Fjordr

Marine and Historic Environment Consulting

Heritage, Natural Capital & Ecosystem Services Case Studies on the Dorset Stour and Tyne to Tees Marine Area

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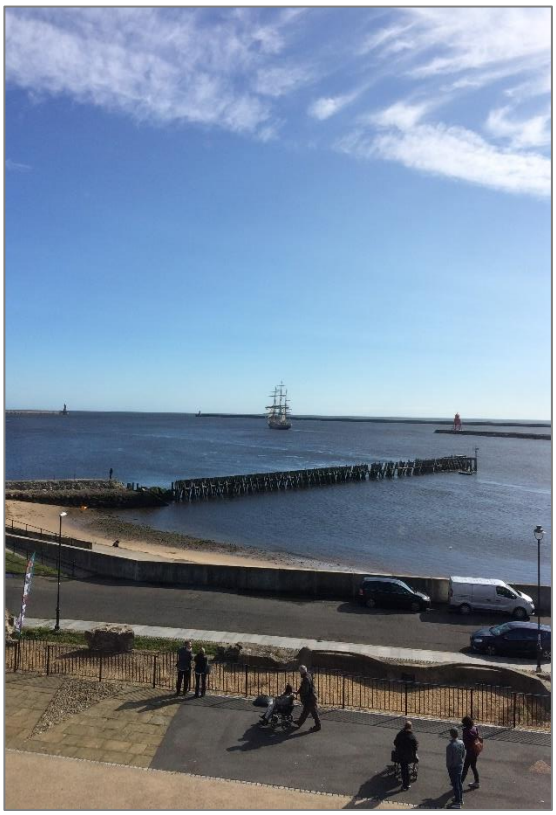
January 2020



A report for Historic England

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Acknowledgements

This document reports on two projects commissioned by Historic England (HE) as part of Historic England's Heritage Protection Commissions programme. The two projects – case studies on the Dorset Stour (HE ref: 7751) and Tyne to Tees marine area (HE ref: 7752) – form part of suite of case studies commissioned by Historic England following a Call for Proposals on Heritage, Natural Capital and Ecosystem Services (HNCES).

We are particularly grateful to Hannah Fluck, Historic England's lead on the HNCES case studies; Gareth Watkins, Historic England's Project Assurance Officer; and to the staff of Historic England's Commissions team.

Historic Environment data relating to the Dorset Stour was taken directly from the Historic Watercourses: Dorset Stour project (HE re: 7244); please see Firth and Firth (2020) for further information.

Historic environment data for the Tyne to Tees case study comprised data from Historic England's Listing Data Download Area[1] and the National Heritage List for England (NHLE)[2]; from Historic England's National Record of the Historic Environment (NRHE); and from the Historic Environment Records for South Tyneside, Sunderland, County Durham and Hartlepool. We would like to thank Hefin Meara of NRHE, Jenny Morrison of Newcastle Council, Nick Boldini of Durham County Council, and Rachel Grahame of Tees Archaeology for their kind help with sourcing heritage data.

The project has benefitted hugely from its association with major collaborative initiatives in the two case study areas: SeaScapes (Tyne to Tees Shores and Seas)[3], which is a landscape partnership project supported by the National Lottery Heritage Fund and local partners; and the Stour Catchment Initiative (SCI)[4], which is a catchment partnership formed as part of Defra's Catchment-Based Approach (CaBA)[5]. Fjordr has attended and given presentations at meetings of both SeaScapes and SCI and is grateful to the representatives of each initiatives' partners for discussing the case studies. Special thanks are due to Veronica Rudd of SeaScapes, Niall Benson of Durham County Council, Nicola Hopkins of Wessex Water, and Fiona Bowles, SCI Chair.

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The project was carried out for Fjordr Ltd by Dr Antony Firth, MCIfA with support from Emma Firth, MCIfA using sources available to March 2019.

[1] https://services.historicengland.org.uk/NMRDataDownload/Default.aspx
[2] https://historicengland.org.uk/listing/the-list
[3] http://www.exploreseascapes.co.uk/
[4] https://www.wessexwater.co.uk/stour
[5] https://catchmentbasedapproach.org/

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Executive Summary

This report addresses the relationship between heritage, Natural Capital and Ecosystem Services through case studies on the Dorset Stour and the Tyne to Tees marine area. The case studies are intended to establish and illustrate how the historic environment might be accommodated within Natural Capital and Ecosystem Services approaches; they are expected to inform the development of guidance or a handbook on best practice by Historic England (HE).

There is a need for greater integration of heritage within Natural Capital / Ecosystem Services approaches because such approaches have become very influential in policy making and implementation in environmental management, both in the public and private sector.

Environmental management decisions based on Natural Capital / Ecosystem Services approaches that take insufficient note of the historic environment may lead directly or indirectly to damage to heritage assets and loss of significance. Also, decisions intended to increase environmental sustainability that do not take account of the long history of human intervention are likely to be less effective, or to lead to their own unanticipated consequences. Further, the technical language of Natural Capital and Ecosystem Services may fail to engage the people whose behaviours it is intended to alter

Following Section 1 (Introduction), Section 2 looks at the concepts associated with Natural Capital and Ecosystem Services, including their shortcomings with respect to heritage. The relationship between culture/heritage and Natural Capital and Ecosystem Services is elaborated and, based on a logic chain developed by Natural England, a re-worked logic chain is set out. the relationship between heritage and Natural Capital / Ecosystem Services is addressed under five headings:

- The importance of heritage in the case study area
- Heritage as Natural Capital / Ecosystem Services
- How people have shaped the environment
- How Natural Capital / Ecosystem Services are valued
- The relationship between people and the environment

These headings are used as a template for two case studies in Section 3 (Dorset Stour) and Section 4 (Tyne to Tees marine area). The case studies have been informed by continuing collaboration with the Stour Catchment Initiative and the Seascapes (Tyne to Teas Shores and Sea) landscape partnership. Conclusions and recommendations are set out in Section 5.

The case studies set out the place of humans in freshwater and marine environments, providing a firm basis for greater reference to heritage in environmental policies and initiatives. The report shows that Natural Capital / Ecosystem Services approaches can accommodate history and change, including a sense of the changes that might be sought in people's behaviour towards these environments in future. The need to direct effort towards quantifying assets and services in standardised formulations is acknowledged; but the report also emphasises the degree to which benefits from the environment arise from people's cultural predispositions and contributions, which vary both in the present and through time.

Greater integration of heritage within Natural Capital / Ecosystem Services offers to help in conserving heritage assets but can also be expected to improve the content and effectiveness of environmental decisions. Overall, greater awareness of the interaction of nature and culture in the formation of the Dorset Stour and the Tyne to Tees marine area – represented by the Stour Catchment Initiative and SeaScapes respectively – can be expected to result in better outcomes both for nature and for people.

It is recommended that Historic England:

> Persists with seeking integration of heritage into Natural Capital and Ecosystem Services approaches.

Encourages the use of 'environment' (encompassing the historic environment) in place of 'nature' in Natural Capital / Ecosystem Services approaches, including in policy and implementation.

Obtains clarification from the relevant Government Departments and agencies about the status of heritage within Natural Capital / Ecosystem Services approaches.

Continues to advocate the relevance of heritage to the broad debate about achieving sustainable relationships between people and the environment.

Reviews the application of all the different forms of heritage designation to heritage assets in freshwater and marine environments, and urgently address how heritage assets are to 'count' within the Government's 25 Year Environment Plan.

Continues to promote the full range of cultural ES arising from heritage assets, drawing attention to the role of heritage in enabling physical and intellectual access to freshwater and marine environments.

Gives even greater priority to mobilising evidence about the human history of rivers among watercourse managers so that the provisioning and regulating ES arising from historic river features can be recognised.

Engages with research into the role of structures in the marine environment, to identify the provisioning and regulating ES that arise from historic marine structures.

Liaises with agencies addressing ES arising from the marine environment to seek greater attention to provisioning and regulating ES from wreck sites.

Further promotes archaeological research into the hybrid character of English rivers and engages with watercourse managers to raise awareness of the implications of hybridity for decision-making.

Develops syntheses on the human environmental history of English coasts and seas that can inform coastal and marine managers.

Amends Heritage Counts to address freshwater and marine-related heritage explicitly in its surveys, research and reports, and collaborates with other agencies collating data relating to cultural ES in freshwater and marine environments to ensure that the contribution of heritage is properly accounted for.

Encourages the identification of historic ES from freshwater and marine environments, especially where ES have lapsed, to highlight the relationship between heritage and Natural Capital / Ecosystem Services concepts and to inform decisions about sustainable uses of these environments in future.

Engages directly in public debate about the need for people's relationship to the environment to change – especially on urgent topics such as flooding, renewable energy, fisheries policy and so on – using heritage assets to stimulate and inform discussion.

The project has been carried out by Fjordr Limited on behalf of Historic England.

Heritage, Natural Capital & Ecosystem Services

Case Studies:
Dorset Stour
Tyne to Tees Marine Area

HE 7751 / 7752
Fjordr ref: 16440 / 16450

1. Introduction

1.1. Background

1.1.1. This report addresses the relationship between heritage, Natural Capital and Ecosystem Services (ES) through case studies on the Dorset Stour (Fig. 1) and the Tyne to Tees marine area (Fig. 2). The report arose from a Call for Proposals (CfP) issued 14 November 2017 by Historic England (HE).

1.1.2. The CfP invited proposals for case studies to address a range of environmental contexts that have been outlined as priorities by Historic England in its Research Agenda (Historic England, 2017). 'Water meadows and other water management features' and 'marine and coastal' were listed amongst the environmental contexts that have been prioritised: the Dorset Stour and Tyne to Tees case studies address these two environmental contexts. In addition to these two, a further seven case studies were commissioned by Historic England in February 2018.

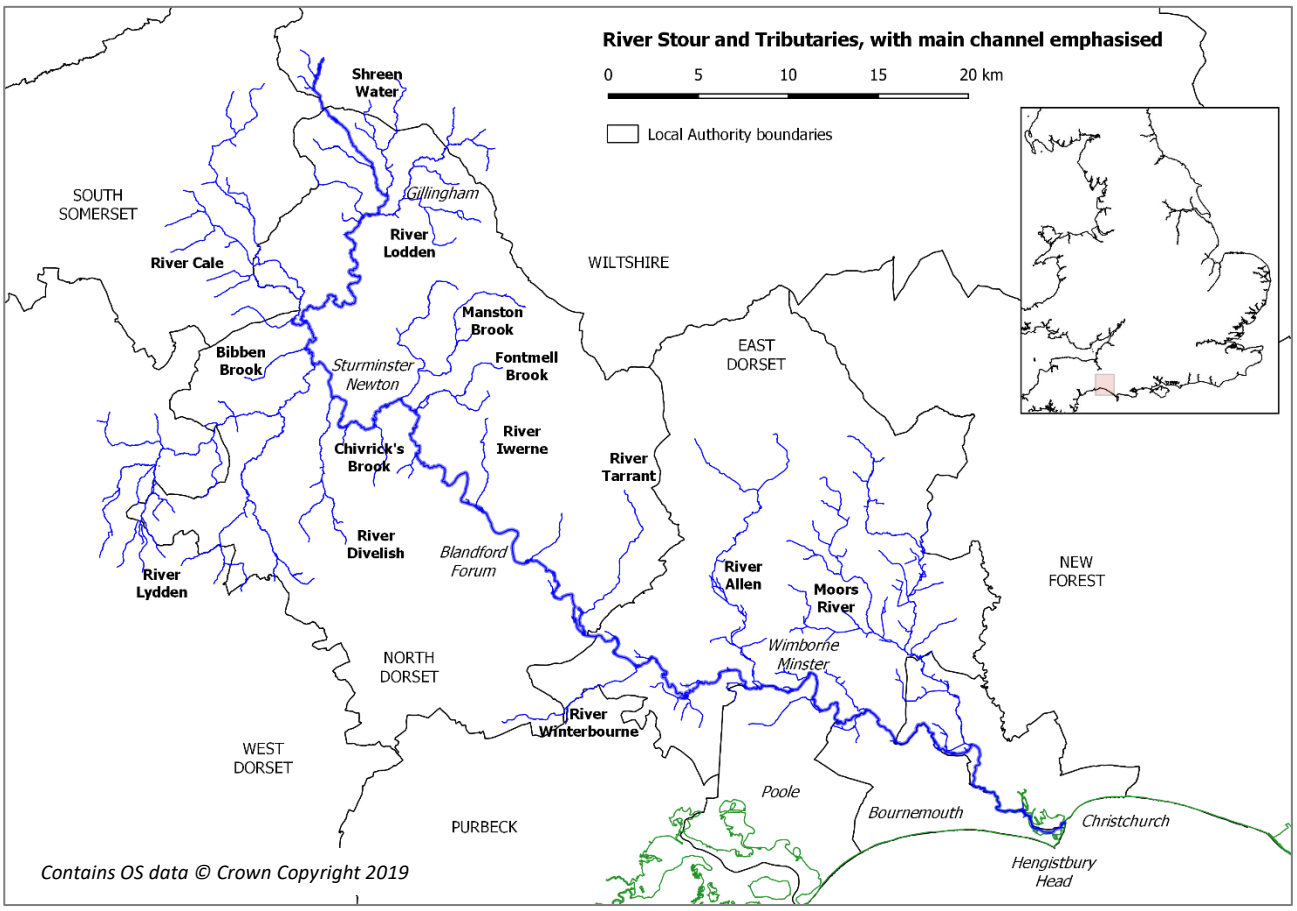

Figure 1: Dorset Stour

1.1.3. The CfP arose from Historic England's broader pursuit of initiatives to support the heritage sector in engaging with Natural Capital and Ecosystem Services methodologies. Natural Capital has been defined as 'the elements of nature that directly and indirectly produce value or benefits to people, including ecosystems, species, freshwater, land, minerals, the air and oceans, as well as natural

processes and functions' (Natural Capital Committee, 2014). The term Ecosystem Services covers similar ground, referring to the benefits that people receive from ecosystems (Alcamo et al., 2003, p. 3). Sometimes a distinction is drawn between services that arise from ecosystems, i.e. living biological systems (biotic); and services that arise from non-living facets of the environment such as geology, air and water (abiotic). In this report, Ecosystem Services are understood to include both biotic and abiotic services. These definitions and their implications for heritage are discussed at greater length below.

1.1.4. The suite of case studies developed for Historic England's Heritage, Natural Capital and Ecosystem Services (HNCES) programme is intended to establish and illustrate how the historic environment might be accommodated within Natural Capital / Ecosystem Services approaches. In turn, the case studies are expected to inform the development of guidance or a handbook on best practice. Historic England's aim and objectives in commissioning the case studies is reflected in the project aims and objectives set out below.

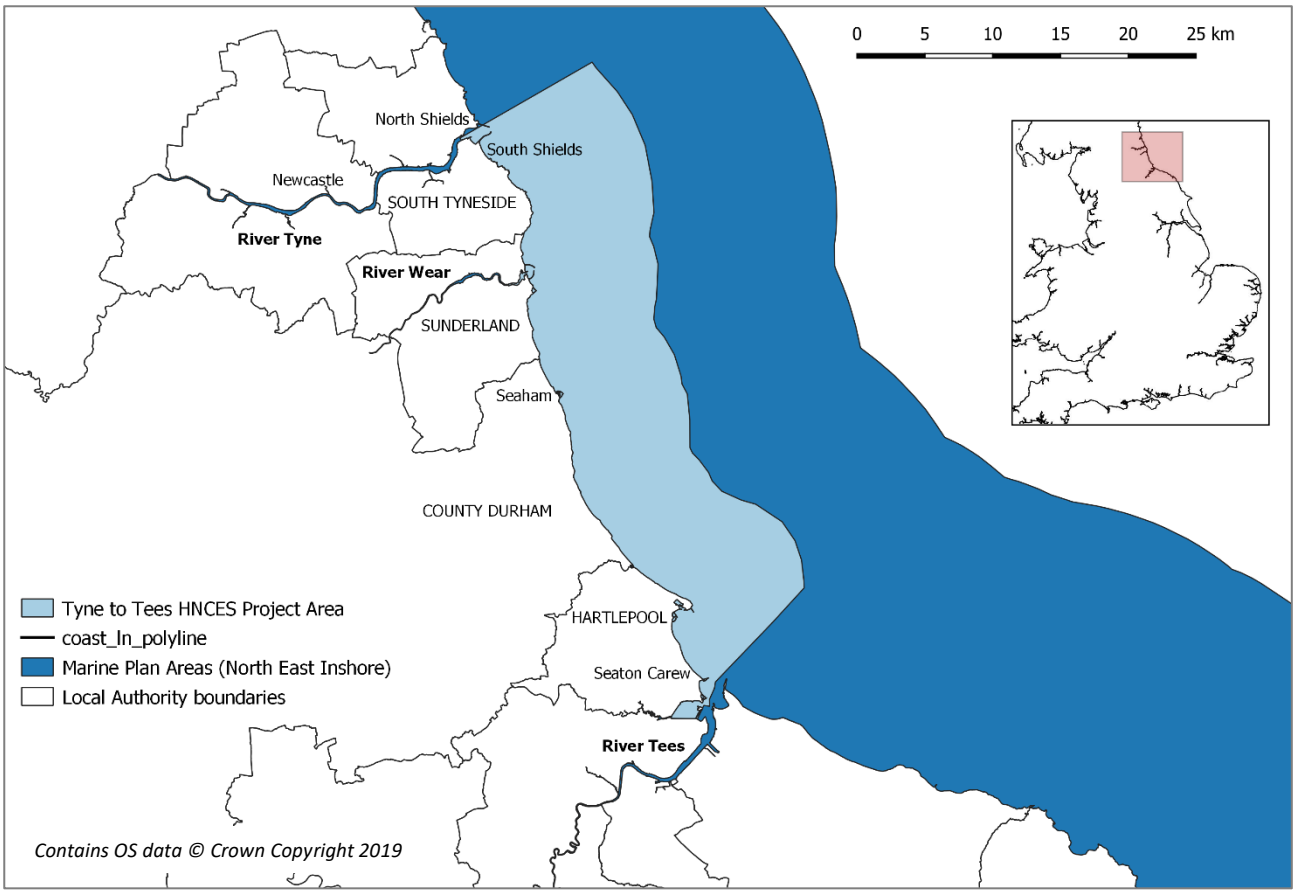

Figure 2: Tyne to Tees marine area

1.1.5. As the CfP explained, there is a need for greater integration of heritage within Natural Capital and Ecosystem Services approaches because such approaches have become very influential in policy-making and implementation in environmental management, both in the public and private sector (see Fluck and Holyoak, 2017). Unfortunately, the way in which Natural Capital / Ecosystem Services address the historic environment is not as well developed as it might be. The currently uneasy relation between heritage and Natural Capital / Ecosystem Services is partly attributable to difficulties relating to data and metrics, but also to some fundamental issues in how Natural Capital and Ecosystem Services are conceptualised.

1.1.6. These difficulties become problematic where environmental management decisions are based on Natural Capital / Ecosystem Services approaches that take insufficient note of the historic environment. Such decisions may lead directly or indirectly to damage to heritage assets and loss of significance. Also, decisions intended to increase environmental sustainability that do not take account of the long history of human intervention are likely to be less effective, or to lead to their own unanticipated consequences. Further, the somewhat technical language of Natural Capital and Ecosystem Services may fail to engage the people whose behaviours it is intended to alter,

especially as compared to the language of place and landscape that acknowledge the interaction of people and nature over long time spans. Consequently, greater integration of heritage within the Natural Capital / Ecosystem Services paradigm has the potential to benefit not only heritage assets, but also the overall sustainability and effectiveness of environmental management.

1.1.7. There is an urgency to better integrate heritage within Natural Capital / Ecosystem Services because of the degree to which such approaches are already informing policy-making and implementation. In particular, the UK Government established the Natural Capital Committee (NCC) as an independent advisory committee which helped government to develop its 25 Year Environment Plan (25YEP), launched in January 2018 (HM Government, 2018). The 25YEP is proving to be an influential document to which subsidiary policies, programmes and plans will be expected to accord. The importance of 25YEP is especially great given the major flux around environmental policy, funding and administration arising from BREXIT, including changes to the management of agriculture and fisheries, and to the environmental principles and governance that underpin UK environmental management generally.

1.1.8. Unfortunately, the NCC has a perspective on Natural Capital that is difficult to reconcile with archaeological understandings of the historic environment. In its *Working Paper 1*, the NCC states that 'Natural Capital is distinguished by being available without human intervention of any kind' (Natural Capital Committee, 2014, p. 3) indicating a strong nature-culture dualism in which culture features only as a recipient of nature. The lack of reference to heritage in the NCC's conception of Natural Capital – including in the NCC Natural Capital Workbook (Natural Capital Committee, 2017) and its recommendations on data, metrics and on research – underlines the ahistorical character of the Natural Capital approach.

1.1.9. The 25YEP acknowledges the influence of the NCC and places emphasis on the Natural Capital approach being at the core of environmental policy for the next 25 years: 'our policy choices will be better-informed with a Natural Capital approach' (HM Government, 2018, p. 20). Fortunately (and perhaps paradoxically), 'enhancing heritage' is flagged as a 25-year goal in 25YEP while the draft Agriculture Bill 2017-19 enabled government to give financial assistance for 'managing land or water in a way that maintains, restores or enhances cultural heritage …'[6]. However, the Natural Capital language is such that heritage is by no means fully integrated within the 25YEP, which makes no reference at all to heritage in the Chapter on seas and oceans. This is a key concern in respect of the management of marine areas such as the Tyne to Tees case study addressed here. The two Marine Pioneer projects[7] currently underway in North Devon and Suffolk – which are intended to apply a Natural Capital approach in the marine environment – should give a clearer indication of where heritage might fit, or not. An indicator on heritage is included in a Defra consultation document on how implementation of the 25 YEP might be measured (Department for Environment, Food and Rural Affairs, 2018), but the indicator is framed so narrowly that 'success' would disregard almost all of the historic environment. A more thorough articulation of the relationship between heritage and policies driven by the Natural Capital approach could not be more pressing.

1.1.10. Fjordr has addressed the background to Natural Capital / Ecosystem Services and the issues they raise for heritage in previous work for Historic England and others (Firth, 2015a, 2016). Fjordr also presented a paper on Ecosystem Services and the marine historic environment at Historic England's seminar *The Historic Environment and Ecosystem Services: linking issues and research* in June 2016. Fjordr's work on Natural Capital / Ecosystem Services has been carried out in the context of long-term experience of seeking to better integrate the historic environment within management frameworks more attuned to the natural environment, especially in the marine sphere (Firth, 2013; Salmon et al., 2017). The case studies selected by Fjordr also reflect previous work both on the archaeology of the north east coast (Firth, 2017, 2014a; Firth and Rowe, 2016) and on the heritage assets of inland waters (Firth, 2014b, 2015b), including the Dorset Stour.

[6] https://services.parliament.uk/bills/2017-19/agriculture.html

[7] https://www.gov.uk/government/publications/marine-pioneer

1.2. Project Aim, Objectives and Products

1.2.1. The aim of this project is to protect the historic environment within future environmental policy by engaging with Natural Capital and Ecosystem Services methodologies. Specifically, the Dorset Stour case study shows how heritage assets associated with water meadows and other water management features can be better included within these methodologies; whereas the Tyne to Tees case study does the same for heritage assets in marine areas.

1.2.2. The objectives of the case studies are as follows:

To identify heritage assets alongside the Natural Capital associated with the case study areas and to outline the relationship between cultural and Natural Capital.

To set out, in the language of Ecosystem Services, the contribution of heritage assets associated with the Dorset Stour and Tyne to Tees marine area.

To identify other values arising from heritage assets that fall outside the Ecosystem Services framework.

To develop a methodology that can be used to ensure that services arising from heritage assets are reflected in a manner compatible with Natural Capital / Ecosystem Services.

To provide the heritage and natural environment sectors with case studies applicable to freshwater and marine environments.

1.2.3. The report has three substantive sections following this introduction. Section 2 looks at the concepts associated with Natural Capital and Ecosystem Services, including their shortcomings with respect to heritage. The relationship between culture/heritage and Natural Capital and Ecosystem Services is elaborated, and a re-worked logic chain – based on a logic chain developed by Natural England – is set out. This section provides five headings for the relationship between heritage and Natural Capital / Ecosystem Services, which is used as a template for the two case studies in Section 3 and Section 4. Conclusions and recommendations are set out in Section 5.

2. Integrating Heritage in Natural Capital and Ecosystem Services approaches: a methodology

2.1. Categorisation of Natural Capital / Ecosystem Services

2.1.1. Ecosystem Services and Natural Capital approaches have been developing for several decades and are still developing rapidly. The conceptual framework developed for the Millennium Ecosystem Assessment provided particular impetus, centred on Ecosystem Services set out under four headings, as follows (Alcamo et al., 2003):

Provisioning	Food
	Fresh water
	Wood and Fibre
	Fuel
Regulating	Climate regulation
	Flood regulation
	Disease regulation
	Water purification
Cultural	Aesthetic
	Spiritual
	Educational
	Recreational
Supporting	Nutrient cycling
	Soil formation
	Primary production

Table 1: Ecosystem Services in MEA

2.1.2. The MEA framework continues to lie at the heart of subsequent elaborations, and was at the core of the UK National Ecosystem Assessment (UK National Ecosystem Assessment, 2011), which is itself a central point of reference both conceptually and in terms of its findings.

2.1.3. Natural Capital approaches seek to identify and place a monetary value on the assets that give rise to Ecosystem Services, including services arising from non-living (abiotic) components of the environment. In a UK context, the role of the Government's Natural Capital Committee (NCC) has been especially influential in developing terminology. In the NCC's terminology, Stocks (assets – i.e. Natural Capital) give rise to Ecosystem Services which, with other capital inputs, produce Goods that provide Benefits that can be Valued:

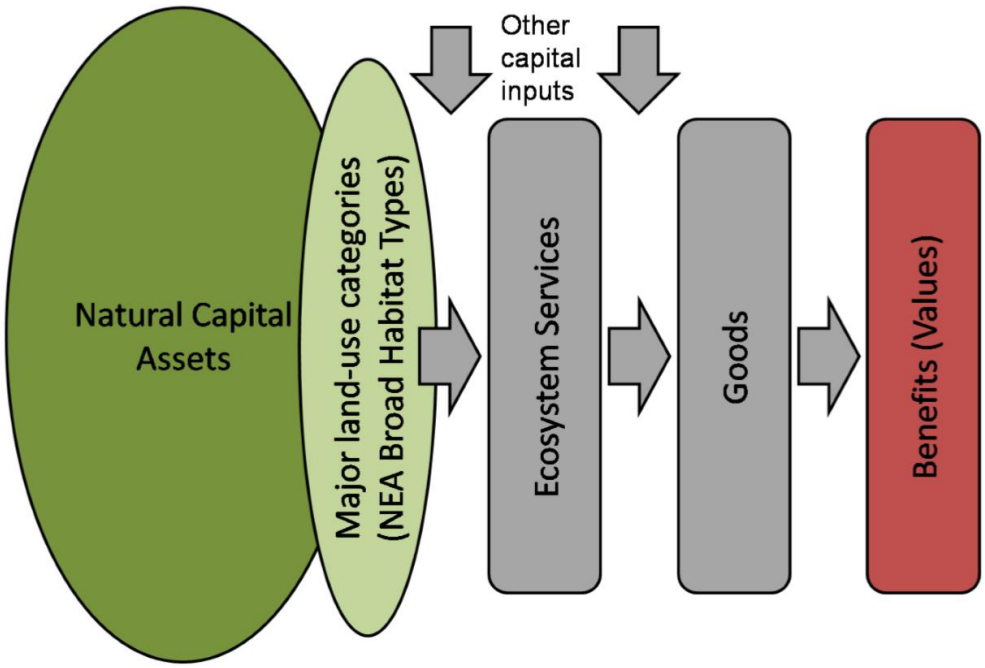

Figure 3: Relationship between concepts in NCC approach (Natural Capital Committee, 2014, p. 7)

2.1.4. Drawing directly on the UK NEA, the NCC adopted Broad Habitat Types – which are themselves already established in UK and European habitat classification systems – as the principle land-use categories to be used in identifying Natural Capital. The NCC identified Assets, Land-use (broad habitat type) and Benefits, to which metrics could be applied, as follows:

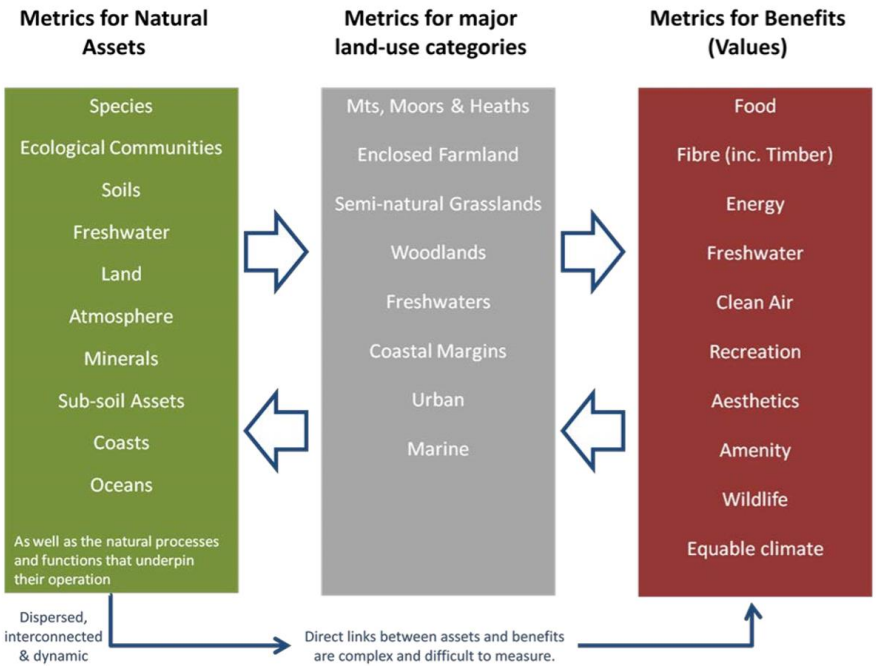

Figure 4: Metrics for NCC approach (Natural Capital Committee, 2014, p. 11)

2.1.5. It is worth noting the close relationship between conceptual development and the capacity to apply metrics, preferably by adopting quantifications. There is a particularly strong relationship between Natural Capital / Ecosystem Services and spatial quantifications, as reflected in the adoption of existing habitat classification systems that are amenable to two-dimensional GIS mapping from which quantifications of area can be derived. It is also worth noting that Natural Capital / Ecosystem Services approaches operate at high levels of generalisation, again evident in the use of Broad Habitat Types such as 'Woodlands', 'Freshwater' and 'Marine' at the core of both conceptualisation and measurement. This in turn implies a high degree of homogeneity within these categories: one bit of woodland is the same as another for the purposes of Natural Capital accounting.

