., Laffoley, D., McGivern, A., 2017. Pathways for implementation of blue carbon initiatives. Aquat. Conserv. Mar. Freshw. Ecosyst. 27, 116–129. https://doi.org/10.1002/aqc.2793

Howard, J., McLeod, E., Thomas, S., Eastwood, E., Fox, M., Wenzel, L., Pidgeon, E., 2017a. The potential to integrate blue carbon into MPA design and management. Aquat. Conserv. Mar. Freshw. Ecosyst. 27, 100–115. https://doi.org/10.1002/aqc.2809

Howard, J., Sutton-Grier, A.E., Herr, D., Kleypas, J., Landis, E., Mcleod, E., Pidgeon, E., Simpson, S., 2017b. Clarifying the role of coastal and marine systems in climate mitigation. Front. Ecol.

Environ. 15, 42–50. https://doi.org/10.1002/fee.1451

Huq, S., Roberts, E., Fenton, A., 2013. Loss and Damage. Nat. Clim. Chang. 3, 947–949. https://doi.org/10.1163/18786561-00402010

Infantes, E., Eriander, L., Moksnes, P.O., 2016. Eelgrass (Zostera marina) restoration on the west coast of Sweden using seeds. Mar. Ecol. Prog. Ser. 546, 31–45. https://doi.org/10.3354/meps11615

IPCC, 2018. Summary for Policymakers, Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change,. https://doi.org/10.1017/CBO9781107415324

IPCC, 2013. 2013 SUPPLEMENT TO THE 2006 IPCC GUIDELINES FOR NATIONAL GREENHOUSE GAS INVENTORIES : WETLANDS Methodological Guidance on Organic and Wet Soils across IPCC Land-use Categories 1, 14–18.

Jordan, A., Wurzel, R.K.., Zito, A.R., 2003. "New" Environmental Policy Instruments: An Evolution or a Revolution in Environmental Policy? Env. Polit. 12, 201–224.

Kates, R.W., Clark, W.C., Corell, R., Hall, J.M., Jaeger, C.C., Lowe, I., Mccarthy, J.J., Schellnhuber, H.J., Bolin, B., Dickson, N.M., Faucheux, S., Gallopin, G.C., Grübler, A., Huntley, B., Jäger, J., Narpat, S., Kasperson, R.E., Mabogunje, A., Matson, P., Mooney, H., Moore, B., Riordan, T.O., Svedin, U., Iii, B.M., 2001. Sustantability Science. Science (80-.). 292, 641–642.

Kosoy, N., Corbera, E., 2010. Payments for ecosystem services as commodity fetishism. Ecol. Econ. 69, 1228–1236. https://doi.org/10.1016/j.ecolecon.2009.11.002

Larkum, A.W.D., Orth, R.J., Duarte, C.M., 2006. Seagrasses: Biology, Ecology and Conservation. Springer, The Netherlands.

Lau, W.W.Y., 2013. Beyond carbon: Conceptualizing payments for ecosystem services in blue forests on carbon and other marine and coastal ecosystem services. Ocean Coast. Manag. 83, 5–14. https://doi.org/10.1016/j.ocecoaman.2012.03.011

Lavery, P.S., Mateo, M.Á., Serrano, O., Rozaimi, M., 2013. Variability in the Carbon Storage of Seagrass Habitats and Its Implications for Global Estimates of Blue Carbon Ecosystem Service.

PLoS One 8. https://doi.org/10.1371/journal.pone.0073748

Macreadie, P.I., Baird, M.E., Trevathan-Tackett, S.M., Larkum, A.W.D., Ralph, P.J., 2014. Quantifying and modelling the carbon sequestration capacity of seagrass meadows - A critical assessment. Mar. Pollut. Bull. 83, 430–439. https://doi.org/10.1016/j.marpolbul.2013.07.038

Marbà, N., Garcia-Orellana, J., Mazarrasa, I., Duarte, C.M., Arias-Ortiz, A., Kendrick, G.A., Masqué, P., Bastyan, G.R., 2015. Impact of seagrass loss and subsequent revegetation on carbon sequestration and stocks. J. Ecol. 103, 296–302. https://doi.org/10.1111/1365-2745.12370

Marbá, N., Holmer, M., Gacia, E., Barrón, C., 2006. Seagrass Beds and Coastal Biogeochemistry, in: Larkum, A.W.D., Orth, R.J., Duarte, C.M. (Eds.), Seagrasses: Biology. Springer, Dordrecht, pp. 135–157.

