NATURAL CAPITAL ASSET AND RISK REGISTER TO INFORM THE TAMAR ESTUARIES MANAGEMENT PLAN AND IMPLEMENTATION OF PLYMOUTH NATIONAL MARINE PARK

PART TWO: BASELINE NATURAL CAPITAL ASSET AND RISK REGISTER

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Author and affiliation: Matthew Ashley[1], Siân Rees[1], Tom Mullier[1]

[1] School of Biological and Marine Science, University of Plymouth.

This report has been compiled by staff at The Marine Institute, School of Biological and Marine Science, University of Plymouth.

Contact Details:

Dr Matthew Ashley / Dr Siân Rees

School of Biological and Marine Science,

Marine Institute

Marine Building

Level 3

University of Plymouth.

Drake Circus

Plymouth

PL4 8AA

Tel 00 44 (0) 1752 584732

Web: http://www.plymouth.ac.uk/marine

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LIST OF ABBREVIATIONS

CPUE Catch per Unit Effort

DEFRA Department for Environment, Food & Rural Affairs

ES Ecosystem Service

EUNIS European Nature Information System

GES Good Environmental Status

ICES International Council for the Exploration of the Sea

IFCA Inshore Fisheries and Conservation Authority

iVMS Inshore Vessel Monitoring System

JNCC Joint Nature Conservation Committee

LRC Likely Relative Condition

MarESA Marine Evidenced Based Sensitivity Assessment

MCAA Marine and Coastal Access Act 2009

MCZ Marine Conservation Zone

MESH Marine European Seabed Habitats

MPA Marine Protected Area

MSC Marine Stewardship Council

MSFD Marine Strategy Framework Directive

MSY Maximum Sustainable Yield

NCC Natural Capital Committee

NMP National Marine Park

SAC Special Area of Conservation

SSB Spawning Stock Biomass

TAC Total Allowable Catch

TEMP Tamar Estuaries Management Plan

iVMS Inshore Vessel Monitoring System

WFD Water Framework Directive

SUMMARY

In Part One of this study we provided an introduction to the natural capital assets within the Plymouth Sound, estuaries and coast to Eddystone reefs (PSEC) area. We also reviewed and summarised the flow of ecosystem services and subsequent ES benefits provided by those assets. In this, Part Two study, we build on Part One to provide a Natural Capital Asset and Risk Register for the PSEC area. The Natural Capital Asset Register identifies the status of habitat, species and water body assets, their current extent and condition and 10 year trends. The Risk Register relates the status and trends of assets to the resulting risk of losing expected provision of ES and performance of the site in relation to environment policy targets. This process allows clear identification of the impact of activities and pressures on risk to status of natural capital assets and provision of ES.

The Natural Capital Approach (NCA) relates the state of natural capital stocks (elements of nature that have value to society, such as forests, fisheries, rivers, biodiversity, land and minerals) to the flow of environmental or 'ecosystem' services over time (Natural Capital Committee, 2013; Natural Capital Committee, 2017b; ONS, 2017)(NCC, 2014). Ecosystem services are the benefits provided by ecosystems that contribute to making human life both possible and worth living (UK National Ecosystem Assessment, 2011). In 2005 the Millennium Ecosystem Assessment identified human induced change to ecosystems and loss of biodiversity was leading to loss of related ecosystem services and associated benefits on a global scale (Millennium Ecosystem Assessment, 2005). National Ecosystem Assessments within individual countries have since been completed. The UK National Ecosystem Assessment (UK NEA) was the first analysis of the UK's natural environment in terms of the benefits it provides to society and continuing economic prosperity (UK National Ecosystem Assessment, 2011). The UK NEA identified that up to 2011, the UK's ecosystems were delivering some ES well, but others were still in long-term decline (UK National Ecosystem Assessment, 2011).

Undertaking this study is intended to provide evidence to inform management within an estuarine and coastal site. We achieve this by focusing on actions that enable habitats and species populations to be maintained in a state that enables continued contribution to ES benefits. In Part One we identified significant contribution of multiple ecosystem services from the habitat and species assets within the Plymouth Sound, estuaries and coast to Eddystone reefs (PSEC) area.

In particular, there is high provision of goods / benefits from: 1) Provisioning services (food), 2) Regulating services (i) healthy climate, (ii) sea defence, (iii) clean water and sediments and 3) Cultural services (i) recreation and tourism.

Part Two focuses on the status of the asset-benefit relationship. Asset-benefit relationships represent the relationship between the condition of the natural asset and the resulting benefit provided to people. Three types of natural capital assets were assessed in the asset register and taken forward for the risk register: 1. Habitat assets – all habitats that provide a moderate or significant contribution to an ecosystem service benefit; 2. Species assets – commercial species (fish and shellfish) with and without quota; migratory species (salmon and seatrout); and, 3. The water column – water bodies, bathing waters, shellfish waters.

The status of the asset benefit relationship is defined via the three metrics of asset extent (how much of /quantity of an asset), asset condition (the quality) and the spatial configuration (defined as the ecological connectivity to make ES available). To determine the nature and the severity of the risk to the asset-benefit relationship the status of the asset-benefit relationship was assessed against UK policy targets.

From this work, the greatest risks to the asset-benefit relationships in the PSEC area are summarised below:

PROVISIONING SERVICES: WILD FOOD

- **Food** (wild food: fish and shellfish) benefits are at high risk due to the extent of sublittoral soft substratum habitat outside MPAs without management objectives and with impaired quality (condition) based on knowledge of previous demersal fishing activity. The condition of important fish and shellfish nursery habitat (seagrass beds, littoral rock and sediment habitats) and shellfish waters are also impaired in relation to elevated contaminant levels, spread of invasive non-native species and physical pressures from anchoring and mooring. Reduced water quality related to elevated bacterial contamination and nutrient enrichment reduces shellfish aquaculture and hand gathering harvesting opportunities.

REGULATING SERVICES: HEALTHY CLIMATE

- **Healthy climate** benefits are at risk due to the degraded quality of the littoral and sublittoral seagrass habitats, littoral mud and mussel bed habitats. Sublittoral soft sediment habitats provide a lower contribution to healthy climate benefits but over a much greater spatial scale. Degraded quality of these habitats in relation to elevated sediment contaminant levels and disturbance from fishing activity and anchoring and mooring is likely to also increase risk to delivery of healthy climate benefits.

REGULATING SERVICES: SEA DEFENCE (FLOOD PREVENTION, STORM DEFENCE)

- **Sea defence** benefits provided by littoral habitats and sublittoral seagrass are at risk, due to a reduction in extent and condition of these habitats related to anchoring and mooring activity.

REGULATING SERVICES: CLEAN WATER AND SEDIMENTS

- **Clean water and sediment** benefits supported by the ecological functions and processes in littoral mud, seagrass, mussel beds and the subtidal sediment and seagrass habitats are considered to be at risk due to impaired quality (condition) of these habitats. Habitats are impacted by elevated contaminant levels and disturbance from demersal fishing and anchoring and mooring activities.

CULTURAL SERVICES: RECREATION AND TOURISM

- **Recreation and tourism** benefits are at risk due to degraded littoral and sublittoral seagrass beds and degraded littoral rock and soft substratum habitats, as well as incidences of poor water quality. Water quality related to recreation activities is primarily impacted by nutrient enrichment from agricultural run-off, pollution events and bacterial contamination from industry and water system infrastructure.

Contribution from infralittoral reef and circalittoral reef habitats to provisioning (wild food), regulating (healthy climate) and cultural services (recreational fishing and scuba diving/nature watching) is maintained at expected levels within the site, due to the favourable condition of these features. Saltmarsh condition is also expected to be delivering expected benefits, although confidence is lower due to lack of monitoring in the past 12 years. The findings of the report display the importance of providing management to recover and maintain all PSEC area habitats to favourable condition. This enables maximising delivery of a number of benefits. The PSEC area provides an important connection between habitats within estuaries and those in deeper water in Plymouth Sound and in coastal seas that, in combination, support multiple ES benefits. For instance saltmarsh habitats, intertidal sediments, offshore sediments and coastal reefs, if in healthy condition, support fish and shellfish populations throughout life stages. Likewise, the connection between estuaries, coastal habitats and the deeper soft substratum habitats offshore, enables carbon captured in plant detritus from terrestrial, estuarine, inshore and water column habitats is effectively stored in coastal and deep sea sediments habitats.

CONTENTS

BACKGROUND AND OVERVIEW

INTRODUCTION

Natural Capital Asset and Risk Registers are undertaken to apply a Natural Capital Approach to develop the underpinning ecological and socio-economic research that supports decision making (Natural Capital Committee, 2013; Natural Capital Committee, 2017b; ONS, 2017; Mace et al., 2015; Rees et al., 2019; Hooper et al., 2018; Ashley et al., 2020). Ultimately, these tools aim to ensure that estuarine and coastal regions, such as those within Plymouth Sound, estuaries and the coastal region to Eddystone reefs (PSEC) area, continue to support a wide range of benefits, locally and internationally.

Estuarine and coastal environments contain a diversity of habitats, water bodies and species populations. Within a Natural Capital Approach these environmental features are considered 'natural capital assets', and are viewed as the 'stock' of resources upon which society depends (Natural Capital Committee, 2017b). When in a healthy condition, these assets support locally, nationally and internationally important benefits that people and societies receive from the natural environment (NCC, 2017). Termed ecosystem service benefits, these include but are not limited to: harvested food resources, climate benefits through capture and storage of carbon, reduction of flood and storm impacts on coastal communities, maintenance of clean water and sediments, as well as availability of environments and features of interest to recreational activities and tourism (Turner et al., 2014).

Biodiversity policy targets and Sustainable Development Goals recognise the crucial interdependencies between the natural and the human system. Targets to sustainably manage marine ecosystems are embedded in international (CBD, 1992; OSPAR Convention, 2002; United Nations, 2014; CBD, 2010) and national policy targets (UK Government, 2009).

A series of policy commitments from UK Government have been made to mainstream "the value of nature across our society, create a green economy, strengthen the connections between people and nature" (HM Government, 2011). The Natural Capital Committee (NCC), acting as an independent advisory body to UK Government recommended development of strategy and a corresponding 25 year plan to protect and improve natural capital, to achieve the governments vision to 'to be the first generation to leave the natural environment in a better state than it inherited' (Natural Capital Committee, 2015a; Natural Capital Committee, 2015b). Acting on the recommendation, has included the development of the 'Natural Capital Approach', as a foundational framework of the United Kingdom's 25 Year Plan to Improve the Environment (HM Government, 2018c; HM Government, 2018b). Since 2018, the Natural Capital Approaches recommended by the NCC are anchored at the centre of the UK Government's *25 Year Plan to Improve the Environment* (HM Government, 2018b).