2.1.6. The degree to which generalisation, homogeneity and two-dimensional extent are built in to Natural Capital / Ecosystem Services approaches is important to note, because methodologically it can create problems for heritage. Although often complex in three dimensions, heritage assets are usually quite small in area, they are heterogenous, and their contributions are often highly specific to their location. Approaches to heritage that address the history of human influence extensively and using generalised categories – such as Historic Landscape Characterisation (HLC) – are not designed to capture the specificities that are so central to heritage and cannot be used in isolation from site-specific approaches. The in-built methodological predilections of Natural Capital / Ecosystem Services towards extensive, homogenised 2D areas are problematic for integrating heritage even if conceptual difficulties – discussed below – can be overcome.

2.1.7. To a degree, greater specificity in Natural Capital / Ecosystem Services approaches is made possible through the Common International Classification of Ecosystem Services (CICES) (Haines-Young and Potschin, 2018). As the name suggests, CICES has arisen to provide a common standard for the classification of Ecosystem Services and is still under development; the version of CICES at time of writing is V5.1. CICES refers to the primary headings for Ecosystem Services as Sections, which are sub-divided into Divisions, Groups and Classes. Although originally concerned with services arising from living processes (i.e. ecosystems / biota), CICES has been broadened to also cover services arising from abiotic (non-living) components of the environment. CICES V5.1 is summarised in the table below (provision for optional 'other' services omitted):

Section	Division	Group	No of Classes	Classes
Provisioning (biotic)	Biomass	Cultivated terrestrial plants	3	Nutritional / fibres / energy
		Cultivated aquatic plants	3	Nutritional / fibres / energy
		Reared animals	3	Nutritional / fibres / energy
		Reared aquatic animals	3	Nutritional / fibres / energy
		Wild plants	3	Nutritional / fibres / energy
		Wild animals	3	Nutritional / fibres / energy
	Genetic material	Plants, algae, fungi	3	Maintaining or establishing / breeding / design & construction
		Animals	2	Maintaining or establishing / breeding
		Organisms	1	Design & construction
Provisioning (abiotic)	Water	Surface water	4	Drinking / non-drinking / energy
		Ground water	3	Drinking / non-drinking / energy
		Other aqueous ecosystem outputs	1	Energy
	Non-aqueous natural abiotic ecosystem outputs	Mineral substances	3	Nutrition / material / energy
		Non-mineral substances	5	Nutrition / material / energy
Regulation & Maintenance (biotic)	Transformation	Mediation of wastes or toxic substances	2	Bio-remediation / filtration
		Mediation of nuisances	3	Reduction / attenuation / screening
	Regulation	Regulation of baseline flows & extreme events	5	Control / buffering / protection
		Lifecycle maintenance	3	Pollination / dispersal / nursery
		Pest & disease control	2	
		Regulation of soil quality	2	Weathering / decomposition
		Water conditions	2	Freshwater / saltwater
		Atmospheric composition & conditions	2	Chemical / temperature / humidity
Regulation & Maintenance (abiotic)	Transformation	Mediation of waste, toxics & other nuisances	2	Dilution / mediation
		Mediation of nuisances	1	
	Regulation	Regulation of baseline flows	3	Mass / liquid / gaseous
		Maintenance of physical, chemical, abiotic conditions	1	
Cultural (biotic)	Direct in situ & outdoor interactions	Physical & experiential interactions with natural environment	2	Active or immersive / passive or observational
		Intellectual & representative interactions with natural environment	4	Creation of traditional ecological knowledge / education & training / culture or heritage / aesthetic

Section	Division	Group	No of Classes	Classes
	Indirect, remote & indoor interactions	Spiritual, symbolic & other interactions with natural environment	3	Symbolic / sacred or religious / entertainment or representation
		Other biotic characteristics that have a non-use value	2	Existence value / option or bequest value
Cultural (abiotic)	Direct in situ & outdoor interactions	Physical & experiential interactions with natural abiotic components of the environment	1	Active or passive physical and experiential
		Intellectual & representative interactions with abiotic components of the natural environment	1	Intellectual
	Indirect, remote & indoor interactions	Spiritual, symbolic & other interactions with the abiotic components of the natural environment	1	Spiritual, symbolic and other
		Other abiotic characteristics that have a non-use value	1	Existence, option or bequest value

Table 2: Ecosystem Services in CICES

2.1.8. CICES does not include supporting ES – as per the original MEA classification – because the focus of CICES is the 'final' Ecosystem Services that most directly benefit people, rather than the basic ecological structures and process on which final services depend. However, CICES also acknowledges that the identification of final services is context dependent (Haines-Young and Potschin, 2018, p. 4).

2.1.9. Previous versions of CICES focussed on biotic services – i.e. Ecosystem Services in the narrow sense of services arising from living things – whereas V5.1 of CICES has more fully integrated abiotic services. Furthermore, CICES V5.1 expressly distinguishes the 'ecological clause' of each service from the 'use clause', where the use clause reflects the human interaction through which the service arises, and the ecological clause is the propensity of the environment to render the service. Hence the ecological clause points towards the aspect of the environment that serves as a stock or asset, and the use clause towards the service. By including both biotic and abiotic services, and by distinguishing the propensity to render a service from the realisation of the service, CICES V5.1 can be quite readily assimilated with Natural Capital approaches and provides a relatively fine-grained categorisation.

2.1.10. Nonetheless, CICES V5.1 is still quite broad and can be expected to be further refined; it also exhibits the shortcoming of the unidirectional nature-culture dualism embedded within the Natural Capital / Ecosystem Services paradigm even though it includes various cultural Ecosystem Services within the categorisation. Heritage appears within CICES V5.1 as Class 3.1.2.3, defined as 'characteristics of living systems that are resonant in terms of culture or heritage' in the Group 'Intellectual and representative interactions with natural environment'. It is, however, only the *natural environment* and the characteristics of *living systems* that may be resonant in terms of heritage; human activity – culture itself – is not recognised as a category of service in CICES. This shortcoming, and other aspects of CICES that demonstrate the poor approach to culture embedded in Natural Capital / Ecosystem Services approaches, are discussed below.

2.1.11. Natural England has recently developed a 'logic chain' to help identify indicators for measuring change in Natural Capital (Lusardi et al., 2018). The logic chain distinguishes Assets, Services,

Benefits and Value. Importantly, recognition that benefits are to some extent dependent on subjective individual perspectives – a point made strongly in the 'further work' of the UK NEA (Church et al., 2014) – prompted a corresponding elaboration of the logic chain for cultural ES:

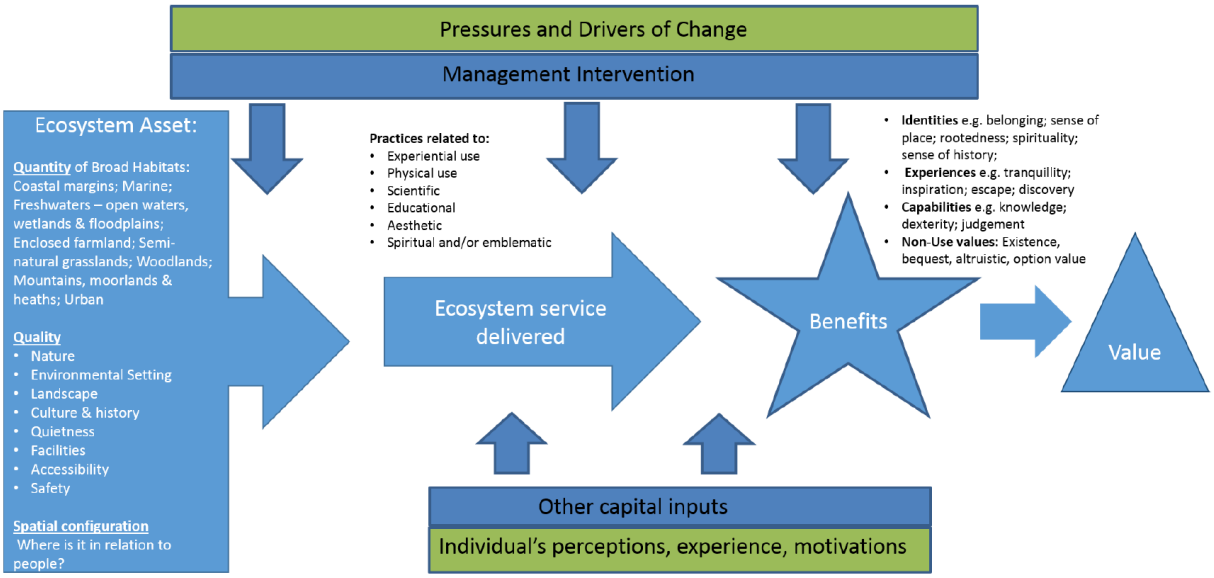

Figure 5: Natural England logic chain for cultural ES (Lusardi et al., 2018, p. 8)

2.1.12. The logic chain exhibits some of the same issues with Natural Capital / Ecosystem services approaches: the chain is one way, from nature to culture; people are seemingly passive, bringing nothing to the service besides 'other capital inputs'; and there is no sense that the chain has a history in which today's ecosystem assets are in part a product of previous human interventions. The clarity with which the chain is laid out, however, is a useful stepping-off point for a model in which heritage is better integrated.

2.2. People and Ecosystems

Introduction

2.2.1. It is axiomatic that the physical environment is changing. These changes have negative impacts on people's lives and are themselves attributable to people's actions; people must change the way in which they act if the effects upon them of the changing environment are to be alleviated. It is equally axiomatic that there are direct links between changes and impacts globally and changes and impacts at the level of the individual, and every social level in between. The need for people to change the way they behave, individually and globally, is urgent.

2.2.2. Natural Capital and Ecosystem Services are approaches to achieving behavioural change by people. They are ways of framing the relationship between people and the physical environment: making connections explicit; underlining causality and human responsibility; and incentivising – through monetary values – necessary changes in behaviour. Such approaches have been introduced because current dominant modes of addressing the relationship between people and their surroundings – economic, political and social – have failed.

2.2.3. The degree to which Natural Capital / Ecosystem Services are expressly designed to cause people to change is important. These approaches are instrumental; they are useful tools, not an attempt to better represent or explain reality. Their value rests on their effectiveness in achieving the changes to people's behaviour that are being sought.

2.2.4. Although they are instrumental, the Natural Capital / Ecosystem Services paradigm is not bound to work. As already indicated, they have a number of weaknesses from a heritage perspective and a range of critiques have been directed towards them generally (see Schröter et al., 2014; Kenter, 2018). Weaknesses in dealing with culture and heritage are likely to detract from the effectiveness

of Natural Capital / Ecosystem Services in motivating change in people's behaviour. Archaeology 'fits' therefore, in a wider and growing movement to address expressly the role of people in delivering positive environmental change (for examples relating to freshwater and marine environments, see Brennan, 2018; Burdon et al., 2018; Gee et al., 2017; Guerrero et al., 2018; Kenter, 2018; Kondolf and Pinto, 2017; see e.g. Köpsel and Walsh, 2018; Wohl et al., 2015). This is sometimes referred as the 'human dimension', addressed through environmental humanities and, for example, marine social science[8].

2.2.5. In view of their influence in policy despite evident weaknesses, a better accommodation of culture and heritage within Natural Capital / Ecosystem Services approaches is extremely pressing. In the following paragraphs, five different dimensions to the relationship between heritage and Natural Capital / Ecosystem Services are set out, as a precursor to the framework used in addressing the two case studies.

First dimension

2.2.6. Both Natural Capital and Ecosystem Services approaches are highly anthropocentric in that they are concerned only with the benefits of nature to people. Other benefits of nature are acknowledged – sometimes referred to as 'intrinsic' and not reduceable to human interests – but the core of the Natural Capital / Ecosystem Services paradigm is centred on humans. The weakness of these approaches in dealing with culture is, therefore, paradoxical. All Natural Capital and all Ecosystem Services are cultural because they pertain to people: this is the **first dimension** in which culture and Natural Capital / Ecosystem Services are integral to each other. Even for those physical elements of the environment that are fundamental to human life – air, water, food, shelter – people make choices about how they satisfy these needs and what characteristics they will tolerate, favour or bring about. People's choices about these fundamentals are often constitutive of what we regard as culture; and how people conceive of and behave towards the environment can vary over time.

Second dimension

2.2.7. Natural Capital and Ecosystem Services approaches concern themselves with the value that people place on the physical environment. In particular, they seek to translate the importance of the environment into economic values where such economic valuation is absent because 'without an economic price, it has too often been assumed to be of zero value' (Natural Capital Committee, 2013, p. 4). Irrespective of how it is framed, economic value is a consequence of choices by people about how much they are prepared to give or take in exchange. Valuation is, therefore, a **second dimension** in which all Natural Capital and all Ecosystem Services are cultural.

2.2.8. In both the first and second dimensions, a key consideration for Natural Capital and Ecosystem Services – given that they are cultural in terms of how people engage with and value them – is that culture is inconstant, mutable, contingent, constructed. In short, the benefits that people obtain from the environment and the way in which they are valued are not fixed; they depend on what people themselves bring to their physical environment. Individual interactions of people and their environments are specific to themselves, to their time and to their place. When individual interactions are multiplied, however, patterning may be apparent. This patterning may be enough to identify a generalised service and generalised value, but the capacity to identify gross patterns between people and the physical environment should not be mistaken as an attribute of the environment itself. Ecosystem Services are best understood as an interaction between people and their environment, where Natural Capital is the propensity of the environment for human interaction to take place (without the anticipation of human use it is not capital); and the human contribution to the transaction gives rise a service being obtained. Neither Ecosystem Services nor Natural Capital have an existence independent of culture. Nonetheless, Natural Capital / Ecosystem Services approaches seem to have given far more attention to the characteristics of the physical environment than they have to their cultural concomitants.

2.2.9. It is perhaps worth underlining that the ubiquity of cultural components in each interaction that give rise to an Ecosystem Services does not undermine the existence of natural processes. There

[8] https://www.marsocsci.net/

are physical, chemical and biological processes in the environment that occur independently of people and to which people are themselves subject. Natural processes are invoked by Ecosystem Services but if their benefit is (by definition) to people then they are inescapably combined with processes that are cultural. This sense of inescapable combination of culture and nature can be captured by paraphrasing the definition of 'landscape' – in Article 1 of the European Landscape Convention 2000[9] – as having character that is the result of the action and interaction of natural and human factors. Of course, natural processes continue to apply after an Ecosystem Service has been obtained, so the attributes of the physical environment that gave rise to a service may change, altering or even removing its capacity to render the same Ecosystem Service in future.

2.2.10. The fundamental pervasiveness of culture to Natural Capital / Ecosystem Services approaches has been obscured because a subset of services is expressly categorised as 'cultural'. Moreover, in most formulations, cultural ES are regarded as solely the benefits that people receive from the physical environment, as if culture is only ever a passive response. In other formulations, cultural ES seem also to encompass benefits that are at least partly attributable to people's own contribution to the physical environment. Reconciling these varying categorisations with the view taken here that all Natural Capital and Ecosystem Services have important cultural dimensions is problematic and warrants elaboration.

2.2.11. As noted, the services that people obtain from the physical environment arise from interaction. Each interaction between people and the environment has both a physical and an intellectual component. This intellectual component is most apparent in accounts of cultural ES as conceived in Natural Capital / Ecosystem Services approaches, described as nonmaterial benefits such as spiritual enrichment, cognitive development, reflection, recreation, and aesthetic experience (Alcamo et al., 2003, p. 29). Plainly, these benefits are not some kind of mystical radiation from the physical environment itself; they depend heavily on what people bring to the environment intellectually – as preferences, beliefs, traditions, scientific understandings and so on – according to their own cultural proclivities. To reiterate the earlier point, an intellectual component is to be found when people obtain any type of service from the physical environment, not just cultural ES.

Third dimension

2.2.12. It is also plain that people often bring something physical and material – as well as intellectual – to their interaction with the environment. As well as nonmaterial benefits, cultural ES obtained from the environment are manifest in tangible art such as paintings, sculpture and crafts. But as well as making material alterations to relatively small elements of their physical surroundings, people can also change their physical environment on very large scales in order to give rise to the benefits they seek. Again, this propensity to re-shape the environment is not limited to cultural ES, it applies to all types of service.

2.2.13. People's physical changes to the environment may be highly transitory, but they can also be persistent. Such material changes become part of the physical environment from which they and others seek benefits in the future. Consequently, Ecosystem Services can be obtained from a physical environment that is at least in part a product of human action.

2.2.14. It should also be borne in mind that even where people do not re-shape the environment physically, they may re-shape it intellectually, altering the services that are obtained by according the place a different status, whether highly prized or taboo. Again, intellectual alteration of the physical world – changing people's behaviours and thereby the Natural Capital and Ecosystem Services that arise – occurs on different scales. Identifying a place as being owned by one person or another is just one way that the physical world can be changed by an abstract boundary on a map, affecting how people act towards the place and the services they obtain. At much larger scales, political boundaries between regions or countries are an intellectual re-shaping of the physical environment that can have profound implications.

2.2.15. This reshaping of the physical environment materially and intellectually, such that it changes the services that can be obtained, is clearly seen in respect of cultural ES. Many places are highly valued for the aesthetic, inspirational or spiritual benefits to which they give rise because of the

[9] https://www.coe.int/en/web/conventions/full-list/-/conventions/rms/0900001680080621

way those places have been shaped by people in the past. In fact, the cultural ES arising from the re-shaped environment are often so strong that they form a major component of the valuation of Natural Capital or Ecosystem Services (see case studies, below, for examples). As noted, however, people's shaping of their environment has not been limited to obtaining cultural ES: the physical manipulation of the environment to provide benefits encompasses provisioning, regulating and supporting ES also.

2.2.16. The manner and extent to which people re-shape their environment is often intentional, in order to gain more or different benefits, or to prevent dis-benefits either for themselves or for others. People's re-shaping of the physical environment can also have unintended consequences on small but also vast scales. Whether intended or unintended, it is this physically re-shaped environment that gives rise to services today. The pervasive re-shaping of the physical environment by people is **third dimension** in which we must acknowledge that many Natural Capital assets and Ecosystem Services are cultural: the physical characteristics of the environment from which we obtain services are often a consequence of past human activity, even though those characteristics may have since been subject to natural processes. Whilst the services obtained from a humanly-modified environment may often be positive, this is not always the case. Negative consequences affect some of the largest and most remote elements of the environment, demonstrated by the presence of plastics in distant oceans and growing understanding that global climate is itself as an artefact. Indeed, Natural Capital / Ecosystem Services are a response to the critical degree to which people have shaped the environment up to the present; yet these approaches seem ill-equipped to account for how the environment has been shaped by people over time.

2.2.17. The intellectual component that people bring to their interaction with more or less humanly-modified environments warrants emphasis. People's physical modifications to the environment often frame future interactions: building a wall changes access, for example. However, physical modifications do not entirely determine future services, and historic re-shaping of the environment to obtain one service may be co-opted in obtaining different services subsequently. For example, the countryside may give rise to cultural ES today because of its aesthetics, even though those aesthetic services arose solely from efforts to maintain provisioning or regulating ES from the landscape in the past.

2.2.18. The degree to which the physical environment escapes its origins may be important in seeking to obtain services from the environment that are different to those that shaped it. For example, it may be difficult to maintain a landscape that is valued for its aesthetic services where provisioning or regulating services arise through completely different ways to those that gave rise to its aesthetic qualities. Under-acknowledgement of the pervasive and persistent contribution of culture in Natural Capital / Ecosystem Services approaches often seems to obscure the past role of people in creating environments that are a focus for practical decisions today. For example, action to manipulate the regulating service of flood prevention in a catchment may be severely compromised if decisions are rooted in an approach that is acultural and ahistorical.

Fourth dimension

2.2.19. If it can contribute to people's understanding and appreciation of the past, the humanly modified environment is regarded as tangible cultural heritage. Heritage can vary in scale from microscopic palaeo-environmental remains to entire landscapes. The contribution that heritage makes to people's understanding and appreciation is itself a service. Even though such services might arise predominantly from its cultural context rather than be regarded as an Ecosystem Service, it is still advantageous to frame heritage within the Ecosystem Services / Natural Capital approach. Heritage situated within the wider environment is subject to natural processes, and the services to which it gives rise can be regarded as an interaction that has both natural and cultural components. As such, heritage can give rise to Ecosystem Services – including provisioning, regulating and supporting ES – in addition to cultural ES. The capacity of heritage to give rise to Ecosystem Services / Natural Capital by virtue of their physical characteristics is a **fourth dimension** to the relationship.

Fifth dimension

2.2.20. It is a concern that the presence and value of heritage could be overlooked in decision-making in Natural Capital / Ecosystem Services approaches, in which consideration for heritage is ambiguous. However, heritage is recognised for its benefits to people entirely outside the Natural Capital / Ecosystem Services paradigm; there are approaches to recognising and safeguarding the benefits of heritage, supported by law, policy and administration nationally and internationally that are independent of – and no less legitimate than – Natural Capital / Ecosystem Services. To some extent, the separate rationale that has developed towards protecting heritage over the last 150 years reflects benefits to people of heritage – as Cultural or Social Capital – that may not be captured by Natural Capital or Ecosystem Services approaches. Whilst there are advantages to addressing heritage within Natural Capital or Ecosystem Services approaches, failure to do so does not mean that those approaches can ignore the public interest in heritage values, or the separate mechanisms that have developed to protect them. Acknowledging heritage within Natural Capital or Ecosystem Services approaches, even if heritage is not part of those approaches, is a **fifth dimension** of the relationship.

2.3. A framework for Heritage, Natural Capital and Ecosystem Services

2.3.1. From the above it can be seen that the relationship between cultural heritage and Natural Capital / Ecosystem Services has several different dimensions. The cultural components of Natural Capital and Ecosystem Services are not fixed, nor are they limited to cultural ES. It is important to recognise that Ecosystem Services arise from an interaction, and that this interaction can reshape the environment physically and intellectually. Material changes to the environment – including those arising from human action – form the physical environment from which Ecosystem Services are obtained subsequently. Cultural heritage is a facet of this re-shaped environment that is valued by the public, which it is advantageous to consider within Natural Capital / Ecosystem Services approaches. However, heritage also has a value outside the Natural Capital / Ecosystem Services paradigm that must be acknowledged by these approaches even if it is not integrated.

2.3.2. The five different dimensions of the relationship between heritage and Natural Capital can be summarised as follows:

Dimension
• Natural Capital and Ecosystem Services always have a cultural component because they arise from interaction by people with the environment.
• Natural Capital and Ecosystem Services also always have a cultural component because their valuation is by people.
• Natural Capital and Ecosystem Services often have a cultural component because they have been shaped – physically and/or intellectually – by people in a way that affects interactions.
• Heritage also gives rise to (non-cultural) Natural Capital and Ecosystem Services because it forms part of the physical environment.
• Heritage forms part of the physical environment with which people interact to obtain services even if heritage is not recognised within the Natural Capital / Ecosystem Services paradigm.

2.3.3. Drawing from this summary, better integration of heritage within Natural Capital / Ecosystem Services approaches can be pursued on several different levels:

Domain	**Heading**
• Raising awareness of and protecting heritage irrespective of Natural Capital / Ecosystem Services approaches	The importance of heritage in the case study area
• Identifying where heritage – as part of the physical environment – gives rise to Natural Capital / Ecosystem Services	Heritage as Natural Capital / Ecosystem Services

• Explaining how the capacity of today's physical environment to give rise to Natural Capital / Ecosystem Services has been shaped by human interactions in the past	How people have shaped the environment
• Understanding how Natural Capital / Ecosystem Services are valued	How Natural Capital / Ecosystem Services are valued
• Providing a medium in which to discuss how relationships between people and their physical environment were different in the past and to raise the possibility that human-environment relations might be different in future	The relationship between people and the environment

2.3.4. These different domains and their headings provide the template used in the case studies on the Dorset Stour and Tyne to Tees marine area, below.

The importance of heritage in the case study areas

2.3.5. As noted above, any weakness in the provision for heritage within Natural Capital or Ecosystem Services approaches does not diminish the need for those approaches to take account of heritage that may be affected by the decisions to which they give rise. Heritage is safeguarded to varying extents by law, policy and administrative measures with which Natural Capital / Ecosystem Services approaches must comply. The provision for heritage in law and policy is a measure of the support by society for its protection; but public support for heritage is not bounded by these frameworks. The strength of public interest in ensuring that a locally important heritage site is not compromised by decisions arising from a Natural Capital / Ecosystem Services approach could be even greater than implied by scheduling or listing.

2.3.6. The case studies underscore the need for Natural Capital / Ecosystem Services approaches to take account of heritage by flagging the specific legal and policy provisions that these approaches need to take into account, including provisions for designated assets, non-designated assets and the potential for assets that have not yet been discovered.

Heritage as Natural Capital / Ecosystem Services

2.3.7. Heritage forms part of the environment that gives rise to Ecosystem Services or Natural Capital. A large part of these services arises from the characteristics of heritage 'as heritage'. For the purposes of this study, the services of heritage as heritage as regarded as cultural ES, adopting a broader scope of cultural ES to the approaches that regard cultural ES as only those cultural ES that arise from (acultural) ecosystems.

2.3.8. However, it is also clear that heritage within the environment can also give rise to other Ecosystem Services that are largely independent of its status as heritage. For example, heritage gives rise to various provisioning and regulating ES. These non-cultural ES arising from heritage are also addressed in each case study.

People's role in shaping the environment

2.3.9. Heritage demonstrates how the capacity of today's physical environment to give rise to Natural Capital / Ecosystem Services has been shaped by human interactions in the past. The case studies show how people have manipulated the environment in the course of obtaining Ecosystem Services, often with the intention of increasing or extending the Ecosystem Services they can obtain. Such changes to the environment often persist either because of ongoing cultural practices, or because natural processes have not returned the environment to its prior state.

2.3.10. The consequences of human interventions in the physical environment – and the response of natural processes – are not always deliberate or predictable. The original action towards the environment always contains some degree of human intentionality, even if this seems obscure to modern viewpoints, which is why archaeologists can study the physical traces of human activity in

order to understand past societies. However, the physical consequences of the original intervention may be largely unintentional.

2.3.11. Natural Capital and Ecosystem Services approaches have been developed to recognise Natural Capital / Ecosystem Services in the present in order to change behaviour for the future. However, Natural Capital and Ecosystem Services are also terms that might be applied to the past. The identification of historical Ecosystem Services might be useful as an analytical approach, especially in mapping-out how Ecosystem Services have been obtained over time. Recognising time-depth and change amongst Ecosystem Services helps in considering changes in the physical environment alongside changes in human interventions in the environment and their interplay. Such a conception of people and the environment through time is a good basis for understanding how human-environment relations need to change in future. Addressing historical Ecosystem Services – noting that people and their physical environments have been entwined since the beginning of human time – might be more productive conceptually than seeking a year zero – an identifiable condition predating human intervention – to which an ecosystem should return. Addressing historical ES could help identify periods in which human activities have – intentionally or otherwise – coincided with significant deterioration in ecosystem function, and periods in which Ecosystem Services were sustainable.

2.3.12. Natural Capital and Ecosystem Services are commonly framed only in terms of benefits, as if the physical environment and natural processes are only ever positive for people. In fact, many historic human interventions in the environment have sought to address natural dis-benefits such as fluctuating availability of water and food, exposure to extremes of temperature, and intractable terrains. Natural Capital / Ecosystem Services approaches express some of these dis-benefits in terms of positive regulating ES, such as preventing flooding; but flooding might best be regarded as a natural process that gives rise to dis-benefits (as well as benefits that are obscured by the focus on prevention). As with time-depth, identifying negative as well as positive Ecosystem Services helps broaden recognition of why people have sought to intervene in the environment through time.

2.3.13. The degree to which people have – intentionally or otherwise – affected the physical environment to provide benefits (and avoid dis-benefits) is such that the resulting capital can hardly be categorised as 'Natural', nor can the resulting services be attributed to solely to ecosystems as such. The case studies show how attributes of the environment that benefit us today and might be regarded as natural or as arising from ecosystems are often a consequence of extensive human intervention in the past. Natural Capital / Ecosystem Services approaches are more likely to be effective if they acknowledged the role of past human activity in creating the circumstances in which ES can arise.

Valuing Natural Capital / Ecosystem Services

2.3.14. The question of valuation has two elements: first, the potential application of monetary values to Ecosystem Services arising from heritage, including both cultural ES on one hand and non-cultural (provisioning / regulating) ES on the other; and second, the overall approach of seeking to apply values – monetary or otherwise – to the physical environment when the process of valuing is itself a cultural construct.

2.3.15. The eventual aim of Natural Capital / Ecosystem Services has been to arrive at monetary values that can be incorporated into broader accounting methods and decision-making processes. However, it is frequently acknowledged that economic valuation is technically difficult due to either the complexity of pathways through which the environment generates economic value, or because of lack of data (See e.g. Natural England, 2015). Whilst economic valuation methods remain under development, Natural Capital / Ecosystem Services often focus on other metrics which describe, for example, the extent, status, thresholds, targets etc. of broad land-use types and habitats (e.g. Sunderland et al., 2019).

2.3.16. Noting that economic valuation methods are complex and still under development, the case studies for this project do not seek to develop economic valuation methods for heritage. Nonetheless, the case studies highlight instances where economic value that is already being identified is (partly) attributable to heritage assets (e.g. tourism as a cultural Ecosystem Service). The cases studies

also highlight economic value arising directly from heritage (i.e. not via ecosystems), as is increasingly demonstrated through annual and thematic studies conducted through the Heritage Counts programme[10]. Where pertinent information is available, the case studies supplement examples of valuation with consideration of the wider economic and social benefits arising from heritage.