Mcafee, K., 2012. The Contradictory Logic of Global Ecosystem Services Markets. Dev. Change 43, 105–131. https://doi.org/10.1111/j.1467-7660.2011.01745.x

McLeod, E., Chmura, G.L., Bouillon, S., Salm, R., Björk, M., Duarte, C.M., Lovelock, C.E., Schlesinger, W.H., Silliman, B.R., 2011. A blueprint for blue carbon: Toward an improved understanding of the role of vegetated coastal habitats in sequestering CO2. Front. Ecol. Environ. 9, 552–560. https://doi.org/10.1890/110004

Mechler, R., Bouwer, L., Schinko, T., Surminski, S., Linnerooth-Bayer, J., 2019. Loss and Damage from Climate Change, Loss and Damage from Climate Change. https://doi.org/10.1007/978-3-319-72026-5_20

Millennial Ecosystem Assesssment, 2005. Ecosystems and Human Wellbeing. Island Press, Washington D.C. https://doi.org/10.1196/annals.1439.003

Ministry of the Environment and Energy, 2018. The Swedish climate policy framework.

Moksnes, P.-O., Gipperth, L., Eriander, L., Laas, K., Cole, S., Infantes, E., 2016. Handbok för restaurering av ålgräs i Sverige.

Muradian, R., Arsel, M., Pellegrini, L., Adaman, F., Aguilar, B., Agarwal, B., Corbera, E., Ezzine de Blas, D., Farley, J., Froger, G., Garcia-Frapolli, E., Gómez-Baggethun, E., Gowdy, J., Kosoy, N., Le Coq, J.F., Leroy, P., May, P., Méral, P., Mibielli, P., Norgaard, R., Ozkaynak, B., Pascual, U., Pengue, W., Perez, M., Pesche, D., Pirard, R., Ramos-Martin, J., Rival, L., Saenz, F., Van Hecken, G., Vatn, A., Vira, B., Urama, K., 2013. Payments for ecosystem services and the fatal attraction of win-win solutions. Conserv. Lett. 6, 274–279. https://doi.org/10.1111/j.1755-263X.2012.00309.x

Muradian, R., Corbera, E., Pascual, U., Kosoy, N., May, P.H., 2010. Reconciling theory and practice: An alternative conceptual framework for understanding payments for environmental services. Ecol. Econ. 69, 1202–1208. https://doi.org/10.1016/j.ecolecon.2009.11.006

Murray, B.C., 2012. Incorporating blue carbon as a mitigation action under the United Nations Framework Convention on Climate Change technical issues to address. Rep. Nicholas Sch. Environ. Policy Solut.

Murray, B.C., Pendleton, L., Jenkins, W., Sifleet, S., 2011. Green payments for blue carbon: Economic incentives for protecting threatened coastal habitats. Nicholas Inst. Environ. … 52.

Nellemann, C., Corcoran, E., Duarte, C.M., Valdes, L., De Young, C., Fonseca, L., Grimsditch, G., 2009. Blue carbon. A Rapid Response Assessment. The Role of Healthy Oceans in Binding Carbon.

Ondiviela, B., Losada, I.J., Lara, J.L., Maza, M., Galván, C., Bouma, T.J., van Belzen, J., 2014. The role of seagrasses in coastal protection in a changing climate. Coast. Eng. 87, 158–168. https://doi.org/10.1016/j.coastaleng.2013.11.005

Orth, R.J., McGlathery, K.J., 2012. Eelgrass recovery in the coastal bays of the Virginia Coast Reserve, USA. Mar. Ecol. Prog. Ser. 448, 173–176. https://doi.org/10.3354/meps09596

Pendleton, L., Donato, D.C., Murray, B.C., Crooks, S., Jenkins, W.A., Sifleet, S., Craft, C., Fourqurean, J.W., Kauffman, J.B., Marbà, N., Megonigal, P., Pidgeon, E., Herr, D., Gordon, D., Baldera, A., 2012. Estimating Global “Blue Carbon” Emissions from Conversion and Degradation of Vegetated Coastal Ecosystems. PLoS One 7. https://doi.org/10.1371/journal.pone.0043542

Policy Research Cooperation, 2009. Country overview and assessment 20. Sweden. Econ. Clim. Chang. Adapt. EU Coast. areas.