Consideration of implications of activities and management plans, inside and outside marine protected areas (MPAs), on habitats, water bodies and species populations and the subsequent impact on flow of ecosystem service benefits, is, thereby, required by marine managers and planners, to achieve international and national policy goals.

The purpose of this, Part Two report is to establish the status of natural capital assets and the associated level of risk to flow of ecosystem service benefits. The report aims to provide a baseline assessment that can be used by the organisations and local authorities with responsibility towards management of natural resources in a UK coastal region: Plymouth Sound, estuaries and the coastal area to the Eddystone reefs. The tools applied are developed from the Natural Capital Asset and Risk Register completed for the North Devon Marine Pioneer (Rees et al., 2020) and application of the approach to fisheries management (Ashley et al., 2020) and sustainability appraisal (Hooper and Austen, 2020). Part Three of the report (Ashley et al., 2021b) assesses the implications of current, ongoing and proposed management actions on the asset and risk register. Although

this report provides a baseline assessment for 2019/20 and 10 year trend 2010-2019/20, comparable in depth assessment of habitats and species extent and condition and the pressures impacting them in Plymouth Sound and estuaries exist over many decades, for instance Hiscock and Moore (1986), providing opportunity for longer term trend comparison.

This project further refines the Natural Capital Asset and Risk Register tool, to better address local decision making needs, within a site that combines nationally and internationally important conservation designations with urban, rural and coastal areas containing multiple economic and recreational activities.

In this, Part Two report, an assessment of natural capital stocks in Plymouth Sound, estuaries and coast out to Eddystone reefs has been completed by undertaking:

i. A natural capital asset register that considers the extent, condition and spatial configuration of the natural capital assets, and the stocks and flows of ecosystem services in the site.
ii. A risk register to identify where expected level of delivery of ecosystem service benefits from natural capital in the site is achieved and where it is impeded by current pressures on the environment.

To realise the ambitions of the UK Government's *25 Year Plan to Improve the Environment,* the Natural Capital Approach has been integrated within monitoring and decision-making practices undertaken by government organisations and local authorities with statutory responsibility towards management of natural resources. Examples include the development of guidance, such as DEFRA (2021a) material on 'Enabling a Natural Capital Approach' and resources and tools, such as, Natural England's Natural Capital Atlas, at national (Wigley et al., 2020) and county scales (Lear et al., 2020). Monitoring programmes are also being reviewed, at the time of writing, to align with the Natural Capital Approach (Environment Agency, 2021b). The Natural Capital Asset and Risk Register links assessment across land and sea to evidence ecological implications of human activities and associated risk to provision of ecosystem services (Lannin, 2021; Rees et al., 2019). As such, it can be integrated into existing natural capital monitoring and evaluation, to provide assessment of impact of management interventions and ability to visualise trade-offs between decision-making options (Hooper et al., 2020; Lannin, 2021). This Part Two report identifies the asset-benefit relationships and their status in relation to policy targets. Then the Part Three report (Ashely et al., 2021) demonstrates how the tools can be applied within a site such as Plymouth Sound, estuaries and coastal region, to inform future decision making inside and outside MPAs.

USING A NATURAL CAPITAL APPROACH

Marine ecosystems provide a number of essential functions, such as primary production and climate regulation, which underpin life on earth (Millennium Ecosystem Assessment, 2005; United Nations, 2015). Since 2011, a systematic approach has developed in the UK to fully incorporate the role of ecosystems in supporting the delivery of ecosystem services and human well-being into decision making (UK National Ecosystem Assessment, 2011).

As identified in Report One, four key definitions are central to the Natural Capital Approach (Natural Capital Committee, 2017a; Natural Capital Committee, 2017b).

- **Natural capital:** The elements of nature that directly or indirectly produce value to people, including ecosystems, species, freshwater, land, minerals, the air and oceans, as well as natural processes and functions.
- **Assets:** a distinctive component of natural capital as determined by the functions it performs, e.g. soils, freshwater, species.

- **Ecosystem services (ES):** Functions and products from nature that can be turned into benefits with varying degrees of human input.
- **Benefits:** Changes in human welfare (or well-being) that result from the use or consumption of goods, or from the knowledge that something exists.

Assessment and appraisal frameworks aiming to understand the rate and change of natural capital in relation to UK policy or management interventions, include tools such as Environmental Impact Assessments, Natural Capital Accounts, Asset and Risk Registers, Regulatory Impact Assessment and Sustainability Appraisal (Hooper et al., 2018).

Asset and Risk Registers are decision support tools developed within the business and industry sector to identify risks to operations based on an assessment of business assets, plausible risk, likely impacts and ownership of the driver of risk (Leonard, 1995). In a first step to operationalising the natural capital approach for the UK, a natural capital asset and risk register was developed by Mace et al (2015). This was a preliminary high-level assessment of broad habitat types (terrestrial and marine) based at a national scale. The development of the asset register by Mace et al (2015), common to the SEEA-EEA guidance, structures ecosystems into units based on the extent of the ecosystem type e.g. km^2 forest, the condition of each ecosystem and the ecosystem services as supplied by the ecosystem type (UNSD, 2014). The monetary value, reflecting ecosystem type unit linked to ecosystem service supply and use values was not included in the Mace et al (2015) asset register, nor are values of the ecosystem assets. Instead, the authors focused on 'risk'. In 2019, the Mace et al., (2015) asset and risk register process was integrated within the UKs first Marine Natural Capital Asset and Risk Register, as a foundational tool to inform routes towards sustainable development and management to underpin the flow of ecosystem services (Rees et al., 2019).

The purpose of this report is to develop the Natural Capital Asset and Risk Register as a tool, providing the underpinning ecological and socio-economic evidence informing MPA Site Management Plans and management of coastal regions with multiple economic and recreational uses.

PLYMOUTH SOUND, ESTUARIES AND COAST TO EDDYSTONE REEFS (PSEC) AREA

This assessment considers the area of the Plymouth Sound and Estuaries Special Area of Conservation (SAC), from the tidal limits of estuaries to the mouth of Plymouth Sound and also the coastal region outside the SAC within the first stage of the proposed Plymouth National Marine Park (Figure 1). The offshore area assessed includes sections of the Start Point to Plymouth Sound and Eddystone SAC. The site assessed also contains the Tamar Estuaries Complex Special Protection Area (SPA), the Tamar Estuary Sites Marine Conservation Zone (MCZ) and estuarine and coastal Sites of Special Scientific Interest (SSSI) (Figure 1).

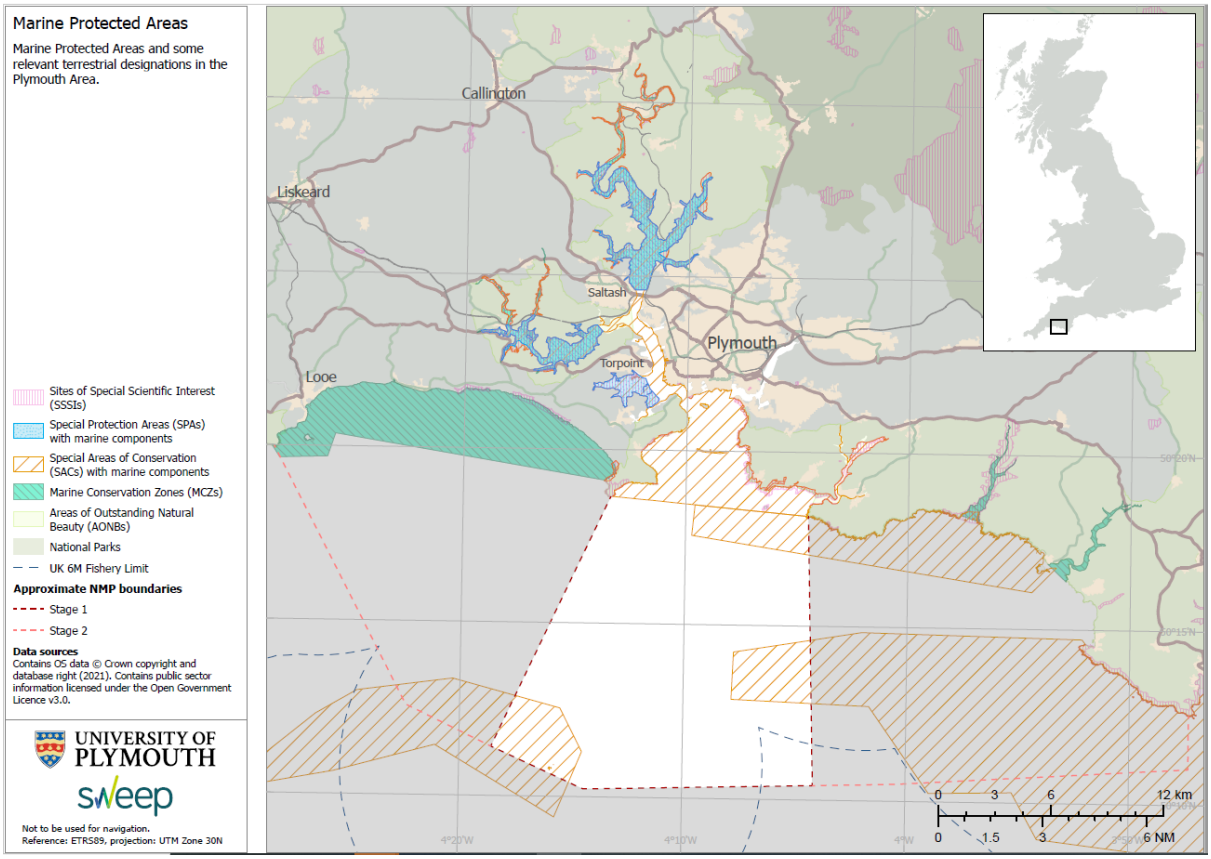


Figure 1 The study site including the Plymouth Sound and Estuaries SAC, from the tidal limits of estuaries to the mouth of Plymouth Sound and also the coastal region outside the SAC within the first stage of the proposed Plymouth National Marine Park (white area). Neighbouring MPA designations are shown for context.

VISION, AIMS AND OBJECTIVES

This Part Two report aims to provide a baseline Natural Capital Asset and Risk Register, including a summary of the extent and condition of natural capital assets and existing pressures. This includes summaries of the links between the natural capital assets and flows of key ecosystem services in the site. The baseline risk register, assesses risk to provision of ES benefits in the site in relation to state of natural capital assets. The following objectives will be addressed to achieve this, implemented within the structure in Figure 2.