2.3.17. The second element to valuation in the case studies is concerned with varying values in respect of heritage and, by extension, of the wider environment. Not only do monetary values change – over time and according to people's circumstances – but economic valuation may not capture why, and to what extent, people regard a service as beneficial. Perspectives on valuation informed by heritage, which regard valuation as a cultural activity, can create space to engage with people about what is important to them now and how valuations change through time. Dialogue about valuation may be more effective in altering public behaviour with respect to the environment than equating services with prices.

2.3.18. It is also worth noting Jones' observation that methods commonly used in heritage management to assess the importance of heritage assets are not adept at capturing the social value of heritage (Jones, 2017). Jones defines social value as a collective attachment to place that embodies meanings and values important to the community, encompassing the ways in which the historic environment provides a basis for identity, distinctiveness, belonging and social interaction. She also makes the case for trying to capture the 'fluid processes of *valuing* the historic environment' as well as regarding values as fixed categories that can be defined and measured. This is a key point, as it suggests that the identification of capital or the receipt of a service (whether it be categorised natural or cultural) does not fully encompass the positive experience that people obtain through their dynamic interaction with heritage. 'Valuing heritage' is something that people do in the course of their everyday lives as they enjoy and engage with their historic environment: it is not just a means of quantifying a transaction.

People and the environment

2.3.19. Heritage provides a space in which to address the roots of the current, precarious state of the relationship between people and the physical environment. The time-depth encompassed by heritage spans periods in which human-environment relations were regarded differently, as expressed in more recent centuries in historical documents and for more distant periods by the archaeological record. That is to say, the contribution that heritage makes to understanding environmental change is not only to provide additional data points further back in time that add to our current understanding of human-environment relations; heritage can also show how our current conceptions of the environment are themselves a product of our times. Heritage demonstrates that people in the past embodied relationships with the environment that were fundamentally different to today and, therefore, that people could opt for a different basis for their interaction with the environment in future. This is important because the Natural Capital / Ecosystem Services paradigm might limit the capacity to conceive of alternatives that are, for example, less transactional or market oriented. The case studies consider how consideration of heritage provides an opportunity to discuss the relationship between people and their physical environment in the past, present and future.

HNCES Logic Chain

2.3.20. As noted above, Natural England recently developed a logic chain for identifying Natural Capital indicators (Lusardi et al., 2018). This logic chain can be re-worked to better reflect the integration of heritage that is set out above.

2.3.21. The core of the Natural England logic chain is the relationship between Ecosystem Assets, Ecosystem Services, Benefits and Value, together with inputs of 'Other Capital'. In the NE chain, these are presented in a linear relationship. These same units are at the core of the re-worked chain also:

[10] https://historicengland.org.uk/research/heritage-counts/

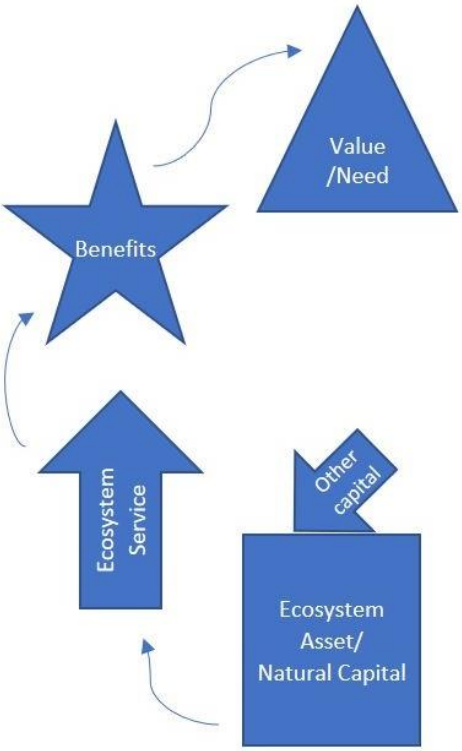

Figure 6: HNCES logic chain - relationship between assets, services, benefits and value/need

2.3.22. The only change here is to recognise that 'Value' can also be regarded as an expression of 'Need' or want: the value that an individual, group or society places on a benefit is equivalent to the degree to which they need or want that benefit.

2.3.23. The role that people play in framing components of the environment as Assets can be represented as Human Intervention: such intervention can be intellectual or non-material to reflect a preference for one component of the environment over another, for example, or the intervention could be physical when the environment is manipulated to create or maintain an asset. Assets are only assets if they are framed as such by people:

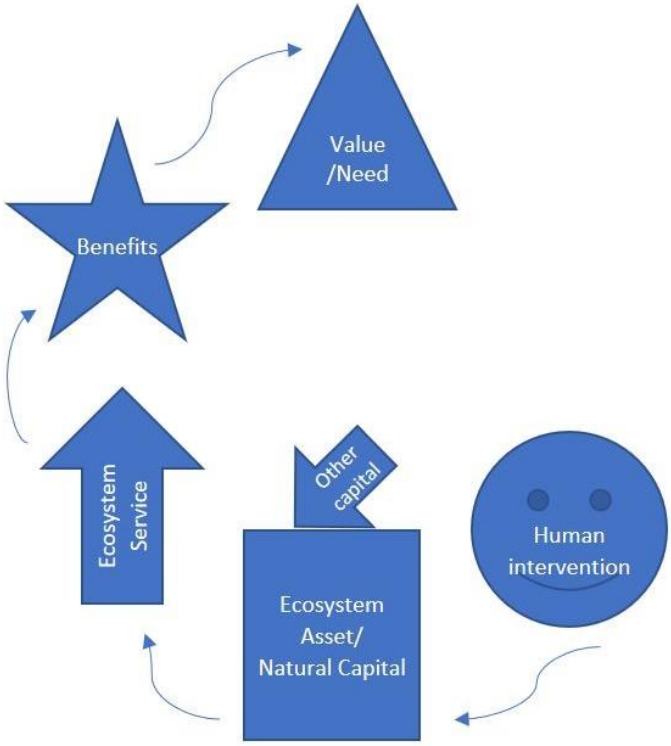

Figure 7: HNCES logic chain - human intervention frames assets

2.3.24. Of course, there is a physical environment external and independent of humans, with features and processes that would function even if humans were not present. This is represented in the re-worked logic chain as 'Environment'.

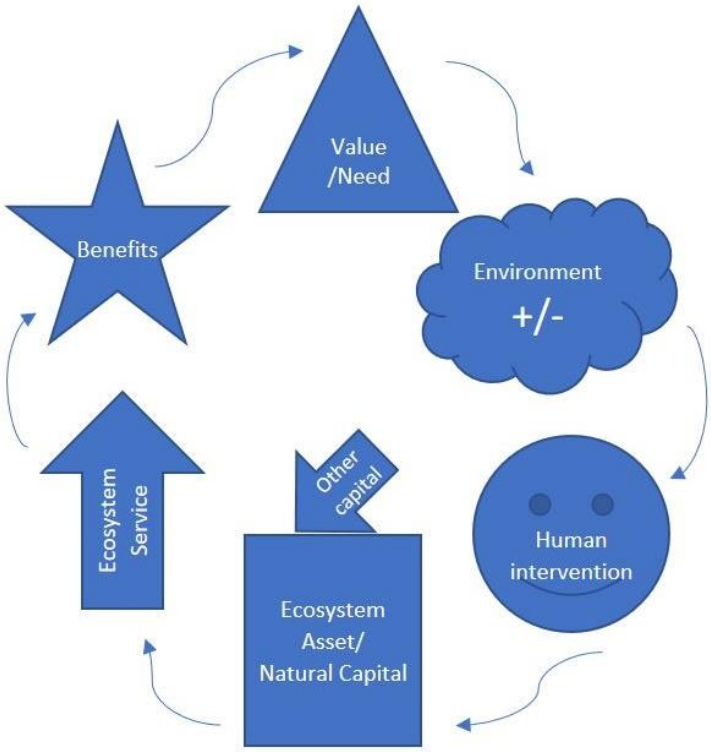

Figure 8: HNCES logic chain - human interventions to address wants and needs are directed towards a physical, external environment

2.3.25. In this logic chain it is important to note that 'Environment' can be negative as well as positive for people, in contrast to Ecosystem Assets which only ever seem to be presented as positives whilst dis-benefits of nature to humans are not represented. It can also be seen in this re-working that Environment is juxtaposed with and linked to Need, the corollary of value; and that the whole chain is circular and generates feedback.

2.3.26. At this point the chain can be summarised as follows: Starting from the top, humans have Needs ranging from the basics of clean air, drinkable water, food and shelter through to the most complex and extravagant. People seek to address these needs and wants in an Environment that is external to them and which can be harmful as well as beneficial. Hence people make Interventions in the environment through preferences and physical activities to reduce harm and discomfort, and to meet the needs they seek. It is at this point that components of the environment – including some which have been physically manipulated by people – can be framed as Ecosystem Assets, to which other forms of capital can be added to obtain Ecosystem Services, which give rise to Benefits that have Value in fulfilling needs. The realisation of certain needs and wants provides a basis – physically and intellectually – for seeking to fulfil others. The chain continues.

2.3.27. The distinction made in this logic chain between Ecosystem Assets – those components of the environment with a propensity to provide services to people – from a wider non-human Environment is important conceptually. It enables clearer recognition of the constructed-ness of Ecosystem Assets, which is implicit in the broad habitat types used to quantify 'Natural' Capital: products of human intervention such as moorland and heath, enclosed farmland, semi-natural grassland, and woodland. Recognition of the Anthropocene as an epoch in which human influence on the environment is pervasive underscores the need to place people explicitly within the logic chain; conceptualising an environment in terms of features independent of people – distanced from Ecosystem Services and Natural Capital – enables this, even though environments untouched by people might be rare, even historically.

2.3.28. However, it is also important to recognise that physical, chemical and biological processes apply to the whole chain: such processes can be influenced and manipulated by people, but they adhere to laws of uniform application independent of humans and can be termed 'natural'. These natural

processes equate to at least some of the pressures and drivers identified in the Natural England logic chain:

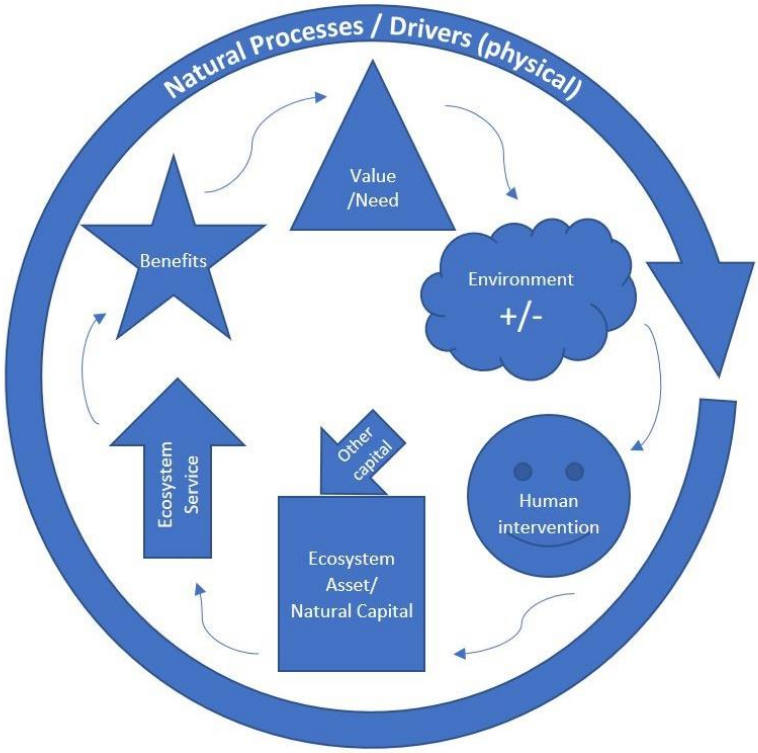

Figure 9: HNCES logic chain - the whole chain is subject to natural processes/drivers

2.3.29. As the Natural England logic chain for cultural ES recognises, the perceptions, experience and motivations of individuals also influence the chain, and can be included within the cultural processes, pressures and drivers that apply alongside natural processes:

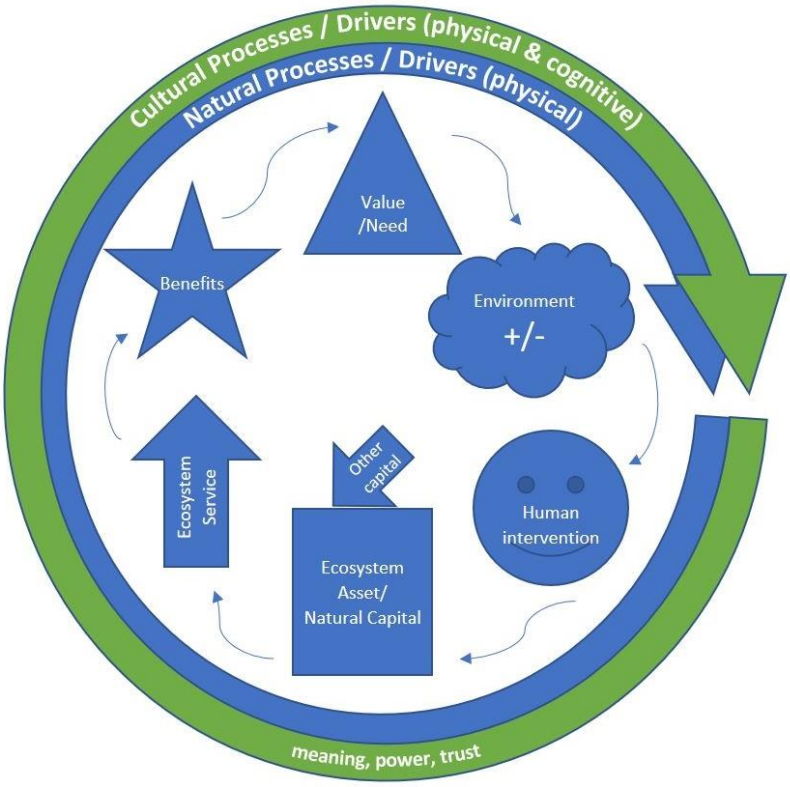

Figure 10: HNCES logic chain - the whole chain is also subject to cultural processes/drivers

2.3.30. Cultural and natural process apply in complex combinations to the whole chain, and to all forms of Ecosystem Service, not just those that are cultural. Unlike natural processes adhering to

independent laws, cultural processes are mutable and embody differentials of meaning, power and trust: cultural processes do not apply equally to all people.

2.3.31. This chain does not repeat on the spot, constantly refreshing: it moves forward in time and has been doing so since people colonised the British Isles following their major re-working by the last major glaciation:

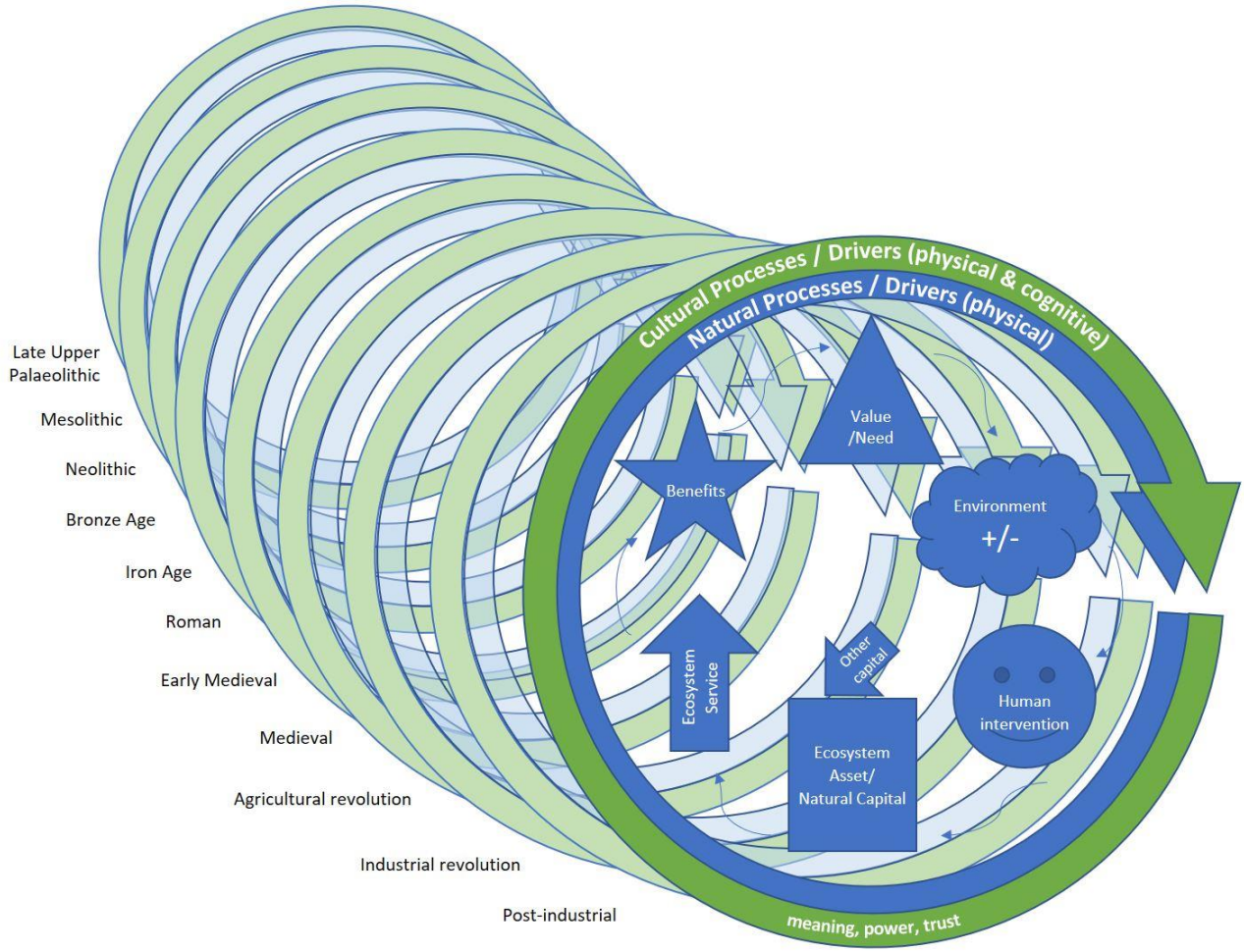

Figure 11: HNCES logic chain - the chain is historically-situated and has considerable time-depth

2.3.32. In places where the surface of the earth has not undergone such major changes, the evidence for the operation of this chain stretches even further back into prehistory, to the origins of human species. The antiquity of this chain draws attention to the potential application of Ecosystem Services approaches to earlier periods, to identify historic Ecosystem Services that might have been obtained in the past but not today; but which might also have potential as renewed Ecosystem Services in future. It also underlines – yet again – the need for an express account of the role of people and time within Natural Capital / Ecosystem Services approaches.

2.3.33. Recognising the antiquity of people as part of ecosystems raises questions about inflection points, where the influence of people within ecosystems changes from sustainable to unsustainable, and what defines and distinguishes sustainability from unsustainability. This debate – framed in terms of thresholds, baselines, tipping points and so on – is critical to Natural Capital / Ecosystem Services approaches because being instrumentally-focussed on motivating change implies a destination: what should human use of Ecosystem Services be? An archaeological perspective, recognising that the propensity of people to intervene physically in the environment is part of a historic chain of great antiquity, suggests that these inflexion points may be further back in the past than assumed, or even that the repeated operation of this chain – subject to the complex variables of natural and cultural processes – is such that no 'year zero' can be identified. Even though the endeavour to place a date on when things 'went wrong' might prove futile, it should be possible to distinguish times in the past when Ecosystem Services were sustainable, and there may

be lessons for achieving the changes in people's behaviour that the Natural Capital / Ecosystem Services paradigm is intended to inspire.

2.3.34. Although this re-worked chain is intended to be comprehensive with respect to Natural Capital / Ecosystem Services, heritage still has an existence beyond it. Decisions informed by Natural Capital / Ecosystem Services will have to deal with heritage even if they cannot accommodate it conceptually; these approaches are not exempt from the laws, regulations and policies that society has put in place to protect the historic environment. Although CICES appears to have no place for heritage other than that which is resonant with living systems, such heritage is valued and protected by the public nonetheless.

2.3.35. The re-worked chain reflects the five different dimensions to the relationship between heritage and Natural Capital / Ecosystem Services that was outlined above:

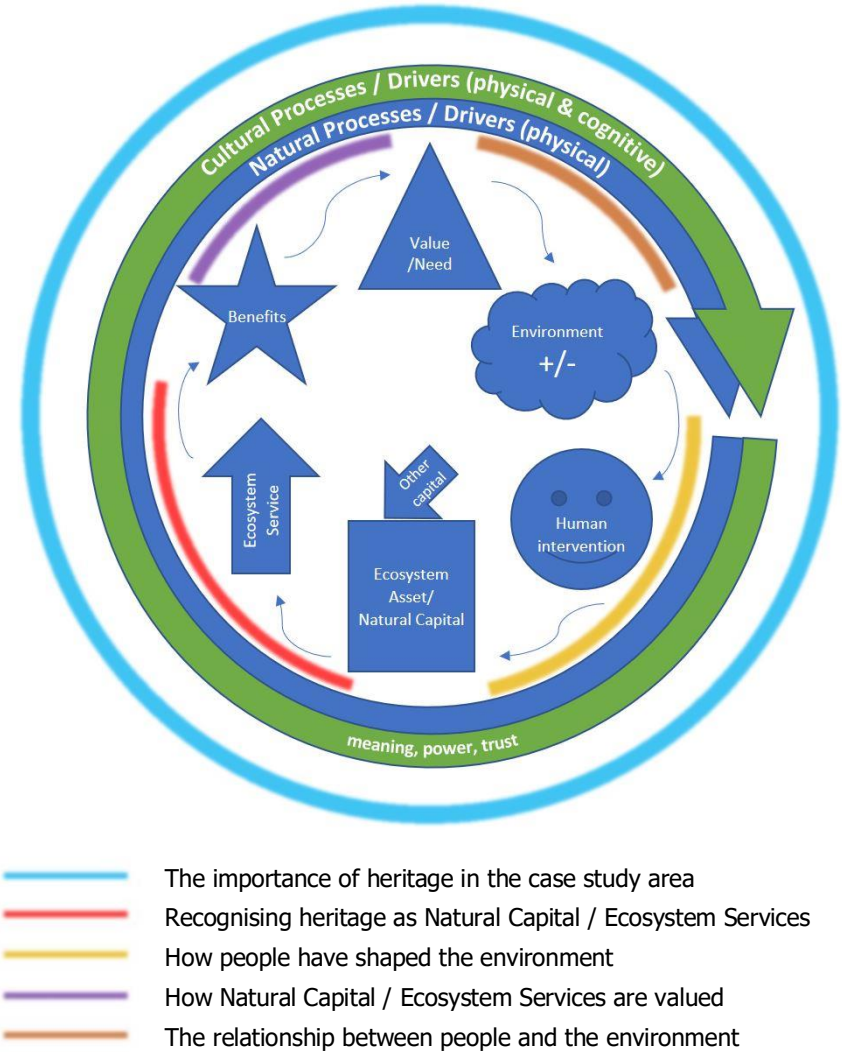

Figure 12: HNCES logic chain - relation to heritage

2.3.36. The capacity of heritage to give rise to Ecosystem Services – whether cultural or (through its physical characteristics) in provisioning and regulating – is addressed in the bottom left quadrant. How Ecosystem Assets themselves have been shaped intellectually and materially by human intervention is addressed in the bottom right quadrant. Questions about how (monetary) value is attributed to benefits arising from heritage are addressed in the top left quadrant. Questions about relationships between people and the environment are addressed in the top right quadrant. The importance of heritage independent of the Natural Capital / Ecosystem Services paradigm applies outside the chain.

2.3.37. These different dimensions to the relationship between heritage and Natural Capital / Ecosystem Services, conceived of as a historically-situated chain, provides the framework for the case studies on the Dorset Stour and the Tyne to Tees marine area that follow.

3. Dorset Stour Case Study

3.1. Background to Case Study

3.1.1. The application of Natural Capital / Ecosystem Services approaches to heritage assets associated with rivers is a priority because rivers are a key focus for interventions that might unwittingly affect the survival and significance of heritage assets. Water quality, topsoil run-off, flooding and ecological status – increasingly conceptualised in terms of Natural Capital / Ecosystem Services – are driving major works in freshwater environments. Common interventions include removing structures, 'restoring' watercourses and introducing 'natural' flood management (NFM) measures, often without fully appreciating the degree and time-depth of previous human intervention in freshwater environments (Firth, 2014b).

3.1.2. Better integration of heritage in the application of Natural Capital / Ecosystem Services to river management should not only help safeguard significant heritage assets; it has the potential to improve natural environment outcomes where new interventions are informed by greater awareness of past human activity. There is a further opportunity that better integration will engage people more fully in river management, framed in terms of the history and future of riverine landscapes and places. Greater integration should also extend benefits attributable to recreation and well-being through greater attention to cultural context.

3.1.3. The Dorset Stour provides several advantages as a focus for a case study focussing on freshwater. The Stour presents a range of freshwater heritage assets and historic uses of the river that is directly analogous to many other English rivers. The Stour includes examples of assets – such as water meadows, watermill complexes, designed landscapes and river crossings – that modify watercourses. Importantly, the Dorset Stour encompasses examples of such assets that are highly degraded or naturalised, such that the modified watercourse now appears as a 'natural' asset. Hence the Stour offers an opportunity to examine the complex interplay of natural and cultural processes in environments that are subject to Natural Capital / Ecosystem Services approaches. The Dorset Stour also has heritage assets that indicate relationships between people and the river reaching much further back in time, to the Iron Age and potentially the Neolithic: relationships that may be obscured by medieval, post-medieval and modern interventions in other catchments.

3.1.4. The Stour is also suitable as a case study because it has the advantage of being examined archaeologically in detail through the Historic Watercourses: Dorset Stour project (Firth and Firth, 2020) funded by Historic England, which is looking at the historic character of every reach of the main channel of the river in a comprehensive, catchment-based manner. The prior project means that the Dorset Stour has the advantage of local and national historic environment data, including sources such as historic mapping and Environment Agency LIDAR data, that would otherwise take considerable time to collate. The Dorset Stour case study also draws upon the experience and outputs of the prior project in addressing heritage assets that are now deeply embedded within the freshwater environment.

3.1.5. A further important advantage of the Dorset Stour as a case study is that it builds upon existing integration with the Stour Catchment Initiative (SCI), which is a CaBA partnership[11]. The SCI is the key forum for liaison between the natural environment sector and other community stakeholders in respect of the Stour. It provides a mechanism whereby this case study has been discussed collectively and disseminated amongst precisely the stakeholders it is intended to inform. Further, as a CaBA partnership, the SCI can enable the results of the Dorset Stour case study to inform over 100 other catchments through the CaBA network and online infrastructure.

3.1.6. The relationship between heritage, Natural Capital and Ecosystem Services in the Dorset Stour is set out under the heads developed above, i.e.:

- The importance of heritage in the case study area
- Recognising heritage as Natural Capital / Ecosystem Services
- How people have shaped the environment
- How Natural Capital / Ecosystem Services are valued

[11] https://catchmentbasedapproach.org/

- The relationship between people and the environment

3.2. The importance of heritage in the case study area

3.2.1. Even where it is not possible to integrate heritage within Natural Capital / Ecosystem Services approaches, heritage retains an independent standing amongst the public – expressed through their interest and actions – and in legal and policy frameworks. In common with many rivers, the Dorset Stour has a rich heritage that is appreciated and valued locally, formally and informally, and which is protected by designations and planning policies. Although there is potential for greater awareness and protection of the heritage of the Dorset Stour, decision-making driven by Natural Capital / Ecosystem Services approaches is obliged to take account of heritage even if heritage is poorly recognised by the Natural Capital / Ecosystem Services paradigm.

3.2.2. Watercourse-related heritage assets are recognised and protected using the same forms of designation that apply to land; there are not separate frameworks for designation. Moreover, 'heritage watercourse-related asset' is a fluid category because watercourse and non-watercourse heritage assets merge and overlap in the rich weave of the historic environment. Bridges and watermills are as much a part of the overall built environment as they are distinctive features of watercourses. Indeed, the role of watercourses is so fundamental to human activity through history that the presence of many heritage assets can be regarded as watercourse-related even if they are not immediately adjacent to the water, including the pattern and character of settlements such as villages and towns. Consequently, it is difficult to draw a boundary around watercourse-related assets, to quantify them or provide a distribution. Many of the heritage assets within the catchment of the Dorset Stour have a direct or indirect relationship to the watercourse: decisions and actions driven by Natural Capital / Ecosystem Services approaches are subject to law and policy that protect these heritage assets and their settings.

3.2.3. The Ancient Monuments and Archaeological Areas Act (AMAA) 1979 protects Scheduled Monuments against activities described as 'works', for which Scheduled Monument Consent (SMC) is required. To qualify for designation, Scheduled Monuments must meet the definition of 'monument' set out in the AMAA 1979 and appear to be of national importance. Even if a monument meets these criteria, designation is at the discretion of the Secretary of State, advised by the Department for Digital, Culture, Media and Sport (DCMS) based on a recommendation from Historic England. A relatively small proportion of heritage assets is scheduled, and the resulting list is not always consistent or comprehensive because it reflects changing perspectives and priorities since scheduling was first introduced in 1882. The selection of assets for scheduling is now more systematic, informed by a series of Selection Guides[12] and further informed by a series of Introductions to Heritage Assets for archaeology[13].