Redford, K.H., Adams, W.M., 2009. Payment for ecosystem services and the challenge of saving nature: Editorial. Conserv. Biol. 23, 785–787. https://doi.org/10.1111/j.1523-1739.2009.01271.x

Roberts, E., Huq, S., 2015. Coming full circle: the history of loss and damage under the UNFCCC. Int. J. Glob. Warm. 8, 141. https://doi.org/10.1504/ijgw.2015.071964

Roberts, E., Pelling, M., 2018. Climate change-related loss and damage: translating the global policy agenda for national policy processes. Clim. Dev. 10, 4–17. https://doi.org/10.1080/17565529.2016.1184608

Röhr, M.E., Boström, C., Canal-Vergés, P., Holmer, M., 2016. Blue carbon stocks in Baltic Sea eelgrass (Zostera marina) meadows. Biogeosciences 13, 6139–6153. https://doi.org/10.5194/bg-13-6139-2016

Röhr, M.E., Holmer, M., Baum, J.K., Björk, M., Chin, D., Chalifour, L., Cimon, S., Cusson, M., Dahl, M., Deyanova, D., Duffy, J.E., Eklöf, J.S., Geyer, J.K., Griffin, J.N., Gullström, M., Hereu, C.M., Hori, M., Hovel, K.A., Hughes, A.R., Jorgensen, P., Kiriakopolos, S., Moksnes, P.O., Nakaoka, M., O'Connor, M.I., Peterson, B., Reiss, K., Reynolds, P.L., Rossi, F., Ruesink, J., Santos, R., Stachowicz, J.J., Tomas, F., Lee, K.S., Unsworth, R.K.F., Boström, C., 2018. Blue Carbon Storage Capacity of Temperate Eelgrass (Zostera marina) Meadows. Global Biogeochem. Cycles 32, 1457–1475. https://doi.org/10.1029/2018GB005941

Ruiz-Frau, A., Gelcich, S., Hendriks, I.E., Duarte, C.M., Marbà, N., 2017. Current state of seagrass ecosystem services: Research and policy integration. Ocean Coast. Manag. 149, 107–115. https://doi.org/10.1016/j.ocecoaman.2017.10.004

Schröter, M., van der Zanden, E.H., van Oudenhoven, A.P.E., Remme, R.P., Serna-Chavez, H.M., de Groot, R.S., Opdam, P., 2014. Ecosystem Services as a Contested Concept: A Synthesis of Critique and Counter-Arguments. Conserv. Lett. 7, 514–523. https://doi.org/10.1111/conl.12091

Serdeczny, O., 2019. Non-economic Loss and Damage and the Warsaw International Mechanism, in: Mechler, R., Schinko, T., Bouwer, L., Surminski, S., Linnerooth-Bayer, J. (Eds.), Loss and Damage from Climate Change. Springer, Cham, p. 221 237.

Serdeczny, O., Waters, E., Chan, S., 2016. Non-economic loss and damage: Addressing the forgotten side of climate change impacts. Ger. Dev. Inst. Brief. Pap. 4. https://doi.org/10.1007/978-94-017-3674-9_66

Short, F.T., 2013. World atlas of seagrasses. Choice Rev. Online 41, 41-3160-41–3160. https://doi.org/10.5860/choice.41-3160

Short, F.T., Neckles, H.A., 1999. The effects of global climate change on seagrasses. Aquat. Bot. 63, 169–196. https://doi.org/10.1016/S0304-3770(98)00117-X