- Integrate the assessment of the contribution of natural capital assets in the PSEC area to provision of key ecosystem service benefits from report Part One to form the basis of the asset-risk register.
- Apply indicator metrics to assess change over time in extent and condition of natural capital assets.
- Apply indicator metrics to assess flow of key ES from natural capital assets.
- Incorporate indicator data sets to provide a baseline Natural Capital Asset Register for Plymouth Sound, estuaries and coast to Eddystone reefs area.
- Apply the risk register tool adapted from Mace et al. (2015) by Rees et al. (2019), to assess risk to provision of ES under pressures identified in the 2020 baseline
- Assess the impact of completed management actions and identify remaining risks to asset-benefit flow.

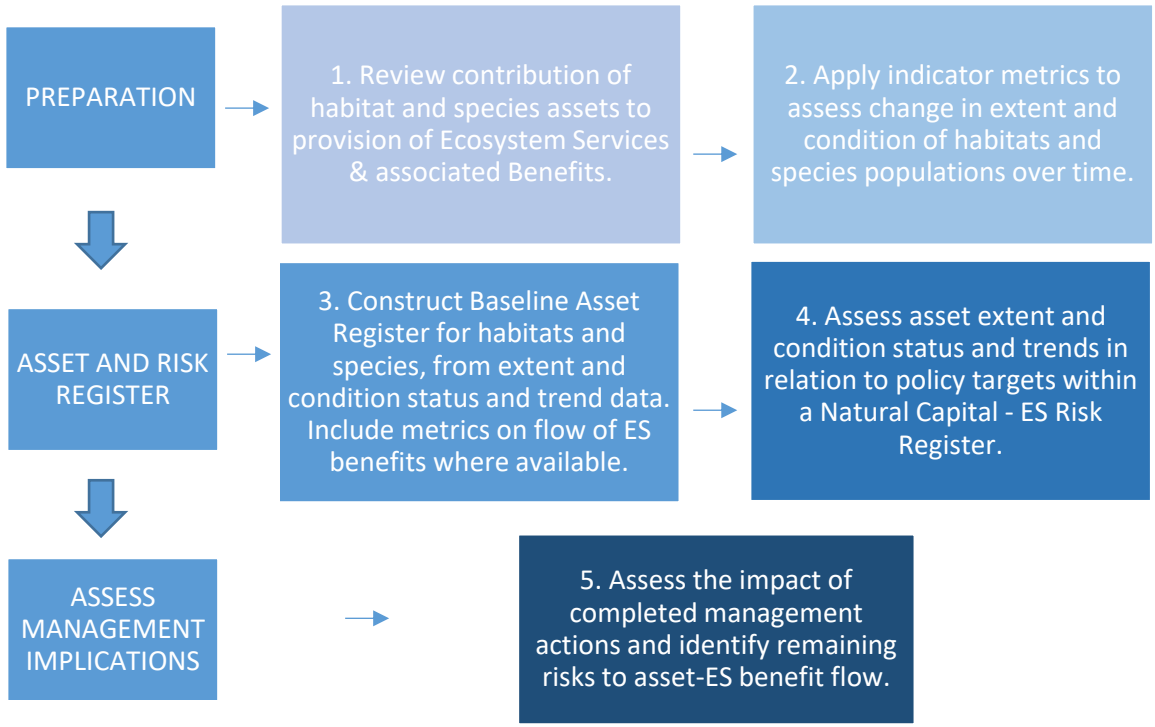


Figure 2 Five Step process undertaken to complete the Baseline Natural Capital Asset and Risk Register for the PSEC area.

BASELINE ASSET AND RISK REGISTER

ASSET REGISTER: EXTENT AND CONDITION OF HABITAT AND SPECIES ASSETS CONTRIBUTING TO ES BENEFITS

Contribution to ES benefits, from natural capital assets assessed in report Part One (Ashley et al., 2021) assumes those habitats and associated species com munities are in healthy condition, providing the structure, function and ecological processes to support flow of intermediate services, ecosystem services and finally the key ES goods/benefits assessed (Figure 3).

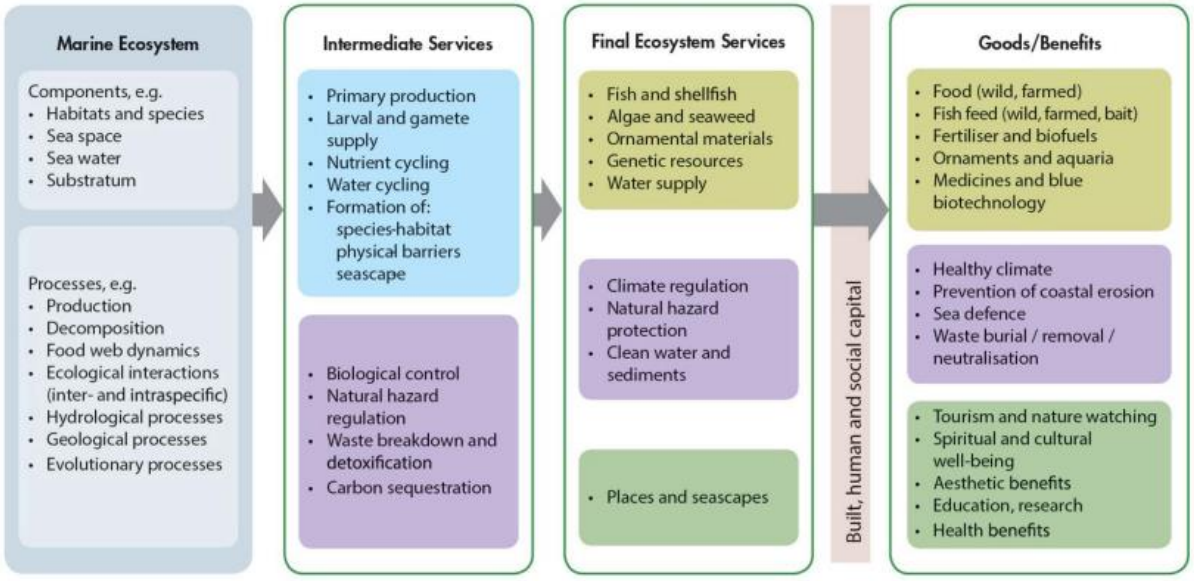


Figure 3 Flow of ES goods/benefits from marine ecosystems and component habitat and species assets, reproduced from Turner et al., (2014).

To assess the status of natural capital assets within the site, as the basis for availability of ES from the site, an asset register was undertaken. The asset register identified current status of extent of habitat or species assets (populations (abundance)) and condition of those assets (structure and function of habitat assets and health of species populations). The most recent 10 year trend in asset extent and condition was also assessed where available. The asset register established which assets were unlikely to be providing expected contribution to key ES benefits. Indicators used to assess asset status (extent and condition), were applied, based on the Asset and Risk Registers completed for the North Devon Marine Pioneer (Ashley et al., 2018; Rees et al., 2019) with additional indicators included to provide specific evidence for the PSEC area. Detail on indicators applied and associated methods are provided in the Technical Methods Report.

HABITAT ASSETS

Current extent of habitat assets was extracted from composite habitat mapping applying the best available habitat data (for detail on data layers see Technical Methods Report) (Figure 4; Table 1).

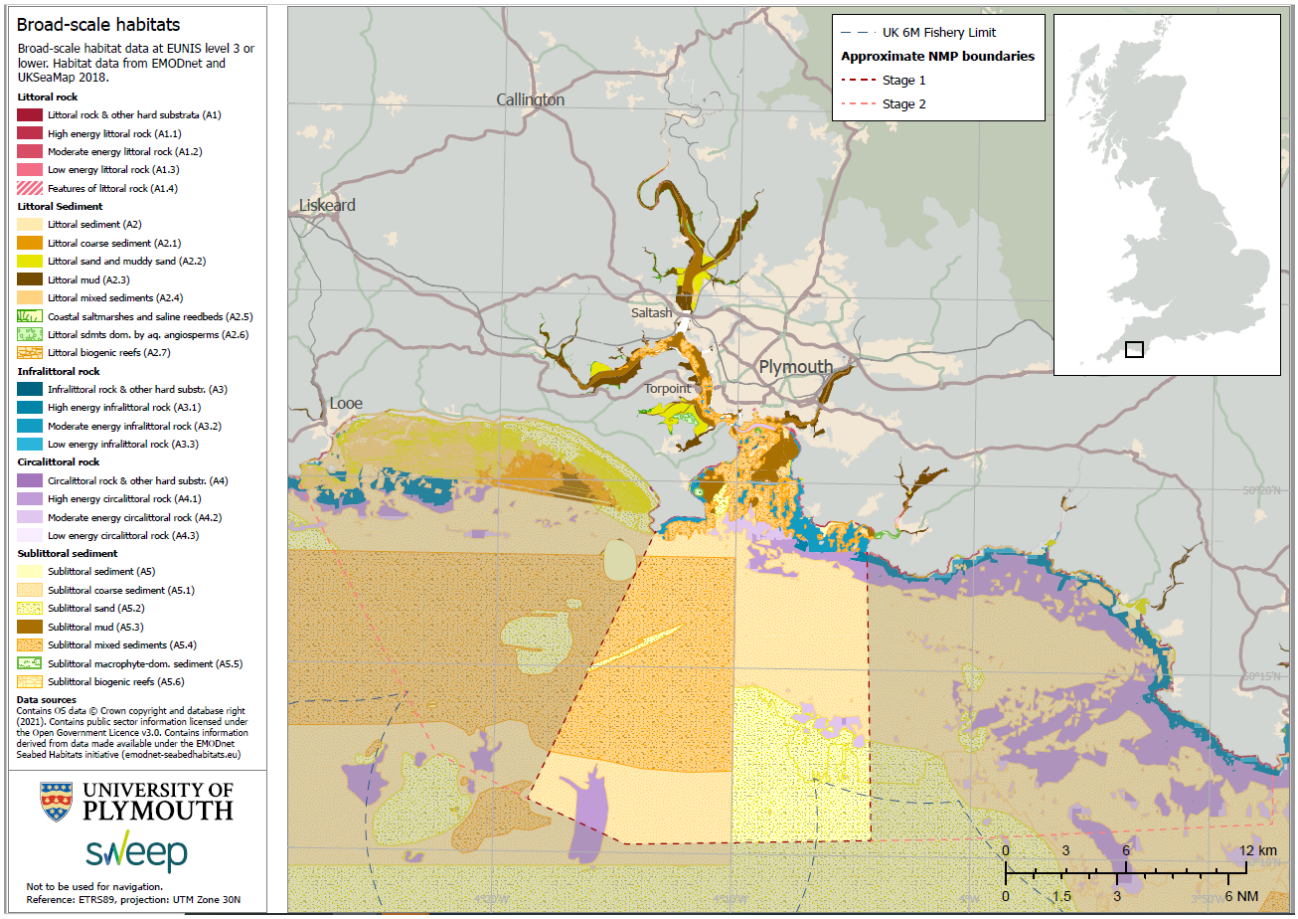


Figure 4 Habitats present in the site, Plymouth Sound, Estuaries and coastal area in the lighter highlighted offshore area, which represents stage 1 of the propsed National Marine Park out to Eddystone reefs.