3.2.4. The list of Scheduled Monuments in the vicinity of the Dorset Stour is quite limited. The principal focus of scheduling close to the main channel of the Stour has been directed towards prehistoric bowl barrows plus an extensive area of prehistoric quarrying at Pen Pits; hillforts and camps of the Iron Age and Roman periods; and settlements/earthworks of the Medieval period:

Prehistoric		
1004687	Pen Pits	https://historicengland.org.uk/listing/the-list/list-entry/1004687
1006139	Pen Pits	https://historicengland.org.uk/listing/the-list/list-entry/1006139
1015184	Bowl barrow near Shapwick	https://historicengland.org.uk/listing/the-list/list-entry/1015184
1002350	Bowl barrow, Tuckton	https://historicengland.org.uk/listing/the-list/list-entry/1002350
1002397	Bowl barrows, Barn Cottage Hengistbury Head	https://historicengland.org.uk/listing/the-list/list-entry/1002397
1002366	St Catherine's Hill	https://historicengland.org.uk/listing/the-list/list-entry/1002366

[12] https://historicengland.org.uk/listing/selection-criteria/scheduling-selection/
[13] https://historicengland.org.uk/listing/selection-criteria/scheduling-selection/ihas-archaeology/

Iron Age / Roman		
1002367	Hengistbury	https://historicengland.org.uk/listing/the-list/list-entry/1002367
1003583	Dudsbury	https://historicengland.org.uk/listing/the-list/list-entry/1003583
1003803	Lake Farm	https://historicengland.org.uk/listing/the-list/list-entry/1003803
1002444	Roman Road, Eye Mead	https://historicengland.org.uk/listing/the-list/list-entry/1002444
1004563	Crawford Castle (Spetisbury)	https://historicengland.org.uk/listing/the-list/list-entry/1004563
1002678	Hod Hill	https://historicengland.org.uk/listing/the-list/list-entry/1002678
1002719	Sturminster Castle	https://historicengland.org.uk/listing/the-list/list-entry/1002719
Medieval		
1005639	Orchard Castle (Stourton)	https://historicengland.org.uk/listing/the-list/list-entry/1005639
1008750	Sturminster Marshall	https://historicengland.org.uk/listing/the-list/list-entry/1008750
1002441	The Leaze (Wimborne Minster	https://historicengland.org.uk/listing/the-list/list-entry/1002441
1005573	Mound near the Leaze	https://historicengland.org.uk/listing/the-list/list-entry/1005573
1013372	Fiddleford Manor	https://historicengland.org.uk/listing/the-list/list-entry/1013372
1002764	Stourpaine Manor House	https://historicengland.org.uk/listing/the-list/list-entry/1002764
1018277	Christchurch	https://historicengland.org.uk/listing/the-list/list-entry/1018277

Table 3: Scheduled monuments in vicinity of Dorset Stour

3.2.5. Listed Buildings are designated under the Planning (Listed Buildings and Conservation Areas) Act 1990. Different levels of protection apply, known as Grades. The Grades reflect different levels of importance and different rules about what works can be carried out with and without Listed Building Consent. The addition of buildings to the list has to be approved by the Secretary of State, based on an assessment by Historic England. There is less scope for discretion in listing, as there is a series of age-based principles about selection. For example, before 1700, all buildings that retain a significant proportion of their original fabric are likely to be listed. As with Scheduled Monuments, selection is informed by Selection Guides[14] and Introductions to Heritage Assets for buildings[15], though listing decisions in earlier decades mean that the overall population of Listed Buildings is not consistent.

3.2.6. There are very many more Listed Buildings in the vicinity of the main channel of the Dorset Stour than Scheduled Monuments, but this largely reflects the general distribution of dwellings in settlements near the Stour. Other than a few dwellings with waterfront locations, most of the Listed Buildings close to the Dorset Stour are extant watermill buildings[16] or bridges[17]. There are a few other Listed Buildings that have a direct relation to the river, such as an ornamental spring head at Sturminster Newton[18]. A case can also be made for several listed parish churches with

[14] https://historicengland.org.uk/listing/selection-criteria/listing-selection/
[15] https://historicengland.org.uk/listing/selection-criteria/listing-selection/ihas-buildings/
[16] Place Mill (Christchurch); Throop; White Mill; Keyneston; Durweston; Fiddleford; Sturminster; Cutt Mill; Kings Mill (Marnhull); Stour Provost.
[17] (Iford; Longham; Canford; Julian's; White Mill; Crawford; Blandford; Durweston; Town (Sturminster); Colber; King's Mill; Trill (Fifehead Magdalen); Wyke Street (Gillingham).
[18] https://historicengland.org.uk/listing/the-list/list-entry/1304122

riverside locations to be regarded as watercourse-related heritage assets[19], though the causality of the relationship between river, church and settlement may be irreducible.

3.2.7. Stourhead, at the source of the Dorset Stour, is a Registered Park and Garden[20]. This is a non-statutory designation, but the significance acknowledged through the designation is a material consideration in the planning process. The Dorset Stour forms a component of a series of other designed landscapes along its course and has been modified in the course of landscaping (at Bryanston, for example), though Stourhead is the only instance that is designated.

3.2.8. The existing protection afforded by heritage designations on the Dorset Stour does not spring from them providing Ecosystem Services or acting as Natural Capital. Although they can be framed in such terms or assimilated with them – at least to some degree – the value of these designated assets also sits outside the Natural Capital / Ecosystem Services paradigm. An independent justification for designation is implicit in the provision made by society through public law and policy. This justification – setting out the importance of designation in public terms – is set out in DCMS guidance. The rationale for scheduling is set out as follows:

> England is renowned for the richness and depth of its archaeological heritage: a tangible – and often highly evocative – link with our prehistoric and historic past that has the potential to transform knowledge and understanding of the lives of our predecessors during the last 900,000 years, including how they sought to respond to and influence their changing environment.
>
> In addition to their intrinsic value, ancient monuments can contribute to our perceptions of cultural identity and spirit of place, including the character of our landscapes and seascapes. In doing so they provide unique opportunities for research, education, leisure and tourism, delivering social benefits and contributing to economic growth.
>
> (Department for Culture, Media and Sport, 2013)

3.2.9. The rationale for Listed Buildings is set out as follows:

> {Listed Buildings} … form a key aspect of the historic environment which lies all around us, and which enriches the lives of present and future generations
>
> (Department for Digital, Culture, Media and Sport, 2018)

3.2.10. There are, of course, parallels between heritage designation and Ecosystem Services, as they both recognise cultural identity and spirit of place, and opportunities for research, education, leisure and tourism. Ecosystem Services approaches almost seem to appropriate such sources of value when they refer to heritage sites. But these values at designated sites do not arise from the natural environment; they are a product of past human interventions manifest in the physical character of places; it is the attributes of these places that prompt the positive benefits of heritage assets that are recognised and protected by heritage law and policy. Undoubtedly, the benefits enjoyed by the public at designated sites along the Dorset Stour arise in part from simultaneous enjoyment of its ecosystems, but services from cultural heritage also arise independently of nature.

3.2.11. The heritage assets that are designated along the Dorset Stour are a small fraction of its overall population of heritage assets. This is a situation that applies throughout the country, so law and policies on designated heritage assets are supported by policies on non-designated heritage assets. Non-designated heritage assets may be as important as designated assets, as recognised by DCMS guidance on scheduling to which reference has already been made (Department for Culture, Media and Sport, 2013) and reflected also in the National Planning Policy Framework (NPPF). The planning process, framed by the NPPF and local plan policies, is the principal means of safeguarding non-designated heritage assets. The NPPF states:

> {Heritage assets} … are an irreplaceable resource, and should be conserved in a manner appropriate to their significance, so that they can be enjoyed for their contribution to the quality of life of existing and future generations.
>
> Plans should set out a positive strategy for the conservation and enjoyment of the historic environment, including heritage assets most at risk through neglect, decay or other threats.
>
> (Ministry of Housing, Communities and Local Government, 2018)

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[19] Parley; Kinson; Canford; Sturminster Marshall; Shapwick; Spetisbury; Charlton Marshall; Bryanston; Hamoon; Manston. In some of these cases the river may have changed substantially since the church was established.

[20] https://historicengland.org.uk/listing/the-list/list-entry/1000471

3.2.12. The primary record of non-designated heritage assets is the Historic Environment Record (HER) maintained by local authorities. As for many other rivers, the quantification of heritage assets associated with the Dorset Stour held in the relevant HERs (principally Dorset, with small sections in Somerset and Wiltshire) is only partial. Rivers have not generally been prioritised in recording programmes; features in floodplains indicative of heritage assets are often masked by alluvium and/or vegetation; and floodplains are not generally favoured by the activities that lead to assets being discovered (such as development or fieldwalking). Further, there can be a tension between identifying discrete, bounded heritage assets and recognising the historic character of extensive landscape features. The degree to which the character of the wider landscape might have been affected by the presence of a river is, to some degree, recognised by Historic Landscape Characterisation (HLC). However, HLC operates at a scale such that watercourse character is relatively undifferentiated. Altogether, this means that the recognition of non-designated heritage assets associated with watercourses such as the Dorset Stour may be sparse or inconsistent.

3.2.13. The lack of consistent recognition of the historic character of watercourses prompted the Historic Watercourses project on the Dorset Stour referred to above. Mapping has been informed by existing sources of data on designated and non-designated heritage assets, HLC and various other forms of evidence, including LIDAR and historic maps. Historic Watercourse Polygons have been identified and recorded, operating at a level between that of specific heritage assets and the application of HLC to the wider landscape. The approach has been comprehensive with respect to the main channel of the Dorset Stour: evidence for historic activity and its material consequences for the watercourse have been recorded along the entire river. A total of 730 Historic Watercourse Polygons has been recorded – this high number alone giving an indication of the intensive interaction between people and freshwater environments through history.

3.2.14. The reason for mapping the historic character of the Dorset Stour is to inform heritage and river managers of the presence of elements of the historic environment that might be affected by maintenance or capital works on the river. The mapped information can also be used to enable decision-making that is better informed about the history of the river, including the history of past human interventions that might affect the success of future interventions intended to reduce flood risk or to 'restore' the river. Opportunities are also identified, specifically and generally, to engage the public in better understanding the history of the river, and the implications for living with the Dorset Stour in future.

3.2.15. The importance of non-designated heritage assets as captured in HER records or the Dorset Stour's Historic Watercourse Polygons can be assimilated to a degree with Natural Capital / Ecosystem Services approaches. Nonetheless, their importance arises independently from – and is as valid as – services arising from the natural environment. As set out in the NPPF, the presence of heritage assets on the Dorset Stour will be a consideration for decisions informed by Natural Capital / Ecosystem Services approaches, even if they are not recognised in that paradigm.

3.2.16. The case for the importance of heritage assets independent of Natural Capital / Ecosystem Services derives most directly from public law and policy, as set out above. The policies referred to above invoke the multiple values of heritage as part of their rationale, but it is also worth noting that these values are themselves independent of policy. For example, a heritage asset can generate economic value – from visitors, for example – irrespective of whether economic value is referred to in planning policy or whether the heritage asset is included in a Historic Environment Record. The same is true of the other social values that arise from heritage: people derive benefits from heritage directly, over and above any recognition of those benefits in official documentation. Indeed, the recent history of heritage management – including the development of policy – has been something of a catching-up exercise in understanding the range and quantity of benefits that people obtain from heritage assets, to ensure that the sources of these benefits are safeguarded and, if possible, enhanced. Again, these values arise independently of any assimilation with Natural Capital / Ecosystem Services approaches.

3.2.17. Recognition of the economic and social benefits of heritage has advanced over the last 10-15 years through the Taking Part Survey[21] and Heritage Counts[22] initiatives. These initiatives do not provide specific information about the importance of heritage on the Dorset Stour, but they demonstrate an overall high level of engagement with heritage by the public; the contribution that heritage makes to enjoyment, wellbeing, sense of place (Historic England, 2018a); and the impact of heritage on growth, prosperity and jobs (Historic England, 2018b). For example, in 2017/18, 72.8% of adults visited a heritage site in the last 12 months (Department for Digital, Culture, Media & Sport, 2018), whilst the total Gross Value Added (GVA) of heritage in England in 2018 was £29bn, equivalent to 2% of national GVA (Historic England, 2018b).

3.2.18. Although they have not been quantified, the social and economic benefits of heritage associated with the Dorset Stour are likely to be high. The few readily-available statistics are for visitor numbers, from the Association of Large Visitor Attractions (ALVA) and Visit Britain. ALVA reports visitor numbers in 2017 for of 381,264 for Stourhead and 325,007 for Kingston Lacy[23]; Visit England also includes numbers for White Mill (3,699) and Sturminster Newton Mill (2,289)[24]. Plainly, more could be done to quantify social and economic benefits of the heritage associated with the Dorset Stour, recognising that many of these benefits are likely to arise through diffuse pathways rather than visits to attractions. In a predominantly rural catchment like the Dorset Stour, the value of the historic environment to many people may be difficult to separate from value arising from ecosystems, and from the value arising from dynamic hybrids such as sense of place or tranquillity.

3.3. Heritage as Natural Capital / Ecosystem Services

Heritage as Cultural ES on the Dorset Stour

3.3.1. CICES sets out the following biotic and abiotic cultural ES:

Division	Group	Code	Class: simple descriptor
Direct	Physical, experiential	3.1.1.1	Using the environment for sport and recreation; using nature to help stay fit
		3.1.1.2	Watching plants and animals where they live; using nature to destress
	Intellectual, representative	3.1.2.1	Researching nature
		3.1.2.2	Studying nature
		3.1.2.3	The things in nature that help people identify with the history or culture of where they live or come from
		3.1.2.4	The beauty of nature
Indirect	Spiritual, symbolic	3.2.1.1	Using nature as a national or local emblem
		3.2.1.2	The things in nature that have spiritual importance for people
		3.2.1.3	The things in nature used to make films or to write books
	Other	3.2.2.1	The things in nature that we think should be conserved
		3.2.2.2	The things in nature that we want future generations to enjoy or use
Direct	Physical, experiential	6.1.1.1	Things in the physical environment that we can experience actively or passively
	Intellectual, representative	6.1.2.1	Things in the physical environment that we can study or think about
Indirect	Spiritual, symbolic	6.2.1.1	Things in the physical environment that are important as symbols
	Other	6.2.2.1	Things in the physical environment that we think are important to others and future generations

Key	biotic	abiotic

[21] https://www.gov.uk/guidance/taking-part-survey
[22] https://historicengland.org.uk/research/heritage-counts/
[23] http://www.alva.org.uk/details.cfm?p=423
[24] https://www.visitbritain.org/sites/default/files/vb-corporate/Documents-Library/documents/England-documents/full_attractions_listing_for_publication_2017_v3.xlsx

Table 4: Definitions of cultural ES, CICES

3.3.2. The cultural heritage of the Dorset Stour already provides extensive benefits to people. Many of these benefits could be assimilated with Natural Capital / Ecosystem Services approaches as cultural ES, echoing the classification above. A clarification is required, however. Whilst the term 'heritage' is used in schemas for cultural ES – including CICES (3.1.2.3) – this is taken to mean only the contribution to heritage that arises solely from the natural environment: 'The *things in nature* that help people identify with the history or culture of where they live or come from' (CICES 3.1.2.3, emphasis added). CICES offers Sherwood Forest as an example of a living system that is resonant in terms of culture or heritage. Cultural heritage cannot give rise to cultural ES in this strict sense because cultural heritage itself is not 'things in nature'.

3.3.3. Given the pervasive influence of people on the environment across millennia, very little of our environment can be said to comprise 'things in nature', somewhat undermining the identification of any Ecosystem Services using the CICES schema. Sherwood Forest is not natural: its character is attributable to a thousand years of active land management. However, it is not uncommon for Ecosystem Services evaluations to assimilate cultural heritage, appropriating its benefits amongst the cultural ES of tourism, recreation and other cultural activities whilst overlooking its non-natural character (see below). Where cultural heritage is assimilated as a cultural Ecosystem Service, at least the role of heritage as ecosystems services can be said to be overt.

3.3.4. The point has already been made that the quantity, quality and distribution of cultural ES are highly dependent on what people bring to their interactions with heritage through prior knowledge, appreciation and capability. Cultural ES are not an intrinsic quality of the environment that arise unbidden: the physical existence of heritage associated with the river, for example, does not yield cultural ES unless people are able to interact with assets or can appreciate their potential presence. This applies both to cultural heritage, and the cultural ES arising from nature; a visitor to Sherwood Forest needs to bring with them a degree of prior knowledge – or at least a willingness to learn – for cultural ES to arise.

3.3.5. Heritage can also be regarded as giving rise to cultural ES that do not – in the eyes of the beneficiaries – appear to be associated with cultural activity. The fact that the role of culture is obscured does not mean that the ES arising from heritage should be ignored. For example, places enjoyed for their aesthetics, as green spaces, as venues for events or as places to see wildlife may all be heritage assets, even if the heritage asset is not apparent to the person enjoying the benefit: visitor's interactions with Sherwood Forest can give rise to cultural ES whilst they remain unaware of its long history of management. In the Dorset Stour, it is likely that many of the visitors to properties such as Stourhead and the Kingston Lacy estate would express the benefits they perceive in terms of nature – trees, gardens and landscapes – even though the entire experience has been meticulously designed, constructed and maintained by centuries of human effort. Similarly, people walking through a water meadow or beside a mill leat are likely to be aware of – and derive benefit from – the flora and fauna of these artificial features without necessarily noting their agricultural heritage.

3.3.6. Whilst many of the cultural ES considered to derive from interactions with nature really arise from or are dependent on artificial underpinnings, the public probably experiences the cultural and natural strands of the environment as a unity. In principle, it should be possible to pick out natural and cultural components and their interplay from such mixtures by using a more granular approach to measuring the services that people obtain.

3.3.7. Nonetheless, some services may be hybrids rather than mixtures, where cultural and natural elements are so completely amalgamated that they cannot be separated. 'Sense of place' and 'landscape' are possible exemplars. Such hybrids cannot be regarded as generating cultural ES in the strict sense because they do not arise solely from nature, even though the benefits might be heavily associated with natural processes by beneficiaries.

3.3.8. The categories of biotic and abiotic cultural ES in CICES broadly equate to each other as follows, the categorisation of abiotic cultural ES being less finely divided than biotic:

Code	Simple descriptor	Code	Simple descriptor
3.1.1.1	Using the environment for sport and recreation; using nature to help stay fit	6.1.1.1	Things in the physical environment that we can experience actively or passively
3.1.1.2	Watching plants and animals where they live; using nature to destress		
3.1.2.1	Researching nature	6.1.2.1	Things in the physical environment that we can study or think about
3.1.2.2	Studying nature		
3.1.2.3	The things in nature that help people identify with the history or culture of where they live or come from		
3.1.2.4	The beauty of nature		
3.2.1.1	Using nature to as a national or local emblem	6.2.1.1	Things in the physical environment that are important as symbols
3.2.1.2	The things in nature that have spiritual importance for people		
3.2.1.3	The things in nature used to make films or to write books		
3.2.2.1	The things in nature that we think should be conserved	6.2.2.1	Things in the physical environment that we think are important to others and future generations
3.2.2.2	The things in nature that we want future generations to enjoy or use		

Key	biotic	abiotic

Table 5: Correlation of biotic and abiotic cultural ES, CICES

3.3.9. As noted previously, heritage – helping to identify with history or culture – is referred to expressly only in 3.1.2.3. As set out, these cultural ES are framed as arising only from nature. Notwithstanding, the predispositions of people that enable them to obtain these services from nature, and which shape the quantity and quality of these services, are themselves cultural and historical. Practically, many of the services that people regard as coming from nature in these categories will – because of the degree to which the environment is a product of human interaction – really be from cultural heritage as much as from nature. In some cases, this may be made explicit, where services arising from heritage are co-opted as (ostensibly nature-derived) cultural ES within such schemas. More fundamentally, a better approach would be to describe these services in terms of the 'environment' (including the historic environment) rather than 'nature'. The benefits that people obtain from an environment that is cultural and historic could then be acknowledged in line with CICES: for recreation, fitness, wellbeing, research, learning, identity, aesthetics, symbolism, transcendence, inspiration, and bequest.

3.3.10. Undoubtedly, the Dorset Stour already contributes cultural ES under these categories. A significant proportion of these services is likely to arise from the culture and history of the Dorset Stour, not just its nature. Data that would enable the cultural heritage element to be distinguished is not readily available: it may not even be sought.

3.3.11. Depending on whether cultural heritage is 'in' or 'out', values attributed to the cultural ES arising from nature alone may be inflated; but if the valuation of cultural ES is strictly on the basis of contributions from nature, then explicitly adding the contribution from cultural heritage could add significantly.

3.3.12. Knowing how cultural ES are constituted is important to ensure that valuation is meaningful and to guide decisions about management options (maintenance, enhancement, access, promotion and so on), which will be informed by valuation. Such decisions could be ineffective or even damaging to cultural ES if the source of value is not understood. A landscape feature that is deeply-rooted historically might cease to function – compromising the ES it generates – if the human contribution to how that feature generates ES is obscured or inadequately attributed.

3.3.13. Equally, a failure to recognise the degree to which the yield of cultural ES is dependent on predispositions which are themselves cultural could reduce the value of ES or prevent their potential from being achieved. Investment in the physical environment has to be matched by investment in the cultural infrastructure that enables and encourages people to obtain those values, taking into account factors such as gender, ethnicity, socio-economic class, disability, region and barriers to participation (see e.g. Department for Digital, Culture, Media & Sport, 2018).

Points of access – physical and intellectual – are likely to be of critical importance to the value of services: cultural heritage sites may play a key role in both attracting and informing people, enabling ES to arise.

3.3.14. The potential importance of points of access to the value that is obtained from cultural ES also raises the earlier question of scale. Assimilating Natural Capital / Ecosystem Services with broad habitat types, represented by extensive areas, may underplay the degree to which cultural ES are dependent on places that have a much smaller footprint. In general terms, heritage assets are much less extensive than habitat areas, but the intensity of their contribution to cultural ES may be very high – both in terms of cultural ES they provide themselves but also in enabling ES to be obtained from adjacent large areas. For example, Kingfisher Barn Visitor Centre[25] is a relatively rare surviving agricultural building within the suburban fringes of Bournemouth, mapped as part of Muscliff Farm in the nineteenth century. It is a key point of entry to the Stour Valley Nature Reserve and undoubtedly plays an important part in securing cultural ES from this much larger area. Equally, historic rights of way – deriving directly from patterns of human movement through the landscape over many centuries – are likely to play a role in people obtaining ES that is disproportionate to their area on the ground.

Non-cultural ES from heritage on the Dorset Stour

3.3.15. The heritage assets of the Dorset Stour also contribute to non-cultural ES, i.e. provisioning, regulating and supporting ES. As noted previously, obtaining these services – which exhibit human preferences and choices – is to some degree cultural and historic. In this section the intention is to focus, however, on the services that arise from heritage assets as physical entities, rather than the cultural inputs that frame these services.

3.3.16. Questions of scale are again important. Heritage assets are not comparable to broad habitat types in terms of extent (leaving aside the degree to which broadscale habitats are partly a product of extensive human activity in the past). Although they are generally smaller, however, heritage assets may provide a high intensity of non-cultural ES. Analysis at the level of broad habitat type is probably unsuited to recognising, for example, the role that historic riverine structures such as weirs and bridges play in regulating water flow, or that their backwaters might play in maintaining nursery populations of fish and invertebrates (see Sayer, 2014).

3.3.17. As noted, CICES distinguishes between services arising from biotic (living) and abiotic (physical; non-living) elements. Where heritage assets give rise to non-cultural ES they might be regarded in the first instance as physical features that can be assimilated with the abiotic category; but in view of the degree to which heritage features frame distinct habitats, then there is at least some overlap with biotic categories – especially when considering broadscale habitats that are a product of historic land-use. This is also true at smaller scales for watercourse-related heritage assets, where the ES arising from a mill leat, for example, may be attributable as much to its biotic vegetation (CICES 2.2.1.3 – example service: 'The capacity of vegetation to retain water and release it slowly') as to its abiotic physical form (CICES 5.2.1.2. – example service: 'Natural levees providing flood protection').

3.3.18. As discussed below, much of the River Stour has been heavily modified over the millennia. The watercourse is often not natural, but this does not prevent it from giving rise to regulating and provisioning ES. Indeed, the ES arising from an artificial channel may be similar to or greater than those arising from an unmodified channel: the quality and quantity of ES may not be dependent on the origin being natural; it may not matter whether the source of benefit is a heritage asset so long as the benefit is the same. Equally, if there is no difference in the ES that arise, then there need be no concern that a natural river channel is intrinsically better or more authentic than a modified channel. Establishing differences in ES between natural and modified counterparts, and about the implications for maintaining and enhancing ES, becomes a starting point for research rather than a presumption.

3.3.19. The character and quantity of provisioning and regulating ES arising from heritage assets and their natural counterparts might be an issue where a feature such as a river channel is thought to be

[25]: https://www.visitstourvalley.co.uk/Kingfisher-Barn/kingfisher-barn.aspx

natural but is in fact modified, especially if the ES derive in part from the modification itself. Rivers are often highly modified, yet their modifications are so deeply buried in time that they appear natural, as numerous instances on the Dorset Stour illustrate. Apparently straightforward actions to restore a river reach could have unintended consequences if the role of earlier human interaction is not addressed. Further, the age and function (in the past and present) of overtly human features such as weirs, which are being targeted generally for removal (Elbourne et al., 2013), may be obscure. The overall effect of removal might be a reduction in provisioning and regulating ES, quite aside from the loss of cultural ES from the structure itself and its story of human use of the river in the past. Even if the intention is to refresh the influence of natural processes in a watercourse, 'restoration' needs to be recognised as just the latest human intervention, not a turning back of the clock to a 'natural' state. This is quite widely recognised in the literature (Brown et al., 2018; Dufour and Piégay, 2009; Wohl et al., 2015), but restoration implies – and is still commonly framed in terms of – returning watercourses to their condition prior to human intervention.

3.3.20. As channel modification has been so extensive in rivers like the Dorset Stour, the relationship between heritage and the Ecosystem Service of flood control should be taken broadly into account. There may be a presumption that human modification of river channels will always have been deleterious with respect to flooding, creating a negative ES. Major channel modification in the twentieth century on the Dorset Stour was intended to reduce flooding, taking out meanders to improve drainage by speeding the flow of water downstream. The understanding now is that such works may have exacerbated downstream flooding – an unintended consequence of well-meaning intervention – and the emphasis now is on slowing the flow in the upper part of the catchment using 'Natural Flood Management'. However, the preoccupation with drainage in the nineteenth and twentieth century need not imply that river modification in even earlier centuries was similarly damaging in terms of flood risk. The construction of leats, weirs, feeders and hatches may have spread the flow of water over more of the floodplain than might have been the case naturally, holding water within the catchment. Such features, although relics, may still serve to hold water both at the surface and in the soil: the potential for negative consequences from well-intentioned actions towards these earlier interventions could be foreseen if the historic functioning of the river is better understood.

3.3.21. Regulating and provisioning ES might also arise at large scales from features of the historic environment such as water meadows, flood meadows and the persistent relics of other cultivation practices, such as cultivating osiers. The Dorset Stour does not have many clearly extant examples of water meadows as compared to other local rivers such as the Nadder, Ebble and Frome. Some water meadows are still actively maintained and function as intended – e.g. Harnham Water Meadows[26]. However, most water meadows no longer function as intended but survive on rivers like the Nadder as quite substantial earthworks that still have a distinct impact on drainage and as habitats and give rise to ES accordingly. In contrast, former water meadows on the Dorset Stour no longer survive as substantial earthworks: although they might be still visible on aerial images and LIDAR, their topography is very muted. The provisioning and regulating ES of these relics is not known – it might not differ from farmland or grassland generally. The reason for the poorer condition of water meadows on the Dorset Stour is not clear either. It seems likely that water meadows were not constructed as extensively as in neighbouring catchments, but they may also have ceased to be maintained at an earlier point (and so started to decay) or have been actively removed. Fields in the floodplain adjacent to the Dorset Stour are often referred to as water meadows – and quite extensive areas have been categorised as water meadow in the course of Historic Landscape Characterisation – but archaeological evidence seems not to support such ubiquity.

3.3.22. The overall picture is made more complex in the Dorset Stour because many floodplain areas seem to have been used as flood meadows, i.e. meadows where seasonal flooding was a central part of land management, but without being augmented by the construction of earthworks on the surface of the fields themselves. Map evidence from the Dorset Stour indicates the survival of flood meadows with characteristic funnel-shaped entrances that date back to the Medieval period. Some are shown on nineteenth century tithe maps to be subdivided into individual plots, probably with marker stones. These flood meadows would have been grazed and used for growing hay. Their origins may lie even further back in time – perhaps in prehistory – with a close connection between

[26] https://www.salisburywatermeadows.org.uk/

pastoralism and flooding. The degree to which these open fields have been affected by modern farming practices is not obvious from map evidence, but it is possible that the Ecosystem Services arising from floodplain habitats are a consequence of hundreds, possibly thousands of years of agricultural practice. Water management features such as ditches may be equally ancient and have complex histories of their own; deep excavation for drainage might be only the most recent phase of much older assets.