Short, F.T., Wyllie-Echeverria, S., Ackerman, J.D., Alberte, R.S., Suba, G.K., Procaccini, G., Zimmerman, R.C., Fain, S.R., Backman, T.W.H., Baldwin, J., Loworn, J., Bazzaz, F.A., Brix, H., Lyngby, J.E., Schierup, H.-H., Bulthuis, D.A., Burdick, D., Short, F., Wolf, J., Cambridge, M.L., Chiffings, A.W., Brittan, C., Moore, L., McComb, A.J., Cambridge, M.L., McComb, A.J., Churchill, A.C., Nieves, G., Brenowitz, A.H., den Hartog, C., Den Hartog, C., Polderman, P.J.G., Dennison, W.C., Orth, R.J., Moore, K.A., Stevenson, J.C., Carter, V., Kollar, S., Bergstrom, P.W., Batiuk, R.A., Dirnberger, J.M., Kitting, C.L., Dunton, K.H., Fonseca, M., Fisher, J., Fourqurean, J., Zieman, J., Gallegos, M.E., Merino, M., Marbá, N., Duarte, C.M., Giese, G.S., Giesen, W.B.J.T., Van Katwijk, M.M., Den Hartog, C., Güven, K.C., Saygı, N., Öztürk, B., Hanekom, N., Baird, D., Harris, J., Fabris, G., Statham, P., Tawfik, F., Hemminga, M.A., Nieuwenhuize, J., Howard, R.K., Short, F.T., Kirkman, H., Larkum, A.W.D., West, R.J., Muehlstein, L., Muehlstein, L.K., Porter, D., Short, F.T., Muehlstein, L.K., Porter, D., Short, F.T., Nienhuis, P.H., Nienhuis, P.H., van Ierland, E.T., Orth, R.J., Heck, K.L., van Montfrans, J., Philippart, C.J.M., Dijkema, K.S., Pirc, H., Buia, M.C., Mazzella, L., Quammen, M.L., Onuf, C.P., RENN, C.E., Robblee, M., Barber, T., Carlson, P., Durako, M., Fourqurean, J., Muehlstein, L., Porter, D., Yarbro, L., Zieman, R., Zieman, J., Robertson, A.I., Mann, K.H., Schneider, F., Mann, K., Short, F.T., Short, F., Mathieson, A., Nelson, J., Short, F.T., Muehlstein, L.K., Porter, D., Short, F., Porter, D., Iizumi, H., Aioi, K., Silberstein, K., Chiffings, A.W., McComb, A.J., Smith, R.D., Dennison, W.C., Alberte, R.S., Stenner, R.D., Nickless, G., Tomasko, D., Lapointe, B., Tubbs, C.R., Tubbs, J.M., Valentine, J.F., Heck, K.L., Valiela, I., Costa, J.E., van Tussenbroek, B.I., Vergeer, L.H.T., den Hartog, C., Vergeer, L.H.T., den Hartog, C., Walker, D.I., Lukatelich, R.J., Bastyan, G., McComb, A.J., Walker, D.., McComb, A.., Wigand, C., Churchill, A.C., Williams, S.L., Wilson, U.W., Atkinson, J.B., Wium-Andersen, S., Borum, J., Zimmerman, R.C., Reguzzoni, J.L., Wyllie-Echeverria, S., Josselyn, M., Alberte, R.S., 1996. Natural and human-induced disturbance of seagrasses. Environ. Conserv. 23, 17. https://doi.org/10.1017/S0376892900038212

Smale, D.A., Wernberg, T., Oliver, E.C.J., Thomsen, M.S., Harvey, B.P., Straub, S., Burrows, M.T., Alexander, L. V., Benthuysen, J.A., Donat, M.G., Feng, M., Hobday, A.J., Holbrook, N.J., Perkins-Kirkpatrick, S.E., Scannell, H.A., Gupta, A. Sen, Payne, B.L., Moore, P.J., 2019. Marine heatwaves threaten global biodiversity and the provision of ecosystem services. Nat. Clim. Chang. IN PRESS. https://doi.org/10.1038/s41558-019-0412-1

Spalding, M.J., 2016. Journal of Ocean and Coastal Economics The New Blue Economy: the Future of Sustainability. J. Ocean Coast. Econ. 2. https://doi.org/10.15351/2373-8456.1052

Spangenberg, J.H., 2011. Sustainability science: A review, an analysis and some empirical lessons. Environ. Conserv. 38, 275–287. https://doi.org/10.1017/S0376892911000270

Swedish Agency for Marine and Water Management, 2015. Marine Spatial Planning — Current Status 2014.

Swedish Environmental Protection Agency, 2018. Swedish national inventory report 2018. Naturvårdsverket.

Swedish Environmental Protection Agency, 2017. Swedish Environmental Law - An introduction to the Swedish legal system for environmental protection REPORT 6790.

Swedish Environmental Protection Agency, 2016. Sweden's envrionmental objectives.

Swedish Environmental Protection Agency, n.d. Allemansrätten: Right of public access - a unique opportunity.

Ullman, R., Bilbao-Bastida, V., Grimsditch, G., 2013. Including Blue Carbon in climate market mechanisms. Ocean Coast. Manag. 83, 15–18. https://doi.org/10.1016/j.ocecoaman.2012.02.009

UNFCCC, 2015a. Submission By Latvia and the European Commission on 1–5.