Table 1 Extent of each habitat asset within the PSEC area and extent of each habitat within MPAs including extent in favourable / unfavourable condition and extent across the whole site in modelled LRC of moderate or below. Extent within a management measure is also provided.

Broad Habitat	Detail (with Eunis code)	Extent (km²)	Extent within MPAs	Extent in MPAs in 'unfavourable / recover'	Extent in site in LRC ≤ moderate	Extent within a management measure
Marine inlets and transitional waters						
Intertidal reef	Littoral rock and other hard substrata (A1)	2.12	1.75	0.02	1.76	1.53
Intertidal sediments	Littoral coarse sediment (A2.1)	0.16	0.16	0	0	0.16
	Littoral sand and muddy sand (A2.2)	5.98	5.92	0.65	4	5.92
	Littoral mud (A2.3)	20.85	17.81	2	9.5	17.81
	Littoral mixed sediment (A2.4)	0.52	0.49	0.49	0.28	0.49
	Coastal saltmarshes and saline reedbeds (A2.5)	0.40	0.39	0	0	0.39
	Littoral sediments dominated by aquatic angiosperms (seagrass bed) (A2.6)	0.43	0.4	0.4	0.4	0.4
	Littoral biogenic reefs (Blue mussel beds) (A2.7)	0.2	0.1	0	0	0.1
Sublittoral habitats						
Subtidal reef	Infralittoral rock and other hard substrata (A3)	9.24	8.97	0	0.12	8.97
	Circalittoral rock and other hard substrata (A4)	15.32	15.17	0	0.08	15.17
Subtidal sediment	Sublittoral coarse sediment (A5.1)	84.54	22.23	22.23	64.68	22.23
	Sublittoral sand (A5.2)	45.97	5.33	0	39.6	5.33
	Sublittoral mud (A5.3)	14.27	10.32	10.32	10.32	10.32
	Sublittoral mixed sediments (A5.4)	83.87	12.77	12.77	83.55	12.77
	Sublittoral macrophyte dominated sediment (A5.5)	0.4	0.4	0.4	0.4	0.4
	Sublittoral biogenic reefs (Mussel beds) (A5.6)	0.02	0.02	0	0	0.02
Totals	All habitats	284.29	102.23	47.26	214.69	102.01

Condition of habitats within designated MPAs are subject to condition monitoring on a six yearly cycle. The monitoring is required to assess if the condition of the habitat features meets conservation objectives for the site and to also monitor the overall condition of the site (Natural England, 2021b; TECF, 2012; Curry et al., 2017).

Trend in extent was assessed in relation to monitoring (every 6 years) of habitat features within MPAs and historical data (eg. ordnance survey mapped extent of saltmarsh) (see detail on indicators in the Technical Methods Report). Limited evidence was available on change of habitat extent outside MPAs.

For the asset register, baseline condition and condition trend was assessed within MPAs in relation to conservation objective targets (favourable condition /maintain (target met), or unfavourable / recover (target not met)) (individual indicator references provided in the Technical Methods Report). For certain features, confidence in assessments are low as results may be based on a small number of sample sizes, or evidence may be from the previous 6 year cycle monitoring (eg. 2010 in 2016 monitoring). Even the most recent monitoring at the time of writing may be up to 5 years ago (Natural England, 2021b; TECF, 2012; Curry et al., 2017).

Due to the large extents of MPAs within the PSEC area, condition of a particular habitat asset may be adversely impacted in one area of the site but not in others. Where data exists on the proportion of a feature assessed in unfavourable condition, this has been presented to aid interpretation of accuracy if the entire extent of that feature as 'unfavourable' in the asset register (Table 3; Table 4).

Baseline condition and estimated trend outside MPAs was assessed in relation to the condition proxy method 'likely relative condition' (LRC) (Rees et al., 2019). LRC proxy condition modelling, assesses level of exposure of habitats to activities and pressures that are likely to have an adverse impact on the species communities present within the habitat feature (Rees et al., 2019).

LRC assessment is recognised to be precautionary as spatial activity data may occur at finer spatial scales within anchoring and mooring zones, and within broad fishing grounds identified in the Fishermap data available. Also, in areas with absence of detailed biotope data from surveys, where only broader Eunis habitat categories/classes are available in the habitat map, the most sensitive species community (Eunis level 4+) identified within south west UK marine habitats (Hiscock et al., 2016) is applied within that Eunis parent class (Eunis level 2/3), across the data poor (Eunis level 2/3) spatial area (Rees et al., 2019) (detail on the LRC method is provided in the Technical Methods Report).

Extent

Extent of all rock habitats within the site were assessed to have remained stable (Figure 4; Table 1). Saltmarsh and saline reed bed habitats, littoral and sublittoral biogenic reefs (mussel beds) and littoral mixed sediment were also assessed to have not reduced in extent (Table 1) (Further assessment provided in (Supplementary Material I).

Declining trends in extent were assessed for littoral sand and muddy sand, mud, mixed sediment and seagrass habitats and sublittoral seagrass habitats. There was insufficient evidence to assess trend in extent of sublittoral soft substratum habitats. Declines in extent of littoral habitats and littoral and sublittoral seagrass beds were due to interaction with pressures associated with anchoring and mooring activity and spread of invasive non-native species (Pacific oyster *M. gigas*) (Natural England, 2021b; Curtis, 2018; TECF, 2012; Curry et al., 2017; Bunker and Green, 2020) (Table 1) (Annex I, Annex II) (Supplementary Material I).

Condition

Of total extent of marine habitats within the Plymouth Sound and Estuaries SAC and Plymouth NMP stage 1 site, 37% are contained within designated MPAs and 36% interact with management measures to reduce human impacts on benthic habitats (Table 1). However, only littoral coarse sediment, intertidal saltmarsh, littoral and circalittoral reef and biogenic reef habitats are meeting condition targets within MPAs (Table 2). All other habitats within MPAs contain extents in unfavourable condition, with entire extents of littoral and sublittoral seagrass (macrophyte-dominated sediment) habitats at risk from damaging activity-pressure relationships (Table 1).

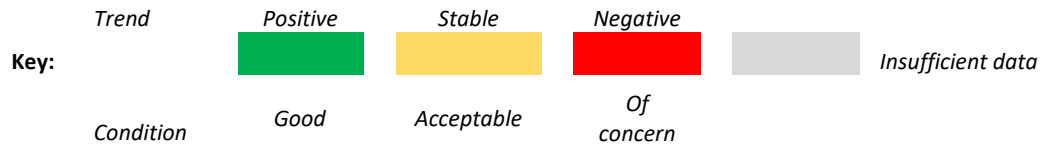
Contamination of water bodies and sediments from chemical or ecological pollutants, spread of invasive non-native Pacific oyster *Magallana gigas* and slipper limpet *Crepidula fornicata* as well as interaction with physical pressures from anchoring and mooring present the current pressures impacting habitats within the PSEC area (Natural England, 2021b; Curry et al., 2017; TECF, 2012). Future sea level rise and urban development present further pressures on natural capital (Natural England, 2021b; Curry et al., 2017; TECF, 2012) (Table 1; Table 2) (Annex 1).

In addition, 63% of habitats in the PSEC area remain outside MPAs, including large proportions of sublittoral soft substratum habitats that provide important contributions to food, clean water and sediment, healthy climate and sea defence ES benefits (Table 1) (Annex III). Although adverse impacts of activities on coastal

sublittoral sediments are considered in marine licensing processes, there remains less evidence of habitat extent, condition and assessment of adverse impacts of activities of habitats outside MPAs. LRC assessment identified high levels of interaction (72-100%) between habitats outside MPAs and activities that create pressures those habitats are sensitive to (Table 1), resulting in concern that condition of these habitats will not be sufficient to support functions and processes contributing to ES at reviewed levels (Table 2) (Annex III). Pressures assessed to be adversely impacting habitats included abrasion and sub-surface disturbance of habitats from anchoring and mooring and bottom towed fishing activities.

Table 2 summarises the current state of extent and condition of habitats at Eunis level 3 and status of water bodies, bathing waters and shellfish waters within the PSEC area. The current pressure identified to be impacting habitats and water bodies in conservation advice condition assessments by Natural England (2021), HRA assessments by Curry et al., (2017), risk assessments in TECF (2012), water body and bathing water assessments in Environment Agency (2020a) and Shellfish Water Classifications (Food Gov UK and Cefas., 2020) are identified, as well as pressures threatening condition where habitats remain assessed as favourable. Full review of the pressures impacting or threatening condition of habitat and water body assets, as well as assessment of indicator metrics are provided in Annex I; Annex II and Supplementary Material I**.**

Table 2 Baseline extent and condition of marine habitat assets in Plymouth Sound, Estuaries and Coast area (Figure 1), including summary of 10 year trend (full review of asset extent and condition provided in Supplementary Material I).