3.3.23. Taken as a whole, the relict water meadows and flood meadows of the Dorset Stour are a consequence of agricultural practices over the long term. They are sufficiently extensive to contribute to broad scale Ecosystem Services whose character and quantity is attributable, in part, to their human history. The Historic Watercourses project did not undertake precise mapping of heritage assets, but even the intentionally fuzzy mapping gives a sense of scale:

Broad Term	**Area (Hectares)**
Beds of rushes	12.97
Bedwork water meadow	343.77
Catchwork water meadow	156.28
Flood meadow	25.32
Funnel-shaped meadow	393.00

Table 6: Historic land use – area of Historic Watercourse Polygons in Dorset Stour

3.3.24. Other forms of cultivation associated with the Dorset Stour include osier and withy beds – both created to enable coppicing and harvesting of willow. As with water meadows, these beds will have fallen into disuse and either been incorporated into modern farmland or still surviving as apparently wild relics. Where relict cultivation still survives, it is likely to give rise to ES in its naturalised state, but the ES to which it gave rise in its cultivated state may have been higher in the past and could increase in future if cultivation of osiers were to recommence. Again, these can add up to quite extensive areas:

Broad Term	**Area (Hectares)**
Osier bed	18.48
Withy bed	4.81

Table 7: Osiers and withies – area of Historic Watercourse Polygons in Dorset Stour

3.3.25. Most of the discussion here has been about ES arising from the watercourse and adjacent land-use. Some consideration is also warranted for the ES that might arise from instream heritage assets such as historic structures or changes to the river bed caused directly or indirectly by human intervention. Reference has already been made to weirs in terms of their connection to the wider landscape; it is perhaps more usual to see them as isolated features with a negative impact on various regulating and provisioning ES that warrants their breaching or removal. Clearly, other forms of instream structures such as bridges also affect riverine Ecosystem Services, due to bridge piers and abutments but also causeways and flood arches whose functioning may have substantially altered the watercourse and floodplain. Hatches and sluices, sheepwashes, bank reinforcement, waterfronts, jetties and other constructed items – together with excavated features such as inlets or vessel berths – could likewise have effects on regulating and provisioning ES. Again, these features are likely to be considered as negative, even if they give rise to positive cultural ES by enabling access, for example. Instream structures could contribute positively to non-cultural Ecosystem Services too by providing specific habitats and adding to the overall diversity of habitats in a way that is favourable to some species. Although not as intensive or extensive as on some rivers, the Stour near Christchurch has a waterfront adapted for recreational boating with numerous jetties, moorings and river-edge constructions. This presents a different habitat to the river upstream or the saltmarsh downstream; its profile in terms of regulating and provisioning ES may not be optimal, but it may not be entirely negative either. Whilst much of this local 'ocean sprawl' (see Tyne to Tees case study) has developed in the last 50 years, elements of the waterfront at the quay and Place Farm are associated with a settlement and monastery stretching

back to Medieval and Anglo-Saxon periods[27]. Artificial structures have been contributing to habitats within the Dorset Stour for over a thousand years.

3.3.26. Construction and excavation have consequences beyond their immediate footprint and can be regarded as changes to the riverbed arising indirectly from human activity. In some cases, people have intervened to change the bed of the river directly: the most obvious example being dredging to increase the depth of the river for navigation or to increase capacity to cope with flooding. Dredging is known to have taken place on the Stour to alter the form of the river in plan by cutting away the sides as well as deepening. Other forms of intervention may have occurred to improve the stability of the bed at fords and other access points, and to improve fishing. Watering points in fields where animals access the river to drink are another distinctive feature of sections of the Dorset Stour. It is not clear whether watering points were intentionally excavated or formed as 'desire paths' as animals repeatedly access the water; though in some cases it seems that watering places have developed from former fords. Watering places offer provisioning ES in the form of drinking water (CICES 4.2.1.1) for reared animals (CICES 1.1.3.1; 1.1.3.2) for centuries, but watering places are also being targeted for removal or improvement because of negative impacts on water quality (Environment Agency, 2016).

3.4. How people have shaped the environment

3.4.1. As indicated above, the relationship between heritage and Natural Capital / Ecosystem Services arises in large part because Ecosystem Services arise from an environment that is the product of the interaction of human and natural processes over long time periods, such that even where a service arises from an ostensibly natural process, the functioning of the process is framed by earlier human intervention. The whole of the environment – freshwater and floodplain – encompassed by the Stour Catchment has been modified by humans. Intentional physical interventions stretch back at least to Roman times and probably earlier. Many of the major modifications to the river are probably Medieval or Post-Medieval in date; they certainly pre-date the industrial or modern period as shown in historic maps from the mid-late nineteenth century onwards.

3.4.2. On the Dorset Stour, none of the functioning of the river or the floodplain – i.e. the provision of ES such as water supply, water quality, flood protection and so on – can be said to be natural or from nature alone. The pervasive role of people in shaping the provision of ES in the Dorset Stour encompassed the entire catchment. Specific historic interventions in the watercourse might be associated with specific reaches, but longitudinal connectivity up and down the river and lateral connectivity with the floodplain is such that the combined effect of multiple interventions implicates the whole of the Dorset Stour. When gauging likely success and how best to monitor effectiveness, further interventions should consider not just the immediate environs of the scheme, but the hybrid character of the whole catchment.

3.4.3. On the Dorset Stour, dependable map sources show that substantial stretches of the river have been modified over the last 140-180 years. Much modification of the river took place in earlier centuries, however, including changes to the principal channel. Dependable map data from earlier centuries is relatively rare, but the Dorset Stour shown on nineteenth century maps – such as estate, tithe and historic OS mapping – includes channel forms and other riverine features that are plainly not natural. The date at which modification took place is not discernible from a map showing 'after' not 'before' but considering the overall catchment, some broad non-exclusive temporal patterns in major watercourse modification on the Dorset Stour can be suggested:

Prehistoric	?defence; ?transport; sedimentation
Roman	crossings
Medieval	mills; fish weirs; flood meadows
Post-medieval	water in designed landscapes water meadows
Nineteenth Century	industrial mills; drainage
Twentieth Century	flood protection

[27] https://historicengland.org.uk/listing/the-list/list-entry/1110074; https://historicengland.org.uk/listing/the-list/list-entry/1018277

Table 8: Broad temporal patterning of human intervention in watercourses from Dorset Stour

3.4.4. The degree to which the current form of the Dorset Stour reflects interventions in prehistory is difficult to establish from desk-based sources. Early inhabitation of the Stour Catchment occurred at a time when climate, vegetation and sea-level were changing, which would also have influenced the river and its dynamics. Small scale woodland clearance on floodplains was taking place in the Mesolithic, even prior to the introduction of farming, and continued alongside the development of pasture and small-scale cereal cultivation in the Neolithic and Early Bronze Age (Straker et al., 2007; Wilkinson and Straker, 2007). The impact of human populations on aquatic fauna – including beaver – might also have had implications for watercourses such as the Stour. Expansion of clearance and cultivation in the Late Bronze Age is marked by substantial depths of colluvium on valley sides, indicating the impact of farming on sedimentation, the floodplain and watercourse:

> Rising sea levels reduced river gradients, which, together with the development of Middle Holocene forests, led to alterations in river bedform. Thus by the beginning of the Neolithic, in common with most lowland rivers in north-west Europe as a whole, rivers in the South West had evolved meandering or anastomosing bedforms ... Unlike the same river floodplains today, there is little evidence for channel migration or indeed deposition of fine grained sediments on floodplains during the Neolithic and much of the Bronze Age. AG Brown … has argued that the stasis of lowland floodplain during the Late Mesolithic to Late Bronze Age was a product of the stabilising influence of the alder and hazel wood land, combined with a less seasonal flood regime than that seen at present … River behaviour only appears to have altered, from the pattern described, from the Late Bronze Age onwards when sedimentation of mineral silts and clays on floodplains is attributed to widespread forest clearance of floodplains and in the wider river catchment ...
>
> (Wilkinson and Straker, 2007, p. 64)

3.4.5. Palaeo-environmental investigations in the vicinity of Hambledon Hill above the Iwerne, a tributary of the Dorset Stour, provide supporting evidence of farming practice generating colluvium in the valley bottom in the Bronze Age, Iron Age and Roman period:

> … the Iwerne valley retained significant tree cover throughout the Bronze Age and, although the old land surface below the burnt mound shows that there was cleared grassland on the banks of the stream at that time, regeneration followed. The scarcity of Iron Age artefacts from the hilltop excavations, given the proximity of two major hillforts, implies that at this time the hilltop may have been given over to pasture. Possibly in the Bronze Age, and certainly by Iron Age and Romano-British times, there were fields on the Stepleton Spur. Many of the other fields on the sides of Hambledon and its spurs are likely to be of similar date, although there is evidence that some pre-date the hillfort. This was the period of greatest arable activity in the landscape, when colluvial deposits were deposited in Coombe Bottom and at the base of the Stepleton slope in the Iwerne valley. The valley floor was cleared and cultivated during the Romano-British period but the stream sides remained shaded and are likely to have retained tree cover. In post-Roman times there is some ridge and furrow on the Shroton spur and in the hillfort but the upland is likely to have been mainly pasture with arable around the valley bottom settlements, as indicated by artefact distributions pointing to arable and manuring in Coombe Bottom and the area which later became Everley Water Meadow.
>
> (Bell et al., 2008, p. 452)

3.4.6. In the Late Bronze Age, Iron Age and thereafter, the Dorset Stour was essentially a farmed landscape (Straker et al., 2007, p. 105) with both arable and pastoral farming in evidence. As with many other European catchments (Brown et al., 2018), agricultural practices on the Stour are likely to have had both indirect and direct effects on the form and character of the watercourse. Communities were certainly shaping their 'dry' environment – sometimes on a grand scale – in the immediate vicinity of the Dorset Stour. Extensive prehistoric earthworking is more evident from adjacent upland areas, but there several places where barrows were constructed on the floodplain or appear to reference the river, as noted above. The most striking evidence of people's capacity to change their environment close to the Dorset Stour is, however, the series of hillforts and other Iron Age earthworks apparently related to the river. Some of these are reasonably distant, but Hod Hill and Dudsbury – perhaps Spetisbury and Sturminster too – seem to incorporate the river into their defences. It has yet to be established whether Iron Age communities also directed their capabilities to making large-scale alterations to the Stour itself. Certainly, water engineering was being undertaken in Dorset in the Roman period, as indicated by the Dorchester Aqueduct supplying water to Dorchester over a length of about 12 miles[28]. On the Stour, however, known

[28] https://www.pastscape.org.uk/hob.aspx?hob_id=959813#

Roman engineering appears to be limited to the river crossings at Shapwick and Eye Mead, near Pamphill.

3.4.7. Whilst the built heritage of extant mills on the Dorset Stour date predominantly to recent centuries, the sites they occupy are much older – reference commonly being made to the presence of mills in the Domesday Book, itself recording mills that were already present in the eleventh century. There are more references to mills than there are extant mills today. Although the location of the lost mills is not known for certain, the Historic Watercourses project has flagged several 'mill islands' where the form of the waterway and other features (such as settlement and access) suggests a mill may have been present. Mills on the Dorset Stour are commonly of the bypass form whereby a leat (head race) takes water from the river upstream of the mill and returns it by another leat (tail race) to the river downstream, leaving an island between the river and the mill leats (Alexander and Edgeworth, 2018). There would typically have been a weir in the natural watercourse adjacent to the head race to add to the head of water. The presence of islands – supported by other contextual evidence – may suggest, therefore, the location of a former mill even if built evidence is absent. The intervention of creating the leats directly affects the watercourse: the river may in fact switch much of its flow to the leat causing the 'natural' route to diminish.

3.4.8. Some small island features in the Dorset Stour have been flagged as former fish weirs, where a channel is cut off the main channel to enable a fish trap to be placed (Haslam, 1991, p. 71). Although not confirmed – and ascribed tentatively to the Medieval period – these features are another case where the later, apparently natural form of the river might reflect a much earlier intervention.

3.4.9. Significant interventions in the form of the Dorset Stour appear to have taken place in the Post-medieval period in connection with designed landscapes, where the river was modified for aesthetic reasons in the vicinity of country houses and their parks. There is rare but unambiguous map evidence for this at Bryanston, where the Bowles Map of the Bryanston Estate, dating to 1659, shows the river taking a different route to that shown in nineteenth century maps and today. The watercourse at Stourhead is also known to have been modified to provide a series of ornamental lakes – submerging some previous medieval fishponds – in the eighteenth century (McKewan, 2006). There are other sections of the river that appear from nineteenth century maps to have been modified in the vicinity of country houses though again, evidence of the watercourse 'before' has yet to be found.

3.4.10. Major interventions also took place to introduce water meadows on the River Stour, including bedworks on the floodplain and catchworks on the valley sides. Bell et al. regard this as the biggest change to the Iwerne, feeding into the Stour, indicating that an entirely new channel was cut for the Iwerne in connection with the construction of water meadows and the creation of designed landscapes. The mollusc assemblage from the new channel is richer and more diverse than the assemblage from pre-eighteenth century deposits, indicating that seasonal winterbournes were entirely replaced by the year-round stream that is known today (Bell et al., 2008, pp. 452–453).

3.4.11. As discussed above, water meadows do not appear to have been constructed as extensively on the Dorset Stour as on neighbouring catchments and their remains are quite ephemeral. However, at the time of building, they would have included weirs in the river, channels taking the water onto the meadow and distributing it, and further channels to receive the water and return it to the river, accompanied by sluices / hatches to control the flows. Also as noted above, some meadows are likely to have been flooded without extensive bedwork systems, but potentially with weirs and channels to feed water to and from the floodplain.

3.4.12. Mills continued to be used into the nineteenth and twentieth centuries, evidently undergoing multiple phases of development not only of the mill buildings but also the leats and sluices used to manipulate the flow of water. Some of the mills on the Stour are industrial in scale and character; the same is true of their associated watercourses.

3.4.13. In the nineteenth century, emphasis seems to have switched from flooding to drainage in seeking to enhance agricultural production (see below). The progress of interventions designed to increase drainage on the Dorset Stour is not clear in the map evidence until the twentieth century, when

major works were carried out on the main channel. Networks of smaller channels are apparent in the floodplain, but the point at which they were cut is not known; indeed, some channels may have served originally to distribute flooding water before being subsequently re-cut, deeper, for drainage.

3.4.14. Infilled palaeo-channels apparent in LIDAR data and aerial photography also indicate interventions in the watercourse. In some cases, palaeo-channels are a consequence of gradual changes attributable to sedimentation – and could indeed be natural – but in other cases they seem closely associated with straight cuts in the channel that are probably artificial. The purpose and dating of palaeo-channels and the associated cuts are difficult to establish from map evidence. They add to the considerable complexity of watercourse features in some areas, forming a palimpsest with mill-related features and water meadow and/or drainage features that it has not been possible to unpick in the course of the work on the Historic Watercourses project. Changes in sedimentation, abstraction and fauna are all human factors that could have shaped the watercourse over millennia. The effects may have been rapid or gradual, focussed or diffuse, and affected the river in section as well as in plan, even though this may not be evident from historic maps. Fortunately, the sedimentation within palaeo-channels can be interrogated using palaeo-environmental methods and scientific dating to understand the sequence of change; palaeo-channels and other small wetland features have especially high potential in archaeological terms because of the palaeo-environmental evidence they can contain (Farrell and Hazell, 2016). The complexity of palaeo-channels underlines the point that the current character of the Dorset Stour and its floodplain – and the Ecosystem Services that arise – are a product of multiple interventions in the watercourse over many centuries.

3.5. How Natural Capital / Ecosystem Services are valued

3.5.1. Obtaining monetary values for cultural ES is generally regarded as problematic and has not been attempted as part of this case study. Even quantifying and mapping cultural ES – without adding monetary values – is regarded as difficult[29]. However, it is worth observing that other studies of watercourses indicate that cultural ES – in which heritage itself plays a significant part – are often highly-valued relative to other Ecosystem Services.

3.5.2. Freshwater – the broad landscape type that encompasses the heritage assets addressed by the Dorset Stour case study – is one of the few forms of Natural Capital for which the Office for National Statistics (ONS) has prepared accounts (Office for National Statistics, 2017). The value of freshwater for abstraction in 2014-15 is by far the greatest service, calculated as almost £29 billion; but recreation is the second most valuable service of freshwater, at over £10 billion. A large part of the recreation arising from freshwater might reasonably be attributed – directly or indirectly – to heritage assets and the historic character of many freshwater environments. Although not identified by separate figures, the contribution of heritage to the value of recreation is probably several orders of magnitude greater than the value of freshwater in terms of pollution removed (£453M), fish capture (£29.4M) or peat extraction (£25.7M).

3.5.3. The scope to place values on cultural ES with respect to rivers is explored in several reports on pilots for Payments for Ecosystem Services (PES) schemes. The PES pilots are principally concerned with valuing other ES relating to regulation of flooding and water quality, but cultural ES form part of the mix even if they are difficult to quantify. The ambiguous relationship between 'heritage' and cultural ES referred to previously is evident in the pilots, but the actual and/or potential of watercourse-related heritage to generate (monetised) ES is raised in several. For example:

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[29] See e.g. Natural England 'we are not convinced that using habitats as proxies for CES is the best way of presenting the evidence base' and 'Understanding how we can characterise, measure and map Cultural Ecosystem Services is an ongoing challenge' (Dales et al., 2014, paras. 3.44, 3.51);

And:

'Important goods and services provided by the {National Nature Reserves} that could be described but not easily quantified include (but are not limited to):

- Conservation of historical and archaeological heritage.
- Aesthetic value, including the contribution to the landscape' (Clark, 2017, p. 32)

Holnicote

The pilot has raised the profile of PES thinking within the National Trust and helped to inform its Land Choices strategy for Holnicote, ensuring that an ecosystems approach and the PES concept are at the heart of Land Choices. In practical terms Land Choices means understanding the current functions of all National Trust land and how these might be better balanced to achieve its aspirations in the future so that water, soils, carbon, wildlife, landscape *and cultural significance* and public enjoyment are as valid functions of farmland as productivity.

(Rogers et al., 2015 Executive Summary, emphasis added)

Cultural Value	There are a number of iconic attractions including the Exmoor pony and red deer and picturesque villages including thatched cottages in Allerford, Selworthy and Bossington.	An estimated 1.2M visitors per annum (based on visitor data from c. 2003) visit the Holnicote Estate providing a potentially significant source of income via a Visitor Giving scheme.

(Rogers et al., 2015 Appendix I)

Irwell Catchment

Key opportunities for environmental enhancements highlighted by commercial businesses, guided by the ES enhancement opportunities identified by our study (Table 2) included:

- Enhancing the visual appearance of the impoundment walls and river banks to improve the character, visual quality and biodiversity value of the area which would help benefit businesses through increased tourism and visitor numbers

(Centre for Local Economic Strategies and Wildlife Trust for Lancashire, Manchester and North Merseyside, 2015, para. 4.5.3)

Leeds and Liverpool Canal: Apperley Bridge

There are several waterfront developments which benefit from their position adjacent to the canal and are afforded visual amenity due to their proximity to the waterfront. These developments benefit from the canal setting.

(JBA Consulting, 2013, para. 3.2.1.2)

This analysis highlights that it is the cultural services provided by the Leeds-Liverpool Canal which benefit the widest range of people and organisations, including visual amenity, recreation, cultural heritage and appreciation for wildlife. The groups which benefit most from the services of the canal include local residents, canal users and interest groups.

Respondents were asked to identify the benefits they believed were provided by the canal at Apperley Bridge, selected from a list … The top five benefits provided by the canal, as identified by the respondents, included:

Access (79% of respondents)

Visual amenity (77% of respondents)

Relaxation (75% of respondents)

Appreciation of wildlife (72% of respondents)

Historic heritage (45% of respondents)

Only around 5% of residents recognised the drainage and flood protection benefits provided by the canal.

(JBA Consulting, 2013, para. 3.2.1.6)

Leeds and Liverpool Canal: Pollard Lane

The demand for visual amenity within this case study location can be considered high.

(JBA Consulting, 2013, para. 3.2.2.2)

Fowey

Respondents were asked to consider the services they felt their respective sectors (constituents) and other stakeholders derive from the Fowey catchment. It is very interesting to note that, across the sample interviewed, responses very much focused on aesthetic and recreational services stemming from "a beautiful landscape".

(CSERGE and West Country Rivers Trust, 2013, p. 66)

Hull

> Participants in the discussions and design charette had a greater interest in the cultural ESs which would be delivered from the schemes – such as recreation, a new image for the area and visual amenity – than the flood aspects per se.
>
> (Ursus Consulting Ltd, 2013, p. 63)

3.5.4. The importance of cultural ES – and their potential value, including in monetary terms – is strongly indicated by a growing body of work on the social and economic benefits of heritage. However, this evidence is focussed predominantly on 'dry' sites and makes little express reference to watercourse-related heritage. The findings of the PES pilots resonate with the headlines of Heritage Counts 2018, but the value of heritage associated with watercourses hardly features in *Heritage and the Economy 2018* or *Heritage and Society 2018*. Obtaining evidence on the social and economic value of watercourse heritage in a manner consistent with Heritage Counts would help considerably not only in making the case directly for watercourse heritage, but in informing studies and calculations being made in the watercourse management sector.

3.5.5. It is worth noting that the national survey on people and the natural environment – Monitor of Engagement with the Natural Environment (MENE) – includes a little information about watercourses. 'River, Lake or Canal' is one of the categories of natural place used in the MENE survey. Leaving aside the point of whether rivers, lakes and (especially) canals are natural places, the MENE survey indicates that 9% of visits in 2017-18 were to such places (Natural England, 2018, p. 10). The survey asks questions about reasons for visiting: engaging with culture/heritage does not appear to be an option, but it is perhaps notable that the highest percentage for reasons for visiting a river, lake or canal in 2015-16 was 'to learn something about the outdoors'[30]. This suggests considerable potential to engage people in the history and future of dealing with watercourses.

3.5.6. Heritage and Society 2018 draws attention to work by the Canal and Rivers Trust (CRT) which 'found that spending time by water, including historic canals and rivers in our cities, is associated with higher levels of happiness and greater life satisfaction' (Historic England, 2018a, p. 10). The CRT report anticipates studies being carried out to estimate the heritage and environmental value of these assets (Simetrica, 2018, p. 6), an approach that is developing as CRT builds its evidence base on waterways and well-being. 'Connection to local cultural identity and built industrial heritage' is regarded as one of the elements that differentiates waterways from general outdoor activities (Canal & River Trust, 2017, p. 86), whilst surveys showed:

> The role and value of waterways in terms of heritage and connection with nature are viewed relatively high by waterway users …
>
> - 79% of the waterway users agreed with the statement that canals/waterways make them appreciate the history and heritage of the area; and
> - 75% of the waterway users agreed that Trust waterways contribute to the cultural richness of the area.
>
> (Canal & River Trust, 2017, p. 97)

3.5.7. Consequently, Cultural & Heritage Assets are distinguished within CRT's Outcomes Management Framework (OMF): specific evidence on people's attitudes and valuation of heritage is being sought (Canal & River Trust, 2017, p. 12) and there are values-based indicators on culture and heritage that contribute to CRT's measurement of its performance.

3.5.8. The CRT work on wellbeing indicators and the wider suite of measures in Heritage Counts demonstrate that evidence on watercourse-related heritage can be sought to inform the value of cultural ES, whilst the PES pilots indicate that heritage is already giving rise to measurable value even where it is not the particular focus of inquiry. It seems likely that if satisfactory measures can be developed, then the contribution of heritage within Natural Capital / Ecosystem Services evaluations of freshwater environments such as the Dorset Stour would be high.

3.5.9. Although the focus here is on how heritage is valued in relation to cultural ES in a watercourse context, it should be recalled that heritage can also have considerable value as non-cultural ES, in

[30] Data via MENE Online Cross Tabulation Viewer: http://naturalengland.tns-global.com/

provisioning and regulating. Returning to the points made above, many of the features of watercourses that give rise to provisioning and regulating ES are heritage assets: value – monetary or otherwise – placed on water meadows, mill ponds, leats, ditches etc. for their role in flood protection, as habitat and so on, is a value that arises in part from the history of human intervention in the landscape. As noted previously, the 'heritage' character of these assets might not be acknowledged, but lack of recognition should not divest them of value. Many of the bridges traversing the River Stour are historic and might be valued for their cultural ES in aesthetic and architectural terms; by far the most numerous and valuable interaction with these heritage assets, however, is simply as a means of crossing the river in the course of daily transport.

3.5.10. Heritage also provides an opportunity to address how values attributed to the Dorset Stour change between people and through time. They are likely to vary considerably between people with different life experiences and may not always coincide with aspirations for conservation or sustainability. Although surveys of values often collect data on factors that may affect values – demographic profile information such as gender, ethnicity, age, health, wealth – this might assume simple correlations between background and values that obscure greater complexity. Further, if respondents are asked to choose or rank values that are predetermined by the surveyor, then there is little scope for them to offer their own values. A further concern is that, because values are mutable, the process of investigating values may affect how the respondents themselves conceptualise or value the subject matter. This may be an issue where a survey is purportedly about existing values but is linked to efforts to change values, to demonstrate that corporate objectives are being met, for example. Efforts to measure and enhance the value that arises from watercourse-related heritage requires care in their design and transparency.

3.5.11. The valuation of watercourse heritage in terms of Natural Capital / Ecosystem Services has a further dimension that warrants exploration, which is in its application to the past. The focus here has been on the value of Ecosystem Services to society today, but the framework can also be applied retrospectively. There is direct evidence of the following ES having been provided by the Dorset Stour in the past:

Historical use of Dorset Stour	CICES Code	CICES Class
Harvesting rushes and flags; osiers	1.1.5.2	Fibres and other materials from wild plants for direct use or processing (excluding genetic materials)
Fishing	1.1.6.1	Wild animals (terrestrial and aquatic) used for nutritional purposes
Water meadows; drains	2.2.1.3	Hydrological cycle and water flow regulation (Including flood control, and coastal protection)
Recreational boating	3.1.1.1	Characteristics of living systems that that enable activities promoting health, recuperation or enjoyment through active or immersive interactions
Designed landscapes	3.1.2.4	Characteristics of living systems that enable aesthetic experiences
Parish and county boundaries	3.2.1.1	Elements of living systems that have symbolic meaning
Riverside churches; holy wells and springs	3.2.1.2	Elements of living systems that have sacred or religious meaning
Livestock watering points	4.2.1.1	Surface water for drinking
Washing; transport	4.2.1.2	Surface water used as a material (non-drinking purposes)
Mills	4.2.1.3	Freshwater surface water used as an energy source

Table 9: Examples of historical ES evident on Dorset Stour

3.5.12. It is worth underlining that these services all require human inputs, and many required physical interventions in the landscape. Even though direct material evidence may be lacking, it is reasonable to infer that other ES categorised in CICES will have arisen in the course of people's interaction with the Dorset Stour in the past.

3.5.13. The list of historic ES is interesting because there may be scope to obtain historical data on the value of some of these services. Moreover, it is apparent that some of these services are no longer obtained, or at least not on the same scale: historical practice might also prompt us to look for value that is being obtained but is overlooked. For example, the Dorset Stour used to be a fundamental source of renewable energy, powering agricultural and industrial processes using mills; yet that service is of negligible value today. Controlled flooding of water meadows was also

significant in rearing livestock, fertilising arable crops (using dung), and growing feedstuffs (hay). Again, these services from the river appear now to be disregarded.

3.5.14. Some historic ES may seem surprising. There is extensive historical documentation about the harvesting of flags (irises) and rushes from the Dorset Stour around Sturminster Marshall, recorded from legal disputes in the nineteenth century. For example, a case (Somerset Heritage Centre DD/HC 99/8/21) was brought against James Gollop by John Barnes in 1806 for cutting 20 cart loads each of rushes, sedge, spears, dwarf spears and grass to the value of £100 – equivalent to over £7,700 in today's currency but with a value as income equivalent to over £100k[31]. The sedge was reported – at least in some places – also to play a role in preventing bank erosion (Somerset History Centre DD/HC 99/8/25). According to other correspondence, rights to cutting rushes between Eyebridge and Shapwick were still being rented out as recently as 1947, though by 1955 the rushes had disappeared due to dredging (Dorset History Centre D-BKL/E/M/1/112).

3.5.15. The ES obtained from harvesting rushes from the Dorset Stour resonates with one of the PES pilots referred to above, which looked at the scope for developing income from rushes as a biofuel through an 'Energy from Nature' initiative (Mills et al., 2015). The PES pilot found that 'within the case study area for the RSPB alone, this could enable the conversion of vegetation which costs c. £70,000 per year to harvest and remove via contractors, into bioenergy products worth £150,000 as wholesale loose biomass, or over £5 million if converted into biochar and sold retail' (Mills et al., 2015, p. 2). Greater value would arise from a Community Model scheme, which 'enables local communities to become involved, growing resilience and promoting rural development at the same time as improving their landscape' (Mills et al., 2015, p. 2). The fact that rushes were a valuable resource harvested historically by communities on the River Stour, which might be used as a source of renewable energy (CICES 1.1.5.3) as well as providing other benefits to the environment and local people, suggests again that heritage could serve an important role in informing approaches to sustainability through the recognition of historic ES.

3.6. The relationship between people and the environment

3.6.1. As noted, the motivation underlying the Natural Capital / Ecosystem Services paradigm is to incentivise changes in decision-making and human behaviour, in order to establish relationships between people and the environment that are much more sustainable than at present. The heritage of the Dorset Stour presents a medium for discussion about wholescale change in the future, based on demonstrable changes in the relationship between people and the environment in the past.

3.6.2. Mapping the Dorset Stour as a historic watercourse indicates that for much of its past, people seem to have worked with the river as a flooding environment (see Jones et al., 2017; Jones, 2016), in which inundation of the floodplain was not only accommodated but was beneficial and in some cases augmented. This is evident in the use of flood meadows and water meadows, already referred to, where letting water on to the land is an integral part of agricultural practice. A more tolerant or resilient approach to flooding is also apparent in the location and form of some villages, which are situated on the floodplain and are open to the river. This is apparent at Deserted Medieval Villages at Little Nutford and opposite Bryanston, but also in surviving villages. Shapwick and Sturminster Newton are both shown on early to mid-nineteenth century estate[32] and tithe (DHC T/SML) maps as having direct access to the water. At Shapwick, there appears to be a track along the waterfront with several roads joining it, whilst Sturminster Marshall has a branch of the Stour along the back of several plots plus direct access from the Stour (at Johnnie's Ditch), as well as access to water via a further drain. Access to the water obviously enabled several ES to be obtained: drinking for animals; perhaps boat landing; laundry places and so on. Such access would also have enabled flood water to rise into the villages, but also to drain away quickly afterwards. Subsequently, these once-permeable settlements appear to have turned their backs on the water: flood defences now lie across the same routes that once provided access. But their past may provide useful lessons for today's communities in adaptation and developing resilience.