UNFCCC, 2015b. Paris Agreement on Climate 1–16. https://doi.org/FCCC/CP/2015/L.9

UNFCCC, 2013. Report of the Conference of the Parties on its nineteenth session, held in Warsaw from 11 to 23 November 2013 1–43.

UNFCCC, 2012. A literature review on the topics in the context of thematic area 2 of the work programme on loss and damage: a range of approaches to address loss and damage associated with the adverse effects of climate change. United Nations Framew. Conv. Clim. Chang. 1–103.

United Nations, 2013. Non-economic losses in the context of the work programme on loss and damage Technical paper Paragraphs.

Unsworth, R.K.F., McKenzie, L.J., Collier, C.J., Cullen-Unsworth, L.C., Duarte, C.M., Eklöf, J.S., Jarvis, J.C., Jones, B.L., Nordlund, L.M., 2018. Global challenges for seagrass conservation. Ambio. https://doi.org/10.1007/s13280-018-1115-y

Van Der Geest, K., Warner, K., 2015. Editorial: Loss and damage from climate change: Emerging perspectives. Int. J. Glob. Warm. 8, 133–140.

van Katwijk, M.M., Thorhaug, A., Marbà, N., Orth, R.J., Duarte, C.M., Kendrick, G.A., Althuizen, I.H.J., Balestri, E., Bernard, G., Cambridge, M.L., Cunha, A., Durance, C., Giesen, W., Han, Q., Hosokawa, S., Kiswara, W., Komatsu, T., Lardicci, C., Lee, K.S., Meinesz, A., Nakaoka, M., O'Brien, K.R., Paling, E.I., Pickerell, C., Ransijn, A.M.A., Verduin, J.J., 2016. Global analysis of seagrass restoration: The importance of large-scale planting. J. Appl. Ecol. 53, 567–578. https://doi.org/10.1111/1365-2664.12562

Vanderklift, M.A., Marcos-Martinez, R., Butler, J., Coleman, M., Lawrence, A., Steven, A., Thomas, S., 2017. Blue Carbon Finance Workshop Summary 24. https://doi.org/10.13140/RG.2.2.18649.21609

Vanderklift, M.A., Marcos-Martinez, R., Butler, J.R.A., Coleman, M., Lawrence, A., Prislan, H., Steven, A.D.L., Thomas, S., 2019. Constraints and opportunities for market-based finance for the restoration and protection of blue carbon ecosystems. Mar. Policy 0–1. https://doi.org/10.1016/j.marpol.2019.02.001

Walters, G., Janzen, C., Maginnis, S., 2017. Nature-based solutions to address global societal challenges, Nature-based solutions to address global societal challenges. https://doi.org/10.2305/iucn.ch.2016.13.en

Waycott, M., Duarte, C.M., Carruthers, T.J.B., Orth, R.J., Dennison, W.C., Olyarnik, S., Calladine, A., Fourqurean, J.W., Heck, K.L., Hughes, A.R., Kendrick, G.A., Kenworthy, W.J., Short, F.T., Williams, S.L., 2009. Accelerating loss of seagrasses across the globe threatens coastal ecosystems. Proc. Natl. Acad. Sci. 106, 12377–12381. https://doi.org/10.1073/pnas.0905620106

Wunder, S., 2015. Revisiting the concept of payments for environmental services. Ecol. Econ. 117, 234–243. https://doi.org/10.1016/j.ecolecon.2014.08.016

Wunder, S., 2013. When payments for environmental services will work for conservation. Conserv. Lett. 6, 230–237. https://doi.org/10.1111/conl.12034

Wylie, L., Sutton-Grier, A.E., Moore, A., 2016. Keys to successful blue carbon projects: Lessons learned from global case studies. Mar. Policy 65, 76–84. https://doi.org/10.1016/j.marpol.2015.12.020

Young, O.R., 2009. Governance for sustainable development in a world of rising interdependencies, in: Governance for the Environment. Cambridge University Press, pp. 12–41.

Zommers, Z., van der Geest, K., de Sherbinin, A., Kienberger, S., Roberts, E., Harootunian, G., Sitati, A., James, R., 2016. Loss and Damage: The Role of Ecosystem Services. https://doi.org/http://dx.doi.org/