Broad Habitat	Detail (with Eunis code)	Extent (km²)	Extent trend	Condition	Condition trend	Pressure impacting condition / *Pressure threatening condition*
Marine inlets and transitional waters						
Intertidal reef	Littoral rock and other hard substrata (A1)	2.12				Tributyltin contamination (TBT), spread of invasive non-native species (INNS).
Intertidal sediments	Littoral coarse sediment (A2.1)	0.16				*Contamination and INNS*
	Littoral sand and muddy sand (A2.2)	5.98				TBT contamination and INNS.
	Littoral mud (A2.3)	20.85				TBT contamination and INNS.
	Littoral mixed sediment (A2.4)	0.52				Low infaunal quality index score.
	Coastal saltmarshes and saline reedbeds (A2.5)	0.40				*Water quality, trampling, coastal development, sea level rise*
	Littoral sediments dominated by aquatic angiosperms (seagrass bed) (A2.6)	0.43				Water quality – nutrient enrichment/opportunistic macroalgae. Anchoring/mooring.
	Littoral biogenic reefs (Blue mussel beds) (A2.7)	0.2				Spread of invasive non-native species (INNS).
Sublittoral habitats						
Subtidal reef	Infralittoral rock and other hard substrata (A3)	9.24				*Water quality/contaminants, anchoring/mooring, angling litter.*
	Circalittoral rock and other hard substrata (A4)	15.32				*Water quality/contaminants, anchoring/mooring, angling litter.*
Subtidal sediment	Sublittoral coarse sediment (A5.1)	84.54				Sediment contamination, Spread of INNS, Low infauna quality scores, benthic fishing, anchoring/mooring.
	Sublittoral sand (A5.2)	45.97				Benthic fishing, anchoring/mooring.
	Sublittoral mud (A5.3)	14.27				Sediment contamination: heavy metals, poly-aromatic hydrocarbons and poly-chlorinated biphenyls (PCBs). Spread of INNS. Benthic fishing, anchoring/mooring.
	Sublittoral mixed sediments (A5.4)	83.87				
	Sublittoral macrophyte dominated sediment (A5.5)	0.4				Anchoring and mooring.
	Sublittoral biogenic reefs (Mussel beds) (A5.6)	0.02				Spread of invasive non-native species (INNS).
Water bodies (combined)	Overall water body status	284.29				Contamination from agricultural run-off and sewage infrastructure: nutrient enrichment and biological contamination.
	Bathing waters					Contamination from historic mining sites and major pollution incidents from industry. Bacterial contamination.
	Shellfish waters					Bacterial contamination

SPECIES ASSETS

Species of conservation importance

Fish

Fish species considered as conservation features within the designated MPAs within the PSEC area include the diadromous species **Allis shad *Alosa alosa*** and **smelt *Osmerus eperlanus*.** Species of international conservation importance include further diadromous species**, salmon *Salmo salar*** and **eel *Anguilla anguilla***. There has been a decline in all species populations (Table 3).

The status of the Tamar allis shad population is uncertain but in 2015 a sharp downturn since 2011 was reported in the number seen migrating upstream via Gunnislake (Cotterell S.P. and Hillman R.J., 2016) (Table 3). Significant migratory barriers including Gunnislake Weir and Duchess Weir which limit access to Allis shad spawning habitat upstream of the tidal limit (Hillman, 2020).

Populations of smelt were detected in monitoring within the Tamar site in 2016 (Cotterell & Hillman 2016). However, populations are likely to be depleted given the UK context (Table 3).

Trends in Atlantic salmon (*Salmo salar*) % of conservation limit (CL) attained 2010-2019 have shown a decrease, as have validated counts and run estimates of salmon smolts and adults (Cefas; et al., 2020) (Table 3) (Supplementary Material I).

European eel stocks are assessed across Europe and have displayed large declines (ICES, 2020b). ICES (2020b) advice concludes that the precautionary approach is applied for European eel and all activities or pressures that decrease production and escapement of silver eels should be reduced to, or kept as close as possible to, zero in 2021 (ICES, 2020) (Table 3).

Migratory barriers and poor condition of water bodies and spawning habitat influence extent (quantity) and condition of all fish species of conservation interest due to their diadromous nature. Removal through bycatch or recreational fishing, potentially impacts stocks.

Shellfish

Native oyster (*Ostrea edulis*) and **Blue mussel (*Mytilus edulis*)** (beds) are included as conservation features within Tamar Estuaries MCZ, and are assessed with a 'recover' conservation objective (Natural England, 2021) (Table 3).

Birds

Avocet *Recurvirostra avosetta* and **Little egret *Egretta garzetta*** are species features within Tamar Estuaries Complex Special Protection Area (SPA). Both species have been assessed with a conservation objective of 'maintain'. Population of Little egret (n Individuals 5-year peak mean 2009/10 to 2013/14) did show a small decline. Population (n Individuals 5-year peak mean 2009/10 to 2013/14) of avocet have remained stable during this period (Natural England, 2021) (Table 3).

Species supporting wild food provision: commercially targeted species

Fish

Adult populations (spawning stock biomass (SSB)) and health of stock in relation to fishing pressure (total allowable catch (TAC)) (ICES, 2020a) have shown positive trends in the wider assessment regions interacting with the site for plaice *Pleuronectes platessa*, sole *Solea solea* and monkfish *Lophius spp.*. SSB of mackeral

Scomber scombrus has shown a stable trend, however TAC continues to decline due to pressures on the wider stock (Table 3) (Supplementary Material 2, Tab 1, Tab 2).

There has been a decline in species stocks at a local level and in the wider areas the fish stocks move within, for bass *Dicentrarchus labrax* and whiting *Merlangius merlangus* (Table 3) (Supplementary Material 2, Tab 1).

All other of the 12 key commercially targeted species landed by under 10m vessels to PSEC area ports have insufficient evidence available to confidently assess population extent and condition, such as not being assessed for SSB or TAC (Table 3).

Due to declines in salmon *Salmo salar* and eel *Anguilla anguilla* stocks commercial fishing has also been prohibited in the site for these species since 2017/18 (Cefas; et al., 2020) and prevented through IFCA netting byelaws (Table 3) (Supplementary Material I).

SSB and TAC calculations correspond to much wider spatial areas (ICES areas) than the PSEC site area. The calculations for wider ICES areas reflect movement scales of the wider regional populations, but may not reflect smaller scale regional populations within the PSEC area.

Shellfish

A lack of data inhibited confidence in assessment of important shellfish and demersal fish species to the PSEC area fisheries. However, crab and lobster stocks at a south west UK regional level were assessed by Cefas (2020, 2020a). **Crab *C. pagurus*** spawning stocks were expected to support sustainable harvesting at current effort levels (Cefas, 2020a) (Table 3) (Supplementary Material 2, Tab 3). **Lobster *H. gammarus*** stocks in the south-west UK may be at slightly higher risk, as the exploitation level for both sexes was assessed between sustainable target levels (MSY) and the maximum reference point limit for both sexes (Cefas, 2020b) (Table 3) (Supplementary Material 2, Tab 3). At smaller spatial scales, landings per unit effort for crab and lobster, within statistical areas intersecting with the study site have been assessed by Cornwall IFCA to be declining in since 2016 (Street et al., 2020). Brown crab (*Cancer pagurus*) LPUE displayed an increase between 2016 and 2017 but decreased between 2017-2018 in belted statistical zones interacting with the study site, with overall declines in LPUE 2016-2019 (Street et al., 2020). Lobster (*Homarus gammarus*) LPUE decreased between 2016 and 2018 at both inshore and offshore (Eddystone) statistical zones interacting with the site, although was more stable over time when all years 2016-2019 were included in analysis, as quarterly LPUE values were consistently higher in 2019 than previous years (Street et al., 2020).

Scallop *Pecten maximus* stocks in the fishing grounds adjoining the study site (7.e.I) displayed an increase between 2017-2019 (Lawler and Nawri, 2019) (Table 3). **Cuttlefish *Sepia officinalis*** ICES assessment for English Channel stocks indicated decreasing cuttlefish abundance, combined with possible northward redistribution of the species (ICES, 2020a), although due to the highly variable recruitment year to year there was low confidence in the assessment (Table 3).

Table 3 The extent and condition of key species supporting ES benefit 'wild food' (landings by under 10m vessels to Plymouth and Cawsand ports) and species designated as protected features or of conservation importance. Full assessment provided in Annex I.

Scientific name	Common name	Quantity	Quantity unit	Quantity trend	Condition	Condition unit	Condition trend
Commercially targeted fish and shellfish							
Pecten maximus	Scallops	10378-15061	(t) 7.e.l stock assessment				
Sepia officinalis	Cuttlefish						
Cancer pagurus	Crab					MSY (CEFAS, 2017)	
Homarus gammarus	Lobster					MSY (CEFAS, 2017)	
Pollachius pollachius	Pollack					(t) advised TAC ICES Area 7	
Dicentrarchus labrax	Bass	11007	(t) SSB ICES Area7d-h			(t) landings corresponding to advice	
Pleuronectes platessa	Plaice	2,200	(t) SSB ICES Area 7e			(t) advised TAC ICES Area 7d+e	
Microstomus kitt	Lemon sole						
Solea solea	Sole	3,974	(t) SSB ICES Area 7d+e			(t) advised TAC ICES Area 7e	
Raja spp.	Skates and rays						
Lophius spp.	Monkfish	59,751	(t) SSB ICES Area 7			(t) advised TAC ICES Area 7	
Scophthalmus maximus	Turbot						
Merlangius merlangus	Whiting	31034	(t) SSB ICES Area 7 e-k			(t) advised TAC ICES Area 7 e-k	
Triglidae	Gurnard species					(t) Red gurnard landings corresponding to advice	
Zeus faber	John dory						
Scomber scombrus	Mackerel	4,186,496	(t) SSB ICES All areas			(t) advised TAC ICES all Areas	
Species of conservation importance							
Salmo salar	Salmon	77 Tamar, 44, Lynher	% Conservation Limit attained				
Salmo trutta	Sea trout		N per license day				
Anguilla anguilla	Eel						
Osmerus eperlanus	Smelt		Returning adult population			Egg deposition	
Alosa alosa	Allis Shad		Returning adult population				
Ostrea edulis	Native oyster		Population size			Population health, condition	
Mytilus edulis	Blue mussel	0.22	Extent of beds km2			Population health, condition	
Egretta gazetta	Little Egret	77	n Individuals 5-year peak mean 09/10 to 13/14			Population health, condition	
Recurvirostra avosetta	Avocet	341	n individuals 5-year mean peak 09/10 - 13/14				

RISK REGISTER

APPROACH

The asset register assessed the state of the habitat or species asset extent and condition. The risk register, adapted from Mace *et al.* (2015), introduces assessment of the risk to the asset – ES benefit relationship identified in Report Part One (Ashley et al., 2021a) (Annex III). Thereby, assessing the risk to the PSEC area assets achieving the assumed contribution under un-impacted condition, to each of the ES benefits considered. Essentially, the risk register considers the nature and severity of risk to the asset – benefit relationship, in relation to the state of each asset's extent and condition.

Mace *et al.* (2015) categorised risk according to the performance of the asset-benefit relationship to relevant policy targets (Table 4). Policy targets in this context are considered to be societal aspirations for the asset-benefit relationship and, as such, form a threshold target against which risk can be defined. Policy targets applied within this Risk Register, relating to the state of each asset (extent and condition) are outlined in Table 4 and Supplementary Material I.