[31] https://www.measuringworth.com/calculators/ukcompare/relativevalue.php

[32] https://dcc.dorsetforyou.gov.uk/bankes-archive/mapping-the-bankes/historical-map-manor-of-shapwick-1813/

3.6.3. The switch from apparent toleration of flooding to emphasis on drainage and flood protection appears to have occurred in the nineteenth and twentieth century, perhaps accompanying a switch in emphasis to arable over pastoral agriculture. This impression is emphatic in a report on the Stour from August 1917:

> I am unable to judge what proportion of the total affected area might become cultivable if it could be relieved of its present liability to injury by water, but the information which I was able to derive leads me to suppose that several thousand acres might, under more favourable conditions, be brought under the plough.
>
> I had little opportunity of discussion with the larger farmers, but took the opportunities afforded me of questioning millers and some of the smaller pasture farmers all of whom were unanimously of opinion that the main cause of flooding in both valleys is the shockingly neglected condition of the channel of the Stour. As a class, these men appeared to take a resigned view of a situation with which some of the younger representatives have grown up, and, with these, flooding and 'kismet' seem to be synonymous.
>
> About 1,200 acres of rich pasture land near the junction of the two rivers {Stour and Cale} is rapidly deteriorating into swamp. I saw large areas which I was informed fattened bullocks a few years ago, now covered with flag iris, rush, and other semi-aquatic plants.
>
> I think a competent engineer should be engaged to prepare sections and specifications of works covering the whole length of the Stour and Cale from below Christchurch Harbour to, say, 2 miles above Five Bridges, the works to comprise the complete restoration to section and grade of the channels within that length, and that those works should be as promptly as possible begun and continued until something like a free and unobstructed channel has been provided. Following such works, I think the whole of the subsidiary channels comprising main dykes, small drains, and field ditches throughout the affected portions of the valley should be thoroughly cleansed, graded, and re-sectioned, and that all culverts should be restored to full efficiency.
>
> (Clayton: D-BKL/E/M/1/54 - 6)

3.6.4. The pejorative language used towards the river in the report is striking, indicating an overall cultural perspective towards how rivers should be. The emphasis is on the channel being capable of providing speedy drainage to prevent flooding, rather than flooding being integral to management. Also, in the quotation above and in the rest of the report, reeds, flags and rushes are highlighted as an indicator of unacceptable quality, whereas previously they had been a valued resource. The re-shaping of the Stour by dredging that took place in the mid-late twentieth century seems consistent with the solution advocated in 1917, even though it took some time to happen. These works are now considered to have exacerbated flooding in the lower part of the Stour, whilst many of the specific issues of which the writer complains relate to features that modern approaches to Natural Flood Management would encourage and reinstate.

3.6.5. The 1917 report has to be seen in the context of the third year of the First World War, with huge pressure on food production arising from the impact of unrestricted submarine warfare (from 1st February 1917) and perhaps a shortage of labour contributing to issues arising from lack of maintenance of the river and its vegetation. However, this focus on getting rid of water emerged prior to the First World War and is probably associated with a general push towards agricultural improvement – with a particular focus on drainage – in the nineteenth century. A report written by Billingsley in 1810 about the Allen, a tributary of the Stour, comments as follows:

> To ascertain upon what foundation and with what as probability of success, this morassy {sic} Vale can be drained & improved it will be necessary to understand, whence this mischief arises. General ideas collected from external appearances when I was at St. Giles, will, I think justify me in stating, that it appears to me – that the principal Cause of its wetness and infertility arises from the circuitous course of the present River and the overflow of the Waters.
>
> Internal Springs may also contribute to the evil, but these are of minor consideration and may be easily drawn off when the grand cause of the mischief is removed.
>
> (Billingsley: D-BKL/E/M/1/54 - 2)

3.6.6. Again, the language is pejorative (morassy; mischief; evil); the diagnosis is that the channel is not straight; and the proposed solution is to engineer a new channel. The proposal for the new channel is by John Rennie, who notes that the river crosses the valley no less than four times to serve mills (Rennie: D-BKL/E/M/1/54 - 1); it seems likely that the route of the river in 1810 was in fact already a highly modified watermill landscape. The new channel proposed by Rennie would have cut off four mills and he provides an estimate for their removal. Two of them he regards as

having very little value; he comments that they can all be replaced with mills on the new channel, or their capacity taken up by the other existing mills. Both Billingsley and Rennie seem more concerned with re-engineering the river to prevent flooding than with its role as a source of energy, perhaps reflecting the growing availability of steam power.

3.6.7. Documents such as these in 1810 and 1917 provide direct insight into people's perceptions about their relationship with the river environment. Such documents may be available for earlier centuries, up to a point. However, it should be borne in mind that much of the history of people's relationship with the environment is written directly into the landscape and has to be explored with archaeological techniques. This case study has shown how human intervention in watercourses stretches back millennia. People's relationship to the water environment can be interpreted over these long timescales for changes, continuities and diversities relative to the relationships we have with watercourses today. If we are serious about change, this range of possibilities in living with rivers in the past should inform how we might live better with rivers in future. Natural Capital / Ecosystem Services should offer an opportunity not only to quantify the contribution that watercourses make to human life within current river management paradigms, but also to improve upon those paradigms by exploring the history of earlier relationships between people and water.

4. Tyne to Tees Case Study

4.1. Background to Case Study

4.1.1. The application of Natural Capital / Ecosystem Services approaches to heritage assets in marine areas is a priority because England's coasts and seas are under pressure from a range of human activities, from natural processes that are themselves affected by climate change, and from quite radical changes to how our seas are managed. The prospect of wholesale change to fisheries management because of Brexit adds to the intensity of this flux. Generally, heritage assets in marine areas have yet to obtain the same level of recording as heritage assets on land, and their context and significance is still relatively poorly understood. The main marine asset types – especially shipwrecks – are also subject to a wide range of interests and responsibilities that are poorly integrated (Firth, 2018).

4.1.2. As with watercourse management, better integration of heritage in the application of Natural Capital / Ecosystem Services approaches to marine management will help safeguard significant heritage assets and has the potential to improve natural environment outcomes associated with marine structures and wrecks. Better integration of the historic, human dimension of the marine environment should also help in engaging people more fully in marine management, framed in terms of the past, present and future of seascapes and coastal places.

4.1.3. The Tyne to Tees marine area provides several advantages as a focus for a marine case study. It contains a range of heritage assets that includes asset types which provide distinct environmental niches, contributing to Natural Capital and giving rise to Ecosystem Services. The area also includes places where there has been very heavy modification of estuaries and their immediate offshore areas as a result of human intervention. Major changes have also occurred along the length of the Tyne to Tees coast in recent decades. Sections of coast that were heavily industrialised – with direct consequences for the marine environment – have been cleaned of the colliery waste that was tipped there. The application of Natural Capital / Ecosystem Services to a marine area that has seen such major changes in its character is especially interesting because such application would seem difficult without acknowledging the area's industrial heritage.

4.1.4. The case study builds on several archaeological projects in the Tyne to Tees marine area funded predominantly by Historic England. In particular, shipwrecks and shoreline installations from the Second and especially the First World War have been the focus of the East Coast War Channels projects (Firth, 2014a), including a HLF-funded project by the National Trust focussing on the area around Souter Lighthouse (Firth, 2017). Further background to marine heritage assets in the Tyne to Tees marine area – and their broader significance to north east communities in respect of seafaring, coal and shipbuilding – is provided by the Tees pilot study on the national importance of cargo vessels (Firth and Rowe, 2016).

4.1.5. A further important factor is ongoing collaboration with the Tyne to Tees Shore to Seas Seascape Partnership ('SeaScapes'). SeaScapes is the first HLF Landscape Partnerships to focus on seascape and provides an ideal opportunity to address the relationship between heritage and Natural Capital / Ecosystem Services. SeaScapes commenced its 18-month development phase in January 2018; its implementation phase is earmarked for 2020-24. The range of actions anticipated by SeaScapes encompasses numerous initiatives where inclusion of heritage within Natural Capital / Ecosystem Services could have a marked impact on heritage and marine environmental management. As the first such seascape partnership, it can also be expected to influence projects addressing the marine environment at other points around the English coast.

4.1.6. For the purposes of this case study, 'marine area' is the same as referred to in the Marine and Coastal Access Act 2009 and includes fully submerged areas and the intertidal area below mean high water springs (MHWS). The marine area does not encompass coastal land above MHWS, but as MHWS follows rivers inland to their tidal limit, the marine area extends a considerable distance landward. In comparison, the SeaScapes project area cuts off just landward of the road and railway bridges at Wearmouth (and does not include the internal waters of the docks), and in The Narrows in the mouth of the Tyne.

4.1.7. There is of course, plenty of coastal heritage above MHWS, very close to the marine area. Coastal heritage above MHWS may be affected by impacts within the marine area from human activity,

weather, erosion and so on, but these are not the focus here. Equally, coastal heritage assets contribute to the character of the marine area even though they lie outside, where the setting of the heritage asset – which may be very extensive – encompasses the sea. However, in this study the focus is only on heritage assets that have a direct connection to tidal waters because their footprint lies within or across the boundary of the marine area.

4.1.8. As in the Dorset Stour case study, the relationship between heritage, Natural Capital and Ecosystem Services in the Tyne to Tees marine area is set out under the following five headings:

- The importance of heritage in the case study area
- Recognising heritage as Natural Capital / Ecosystem Services
- How people have shaped the environment
- How Natural Capital / Ecosystem Services are valued
- The relationship between people and the environment

4.2. The importance of heritage in the case study area

4.2.1. As noted previously, heritage retains an independent standing in legal and policy frameworks and amongst the public even if it is not integrated with Natural Capital / ES approaches. Decision-making informed by the Natural Capital / Ecosystem Services paradigm in the Tyne to Tees area must take account of heritage even if heritage is not regarded as Natural Capital or as being a source of Ecosystem Services.

4.2.2. The Tyne to Tees marine area is appreciated as a rich marine historic environment with numerous heritage assets. However, relatively few of its heritage assets are designated. There is only one Protected Wreck in the Tyne to Tees marine area: the wreck of an eighteenth-century collier brig at Seaton Carew. Equally, there is only one Scheduled Monument in the Tyne to Tees marine area: Town Wall and Sandwell Gate at Hartlepool, which forms the high-water mark. The Town Wall and Sandwell gate is also a Listed Building. There is, however, a range of piers, walls and bridges at Seaham, Sunderland / River Wear, and on the Tyne whose structures include elements within the marine area. One of these – the Wave Basin Battery at Sunderland – is to have its conservation addressed in the development phase of SeaScapes:

Seaton Carew Protected Wreck		
1000077	Seaton Carew Wreck	https://historicengland.org.uk/listing/the-list/list-entry/1000077
Town Wall and Sandwell Gate, Hartlepool		
1006761	Town Wall and Sandwell Gate, Hartlepool (SM)	https://historicengland.org.uk/listing/the-list/list-entry/1006761
1250535	Town Wall and Sandwell Gate, Hartlepool (LB)	https://historicengland.org.uk/listing/the-list/list-entry/1250535
Listed Buildings		
Seaham		
1232439	North and South Inner Piers, Seaham	https://historicengland.org.uk/listing/the-list/list-entry/1232439
1277116	Inner North Dock Walls, Seaham	https://historicengland.org.uk/listing/the-list/list-entry/1277116
Wear		
1279893	Dock Office, Walls and Piers, Hudson Dock, Sunderland	https://historicengland.org.uk/listing/the-list/list-entry/1279893
1207097	Swing Bridge, Hudson Dock, Sunderland	https://historicengland.org.uk/listing/the-list/list-entry/1207097
1207112	Wall and Pier, Tide Basin, Sunderland	https://historicengland.org.uk/listing/the-list/list-entry/1207112
1207135	Wave Basin Battery, Sunderland	https://historicengland.org.uk/listing/the-list/list-entry/1207135
1293182	Walls and Mooring Posts, North Dock Basin, Sunderland	https://historicengland.org.uk/listing/the-list/list-entry/1293182

1207085	North Dock Walls, Sunderland	https://historicengland.org.uk/listing/the-list/list-entry/1207085
1279911	Wearmouth Bridge	https://historicengland.org.uk/listing/the-list/list-entry/1279911
1207051	Monkwearmouth Railway Bridge	https://historicengland.org.uk/listing/the-list/list-entry/1207051
1279906	Roker Pier, Sunderland	https://historicengland.org.uk/listing/the-list/list-entry/1279906
Tyne		
1436854	South Pier, South Shields	https://historicengland.org.uk/listing/the-list/list-entry/1436854
1232321	South Groyne, South Shields	https://historicengland.org.uk/listing/the-list/list-entry/1232321
1025352	North Pier, Tynemouth	https://historicengland.org.uk/listing/the-list/list-entry/1025352

Table 10: Designated heritage assets in the SeaScapes project area

4.2.3. The Swing Bridge and Dunston Staithes on the Tyne are also Scheduled Monuments and Listed Buildings, though they are in the marine area landward of the SeaScapes project area. Similarly, there is a series of Listed Buildings with elements below high water and therefore within the marine area that are landward of the SeaScapes project area on the Wear and Tyne:

Tyne Scheduled Monuments/Listed Buildings		
1003722	Swing Bridge, River Tyne (SM)	https://historicengland.org.uk/listing/the-list/list-entry/1003722
1390930	Swing Bridge, River Tyne (LB)	https://historicengland.org.uk/listing/the-list/list-entry/1390930
1005898	Dunston Staithes, River Tyne (SM)	https://historicengland.org.uk/listing/the-list/list-entry/1005898
1248994	Dunston Staithes, River Tyne (LB)	https://historicengland.org.uk/listing/the-list/list-entry/1248994
Wear Listed Buildings		
1279892	Swing Bridge, Hudson Dock, Sunderland	https://historicengland.org.uk/listing/the-list/list-entry/1279892
1207096	Machinery Pit, Hudson Dock, Sunderland	https://historicengland.org.uk/listing/the-list/list-entry/1207096
1218456	Coal Staithe, Wearmouth Colliery	https://historicengland.org.uk/listing/the-list/list-entry/1218456
1292063	Lime Kilns, River Wear	https://historicengland.org.uk/listing/the-list/list-entry/1292063
1207052	Queen Alexandra Bridge, River Wear	https://historicengland.org.uk/listing/the-list/list-entry/1207052
1354978	Victoria Viaduct, River Wear	https://historicengland.org.uk/listing/the-list/list-entry/1354978
1120952	Lamb Bridge, Lambton Park, River Wear	https://historicengland.org.uk/listing/the-list/list-entry/1120952
Tyne Listed Buildings		
1184814	Lock and Lock Gates, Albert Edward Dock, River Tyne	https://historicengland.org.uk/listing/the-list/list-entry/1184814
1380276	Tyne Pedestrian and Cyclist Tunnels, River Tyne	https://historicengland.org.uk/listing/the-list/list-entry/1380276
1355285	Wall from Swing Bridge to Quayside Sheds, River Tyne	https://historicengland.org.uk/listing/the-list/list-entry/1355285
1248569	New Tyne Bridge, River Tyne	https://historicengland.org.uk/listing/the-list/list-entry/1248569
1248568	High Level Bridge, River Tyne	https://historicengland.org.uk/listing/the-list/list-entry/1248568

1242100	King Edward Railway Bridge, River Tyne	https://historicengland.org.uk/listing/the-list/list-entry/1242100
1370704	Tidestone, River Tyne	https://historicengland.org.uk/listing/the-list/list-entry/1370704

Table 11: Designated heritage assets in the marine area (outside SeaScapes project area)

4.2.4. Two other Listed Buildings of a maritime character – Beacon Tower[33] and Seaton High Light[34] – are on piers that are not designated and are to have their conservation addressed in the development phase of the SeaScapes project.

4.2.5. Although its boundary does not encompass the marine area, it is worth noting that elements of the World Heritage Site, Frontiers of the Roman Empire[35] (including the remains of Hadrian's Wall in Newcastle and the Roman Fort at South Shields), effectively span the marine area across the Tyne.

4.2.6. Conservation Areas at Tynemouth, North Shields Fish Quay, Old Sunderland Riverside, Seaham, Hartlepool Headland and Seaton all abut or overlap the marine area. In some cases, the Conservation Areas encompass structures built out into the sea, most notably at Seaham where the harbour works are a substantial part of the designation. The Conservation Areas at Old Sunderland Riverside[36], Seaham[37], Hartlepool Headland[38] and Seaton[39] are all registered as 'Heritage at Risk'; Old Sunderland Riverside also falls within the scope of the Sunderland Heritage Action Zone (HAZ)[40]. Dunston Staiths – a Scheduled Monument and Listed Building already referred to – is also registered as 'Heritage at Risk'. Also 'at Risk' is the only Registered Battlefield in the Tyne to Tees marine area – the Battle of Newburn Ford of 1640[41]. The battlefield is well inland of the SeaScapes project area but below the tidal limit of the Tyne, so it still falls within the marine area.

4.2.7. As demonstrated, the Tyne to Tees marine area touches numerous heritage designations, encompassed by the SeaScapes project area but also within tidal limits further inland. These assets are all recognised as being of such significance as to warrant designation, and all have a degree of protection under heritage or planning law, irrespective of the application of Natural Capital or Ecosystem Services approaches.

4.2.8. It is obvious, however, that all these designations relate to the coast rather than the open sea. The only designations seaward of low water are piers, whose structures are largely above low water even if their bases are below. The lack of designated heritage assets in subtidal parts of the Tyne to Tees marine area is problematic for Natural Capital / Ecosystem Services approaches and for measures that address designated assets only (Sunderland et al., 2019). However, designation is not the only way of denoting significance or of providing protection. Planning law on land and at sea can be used to protect non-designated heritage assets according to their significance; non-designated assets of equivalent significance must be managed according to the same principles as designated assets:

> 2.6.6.5 Many heritage assets with archaeological interest in these areas are not currently designated as Scheduled Monuments or Protected Wreck sites but are demonstrably of equivalent significance. The absence of designation for such assets does not necessarily indicate lower significance and the marine plan authority should consider them subject to the same policy principles as designated heritage assets (including those outlined) based on information and advice from the relevant regulator and advisors.
>
> (HM Government, 2011)

[33] https://historicengland.org.uk/listing/the-list/list-entry/1250819
[34] https://historicengland.org.uk/listing/the-list/list-entry/1263126
[35] https://historicengland.org.uk/listing/the-list/list-entry/1000098
[36] https://historicengland.org.uk/advice/heritage-at-risk/search-register/list-entry/9061
[37] https://historicengland.org.uk/advice/heritage-at-risk/search-register/list-entry/4155
[38] https://historicengland.org.uk/advice/heritage-at-risk/search-register/list-entry/2184
[39] https://historicengland.org.uk/advice/heritage-at-risk/search-register/list-entry/2186
[40] https://historicengland.org.uk/services-skills/heritage-action-zones/sunderland/
[41] https://historicengland.org.uk/listing/the-list/list-entry/1000025; https://historicengland.org.uk/advice/heritage-at-risk/search-register/list-entry/24542.

4.2.9. Again at the coast, there are numerous non-designated assets recognised in local authority Historic Environment Records that overlap the marine area. These include harbour structures around Hartlepool for example, including West Harbour, the Commissioner's Harbour, the Tide Harbour and Victoria Dock. The Headland Breakwater, North Gare breakwater and seaplane station at Seaton Carew are all assets on the HER with substantial structural elements in the marine area. Similarly, piers, docks, jetties, staithes, former shipyards and waterfront sites are included in the HER for Sunderland and Newcastle. A series of other sites – former collieries, quarries and military sites – abut the marine area on the open coast between the Tyne and the Wear.

4.2.10. Evidence of much earlier inhabitation of the marine area is also recognised in HER records, including reports of Mesolithic flint from several intertidal locations: Velvet Island; Marsden; Ryhope; Whitburn; Seaham; Easington Colliery; Horden; Blackhall; Seaton Carew. The prehistoric submerged forest at Hartlepool also features an HER record[42] extending north and south of Hartlepool Headland and beyond the low water mark. As well as the extensive deposits around Hartlepool, submerged forests have also been identified at Sunderland[43] and Whitburn[44]. As indicated at Hartlepool, prehistoric deposits comparable to submerged forests are likely to be present seaward of the low water mark at other locations off the Tyne to Tees coast, though they have yet to be recorded. The presence of prehistoric material from below low water is also indicated by a Neolithic greenstone axe recovered from the River Wear[45]. Numerous recoveries of Bronze Age metalwork from the Tyne[46] and the Wear[47] during dredging in the nineteenth century might also point to the presence of prehistoric material in areas now below low water.

4.2.11. Notwithstanding these pointers towards prehistoric material in subtidal areas, the principal form of heritage asset recorded off the Tyne to Tees coast are shipwrecks. No wreck sites below low water are designated; the one designated wreck – at Seaton Carew, referred to above – being a reminder that wrecks are found in intertidal areas too as a result of going ashore, or being abandoned as hulks.

4.2.12. Archaeological records of shipwrecks are of two main types: casualties – where there is a documentary record of vessel being lost but the wreck itself has yet to be found; and wreck sites – where the physical remains of a vessel are known to be present. Whilst some wrecks have been attributed to a named vessel and are thereby identified, other 'known' wrecks are not yet unidentified. In some cases, identifications are provisional and open to revision. Casualties are important because they indicate the historic character of seafaring in a region: the kinds of ships, cargos, circumstances of loss and so on. However, casualties are not features of the physical environment and as such they are not 'heritage assets', so they are not considered further in this case study. In contrast, wreck sites are features of the environment, irrespective of whether they are identified or unidentified.

4.2.13. As well as uncertainties in the identification of known wreck sites, the dynamics of the environment, the variability of methods used to discover shipwrecks on the seabed, and major issues over position-fixing at sea can all contribute to a degree of uncertainty over the position and character of recorded wreck sites. Archaeological records of wreck sites across a region, drawing on records in multiple local HERs plus national records, can add to imprecision. Fortunately, major improvements in routine wreck survey and position-fixing are occurring courtesy of the Civil Hydrography Programme (CHP)[48] in particular. However, the CHP does not yet encompass the whole of the Tyne to Tees region. In the absence of consolidated archaeological data, it is estimated from the sources considered for this case study that there are 120-150 known wreck sites in the Tyne to Tees marine area.

4.2.14. The known wreck sites are predominantly of mid-nineteenth to mid twentieth-century date, fitting a national pattern in terms of the date of known wrecks. This is attributable to improving record-

[42] Tees HER 1603; https://historicengland.org.uk/content/docs/research/peat-database-co-durhampdf/

[43] T&W HER 13594; https://historicengland.org.uk/content/docs/research/peat-database-co-durhampdf/

[44] T&W HER 1997; https://historicengland.org.uk/content/docs/research/peat-database-co-durhampdf/

[45] T&W HER 59; NRHE 762642.

[46] E.g. NRHE 22723; 25047; 25048; 25090; 25091; 25123; 26209; 26573; 623289; 622133; 623288; 762553.

[47] E.g. NRHE 26162; 762384

[48] https://www.gov.uk/guidance/the-civil-hydrography-programme

keeping in the nineteenth century and the number of losses caused by wartime conditions in 1914-1918 and 1939-45. Moreover, vessels of this period often have large ferrous components and/or hulls that remain prominent on the seabed after sinking, meaning that they can be found using echosounders, or by being snagged by fishing gear. The emphasis in archaeological records on mid-nineteenth to mid-twentieth century wreck sites does not mean that there are no earlier wrecks present – discoveries of Roman armour off the Tyne might indicate an as yet unlocated shipwreck from that period[49] – simply that such earlier vessels do not emerge as easily from the available data. The same is true of smaller vessels of more recent date: wrecks of wooden fishing vessels are probably under-represented in archaeological records even for relatively recent periods.

4.2.15. A further consequence of the inherent emphasis on prominent wrecks is that air crash sites are probably also under-represented. Aircraft are known to have crashed into the sea off the Tyne to Tees coast, especially during the Second World War. However, the only references in archaeological records are to reported losses (casualties) rather than known air crash wreck sites[50].

4.2.16. Notwithstanding the biases in archaeological records, shipwreck sites are the principal type of heritage asset in the subtidal area of the Tyne to Tees study area. They are significant – probably highly significant in some cases (Firth and Rowe, 2016) – and receive a degree of protection as non-designated heritage assets by virtue of the UK Marine Policy Statement. Their archaeological significance and protection are independent of Natural Capital / Ecosystem Services approaches.

4.3. Heritage as Natural Capital / Ecosystem Services

Heritage as Cultural ES in the Tyne to Tees marine area

4.3.1. As discussed in respect of the Dorset Stour, the role that heritage assets play in respect of Natural Capital / Ecosystem Services depends on whether Ecosystem Services are defined in such a way as to apply only to services arising from features that are wholly natural in origin. If ES can only arise from 'things in nature', then the capacity of heritage assets in marine areas to give rise to ES is foreclosed. Taking the broader view – that 'things in the physical environment' can give rise to ES even if they are non-natural in origin – prompts acknowledgement that marine heritage assets can contribute to an extensive range of ES.

4.3.2. It is also worth recalling the earlier point that the capacity of physical features to give rise to ES is framed by people's predispositions; that even for the most natural sources of ES, the ability of people to derive such services is a product of their culture.

4.3.3. As noted above, CICES offers the following categorisation of cultural ES:

Divi-sion	Group	Code	Simple descriptor	Code	Simple descriptor
Direct	Physical, experiential	3.1.1.1	Using the environment for sport and recreation; using nature to help stay fit	6.1.1.1	Things in the physical environment that we can experience actively or passively
		3.1.1.2	Watching plants and animals where they live; using nature to destress		
	Intellectual, representative	3.1.2.1	Researching nature	6.1.2.1	Things in the physical environment that we can study or think about
		3.1.2.2	Studying nature		
		3.1.2.3	The things in nature that help people identify with the history or culture of where they live or come from		
		3.1.2.4	The beauty of nature		
Indirect	Spiritual, symbolic	3.2.1.1	Using nature to as a national or local emblem	6.2.1.1	

[49] T&W HER 1087; NRHE 26493.

[50] Durham HER H10254; H10255.

Divi-sion	Group	Code	Simple descriptor	Code	Simple descriptor
		3.2.1.2	The things in nature that have spiritual importance for people		Things in the physical environment that are important as symbols
		3.2.1.3	The things in nature used to make films or to write books		
	Other	3.2.2.1	The things in nature that we think should be conserved	6.2.2.1	Things in the physical environment that we think are important to others and future generations
		3.2.2.2	The things in nature that we want future generations to enjoy or use		

Key	biotic	abiotic

Table 12: Biotic and abiotic cultural ES, CICES

4.3.4. The cultural ES categorised in CICES can be seen to arise from the three main types of heritage in the Tyne to Tees marine area: historic marine structures; submerged forests; and wreck sites.

4.3.5. Heritage assets play a particularly important role in enabling people to obtain Ecosystem Services in the marine zone. Much of the coastal infrastructure that people use to interact with the marine environment is a heritage asset: piers, breakwaters, jetties, esplanades and promenades and their various steps and slips to the foreshore or sea. At Tynemouth and South Shields, Roker and Sunderland, Seaham, Hartlepool Headland and Seaton Carew, the coastal edge is made up of marine structures dating back to the nineteenth century. These historic structures provide people with opportunities to experience wildlife and aesthetically pleasing landscapes, contributing to their well-being, tranquillity and exhilaration; they are a fundamental feature of people's experience of the seaside and of the cultural ES that they draw from the seaside environment.

4.3.6. The quantitative contribution that historic marine structures make to cultural ES at the coast is difficult to estimate because they tend to be openly accessible and used for informal recreation, and visits. Consequently, there is no information about levels of usage in, for example, Visit Britain's data on visitor numbers. The nearest proxies are counts in 2017 of 27,885 visitors to Souter Lighthouse and the Leas and 25,457 visitors to Tynemouth Priory and Castle[51]. Another indirect measure is provided by research on sea angling by Defra, which indicated almost four million days spent fishing from the shore in 2012 (Armstrong et al., 2013 Annex I) – a fair proportion of which is likely to have taken place from heritage assets. Marine structures on the Tyne itself, South Shields Pier, Roker Pier, the River Wear, Hendon Promenade, Seaham North Pier, Middleton Pier (Hartlepool) and the breakwaters at the mouth of the Tees are all flagged as favourable angling locations[52]. Attempts to model marine recreation nationally emphasise access and infrastructure (Marine Planning Consultants, 2014); without the access provided by heritage assets, the number and range of people who can experience the marine environment would be far lower.

4.3.7. It might be argued that the source of cultural ES arising from these heritage assets is natural, i.e. the sea itself, fish, seabirds, the experience of a rocky coast or sandy shore: providing access to ES is not, in itself, an Ecosystem Service. Even if people do not draw explicit distinctions, however, the character of a historic pier or seafront steps is likely to be contributing to the whole experiential package. Regarding historic infrastructure simply as a passive means of providing access also overlooks the active and creative manner in which people's engagement with their environment generates ES. The effort directed towards seaside architecture and furniture, and people's responses to it (Brodie, 2018; Crust, 2009; Hassan, 2003) strongly suggest that the built environment of the seafront is not neutral in terms of the services that are conveyed. Nonetheless, the role that seaside heritage plays in delivering Ecosystem Services does not appear to have been subject to qualitative or quantitative investigation. A photograph of Cleethorpes Pier illustrates the

[51] Visit Britain – full attractions listing 2017: https://www.visitbritain.org/sites/default/files/vb-corporate/Documents-Library/documents/England-documents/full_attractions_listing_for_publication_2017_v3.xlsx
[52] https://britishseafishing.co.uk/north-east-england/

section on heritage, health and wellbeing of *Heritage and Society 2018* (Historic England, 2018a, pp. 8–9), but there is no express reference to the seaside in the text.

4.3.8. The cultural ES categorised in CICES provide a framework through which the role of historic structures play in the Tyne to Tees area: for marine-based recreation, de-stressing, appreciating aesthetics, symbolising the region, inspiring creativity and so on. Application of CICES should encompass the cultural ES derived directly from historic marine structures – from their immediate spatial extent and setting – but also from the wider marine environment that is accessed from heritage assets such as slipways, harbours and jetties. Research in this direction could help distinguish the interplay of nature and culture in delivering benefits from the marine environment.

4.3.9. The submerged forests in the Tyne to Tees marine area present a contrast to historic marine structures because these deposits and surfaces are predominantly a product of natural processes. Formed of organic plant material interspersed with inorganic silts and clays, they owe their origin to natural vegetation overtaken by waterlogging and sea-level rise. The appellation 'submerged forest' arises from the presence of large timber elements such as root boles, fallen branches and trunks. Submerged forests and other comparable former landsurfaces may be visible on the foreshore at periods of very low tide, or when beach material has been stripped away by storm action, for example. Other similar deposits can be found fully submerged and buried: in most circumstances they are only accessible through specialised research using geophysical or geotechnical methods, though they might be encountered by fishermen (as 'moorlog') or divers.