Good Environmental Status MSFD targets were identified for application within the risk register from existing assessment (Department for Environment Food & Rural Affairs, 2019 ; Cefas, 2012). For multiple assets there is an absence of a defined MSFD threshold for 'acceptable impact'. For habitat assets outside MPAs a midpoint in modelled Likely Relative Condition assessments of 'above moderate' >3 was used. The limitations of this approach are recognised in interpretation of assessments. For instance, LRC of >3 still represents some adverse impact, and even level 5, un-impacted condition is only relevant to the activity pressure combination assessed and time period assessed. Thereby it does not represent recovery to a baseline, un-impacted by all anthropogenic and environmental pressures. Threshold for many fish and shellfish species is that: '*abundance and demography of fish indicate healthy populations that are not significantly affected by human activities'* (Department for Environment Food & Rural Affairs, 2019). Currently there are few species populations assessed and those that are, in relation to ICES assessments are assessed at much greater spatial scales than the PSEC area. These species are subject to pressures outside the management of MPAs and marine areas within the PSEC area. Population assessments may also not reflect sub-populations that move over smaller spatial scales than entire ICES areas.

Table 4 Summarised policy targets for natural capital assets across national (UK) and international policies. (Full table assessing individual assets provided in Supplementary Materials I).

	Asset Status	Indicator	Policy	Target
Habitat	Extent	Area of habitat (km^2)	CBD Aichi 11; SDG 14	10% of habitat extent within MPA
			Marine Strategy Framework Directive (MSFD) Descriptor 1	*Target for rock/reef habitats and saltmarsh.* **Inside MPAs:** extent is stable or increasing (>95% of extent has conservation objective 'maintain') (Natural England 2021). **Outside MPAs**: 95% extent of assessed habitat to be unimpacted by anthropogenic activities (in LRC >3). *Target for all soft substratum habitats (where extent of the habitat is less than 50% of the assessed region).* I**nside MPAs**: extent is stable or increasing (>95% conservation objective 'maintain'. **Outside MPAs**: area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC 3 or below) ≤ 10% for entire assessed area. *Target for all soft substratum habitats (where extent of the habitat is above 50% of all assessed area)*. **Inside MPAs:** extent is stable or increasing (>95% conservation objective 'maintain').**Outside MPAs:** area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC 3 or below) ≤ 15% for entire assessed area.
	Condition	Area of each habitat within MPAs with conservation objective to be maintain or recover	MSFD Descriptor 6	Pressure based target: extent affected by human disturbance should be minimised, and, physical loss is minimised and where possible reversed (Defra, 2019): **Inside MPAs:** ≥95% of extent to be in favourable condition. i) presence and spatial distribution of biological communities representative of the feature are maintained. ii) presence and abundance of key structural and influential species are maintained (≥95% of extent to have conservation objective 'maintain'). **Outside MPAs**: as for 'extent'.
		Area of each habitat outside MPAs with a modelled LRC of 3≥		
	Spatial Configuration	**Inside MPAs** and **Outside MPAs** were assessed as for 'extent'. Unless specific conservation objectives contained		
Species	Extent	Proportion of fish stocks within biologically sustainable limits	MSFD Descriptor 3	UK assessment of progress towards GES for non-commercial, or fish populations in general require: 'abundance and demography of fish indicate healthy populations that are not significantly affected by human activities' (Defra, 2019). Estimated adult population is represented by Spawning Stock Biomass (SSB). Proportion of commercially exploited stocks within MSY targets and comparison to historical populations also provide indicators, but data are lacking at site specific spacial scales.
	Condition	1. Age and size structure of species stocks, 2. Spawning stock biomass		Scientific advice on Spawning Stock Biomass (SSB) and recommended Total Allowable Catch (TAC) provides the closest proxy for the health (and thereby condition or quality) of a stock (in relation to the fishing effort it can support).
	Spatial Configuration	Not assessed as stocks move over larger spatial scales than areas assessed		
Migratory Species	Extent	CPUE of adult salmon	North Atlantic Salmon Conservation Organisation (NASCO)	Maintain all stocks above their conservation limits
	Condition	Conservation Limit in relation to egg deposition estimates		Conservation Limit met or exceeded in at least 4 years out of 5
	Spatial Configuration	Quantity and Quality assessment in PSEC area rivers		Stocks meet CLs in at least 4 out of 5 years in all PSEC area rivers.
Water Bodies	Extent	Proportion of water bodies or bathing waters within assessed region	Water Framework Directive (WFD) Article 4	All coastal and estuarine water bodies to achieve 'good' or 'high' status. All designated bathing waters to be assessed as 'sufficient' or above.
			New Bathing Water Directive	
	Condition	Shellfish water status	WFD (shellfish waters)	Monitoring of harmful plankton and reported toxin levels to be below action level.
	Spatial Configuration	Not assessed		

Following the process defined by Mace *et al.* (2015), each asset-benefit relationship was assessed against the complied evidence according to the identified policy targets (Table 4). Each component characteristic (extent/ condition and spatial configuration was assessed for status and trend (Supplementary Materials I, 2). Within the red, amber green risk ratings proposed by Mace *et al.,* (2015), we applied an additional precautionary approach to identify risk. In instances where the status of benefit is below target, and the trend negative, we apply an adapted amber risk rating with an asterisk to highlight those asset-benefit relationships that are at risk of tipping over to a red risk rating.

Within the risk register a confidence score based on robustness and agreement of evidence (IPCC, 2014) linked to the trend and status, enabled confidence in results to be presented (Supplementary Materials I).

In the final output asset and risk register, lighter shaded, red, amber or green cells indicates a risk rating where there is less confidence (greater uncertainty) in the risk rating, due to limited evidence and/or limited agreement between evidence sources e.g. modelled habitat data (Supplementary Materials I).

BASELINE RISK REGISTER

The risk register under baseline condition (2019/2020) considered 233 benthic habitat, water body and species asset components, within asset – ES benefit relationships that provided a low – significant contribution to the 5 key ES benefits considered (Figure 5). Of these, 173 components were assessed to have a moderate or high contribution to ES benefits (Figure 5).

The risk register focused on asset –benefit relationships where the asset provided a moderate to significant contribution to the benefit (Annex III) (Ashley, 2021 Report Part One). However, where components relate to an asset that provides a low contribution (64 components), the implications are important to consider, especially for habitats that cover large spatial areas (Figure 5). For example, contribution of sublittoral soft substratum habitats was reviewed to be comparatively low (per unit area) to healthy climate benefits, but the habitats cover very large extents, and contribute to sequestration of carbon captured by plant and animal communities within water bodies, coastal and even freshwater and terrestrial environments. Therefore, total contribution to asset-ES benefit relationships, and associated risk, where components are degraded, is likely to be higher than the risk register represents.

Within the risk register, 39 potential habitat and water body interactions with ES benefits were not assessed as, either no data were available, or the habitat or water body asset provided negligible contribution to that ES benefit (Figure 5, Supplementary Material I).

Of the asset components assessed, as they provided moderate to high contribution to ES benefits, 41 were identified in the lowest risk category, as baseline extent and condition met policy targets (Figure 5; Supplementary Material 3, Tab 3; Tab 4).

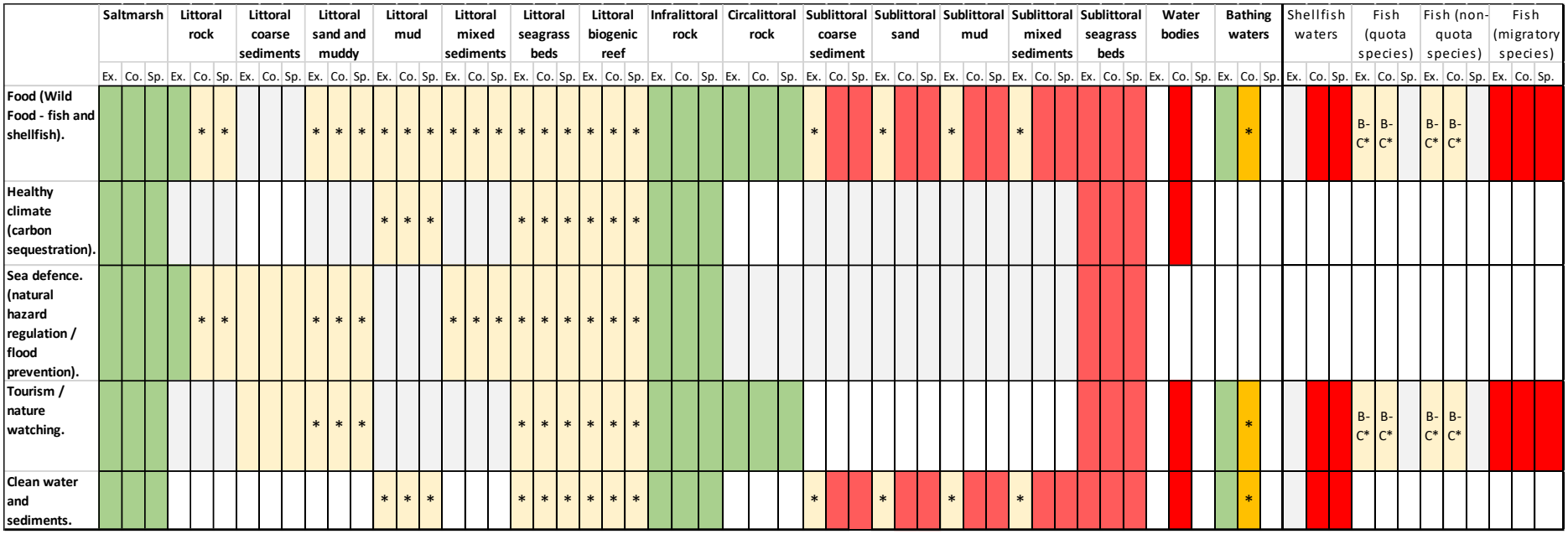


Figure 5 Priority relationships assessed in the risk register. The assets are columns and the benefits in rows. For each ES the top row is risk assessed through analysis of indicator data in relation to policy targets. The colour of the cell shows the risk rating for the asset status Extent (Ex), quality/condition (Con), spatial configuration (Sp) based on the scoring matrix (Supplementary Material I). Red indicates it is at high risk, amber at medium risk (*amber cells with an asterisk, indicate asset status is below target and the trend in status is declining, suggesting risk rating is close to moving to the high risk category), green risk ratings are at low risk. Lighter shaded, red, amber or green cells indicates RAG risk rating where there is less confidence (greater uncertainty) in the risk rating, due to limited evidence and/or limited agreement between evidence sources (e.g. modelled habitat data). The light shading for commercial fish species indicates a RAG assessment based on an assessment of data at a spatial scale greater than the case study area. The grey cells indicate asset- benefit relationships, which provided a low contribution of the asset to the benefit, or limited information to make an assessment. White cells represent negligible or no asset-benefit relationship.

In summary the baseline risk register identified Food provision ES category contained 43 natural capital components in highest 2 risk categories. Healthy climate 13 components in highest 2 risk categories. Flood/Sea defence: 17 components in highest 2 risk categories. Recreation/Tourism: 23 components in highest 2 risk categories. Clean water/ sediments: 28 components in highest 2 risk categories (Figure 4).

Under current baseline conditions, 48 components were identified in the highest risk category (red cells), whereby habitat, water body or species assets were significantly below policy targets, resulting in high risk to expected contribution to ES benefits (the asset-benefit relationship) (Figure 5). Elevated sediment contaminant levels, spread of non-native invasive slipper limpet populations and interaction with physical pressures related to anchoring and mooring, contributed to sublittoral soft substratum habitats not meeting policy targets within MPAs (Annex I, Supplementary material I). Large proportion of sublittoral soft substratum habitat extents outside MPAs were assessed to have a LRC of moderate or below (Supplementary material I). This was predominantly due to interaction with physical pressures related to fishing activity. Water bodies failed to meet policy targets for overall status in all water bodies (Supplementary material I). Migratory fish (salmon) populations have declined in PSEC area rivers, with declining % of conservation limit attained (Supplementary material I).

All intertidal habitats, aside from littoral coarse sediment habitats are currently adversely impacted, either in relation to failing conservation objective targets, or exposure of >5% of extents to pressure that relate to moderate or lower LRC (Supplementary material I). All but littoral coarse sediment are below policy targets and have shown a declining trend. This resulted in 78 components assessed within the moderate (declining) to high-risk category and 6 components were assessed in the moderate risk category. Spread of invasive non-native Pacific oyster *M. gigas* populations, particularly in the Yealm, and elevated contaminant levels in the Yealm and Tamar estuaries, were the predominant pressures contributing to littoral rock and littoral soft substratum not meeting policy targets (Supplementary material I). Shellfish water and bathing waters were degraded due to elevated bacterial contamination and pollution events (Supplementary material I). Non-quota shellfish species displayed declining trends in LPUE in small-scale statistical areas within the inshore and offshore areas of the PSEC area between 2016-2019, although wider regional populations were assessed to be harvested within sustainable limits (Supplementary material I).

These risks are summarised as:

-  **Food** (wild food fish and shellfish) is high risk due to the extent of sublittoral soft substratum habitat outside MPAs without management objectives and with impaired quality (condition) based on knowledge of previous demersal fishing activity. The condition of important fish and shellfish nursery habitat (seagrass beds, littoral rock and sediment habitats) and shellfish waters are also impaired in relation to elevated contaminant levels, spread of invasive non-native species and physical pressures from anchoring and mooring.
-  **Healthy climate** benefits are at risk due to the degraded quality of the littoral and sublittoral seagrass habitats, littoral mud and mussel bed habitats. Sublittoral soft sediment habitats provide a lower contribution to healthy climate benefits but over a much greater spatial scale. Degraded quality of these habitats is likely to also increase risk to delivery of healthy climate benefits.
-  **Sea defence** benefits provided by littoral habitats and sublittoral seagrass are at risk.
-  **Recreation and tourism** benefits are at risk due to degraded littoral and sublittoral seagrass beds and degraded littoral rock and soft substratum habitats, as well as incidences of poor water quality.
-  **Clean water and sediment** benefits supported by the ecological functions and processes in littoral mud, seagrass, mussel beds and the subtidal sediment and seagrass habitats are considered to be at risk due to impaired quality (condition) of these habitats.

Saltmarsh habitats are assessed in maintain/favourable condition, although extents have decreased since long-term historical baseline (1860s) (Supplementary Material I). Saltmarsh habitat condition assessment evidence is also lacking in recent years, with assessment based on monitoring between 2008-2012. This results in to low confidence in the 'green' risk rating in the risk register.

Intralittoral and Circalittoral reef habitats are also in maintain/favourable condition within MPAs, although outside MPAs 0.12km² and 0.8km² respectively, (1.3% and 0.5% of total extent) are likely to have interacted with pressures related to fishing activity. Both habitats are assessed as just below target with a non-discernible trend in condition, due to limited recent monitoring (Supplementary Material I). Combined, these habitats are likely to be providing at, or just below, expected contribution to all ES benefits assessed (Supplementary Material I).

IMPLICATIONS OF ASSESSED RISK TO ES BENEFIT FLOW FOR 5 KEY ES BENEFITS

The Asset Register summarised the baseline state of habitat, water body and species asset extent and condition, in relation to established indicator metrics. The Risk Register summarised risk to the asset - ES benefit relationship for the PSEC area, in relation to thresholds established in accordance with policy targets. Policy targets in this context are considered to be societal aspirations for the asset-benefit relationship. This section provides analysis of indicator data on ES benefit flow to investigate the risks identified in the Asset and Risk register and provide context for the holistic assessment.

In this section indicator metrics to assess baseline delivery of ES benefits within the site are summarised for each of the 5 key ES benefits considered. Baseline data from metrics for delivery of ES benefits, are related to the state of relevant assets contributing to each ES benefit.

The summaries provided aim to demonstrate links between asset status and flow of ES benefits and also the importance of the full range of habitat and species assets being in healthy / favourable condition to be able to support the expected range of ES benefits.

The pressures that threaten continued delivery of ES benefits are also considered and the existing management actions that aim to reduce risk to degradation of the asset-benefit relationship are summarised. Indicator metrics analysed are those identified in Ashley et al. (2018) and summarised in the Technical Methods Report.

ES BENEFIT FLOW: WILD FOOD

There are a range of species and associated habitats within the PSEC area that support the ecosystem service (ES) Wild Food (Fish and Shellfish) and deliver the benefit of food provision from natural capital at both a local and regional scale.

Habitats within the PSEC area provide structure, complexity, and niches, provide shelter and food resources for fish and shellfish species. For example:

A. The three-dimensional structure of saltmarsh and seagrass vegetation, provides significant shelter benefits to juvenile fish species, as well as food resources.
B. Reefs (including biogenic reefs) and kelp communities provide shelter and prey resources for juvenile stages of commercially targeted fishes, crustaceans and bivalve mollusc.
C. Sediment habitats that cover a vast tract of the PSEC area are a significant provider of food resources for adult fish and shellfish.

Full details of literature reviews on habitat requirements, supporting commercially targeted species are summarised in Table 5 and the Technical Methods Report).

Table 5 habitat requirements, supporting principle commercially targeted species

	Very High importance to supporting species
	Moderate to High importance
	Low importance
	Negligible importance

a	Provides adult habitat
spn.	Associated with spawning
jv.	Provides nursery habitat

Habitat interactions		Key commercial species (landings by value in 2019) landed to Plymouth and Cawsand by under 10m vessels													
		Crab Cancer pagarus	*Lobster Homarus gammarus*	*Pollack Pollachius pollachius*	*Sole Solea solea*	*Plaice Pleuronectes platessa*	*Thornback ray Raja clavata*	*Blonde ray Raja brachyura*	*Small-eyed ray Raja microocellata*	*Monkfish Lophius spp*	*Turbot Scophthalmus maximus*	*Scallop Pecten maximus*	*Cuttlefish Sepia officinalis*	*Lemon sole Microstomus kitt*	Bass *Dicentrarchus labrax*
Habitat interactions	Coastal saltmarshes and saline reedbeds (A2.5)				jv.	jv.	jv.								jv.
	High Energy, Moderate Energy and Low Energy Infralittoral Rock (A3.1, 3.2, 3.3)	a, jv	a	a, jv		a	jv.					jv.			
	High Energy, Moderate Energy, Circalittoral Rock (A4.1, 4.2.)	a	a	a								jv.			
	Sublittoral Coarse Sediment (A5.1)	a (females)	a,jv.				a				a, spn	a			
	Sublittoral Sand (A5.2)	a (females)	jv.		a	a	a	a	a	a, juv.	a	a			
	Sublittoral Mud (A5.3)		jv.		a		a	a		a, juv.	a				
	Sublittoral Mixed Sediments (A5.4)	a (females)	a, jv.		a		a					a			
	Seagrass beds (A5.53)	jv.		jv.	jv.	jv.	jv.					jv.	jv.		
Prey resources supporting commercial species (food web interactions)															
Food web interactions (bottom up)	Phytoplankton														
	Zooplankton														
	benthic fauna (polychaeta)														
	benthic fauna (crustacea)			jv.											
	benthic fauna (mollusc)														
	benthic fauna (fish)														
Seasonal presence of species within Plymouth Sound Estuaries and Coast															
Season	Winter			spn.		spn.									
	Spring				spn.		spn.				spn.				
	Summer						spn.				spn.			spn.	
	Autumn														

Fisheries are a key economic industry in the PSEC area linked to and dependent upon the natural capital assets (Table 5). Smaller under 10m vessels, based in Plymouth Sound ports, are most likely to be fishing within the PSEC area and land a diverse range of over 80 fish and shellfish species (MMO, 2020a). Trends in landings weight for the top 15 species by landings weight and value 2010-2019 have been positive for bass, scallops, cuttlefish, sole, pollack, lobsters, turbot, plaice, john dory, gurnard (all sp.) (Table 6). Trends have remained stable for skates and rays (all sp.) and whiting. Negative trends in landings weight have occurred for monkfish, crabs, lemon sole and mackerel (Table 6).

Table 6 Annual landings in 2019 for under 10m vessels to all ports within Plymouth Sound (Plymouth, Cawsand) in order of value, top 15 species (Kendall's tau-b positive or negative trend over time summarised as ↑positive, ↓negative, ↔negligible change, * indicates significant trend).

SPECIES	SUM OF LANDED WEIGHT (TONNES) 2019	TREND IN LANDED (WEIGHT) 2010-2019	SUM OF VALUE(£) 2019	MANAGED BY TAC OR QUOTA IN ICES AREA 7 Y/N	MANAGED BY LOCAL OR EU LANDING SIZE Y/N
BASS	29.63	↑*	361305.50	Y	Y
SCALLOPS (ALL SP.)	145.12	↑	276650.90	N	Y
CUTTLEFISH	103.23	↑	252482.30	N	N
SOLE	16.75	↑*	231535.10	Y	Y
POLLACK (LYTHE)	62.94	↑	225289.50	Y	Y
MONKS OR ANGLERS	17.51	↓	149623.60	Y	EU common marketing standard
CRABS (ALL SP.)	56.09	↓	138370.30	N	Y
LEMON SOLE	26.72	↓	132412.90	N	EU minimum marketing standard
LOBSTERS	13.70	↑*	119592.00	N	Y
TURBOT	7.75	↑*	102475.40	N	Y
PLAICE	29.06	↑	79817.39	Y	Y
JOHN DORY	8.01	↑	63092.65	N	N
SKATES AND RAYS (ALL SP.)	18.63	↔	41166.21	Mixed quota	N
WHITING	13.53	↔	23673.33	Y	Y
GURNARD (ALL SP.)	13.14	↑*	17357.78	N	N
MACKEREL	3.31	↓	10559.06	Y	Y

Individual vessel landings and spatial effort data were not available for this study and thereby, trends in spatial catch per unit effort (CPUE)/landings per unit effort (LPUE) could not be calculated. Thereby, it is unknown if trends in landings weight reflect actual CPUE or LPUE, and cannot be interpreted with confidence as a proxy for species abundance.