4.3.10. The heritage interest of submerged forests arises from evidence of human inhabitation of the former landsurface, either directly in the form of artefacts, cut marks on timber or footprints, or indirectly in the rich palaeo-environmental record often associated with these deposits that can show changes caused to the environment by the presence of people. Hence even if a submerged forest is predominantly natural in origin, the details of its composition might indicate that it has been shaped by human activity such as burning, grazing, introduction of new species for cultivation and such like. The palaeo-environmental evidence is also important geologically, so Hartlepool Submerged forest is designated as a Site of Special Scientific Interest (SSSI) because it 'provides important stratigraphic evidence for Flandrian sea-level changes in Eastern England'[53].

4.3.11. The cultural ES provided by submerged forests at Hartlepool, Sunderland and Whitburn arise from researching (CICES 3.1.2.1) and studying (CICES 3.1.2.2). Public interest in submerged forests can be quite high – especially when such intriguing features are suddenly exposed beneath a familiar beach – so there might also be a contribution to identity, history and culture (CICES 3.1.2.3). For the people that visit them, features like the submerged forest at Hartlepool may contribute to historic character and local pride, reported by Willis *et al.* (2014) as an important component of the benefits that people feel from the coastal environment.

4.3.12. Arguably, these kinds of prehistoric deposits, which point back to lands lost beneath the waves as a result of climate change, are having a yet more profound effect. 'Doggerland' – the term coined by Bryony Coles to refer to extensive prehistoric landsurfaces beneath the North Sea – has gained a currency far beyond archaeology (Firth, 2010) and continues to inspire new literary and artistic work (Blackburn, 2019) (CICES 3.2.1.3). Again, it is worth underlining that cultural ES are not intrinsic but depend on prior knowledge, appreciation and access: inspiration arising from the environment will draw heavily on the cultural input of the artist. Designation of Hartlepool Submerged Forest as an SSSI and protection of other examples through the historic environment provisions of the UK Marine Policy Statement also indicate that submerged forests give rise to cultural ES as things that ought to be conserved and bequeathed (CICES 3.2.2.1; 3.2.2.2).

4.3.13. Comparable forms of cultural ES can also arise from wreck sites in the marine area, though the character and volume of access is different to people's experience of historic marine structures or even submerged forests. The opportunities for direct, physical or experiential ES from submerged wreck sites is limited principally to divers, though the case might also be made for fishermen, sea anglers and other sea users who 'visit' wreck sites and experience them as marks on the chart, through fish on their lines, or as readings on their echosounders. Again, this illustrates that Ecosystem Services are heavily dependent on what people bring to the environment: shipwrecks

[53] https://designatedsites.naturalengland.org.uk/PDFsForWeb/Citation/1002491.pdf.

are not inherently legible even to divers; the service that they obtain is likely to be driven by what they already know of a wreck, its history, circumstances of loss, general layout and so on. For other sea-users this is likely to be truer: they will be conscious of a wreck and frame their activities accordingly, but may know very little about the wreck as a feature of the historic environment. The variability of ES from the same asset based on what people bring to it is especially important when considering how people who remain on shore might obtain intellectual, representative or symbolic services from wreck sites. Ecosystem Services from the marine environment need not be divided between people onshore and offshore; there is instead a spectrum in what people bring to the asset that cuts across this distinction. People ashore can derive services from wreck sites that may be just as beneficial as those derived by divers in direct contact, depending on what they are able to bring to the asset.

4.3.14. The capacity for people onshore to derive ES from wreck sites they can never visit goes back to literary accounts of wrecking in antiquity (CICES 3.2.1.3). The huge increase in wreck site investigation through the invention of SCUBA after the Second World War has been accompanied by strong public interest amongst non-divers in the media, in books and on television. More recently, precise position-fixing, a vast increase in the detail of sub-sea surveying, the availability of 3D visualisation methods and the connectedness of the internet are revolutionising the accessibility of wreck sites and other underwater features. Underwater photographs, 3D surveys and all sorts of documentation are being made available and combined into 'virtual dives' that people can experience on computers and smart phones, whether they are just on the coast or indeed anywhere across the world (Firth et al., 2019). Enabling people to engage with wrecks is not only about technology, however: a wide range of methods is increasingly being used to engage people in heritage that is just out of sight beneath the waves[54].

4.3.15. As noted in respect of other forms of heritage asset, cultural ES from wreck sites do not arise solely from the material being cultural. Divers' interest encompasses the marine life that colonise wreck sites and the fish that congregate around them, as well as the structure of the wreck itself (CICES 3.1.1.2); and technical interest may arise from the depth, hazards and discipline associated with wreck diving rather than the wreck as a heritage asset. Similarly, the undoubted recreational importance of wreck sites to sea anglers is based predominantly on marine life, not the history of the former ship (CICES 3.1.1.1). More remotely, underwater photography featuring wreck sites may focus more on overall aesthetics and/or the details of marine life (CICES 3.1.2.4) than on the wreck as a cultural artefact. Finally, even where interest lies in the history of a wreck site, this may be for commemorative reasons relating to family or community members who were once aboard the ship or who have died through its loss (CICES 3.2.1.2), rather than for the wreck site's heritage or archaeological interest.

Non-cultural ES from heritage in the Tyne to Tees marine area

4.3.16. A first point to make about the vessels that lie wrecked on the Tyne to Tees coast and many of the region's marine structures is that they were not built to furnish cultural ES. Rather, they were built in order to help deliver what can now be termed provisioning and regulating ES. The ships and the structures arose from the wish to address the disbenefits of the marine environment and make available its benefits, notably fish and transport: especially the export of coal, and of iron and steel products. These exports in turn reflect the natural resources available in the region, which also enabled staggering advances in engineering – including shipbuilding – that contributed so much to the economic base and identity of the communities that developed here.

4.3.17. The role that water plays in transport and communication is not easily reconciled with CICES, but it is plainly a service that arises from the environment. Access to this service, to be able to move with relative ease up and down rivers, along the coast and across the sea, is one of the most fundamental benefits to people of the Tyne to Tees coast and has been central to the history of the region. The dis-benefits that go hand-in-hand with the sea in particular – the danger it presents when the weather is foul or the seabed becomes shallow – is the reason why parts of the coast have been artificially protected with breakwaters and piers, to maximise and extend marine transport as an Ecosystem Service. The coast has also been modified artificially with seawalls to

[54] See e.g. http://www.fjordr.com/fjordr-blog/the-spoken-word-as-virtual-reality-exploring-first-world-war-shipwrecks-through-creative-writing

regulate erosion and safeguard resources onshore, in some cases interfering with the capacity of the coast to regulate itself and thereby prompting the need for yet further human intervention. The sea has also been used to dispose of and dilute waste (CICES 5.1.1.1) including sewage and mineral waste, which characterised the Durham coast until recently. The complex interaction between human and natural processes on the Tyne to Tees coast – largely driven by the pursuit of provisioning and regulating services – has resulted in an environment that is far from nature even though natural processes were – and continue to be – very powerful. This is perhaps best illustrated by the changes to the estuary of the River Tees[55] as a result of breakwaters at North Gare and South Gare, dredging and reclamation. Although very heavily altered by human activities, and despite being a continuing focus of heavy industry, the modified coast offers important habitat, is protected by nature conservation designations, and gives rise to various ES accordingly.

4.3.18. The capacity of heritage assets in the marine environment to give rise to provisioning or regulating ES appears not to have received much attention. In the case of marine structures and wreck sites, attention can be directed to the provisioning and regulating ES they give rise to directly from their immediate footprint in the environment; and also from the indirect ES that arise over a larger area because of their wider impact on the environment. For example, the presence of a wreck can influence the tidal flow of water and the movement of sediment, often creating areas of erosion and deposition that may extend tens or even hundreds of metres from the wreck itself. The influence of marine structures may be far more extensive: piers and breakwaters such as those at the mouth of the Tyne and the Wear were built to protect shipping from the energy of the sea, effectively changing the environment within their enlarged harbours. The provisioning and regulating roles of those protected waters is a consequence of the heritage assets that enclose them.

4.3.19. The non-cultural ES of marine structures – and the water column and seabed they affect – also arises from the habitat they present. At many places on the Tyne to Tees coast, the edge of the sea is entirely artificial and engineered; but it still provides places for marine flora and fauna to live. As noted previously, these structures are often heritage assets and can be very extensive: At Hartlepool, Seaham, on the Wear and the Tyne, marine structures – often dating back to the nineteenth century – provide an unnatural edge to the sea over many kilometres. The proliferation of artificial structures at the coast has been referred to as ocean sprawl (Firth et al., 2016a), and its expansion is a continuing concern. But it is important to note that ocean sprawl has its roots far in the past and has been assimilated as habitat as decades and centuries have passed. For example, Hartlepool Sandgate and Town Wall – which the sea laps against at high water – dates to the fourteenth century[56]. Some marine structures may be quite inhospitable to marine life because of their hard and uniform components and because they receive the full force of the marine environment against their surfaces. But the shelter they create, and more complex structures such as piers and jetties built on piles or pillars, can form quite rich habitats. The finer sediments of sheltered waters may be targeted for shell fishing (CICES 1.1.6.1); marine structures may also play an important part in the lifecycles of nursery populations (CICES 2.2.2.3). Interest in improving the ecological value of new structures (Firth et al., 2016b) could be informed by assessment of the development of habitats around heritage structures and the characteristics of those structures where they play a positive role. Importantly, looking at the history of marine structures as habitats also provides an opportunity to consider large-scale and cumulative effects across coastlines that have been heavily modified over centuries, as context for the detail of single new features.

4.3.20. Submerged forests and comparable deposits in the marine area may also provide provisioning and regulating ES. Submerged forests are a form of peatland, serving an important regulating role as a carbon dioxide store (CICES 2.2.6.1). Their extent and volume may not be as great as peatlands on land, but their degradation will still result in the release of carbon dioxide that was formerly locked away. The other key role that submerged forest may play is as a habitat, offering provisioning ES where it contributes to commercial fishing, and regulating ES where it plays a role in species' lifecycles. The role played by peat as a seabed habitat arises because – where exposed – it is amenable to burrowing animals such as shellfish, or it provides a convenient roof for animals that burrow beneath it. At Bouldnor Cliff – a sequence of submerged prehistoric peats and silts in the Solent – the first direct evidence of human inhabitation comprised flint artefacts in the spoil in

[55] http://archiveshop.northyorks.gov.uk/latest-products/ZK4861.html

[56] https://historicengland.org.uk/listing/the-list/list-entry/1250535

front of a lobster burrow (Momber et al., 2011). The frequent references to moorlog in accounts of trawling – particularly associated with the Dogger Bank – might also suggest that areas where peat is exposed on the seabed are productive areas for fishing.

4.3.21. Fishing is also the means through which the provisioning ES of wreck sites is most evident, though not quantified. Relatively little work has been done on the role that wreck sites play as habitats in UK waters, but they clearly serve as points at which fish aggregate and they are targeted by sea anglers and commercial fishermen accordingly. There are 269 fishing vessels with North Shields as their administration port (which covers the coast to the north as well as south of the Tyne), of which 214 (almost 80%) are relatively small (under 10m) and are likely to focus on inshore waters (Elliott and Holden, 2018 Chart 2.5). A total of 556 fishermen are attributed to the North Shields administration port, predominantly in the under 10m fleet (Elliott and Holden, 2018 Chart 2.12). More detail about the under 10m fleet is provided in online statistics, listing 64 vessels at North Shields, South Shields, Hartlepool and Sunderland in February 2019[57]. North Eastern IFCA statistics indicate that the inshore fleet is involved in potting, netting and trawling (North Eastern Inshore Fisheries and Conservation Authority, 2012). The weight and value of landings published in 2018 is as follows, split by vessel group and species group (demersal = seafloor; pelagic = water column)[58]:

Port of Landing	Landed weight (tonnes)	Value(£000s)
Hartlepool	**1107**	**3070**
Demersal	**89**	**130**
10m&Under	56	90
Over10m	32	40
Pelagic	**6**	**11**
10m&Under	5	9
Over10m	1	3
Shellfish	**1012**	**2929**
10m&Under	108	615
Over10m	905	2314
North Shields	**1090**	**4057**
Demersal	**324**	**369**
10m&Under	1	1
Over10m	323	368
Pelagic	**2**	**4**
Over10m	2	4
Shellfish	**764**	**3684**
10m&Under	166	826
Over10m	598	2859
North Sunderland	**3**	**17**
Demersal	**0**	**0**
Over10m	0	0
Shellfish	**3**	**17**
Over10m	3	17
Seaham	**20**	**140**
Shellfish	**20**	**140**
10m&Under	1	8
Over10m	20	132
South Shields	**13**	**46**
Demersal	**0**	**0**
10m&Under	0	0
Over10m	0	0
Shellfish	13	45
10m&Under	1	14

[57] https://www.gov.uk/government/statistical-data-sets/vessel-lists-10-metres-and-under

[58] https://www.gov.uk/government/statistics/monthly-sea-fisheries-statistics-december-2018

Over10m	11	32
Sunderland	**33**	**155**
Demersal	**5**	**6**
10m&Under	5	6
Pelagic	**1**	**0**
10m&Under	1	0
Shellfish	**27**	**149**
10m&Under	21	119
Over10m	5	30
Grand Total	**2266**	**7485**

Table 13: Monthly sea fisheries statistics, December 2018

4.3.22. Unfortunately, it is not possible to say what proportion of these landings are attributable to fishing in the vicinity of wreck sites, or to indicate the degree to which wreck sites contribute towards these provisioning ES through the lifecycle of the species being caught. There is enough in these numbers to suggest, however, that further attention should be directed to the role that heritage assets – wreck sites – might play in commercial fishing.

4.3.23. Given the interest arising from wreck sites as habitats – manifest in recreational diving, sea angling and commercial fishing – it seems surprising that relatively little work has been done on wrecks as habitats in UK waters. Hiscock (2018) sets out the general characteristics of wrecks and other artificial structures as habitats in UK waters, but more seems to have been done on the Continent. In the Netherlands, it has been contended that shipwrecks function as key habitats, nurseries, and refugia that are rare or absent anywhere else in the Netherlands (Lengkeek et al., 2013). The biodiversity of one wreck, the *Birkenfels*, was found to be greater than that of nearly all the soft bottom communities of the Belgian Continental Shelf (Massin et al., 2002). Zintzen et al. (2006) commented on the probable importance of the increased density of fish around shipwrecks, including commercially important species. Zintzen et al. (2008) concluded that even though the spatial area of shipwrecks is a very small percentage of the Belgian part of the North Sea, they may concentrate locally a significant part of the biomass (and see Zintzen, 2007). Shrieken et al. (2013) note that traditional survey methods favour soft substrates and that monitoring hard substrates could increase records relating to species diversity by 10%, presenting a more accurate view of the dynamics of the biodiversity present in marine regions. Coolen et al. identified *caryophyllia smithii* on a wreck located through archaeological assessment of an offshore wind farms, the first observation of a hard coral in the central southern North Sea which points to the role that wrecks might play as stepping stones in extending the range of species with pelagic larval stages (Coolen et al., 2015). Krone and Schröder also noted the potential importance of wrecks as stepping stones for lobster across the North Sea, as well as providing habitat that was otherwise rare in the German Bight (Krone and Schröder, 2011).

4.3.24. The relatively limited evidence from shipwrecks has been used in gauging the Ecosystem Services that arise from newer structures on the seabed, notably offshore wind farms (Causon and Gill, 2018). Inger et al. (2009) made the case for further research into the potential benefits of marine renewable energy installations because of their potential of structures to increase local biodiversity as 'artificial reefs' and act as fish aggregation devices. The potential for habitat creation around offshore windfarms is also addressed in detail by Wilson (2011) again drawing on the limited studies that have been conducted on wreck sites as well as other structures, concluding 'studies have shown that the introduction of almost any structure into the oceans will result in the colonisation of that structure, and that in many cases, this brings about increased productivity, rather than simply aggregating life from adjacent areas (Wilson, 2011, p. 199).

4.3.25. Evidence for the Ecosystem Services arising from artificial structures in the marine environment has also been used in another sector, oil and gas, in considering the advantages and disadvantage of removing redundant installations. The 'Influence of man-made Structures In The Ecosystem' (INSITE) programme[59] carried out a series of investigations into the ecosystem effects of oil and gas infrastructure and their connectivity in the North Sea, to help in making decisions about decommissioning. Synthesis of a number of empirical and model-based studies notes how the

[59] https://www.insitenorthsea.org/

pattern of biodiversity in the North Sea has been changed by the introduction of oil and gas infrastructure over the last 40-50 years, which provide 'islands' that support hard bottom communities. A wide range of elements of the North Sea ecosystem are considered, and it is noted that areas where there are numerous wrecks are considered to be less sensitive to the removal of oil and gas installations because of the role that the wrecks themselves play (Independent Scientific Advisory Board (ISAB), 2018, p. 20).

4.3.26. Studies such as these suggest that wreck sites, as a specific form of heritage asset, are playing a substantive role in North Sea ecosystems. In addition to their local effects, they may have much wider systemic effects by forming stepping stones or a network. Their very limited spatial extent – compared to the habitat types that are usually mapped – may mask the intensity of the effect they have; and this may be being missed because of the emphasis on traditional survey methods that favour extensive soft substrates. Wreck sites are topographically complex, providing places with different attitudes and orientations that encourage biodiversity. Although the specific literature on wreck sites as habitats in UK waters is limited, there is a range of scientific literature from other sectors that could be brought to bear. As noted above, there are 120-150 wreck sites off the Tyne to Tees coast; further work to understand the contribution that these heritage assets make to non-cultural ES is recommended.

4.3.27. Wreck sites may also present a negative service in relation to the use of water for transport, if the wreck presents a hazard to navigation. This was a key consideration during the First and Second World War and their aftermath, when newly-sunk wrecks could present a major hazard. Action to disperse dangerous wrecks and subsequent deterioration caused by the marine environment have reduced this issue, though wreck surveys are still carried out as a matter of course for navigational safety. Navigational issues are more likely to arise from historic wrecks where changes to the seabed occur or are contemplated, where moving sandbanks uncover a wreck or plans are made to make a new or deeper channel, for example. The negative service of a historic wreck in the marine environment could place it at risk from dispersal or clearance in the interests of navigational safety.

4.3.28. Historic wreck sites might also present a complex Ecosystem Services where they are associated with pollutants such as oil or chemicals or other hazards such as explosives (Firth, 2018). The presence of pollutants and other hazardous materials in the marine environment is negative, but a wreck may serve to contain the pollutant and prevent it from causing damage, which is a valuable service akin to the role played by peat in locking-up carbon dioxide. However, wrecks sites are often not stable in the long term, as they are made of materials that corrode in seawater and which are susceptible to collapse or other deterioration. The sudden release of a previously-contained pollutant could have a serious negative impact, diminishing a range of cultural, provisioning and regulating ES. On the Tyne to Tees coast, the Royal Navy took the precaution of destroying a torpedo that had been exposed from the U-boat UC-32 just off Roker, presumably because of the threat this posed in the marine environment[60].

4.3.29. The propensity of wreck sites to generate non-cultural ES arises mainly from vessels with metal components and/or hulls that remain prominent on the seabed, which have features that can be colonised and provide protection. The Tyne to Tees area also includes predominantly wooden shipwrecks whose prominence is far less, but which may present distinct environmental niches – and give rise to Ecosystem Services – nonetheless. MSDS and Carcinus have examined the ES associated with wooden wrecks sites in detail as part of their case study under the wider HNCES programme (Evans and Davison, 2019).

4.4. How people have shaped the environment

4.4.1. It is well-established that the landscape on land in England is predominantly artefactual, having been heavily modified by human activities over millennia. The sense that the marine zone has also been subject to significant human modification over similar periods is less widely recognised. The time-depth of human modification of the marine environment is most evident at the coast, where

[60] https://www.sunderlandecho.com/our-region/sunderland/first-world-war-german-submarine-torpedo-safely-detonated-off-coast-1-7989419. And see https://hec.lrfoundation.org.uk/whats-on/blogs/below-the-waves-rfa-war-methar on concern about oil from wreck of *War Mehtar* off East Anglia.

the familiar form of rivers, estuaries and even the open coast is often likely to be a product of human intervention. The degree to which the offshore environment has been shaped by people – over long timespans – is less widely recognised.

4.4.2. In the previous section, the discussion focused on Ecosystem Services arising from heritage assets in the marine area, including where the presence of those assets has influenced the environment and the services it gives rise to. The point was made that many heritage assets owe their origins to efforts to derive or maximise Ecosystem Services from the marine environment, or at least to diminish the disbenefits of that environment. Many heritage assets originated as interventions in the environment that were intended to shape it; unintended consequences also arose from those interventions, and yet more interventions were accidental or incidental.

4.4.3. The need to deal with the way people have shaped the marine environment is a key driver for Natural Capital and Ecosystem Services approaches, so that human interventions are managed to be more sustainable. The existence of these approaches underlines the degree to which the marine environment is not pristine; human impacts are so pervasive that a different epoch – the Anthropocene – is widely recognised. The quite sudden public response to the extent, volume and impacts of plastic in the marine environment – which is directly informing regulation, policy and behaviour – underlines an acceptance that people shape the seas and oceans; and that those changing oceans – through sea-level and storminess – will change the coast also. What seems harder for people to acknowledge is that people have been shaping the marine environment for a very long time. The human history of the marine environment is poorly understood: when, how and why did human impacts on the marine environment become unsustainable, and what does this mean for attempts to achieve sustainability soon? These are questions that must be addressed over timescales measured in centuries and millennia, not just decades.

4.4.4. Unfortunately, information on the human history of the marine environment has not been collated at scales that could inform the management of the Tyne to Tees coast, yet such a body of work can be contemplated. Historical and archaeological investigation of the marine environment and the adjacent land could be expected to play a large part. Two key aspects of the history of the Tyne to Tees marine are associated with heritage assets and have been considered above, namely the physical shaping of the coast, and the introduction of wreck sites. Two other key aspects have a less immediate connection to heritage assets but still fall within the scope of heritage-based investigation: the input of sediments and pollutants; and fishing.

4.4.5. To recap, marine structures provide and shape much of the Tyne to Tees coastline, especially at the mouths of the major estuaries (Tyne, Wear and Tees) but also at Seaham, Hartlepool and Seaton Carew. Their historical development is set out in detail in a series of Port Heritage Summaries[61]. Many of the marine structures are heritage assets, both designated and non-designated. The marine built environment – a historic ocean sprawl – forms a distinct and extensive set of substrates and habitats; it also influences substrates and habitats beyond its immediate footprint. Also as noted above, marine structures give rise to both cultural and non-cultural ES and provide access to many more. As well as built structures, the shaping of estuaries and coasts also includes excavation by dredging, altering the form of channels, and removing former features. These underwater earthworks are not commonly recognised as heritage assets, despite their scale, age and importance to the communities they served.

4.4.6. Wreck sites are usually incidental impositions on the marine environment (though there are also instances of vessels being sunk with the intention of changing the environment, as blockships or to form a base for reclamation). Like marine structures, they have both an immediate footprint and a wider influence because of their effect on local currents and sedimentation. Again, they provide substrates and habitats, which may be distinctive and important where their hard forms contrast with extensive areas of soft substrates. Drawing from work on offshore wind farms and oil and gas infrastructure referred to above, there are indications that the influence of wreck sites on the marine environment could be very extensive where wreck sites form networks and act as 'stepping stones'. The influence of wreck sites on the environment appears to give rise to Ecosystem

[61]. Port Heritage Summaries for Teeside, Hartlepool, Seaham, Sunderland, Tyneside. Cornwall Archaeology Unit, 2016, for Historic England: https://archaeologydataservice.ac.uk/archives/view/northsea_eh_2016/downloads.cfm

Services through fishing, and it seems that the impact of wrecks on ecosystems has positive aspects in addition to any negatives.

4.4.7. It is worth bearing in mind that shipwrecks represent a tiny percentage of the much bigger volume of successful shipping that has travelled up and down the Tyne to Tees coast, evidently as early as the Roman period but undoubtedly reaching back into prehistory. Historic shipping also shaped the marine environment as a source of emissions, invasive species and debris, some of which is still apparent today as, for example, fragments of firebox clinker on the seabed. Shipping inputs may well have been within tolerances that the marine environment could withstand, though individual catastrophes and the sustained periods of numerous losses in wartime could have presented notable stresses on the environment.

4.4.8. Although shipping can be a source of inputs into the marine environment, inputs originating on land are much greater, washed down through rivers or emitted straight from the open coast. These inputs include sediment that runs off land as a result of agricultural practices, human waste (sewage), pollutants such as oil, chemicals and metal residues, and bulk waste tipped into the sea or disposed of from hopper vessels. These are all familiar issues from recent decades, though mostly subject to greater regulation than even a few years ago. However, it would be wrong to assume that such inputs are a facet only of modern life. As noted on the Dorset Stour, the intensification of arable agriculture in prehistory increased the flow of sediments into watercourses, and consequently into the sea. Metal mining – already being conducted in the headwaters of the Tyne, Wear and Tees in prehistory – would have contributed sediment, metals and other chemical residues. Coal mining in the catchments of these rivers would have added to the inputs reaching the sea, as would other processing industries and the population at large. The composition and quantity of marine inputs will have varied through the technical, political and economic cycles of agriculture, industry and urbanism (see Skelton, 2017), perhaps with additional 'spikes' due to periodic remobilisation of contaminants caused by alterations to watercourses. Inputs may have been sustainable, but they would not have been absent: the increase in riverine inputs in the later industrial period should not obscure the likelihood of significant inputs dating much earlier than the eighteenth or nineteenth century.

4.4.9. Industrial inputs also occurred on the open coast, most notably the deposition of huge volumes of coal waste on the Durham Coast starting in the late nineteenth century but increasing very markedly in the mid-late twentieth century until it ceased completely. The dumping of colliery waste resulted in major changes to the form and appearance of the coastline, which became the focus of large-scale remediation in the 1990s-2000s[62]. The expectation of tipping onto the foreshore – at least initially – was that the spoil would be removed by the sea, though of course 'moved' is more accurate than 'removed'. Large volumes of coal waste were transported by marine processes into the offshore area (Hydraulics Research Station, Wallingford, 1970), where it continues to be present in the marine environment (Alderton, 2012, pp. 78–79). Other forms of dumping directly into the coastal and marine environment include waste used for reclamation and even construction: furnace slag cast into blocks was used in the construction of the breakwaters at the mouth of the Tees. Other forms of industrial activity took place on the open coast between the Tyne and Tees, such as quarrying and calcining limestone, which would have resulted both in direct changes to the form of the coast and to inputs of material. The large coastal quarry at Trow near South Shields was subsequently used for landfill – another potential threat to the marine environment – prompting a substantial coastal defence scheme to prevent its erosion.

4.4.10. Fishing shapes the marine environment by changing the overall composition of marine fauna – both in target fisheries and the broad range of species whose lifecycles interact – and through the effect of gear on the seabed (Rumohr and Kujawski, 2000; Frid et al., 2000, 2001). Again, advances in fishing capability in the twentieth century – catching large volumes of fish and dragging dredges and trawls across the seabed with powerful vessels – should not obscure the effects of fishing on the marine environment in earlier centuries (Fock et al., 2014). Various forms of fishing at certain levels of effort may have been sustainable in the past and may act as a guide for sustainable fishing in future (Koutrakis, 2018), but it cannot be assumed that pre-industrial fishing was only small scale or had no impact on the marine environment as a whole (Watson et al., 2017). Archaeological and historical methods have a potentially-important role to play in better

[62] http://www.turning-the-tide.org.uk/

understanding the trajectory through time of fishing and its effects, including better quantifying historic impacts (Bennema and Rijnsdorp, 2015).

4.5. How Natural Capital / Ecosystem Services are valued

4.5.1. As noted above, obtaining monetary values for cultural ES is generally regarded as problematic and has not been attempted as part of this case study; monetary values for non-cultural ES arising from marine heritage assets are even harder to find.

4.5.2. The general case for greater recognition – and the need for analysis – of the economic value of the coastal and marine historic environment has been made in two previous reports, for the Honor Frost Foundation (Firth, 2015a) and for Historic England (Firth, 2016). The HFF report concluded that participation and economic activity relating to marine and maritime cultural heritage can already be measured in millions, but that further research, including quantification, is required (Firth, 2015a, p. 53). The report for Historic England inferred from a few specific statistics and the high value ascribed to heritage in general terms that the marine historic environment has economic value; but the main sources of economic data on heritage do not address the marine and maritime sphere, or lack the granularity through which its distinct contribution can be identified (Firth, 2016, p. 38).

4.5.3. *Heritage and the Economy 2018* is entirely silent on marine heritage assets; yet the economic value of coastal activities that are likely to have a major heritage component is very high. The National Coastal Tourism Academy stated in written evidence to the House of Lords Select Committee on Regenerating Seaside Towns[63] that coastal tourism alone was valued at £10 billion in 2017[64]. The 2017 Great Britain Tourism Survey (GBTS) showed that a higher proportion (36%) of holiday trips in England were to the seaside than to other types of place: city/large town, small town or countryside (Kantar TNS, 2018, p. 56). A study of sea angling in 2012 valued that sector at £2.1 billion (Armstrong et al., 2013) – a large proportion of which is likely to be conducted from historic marine structures on shore, or on historic wreck sites at sea. The value of recreational diving in the UK – much of which is directed at wreck sites – is estimated as £360 million (Firth, 2018, p. 28).

4.5.4. Information made available by the SeaScapes project shows that the economic value of tourism on the Durham Coast in 2017 is £127 million: 3.2 million visitors support over 1600 jobs[65]. It is worth noting that 94% of visitors (and 66% of expenditure) on the Durham Coast relate to day visits and would not be captured in the national figures based on overnight stays flagged above. In 2010, visiting heritage sites was the fourth biggest reason for visiting Durham Heritage Coast, after visiting friends and relatives, walking, and general sightseeing (One North East, 2010, p. 6).

4.5.5. The MMO's economic baseline for the north east marine plan, which extends from Flamborough to Berwick and is therefore very much larger than the Tyne to Tees area, estimates that coastal tourism in the North East employs 12,920 people across 510 businesses. Of these, almost 13% are attributable to museum activities, operation of historical sites and buildings, and similar visitor attractions (Atkins, 2016, sec. 7.3.5). Coastal tourism accounts for half of the total direct employment in coastal sectors in the north east. This is over three times the direct employment of each of the next biggest sectors: oil and gas; and ports; and shipping (Atkins, 2016, sec. 7.4). The Gross Value Added (GVA) for coastal tourism, based on employee numbers, is over £4.8 billion: not as high as the oil and gas, ports and shipping or nuclear sectors because tourism has a low figure for GVA per employee, but still significantly higher than most coastal/marine sectors (Atkins, 2016, sec. 7.6). Private data analysis indicates significantly higher values for employment and turnover (Atkins, 2016, sec. 7.6.1). Heritage is also likely to have a role in the economic contribution of marine recreation noted in the MMO economic baseline, including diving and angling, but more granular data would be needed to draw quantitative inferences (Atkins, 2016, sec. 7.3.10).

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[63] https://www.parliament.uk/business/committees/committees-a-z/lords-select/regenerating-seaside-towns/

[64] http://data.parliament.uk/writtenevidence/committeeevidence.svc/evidencedocument/regenerating-seaside-towns-and-communities-committee/regenerating-seaside-towns/written/91381.html.

[65] https://www.visitcountydurham.org/images/uploads/files/Volume%20and%20value%20of%20tourism%20area%20breakdown.pdf

4.5.6. There is a pressing need to develop a quantified understanding of the value associated with heritage assets in the different sectors. The value of a heritage asset need not arise solely from its qualities as heritage; it must be remembered, for example, that the value of recreational diving on wrecks may be partly attributable to the flora and fauna of the wreck site and/or the technical challenges of wreck diving, as well as the enjoyment of a historic wreck. Nonetheless, both the cultural and non-cultural ES arising from marine heritage assets should be recognised and quantified.

4.5.6. An important point about the Tyne to Tees coast is that the character of the coast and the values it gives rise to are changing. These changes are attributable in part to the values that people place on the marine area, as well as to changes in the physical characteristics of the coast. Chief amongst these changes are the efforts to re-frame the Tyne to Tees marine area as an attractive, enjoyable environment in contrast to the despoiled, industrial coast of two decades ago. Clearly, this involved physical changes through the Turning the Tide project[66], but there have been attitudinal changes too. Durham Heritage Coast, made up of three sections (broadly Ryhope, Easington and Blackhall Rocks), was designated in 2001 towards the end of the Turning to Tide project: 'From Sunderland to Hartlepool, the Durham Heritage Coast has emerged from its industrial past to an area worthy of Heritage Coast status with one of the finest coastlines in England'[67]. The 2018-2025 Management Plan notes that 'the Heritage Coast is now recognised for its rich and varied heritage, wildlife and landscape. It is becoming a wonderful place to visit and an enjoyable place to live and work' (Durham Heritage Coast Partnership, 2016, p. 11). Building on the Heritage Coast, the SeaScapes project is seeking change across the wider Tyne to Tees marine area: 'Whilst perceptions of this coastline are blighted by its industrial past, this seascape is bound in character by unique geology, the natural environment and a shared cultural heritage'[68]. The way in which the Tyne to Tees coast is perceived – including, expressly, its cultural heritage – is in a state of flux. The value of heritage is being changed through awareness, accessibility and engagement as much as through conservation of its physical assets.

4.5.6. The approach of combining physical restoration with engagement to fundamentally shift people's perceptions of a place and prompt regeneration also lies at the heart of the Heritage Action Zone initiative[69]. Sunderland HAZ focusses on its historic high streets but encompasses the riverside below Wearmouth bridge, formerly used for shipbuilding and repair, and other maritime activities. In common with other former civil shipbuilding areas – and in contrast to historic naval dockyards – much of the industrial maritime heritage of Sunderland HAZ was erased following the decline of shipbuilding in the UK (Firth and Rowe, 2016). Nonetheless, there is still scope to evoke this past locally, making connections to the heritage of ships built in Sunderland that survive as wreck sites offshore, to give rise to a range of valuable cultural ES. Engaging people in valuing their cultural heritage may be as important as counting its current value.

4.6. The relationship between people and the environment

4.6.1. The Natural Capital / Ecosystem Services paradigm seeks to change decision-making and human behaviour to make that behaviour more sustainable with respect to the environment. Changing people's relationship to the environment is central; heritage – with its focus on changing relationships between people and their surroundings through time – clearly has a role to play.

4.6.2. In her book about environmental protection on the River Tyne since the sixteenth century, Skelton underlines the degree to which relationships with the river vary through time and between people:

> Stepping back to survey the socio-environmental entanglement with one natural system over a relatively long chronology enables us to appreciate each phase of the river's history as equally narrow, equally vulnerable to being swept away and supplanted by a different framework and equally open to interpretation as morally or ethically right or wrong, progressive or wasteful, by particular human societies, and by different groups within those respective societies.
>
> (Skelton, 2017, pp. 10–11)

[66] http://www.durhamheritagecoast.org/our-story/history/turning-the-tide/
[67] http://www.durhamheritagecoast.org/
[68] http://www.exploreseascapes.co.uk/
[69] https://historicengland.org.uk/services-skills/heritage-action-zones/sunderland/

4.6.3. This observation is as true of the estuaries and open coasts of the Tyne to Tees marine area as it is of the Tyne itself. Varying conceptions of the relationship between people and the marine environment have a physical component; they can be interpreted in part from their material remains, as well as from such historical documentation as is available. These conceptions shape the coast and have a lasting effect, and those effects are the focus of our management of the marine environment for the future. Skelton also notes:

> By looking back over five centuries, it is hoped, people will be more inclined to look forward into a similarly long-term projection of the Tyne's future to imagine just how differently socio-environmental relationship between people and the River Tyne might be conceptualised ...
>
> (Skelton, 2017, p. 25)

4.6.4. The inference from Skelton is clear: heritage is important not only for understanding different relationships between people and the coast in the past; but also as a platform for framing how those relationships might be in future. Heritage at the coast is not just something to see and do, it is a critical foundation for its future management.

4.6.5. This is not a case for keeping hold of the past, favouring the stronger memories of recent generations over the evidence of earlier environments (Coates, 2018), but it is an argument for actively using the physical remans of the past to discuss options for the future. Decisions always have to be taken about what stays and what goes, what will be lost and what will be gained; it is regrettable that such decisions are not always informed by an understanding of historic change in the environment.

4.6.6. Skelton's detailed examination of the many strands of the River Tyne's historic identity over the last 500 years is beyond what can be achieved for the whole Tyne to Tees coast in this section. There is, however, scope to apply similar thinking and to encourage the development of such thorough environmental histories of the coast, informed by archaeological approaches.

4.6.7. This can only be a vignette, but the heritage of the Tyne to Tees coast is bound up in both the carbon economy and in moves towards a low-carbon economy. Fundamentally, carbon in the economy is concerned with people's relationship to the environment in the past and how that relationship must change as we face the future.

4.6.8. The historic environment of the Tyne to Tees coast has numerous strands, but many of its heritage assets and often the shape of the coast itself are a consequence of coal. Although the effects are manifest in the historic environment in the region, it is important to recognise that the demand for carbon was national and international; the impact of coal on the Tyne to Tees coast reflects dependence on carbon further south. Coal was being exported from the Tyne and Wear to London, southern England and continental Europe from the Medieval period onwards. In the early eighteenth century, Defoe wrote 'the road to Newcastle gives a view of the inexhausted store of coals and coal-pits, from whence not London only, but all the south part of England, is continually supplied' (in Dougan, 1968, p. 22). Coal was exported using wooden sailing vessels: keels transported coal down river, transhipping to sailing colliers for the voyage south. Ships were provided by shipbuilding on the rivers of the north east, so there were shipyards, maritime infrastructure and other manufacturing associated with coal well before heavy industry took hold. In the late eighteenth and nineteenth century, demand for coal increased for fuelling steam engines, in manufacturing, and for the production of gas and later electricity. Locally, the introduction of iron and steel in shipbuilding, and of steam engines to power vessels, radically expanded shipbuilding, iron and steel-making, and related engineering in the north east to produce screw colliers but also a very wide range of civilian and military shipping. Again, manufacturing was powered by coal and the demand was driven externally – even globally – as much as by local markets. Shipyards, works and staithes significantly altered the estuaries and also the coast, through dredging in the rivers, seaward expansion of facilities – typified by Sunderland and Seaham – and by the construction of piers and breakwaters to provide shelter to shipping as it moved in and out of port and up and down the coast (Westgate, 1957).

4.6.9. Whilst improved harbours no doubt lessened the hazards faced by shipping, ships – including numerous colliers – still came to grief. The coal trade – the high-carbon economy – is thus represented also by wreck sites on the Tyne to Tees coast. This is especially true of wartime

wrecks from the twentieth century, when the transport of coal from the north east was of strategic importance and was protected using the East Coast War Channels (Firth, 2014a). Ships were targeted predominantly by U-boats using torpedoes and mines in the First World War and by aircraft dropping bombs or mines in the Second World War. A large proportion of the prominent wreck sites characteristic of the Tyne to Tees marine area were either carrying coal – or returning empty 'in ballast' for more coal – when they were sunk. Although lost in the particular context of war, the wreck sites of the Tyne to Tees coast present an often tragic snapshot of the general characteristics of north east shipbuilding and seafaring in the first half of the twentieth century (Firth and Rowe, 2016).

4.6.10. Although the dumping of colliery waste on Durham beaches was the most striking manifestation of the historical impact of coal on the marine environment on the Tyne to Tees coast, the direct physical consequences of the high carbon economy on the marine area were extensive and had considerable time-depth. If we also take into account the effects of marine-enabled demand for coal on settlement, employment, communities and so on – each with a plethora of further relationships with the sea – then it can be seen that coal, people and the sea have been heavily bound together in the historic environment of the Tyne to Tees coast. The fact that the cultural heritage of the Tyne to Tees coast is so closely related to the carbon economy does not mean that it should be disparaged or, like colliery spoil from the beaches, somehow removed. Rather, engaging with the rich maritime heritage of coal in the north east presents a platform for examining how the relationship has changed and – at a national and international scale – must continue to change. The continuing cultural legacy of this coastline provides the foundations for what follows.

4.6.11. The coast is one of the main zones where the impact of the high-carbon economy is most quickly being felt. Climate-induced sea-level change and increased storminess have already ended the presumption that shoreline change can be arrested by coastal defences. Strategies have switched to adaptive management and coastal heritage is implicated. The submerged forests around Hartlepool, Sunderland and Whitburn – together with earlier discoveries of prehistoric artefacts at various points on the coast – provide tangible evidence of major changes to places where people once lived as a direct consequence of sea-level rise. Heritage assets and related documentation also show how the shoreline has changed – and how people have responded and intervened – in more recent centuries. Hence, heritage assets provide a platform for engaging the public in discussion about the kinds of changes to the shoreline likely to be experienced over the next 20, 50 and 100 years.

4.6.12. Heritage assets are also already entangled in responses to climate change and in the steps being taken towards a low-carbon economy. Heritage assets are amongst the features that are being impacted by sea-level rise and increased storminess, degrading them and placing them at risk (Murphy and English Heritage, 2014); further heritage assets – including as-yet unknown assets – may be impacted by engineering works to counter the effects of climate change, or by coastal erosion on unprotected coasts and at places where shoreline management policies are changing. More positively, heritage assets such as breakwaters and sea walls already help protect people and property from climate change, and may provide the foundation for further works where additional protection is required.

4.6.13. The switch away from coal as a source of energy has happened quickly in the UK; some of the effects of this switch are visible on the Tyne to Tees coast. Offshore wind farms lie outside the SeaScapes project area, off Redcar and Blyth, but are visible from within. Wind farm construction is accompanied by assessments of impacts on heritage assets: such impacts include impacts on heritage assets affected by construction within the wind farm and its cable corridors; but also possible effects on setting, especially through visual interference given the often-extensive views to and from coastal heritage. As well as addressing impacts, archaeological assessment of wind farms generates new data about the marine historic environment, especially through geophysical and geoarchaeological investigations.

4.6.14. Further examples of the interrelationship between renewable energy and heritage in the Tyne to Tees marine area include the use of historic docks and harbours as bases for offshore wind farm installation and for subsequent operations and maintenance over their intended lifetime. The historic features of ports supporting offshore wind may seem incidental to their activities, but it is

nonetheless the case that the facilities being used are rooted in earlier construction sites. Similarly, historic shipyards have become bases for wind farm construction, such as at the Neptune Yard and Offshore Technology Park located in the former Wigham Richardson (later Swan Hunter & Wigham Richardson) shipyard in Low Walker. Similarly, EEW OSB's fabrication site for wind farm transition pieces is based at the Furness Yard, Haverton Hill on the Tees, which was constructed as an emergency shipyard towards the end of the First World War (Firth, 2015c, p. 7). Yards that were very much part of the high-carbon economy are now part of the transition to low-carbon.

4.6.15. The high-carbon to low-carbon transition is just one strand of the changing relation between people and the marine environment manifest in the heritage of the Tyne to Tees coast. Other intertwining strands could be picked out for north east fishing or seaside recreation, for example, whose histories and futures can be approached through heritage assets in the Tyne to Tees marine area. Only counting the Ecosystem Services that might be claimed of heritage assets at this specific point in time, ignoring the bigger questions that the historic environment prompts about society's future, is inconsistent with the instrumental intent of Natural Capital and Ecosystem Services approaches. Their point, after all, is not to quantify people's relationship with the environment, but to change it.

5. Conclusion and Recommendations

5.1. Natural Capital and Ecosystem Services approaches are pervasive and influential, especially in Government environment policy led by the 25 Year Environment Plan, from which specific actions are already flowing. Unfortunately, Natural Capital / Ecosystem Services are not easily reconciled with approaches to heritage. This stems from weaknesses in addressing the role of people in shaping the physical environment and in shaping how the environment is understood and valued. These weaknesses are compounded by the great time-depth of human physical and intellectual interaction with the environment. Consequently, Natural Capital / Ecosystem Services are commonly represented as a unidirectional flow of homogenous benefits from 'nature' to people, even when the 'nature' from which these benefits flow is manifestly a product of human intervention. Methodological preferences for identifying assets/services at quite a high level of generalisation, quantified as large GIS-friendly two-dimensional areas, further militates against heritage, which tends to have a small footprint but with complex and intense place-specific attributes.

5.2. There is a case for saying that Natural Capital / Ecosystem Services approaches are so problematic with respect to heritage that the wish to reconcile them is misplaced. The rationale for conserving, understanding and sharing heritage can be made directly to a receptive public without wrangling with the conceptual shortcomings of Natural Capital / Ecosystem Services. There are two sets of reasons for not walking away. First, the point already made about the pervasiveness and influence of Natural Capital and Ecosystem Services in Government and more widely will disadvantage heritage, especially when heritage touches against laws, policies and administrative arrangements pertaining primarily to the 'natural' environment. At these points of contact, which are extensive, a degree of assimilation is essential. Second, efforts to render how people interact with the environment more sustainable – which are as pressing for archaeologists and heritage managers as anyone else – will be less effective and may falter if Natural Capital / Ecosystem Services approaches do not get to grips with the enduring influence of culture on our world. Consequently, **it is recommended that Historic England persists with seeking integration of heritage into Natural Capital and Ecosystem Services approaches**.

5.3. A relatively small change in definition – which might prove quite a large conceptual jump for some – would make integration of heritage within National Capital / Ecosystem Services approaches much more straightforward. Replacing references to 'nature' with references to 'the environment' in Natural Capital and Ecosystem Services would open up dialogue so long as 'environment' is understood to encompass human interventions that have shaped the physical world and given rise to benefits. The conceptual jump is to acknowledge that human interventions in the environment can be positive, when much of the impetus to Natural Capital / Ecosystem Approaches is to remove or reduce the consequences of human interactions. Reconfiguring the Natural Capital / Ecosystem Services paradigm to properly incorporate heritage would be welcome, so **it is recommended that Historic England encourages the use of 'environment' (encompassing the historic environment) in place of 'nature' in Natural Capital / Ecosystem Services approaches, including in policy and implementation**.

5.4. In the meantime, ambiguity is reducing the scope for a more joined-up approach. It seems plain that cultural heritage is not Natural Capital as defined by the Natural Capital Committee: there is little place conceptually for hybrids or co-production; no recognition that benefits arise from culture working in conjunction with nature. This division of nature and culture is reinforced by references to cultural ES, because these are clearly framed as a unidirectional flow of benefits from nature to culture. In practice, however, heritage is quite frequently (though not comprehensively) absorbed within the Natural Capital / Ecosystem Services paradigm as a source of Ecosystem Services. Where there are obvious benefits from heritage that can be assimilated as Ecosystem Services, then heritage is co-opted. In the interests of clarity, the ambiguity of heritage in concepts and practice should be resolved, so **it is recommended that Historic England obtains clarification from the relevant Government Departments and agencies about the status of heritage within Natural Capital / Ecosystem Services approaches**.

5.5. This report has addressed directly the overlap between heritage and the apparent scope of Natural Capital and Ecosystem Services both conceptually and using two case studies: one on a river – the Dorset Stour; and one on a marine area, between the Tyne and the Tees. The report and its case

studies can be used to support the three recommendations above. If no progress is made on these recommendations, this report could still be used to support the case for addressing heritage and the environment in parallel with Natural Capital / Ecosystem Services: even if concepts are not shared or integrated, they can still be mapped to each other.

5.6. The report has set out five dimensions to the relationship between culture/heritage and Natural Capital / Ecosystem Services, as follows:

- Natural Capital and Ecosystem Services always have a cultural component because they arise from interaction by people with the environment.
- Natural Capital and Ecosystem Services also always have a cultural component because their valuation is by people.
- Natural Capital and Ecosystem Services often have a cultural component because they have been shaped – physically and/or intellectually – by people in a way that affects interactions.
- Heritage also gives rise to (non-cultural) Natural Capital and Ecosystem Services because it forms part of the physical environment.
- Heritage forms part of the physical environment with which people interact to obtain services even if heritage is not recognised within the Natural Capital / Ecosystem Services paradigm.

5.7. These five dimensions provide the setting for a re-working of a logic chain developed by Natural England to identify and measure the assets, services, benefits and value of the (natural) environment. The Natural England logic chain is unidirectional and has shortcomings arising from the Natural Capital / Ecosystem Services paradigm. Re-working the logic chain for this project helped to identify, expressly, the role of people in giving rise to ecosystem assets, distinct from an environment that is – at least in conceptual terms – entirely independent of people. The re-worked logic chain is also circular, again making express the relationship between people's values and needs with respect to the environment, which effectively drives the whole chain. The chain is subject to both natural processes and cultural processes that combine in complex ways. Recognising that the chain is perpetual, the re-working also recognises expressly the role of history: our present engagement with the environment is affected by the environmental interactions of our predecessors. Indeed, it is the unsustainability of earlier human actions that makes the need for new approaches so pressing.

5.8. The quadrants of the logic chain – plus the fact that heritage has to be addressed even if it is not framed in terms of Natural Capital / Ecosystem Services – gives rise to five headings (corresponding to the five dimensions) under which each of the two case studies has been elaborated. These headings are as follows:

- The importance of heritage in the case study area
- Heritage as Natural Capital / Ecosystem Services
- How people have shaped the environment
- How Natural Capital / Ecosystem Services are valued
- The relationship between people and the environment

5.9. It is fundamentally important that the relationship between heritage and Natural Capital / Ecosystem Services is addressed across all five headings, rather than heritage being co-opted within frameworks that have such evident shortcomings. It is possible to shoe-horn heritage into categories of Natural Capital or Ecosystem Services and to quantify – even monetise – the value of heritage, but to do so without raising these broader questions detracts from the historic environment and from the capacity of the Natural Capital / Ecosystem Services paradigm to achieve change. Accordingly, **it is recommended that Historic England continues to advocate the relevance of heritage to the broad debate about achieving sustainable relationships between people and the environment**.

5.10. The case studies provide supporting evidence about the relationship between heritage and Natural Capital / Ecosystem Services in respect of freshwater and marine environments under each heading as follows.

The importance of heritage in the case study areas

5.11. Both the Dorset Stour and the Tyne to Tees marine area have numerous heritage assets and a rich historic environment that is conserved through heritage legislation and the planning systems, independently of Natural Capital / Ecosystem Services. In both case study areas, the public engages with the historic environment to a greater degree than is captured in existing quantifications. Decisions arising from Natural Capital / Ecosystem Services approaches will have to take account of heritage in freshwater and marine environments even if they heritage is not incorporated within these approaches.

5.12. The land-based and marine planning systems – which make express provision for heritage in the NPPF and UK MPS – plays a more important role than heritage designation across the two case studies. There are no heritage designations below low water in the Tyne to Tees marine area; all conservation falls to the marine planning system. Even landward of low water in the Tyne to Tees marine area – and on the Dorset Stour – the designation of heritage assets is very limited. The fact that protection extends below water on a range of coastal and riverine heritage assets seems incidental; there does not appear to have been systematic consideration of designation for in-water heritage assets in marine or freshwater environments for assets other than shipwrecks. The shortcomings of heritage designation in freshwater and marine environments is a key concern where the implementation of Natural Capital / Ecosystem Services focuses only on (a limited range of) designated heritage assets. **It is recommended that Historic England reviews the application of all the different forms of heritage designation to heritage assets in freshwater and marine environments, and urgently addresses how heritage assets are to 'count' within the Government's 25 Year Environment Plan**.

Recognising heritage as Natural Capital / Ecosystem Services

5.13. The scope for recognising heritage as Natural Capital and Ecosystem Services in the two case studies was framed in terms of both cultural and non-cultural (i.e. provisioning and regulating) ES. Leaving aside the problematic definition of cultural ES as deriving only from 'nature' noted above, cultural services that are comparable to experiential, intellectual, symbolic and legacy ES are categorised in frameworks such as CICES. Heritage assets also play an important but overlooked role in enabling people to obtain physical and intellectual access to Ecosystem Services from 'nature'. Investment is required to enable cultural ES to be obtained by people across the demographic spectrum, as well as to safeguard the assets from which ES arise. Importantly, cultural media enable ES to arise from heritage assets even if the beneficiary is not physically present at the asset. This point is especially important in considering the ES of heritage assets such as wreck sites that are physically remote, because of the massive expansion of visualisation technologies that can engage people in heritage that is deep offshore. **It is recommended that Historic England continues to promote the full range of cultural ES arising from heritage assets, drawing attention to the role of heritage in enabling physical and intellectual access to freshwater and marine environments.**

5.14. Heritage assets also give rise to important provisioning and regulating ES in both freshwater and marine environments by virtue of their physical attributes, independently of their cultural value. Again, this is largely unrecognised in current accounting for Natural Capital / Ecosystem Services from a natural sciences perspective, and it has yet to be promoted as an important facet of historic freshwater and marine environments by the heritage sector. The degree to which rivers and their immediate environs such as the Dorset Stour are largely artefactual – because of human interventions going back into prehistory – does not appear to be widely recognised. Consequently, the degree to which the provisioning and regulating ES of rivers arise from the historic environment, rather than 'nature', is missed. **It is recommended that Historic England gives even greater priority to mobilising evidence about the human history of rivers among watercourse managers so that the provisioning and regulating ES arising from historic river features can be recognised**.

5.15. Similarly, the provisioning and regulating ES that arise from historic marine structures – both directly and indirectly – appears to have been largely overlooked. The contribution of historic marine structures could be usefully placed within current scholarship about 'ocean sprawl' and the incorporation of ecosystem benefits within the design of new structures and materials, because historic structures provide a wide range of dated forms that will have given rise to habitats and affected ecosystems both as individual structures and cumulatively. The value of historic marine structures in these terms may contribute significantly to decisions about – and sources of funding for – maintenance and restoration of historic marine structures, many of which are designated. **It is recommended that Historic England engages with research into the role of structures in the marine environment, to identify the provisioning and regulating ES that arise from historic marine structures.**

5.16. Although currently under-researched, especially in UK waters, it seems that wreck sites play a significant role in marine ecosystems both as discrete features and as networks. They give rise to provisioning and regulating ES that are important for commercial fishing, sea angling and recreational diving; and potentially in relation to pollution and navigation risks also. Nonetheless, quantifications of ES do not appear to be sufficiently granular to pick out the contribution of wreck sites: the focus on extensive, homogenised 2D areas in ES methodologies is a notable drawback. **It is recommended that Historic England liaises with agencies addressing ES arising from the marine environment to seek greater attention to provisioning and regulating ES from wreck sites.**

How people have shaped the environment

5.17. As noted already, rivers such as the Dorset Stour have been heavily modified by human interventions over very long timescales, often to the extent that their current form is assumed to be natural. The Dorset Stour case study – drawing from the Historic Watercourses project – supports the conclusion of Brown et al. that 'the sustainable restoration of rivers and floodplains designed to maximise desirable {riverine Ecosystem Services} and natural capital must be predicated on the awareness that Anthropocene rivers are still largely imprisoned in the banks of their history' (Brown et al., 2018, p. 185). **It is recommended that Historic England further promotes archaeological research into the hybrid character of English rivers and engages with watercourse managers to raise awareness of the implications of hybridity for decision-making**.

5.18. As with rivers, the coast of England is often an artefact, shaped directly and indirectly by human interventions in the past that are now obscured or ignored. In the Tyne to Tees marine area, all three major estuaries are artificial, and their effects on coastal morphology – plus other interventions – spread along the open coast. Further, the characteristics of the marine environment – water quality, flora and fauna, and condition of the seabed – have been heavily affected by terrestrial inputs and marine activities such as fishing. Importantly, these effects have much greater time-depth than might be presumed: agriculture, mining and fishing have been occurring on scales that have affected the marine environment for many centuries. Building on its substantial body of previous investigations (including the RCZAS), **it is recommended that Historic England develops syntheses on the human environmental history of English coasts and seas that can inform coastal and marine managers**.

How Natural Capital / Ecosystem Services are valued

5.19. In practice the contribution of history and heritage to Ecosystem Services is being acknowledged (if implicitly) in both study areas. Indeed, the contribution of heritage to cultural ES is often a major source of value. Nonetheless, the capacity of heritage to render or enable cultural ES in freshwater and marine environments is under-recognised even in accounts of the social and economic value of heritage. **It is recommended that Historic England amends Heritage Counts to address freshwater and marine-related heritage explicitly in its surveys, research and reports, and collaborates with other agencies collating data relating to cultural ES in freshwater and marine environments to ensure that the contribution of heritage is properly accounted for.**

5.20. Greater integration of heritage and Natural Capital / Ecosystem Services could be facilitated by careful use of concepts such as ES in examining how people have inhabited their environment in

the past. Plainly, the way that the benefits to people of the environment in the present are being categorised as ES might also be relevant in categorising past benefits. It is possible, for example, to identify a series of historic provisioning and regulating ES that people sought from the Dorset Stour across the centuries. Broadly, the river may have been a more important source of ES in the past than today, when many of our needs are met from more distant sources. One example is that the Dorset Stour – like most rivers – used to be a vital source of renewable energy, harnessed using agricultural and industrial mills. This ES is no longer obtained from the Dorset Stour, underlining the degree to which values change. **It is recommended that Historic England encourages the identification of historic ES from freshwater and marine environments, especially where ES have lapsed, to highlight the relationship between heritage and Natural Capital / Ecosystem Services concepts and to inform decisions about sustainable uses of these environments in future.**

The relationship between people and the environment

5.21. Natural Capital / Ecosystem Services are instrumental, seeking to change people's behaviour by recognising the (monetary) value of the benefits that people obtain from the environment. The approach developed in this project offers opportunities to address the relationship that people have with the environment using heritage assets, drawing attention to how that relationship has changed through time, and how it may yet change in future. In the Dorset Stour, for example, several strands of evidence indicate that people lived with and even augmented flooding in their management of the riverine environment, their settlements and so on. This appears to have changed in the nineteenth and twentieth century to a preoccupation with drainage and flood protection. It is increasingly recognised that keeping floodwater within the river system is an important component of dealing with flood risk, and people's accommodation of flooding in earlier centuries may be instructive. Equally, many of the heritage assets of the Tyne to Tees coast reflect national and international dependence on coal within a high carbon economy, reflected in the character and identity of the north east. Staithes, shipyards, industrial sites, harbours and wrecks all relate to the history of coal, whilst submerged forests on the foreshore are a reminder of the effects of climate change on sea-levels. Renewable energy in the form of offshore wind farms visible within the setting of coastal heritage assets, built and maintained through the reuse of historic harbours and yards, reflect the urgent change in the direction of energy policy. Both in terms of past and future, heritage assets present an opportunity to acknowledge the importance of the industries that so heavily influenced north east communities, whilst also recognising the benefits and opportunities that a low carbon future will bring. **It is recommended that Historic England engages directly in public debate about the need for people's relationship to the environment to change – especially on urgent topics such as flooding, renewable energy, fisheries policy and so on – using heritage assets to stimulate and inform discussion.**

5.22. This report has provided comprehensive case studies on the Dorset Stour and the Tyne to Tees marine area that can inform practitioners in the heritage and natural environment management sectors. It is anticipated that these case studies will be included in some form within Historic England's Research Report on heritage, Natural Capital and Ecosystem Services and will feed in to future guidance. The case studies have set out expressly the place of humans in freshwater and marine environments and provide a firm basis for greater reference to heritage in environmental policies and initiatives. The report has shown that Natural Capital and Ecosystem Services approaches can accommodate history and change, including a sense of what changes might be sought based on an understanding of the history of these environments. The need to direct effort towards quantifying assets and services in standardised formulations has been acknowledged, but the report also emphasises the degree to which benefits from the environment arise from people's cultural predispositions and contributions, which vary both in the present and through time. Greater integration of heritage within Natural Capital / Ecosystem Services offers to help in conserving heritage assets but can also be expected to improve the content and effectiveness of environmental decisions. Overall, greater awareness of the interaction of nature and culture in the formation of the Dorset Stour and the Tyne to Tees marine area – represented by the Stour Catchment Initiative and SeaScapes respectively – should be expected to result in better outcomes both for nature and for people.

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