Between 2010 and 2019 numbers of under 10m vessels registered to Plymouth Sound Ports has increased from 73 vessels in 2010 to 160 vessels in 2019 (MMO, 2020b). A positive trend in landed weight for valuable species such as bass, scallops, cuttlefish, sole, lobsters, turbot, plaice, john dory and gurnard (all sp.) may reflect the increased effort related to increased active vessels. Landings trends may also reflect many other factors such as change in gear types used, available quota for quota species, new market demands and / or social and economic factors. Without detailed effort data related to landings and perceptions on fishers on the factors influencing landings, precise factors influencing landings trends cannot be confidently identified.

The condition of habitats, including water bodies supporting juvenile and adult life stages of species supporting wild food harvesting are, however, a key factor in supporting species populations. All seagrass habitat that provide essential nursery habitat to multiple species within the PSEC area is assessed at risk due to pressures from anchoring and mooring and water quality. Saltmarsh habitat also provides an essential nursery habitat for multiple species and although assessed as 'favourable' condition has not been surveyed since 2008-2012. Over 80% of subtidal soft substratum habitats, supporting adult life stages of all commercially targeted species, are in adversely impacted condition, due to: sediment contamination, anchoring and mooring pressure or pressures related to historical demersal fishing activity.

The ES benefits of wild food are also impacted throughout the PSE area, as shellfish waters in the site were assessed as 'negative/of concern' in most recent shellfish classifications (Food Gov UK and Cefas., 2020). Poor water quality has impacted shellfish waters supporting aquaculture sites and potential for hand gathering. Shellfish waters containing aquaculture operations have been limited to Class C due in the Yealm estuary, due to potential for contamination due to high e.coli levels in most recent assessments (Food Gov UK and Cefas., 2020). While, high contamination levels present in Tamar estuary above Henn Point and Plym estuaries, have currently led to bivalve mollusc harvesting and production being prohibited in these areas (Food Gov UK and Cefas., 2020).

RISKS TO HABITAT AND SPECIES ASSETS CONTRIBUTING TO WILD FOOD ES BENEFIT

Key risks to wild fish and shellfish fisheries in the PSEC area are:

a. Historical exposure to abrasion (linked to demersal fishing activity and anchoring and mooring activity) has negatively impacted the condition of habitats which provide shelter and food resources for fish stocks supporting commercial fisheries.
b. Essential nursery habitat extent and condition is adversely impacted (seagrass beds) or has not been monitored in recent condition assessments (saltmarsh).
c. Due to declines in salmon *Salmo salar* and eel *Anguilla anguilla* stocks commercial fishing has not been permitted for these species (license granted) since 2017/18. Barriers preventing access to spawning grounds beyond the tidal limit of estuaries and water and habitat quality issues adversely impact returning stocks of these species within the PSEC area.
d. Poor water quality has impacted shellfish waters supporting aquaculture sites and potential for hand gathering. Shellfish waters in the site were assessed as 'negative/of concern' in most recent shellfish classifications (Food Gov UK and Cefas., 2020). Shellfish waters containing aquaculture operations have been limited to Class C due in the Yealm estuary, due to potential for contamination due to high e.coli levels in most recent assessments (Food Gov UK and Cefas., 2020). While, high contamination levels present in Tamar estuary above Henn Point and Plym estuaries, have currently led to bivalve mollusc harvesting and production being prohibited in these areas (Food Gov UK and Cefas., 2020).
e. Spread of invasive non-native species Pacific oyster *M. gigas* may reduce extents of native blue mussel and native oyster populations, although all species can potentially be gathered for food dependant on water quality.
f. A large extent of habitats supporting adult life stages of fish and shellfish species are outside MPAs and therefore without management objectives or regular monitoring.
g. Species stocks with quota are monitored and managed at far greater scales than may reflect local populations. (For example some skate and ray species may have more localised populations within the wider ICES area stocks, and species such as bass display inter-annual fidelity to inshore foraging areas, placing local stocks at risk of depletion even if wider populations are assessed in favourable quantity and condition (Doyle et al., 2017).
h. Nine of the top 15 species supporting landings from under 10m vessel to Plymouth Sound ports are not managed by one of quota or landing size. Cuttlefish, john dory and gurnard have no quota restriction or minimum landing size at present.
i. Increased landings may reflect increase over time in vessel numbers and not increase in species abundance. Restrictions on availability of fishing activity data prevent catch per unit effort or even landings per unit effort being calculated to give a better indicator of species abundance. Availability of effort data to calculate CPUE/LPUE and species population assessment and fishing effort assessment at spatial scales relevant to fishing grounds supporting landings to the PSEC area, will aid assessment of species population condition in relation to fishing pressure. Collection and access to these data are required to maintain sustainable use of resources/assets and flow of benefits.

EXISTING MANAGEMENT ACTIONS THAT REDUCE RISK TO ASSETS CONTRIBUTING TO WILD FOOD ES BENEFIT

Management actions to reduce adverse impacts on habitats, water bodies and fish and shellfish populations have reduced risk to flow of ES benefit wild food, these include:

a. Designation of habitat and species as features within MPAs within the PSEC area and regional seas.
b. IFCA byelaws prohibiting use of demersal towed gears reduce adverse impacts on habitats within Plymouth Sound and Estuaries SAC and Start Point to Plymouth Sound and Eddystone SAC.
c. IFCA byelaws prohibiting use of nets within estuaries within the PSEC area reduce removal of fish species, in particular diadromous migratory species of conservation importance.
d. Regional IFCA landing sizes and EU minimum marketing standard 12 of the top 16 species landed by under 10m vessels to Plymouth Sound ports enhance potential recruitment and support stocks of those species.
e. Council Regulation (EU) 2020/123 introduced 27th January 2020 ensured bass caught by recreational fishers were released immediately if caught between months of December and February.
f. Regional IFCA regulations for recreational bass fishing, limit fishers to retain only 2 bass with a Minimum Conservation Reference Size (42cm) between March and November and prohibit use of fixed nets for recreational fishing.
g. Regional IFCA byelaws to protect wrasse stocks maintain populations of species of interest to this emerging fishery.
h. Regional IFCAs have undertaken Habitats Regulation Assessments on interaction of fishing gears at levels of spatial effort existing within SACs within the PSEC area to establish need for management above.
i. Westcountry Rivers Trust, Environment Agency and Natural England have continued to work to monitor migratory species populations, remove or mitigate barriers to migration and improve spawning habitat.

ES BENEFIT FLOW: HEALTHY CLIMATE

There are a range of species and associated habitats within the PSEC area that support the ecosystem service (ES) carbon sequestration and associated healthy climate benefits from natural capital. These benefits are relevant at both a local and international scale.

A healthy climate is dependent on the balance and maintenance of the chemical composition of the atmosphere and the oceans by marine living organisms. The capture and export of carbon and long term storage within sediments, provided by species within water body and habitat assets within the PSEC area is central to this process.

A. Saltmarsh plant communities, seagrass, algae and kelp communities capture carbon and soft substratum sediments contribute towards storage / sequestration.
B. The water column supports the carbon cycle though oceanic primary production harvesting light to convert inorganic to organic carbon.
C. River and estuaries provide relatively large C efflux through terrestrial detritus and sewage inputs to the coastal zone.

FLOW: ASSET - BENEFIT

Comparative sequestration t/c/km²/yr related to each habitat asset and associated species community within the PSEC area were reviewed from evidence from comparable sites. Confidence was attributed to the sequestration t/c/km²/yr value attributed to each habitat, based on the value being from comparable UK or European sites or from overseas literature, and the number of sources and level of agreement (eg range in values provided in the literature). Evidence, including low and high sequestration t/c/km²/yr values for PSEC habitats, from literature reviews are summarised in Table 7. Low and high values provided were from the evidence sources in peer reviewed literature, from the most comparable study sites.

It is important to note that total estimated values provided for the PSEC area (Table 7) are based on the entire extent of each habitat and associated species community asset being in a condition that supports the structure and function to provide the ecological processes required to capture and store atmospheric carbon.

Table 7 Sequestration data values transferred to Plymouth SAC/NMP t/c/km²/yr. Low and high values used in the analysis in the study are provided, with the selected value based on highest confidence for relevance to the UK/European temperate study site in bold. Ranges in reviewed literature for low and high values are provided, with confidence assessment, comments on selection of values and references values were extracted from.

Habitat	Sequestration data values transferred to Plymouth SAC/NMP t/c/km²/yr		Confidence	Comments	References
	Low	High			
Intertidal reef fucoid communities	**13.5** ('low' range in literature: 13.5-23)	**135** ('high' range in literature: 102-175)	Low	Large range due to lack of evidence on long-term carbon sequestered from C available n fucoid biomass. Estimate of 11%-17% macroalgae carbon stock sequestered in shelf sediments used in low estimate. High estimate based on UK productivity calculations.	(Burrows et al., 2017; Ugarte et al., 2010; Duarte and Cebrián, 1996; Krause-Jensen and Duarte, 2016; Krause-Jensen et al., 2018)
Intertidal sediments	**1.5**	**16**	Low	Low value transferred from shelf sediment estimates. High value used UK data reporting a sample from intertidal mud close to saltmarsh. Intertidal sediment exposed to greater disturbance from storms, tidal flow and human activity.	(Andrews, 2006; Alonso et al., 2012; Luisetti et al., 2019)
Saltmarsh	**120**	**550** ('high' range in literature 235 – 804) (Beaumont et al., 2014; Stafford et al., 2021)	High	Multiple data from UK sources, provides confidence in data and a low-high range with comparatively large values compared to other habitats. Importance of species community and species health to level of sequestration (Ouyang and Lee, 2014).	(Beaumont et al., 2014; Cannell et al., 1999; Chmura and Hung, 2004; Chmura et al., 2003 ; Adams et al., 2012; Stafford et al., 2021; Ouyang and Lee, 2014)

Seagrass	**45** ('low' range in literature: 36-45)	**186** ('high' range in literature: 160-186)	Moderate	Data from UK sources, provides understanding of carbon stocks, but data on sequestration rate is limited, thereby a large disparity in low-high range.	(Kennedy, 2009; Green et al., 2018; Greiner et al., 2013; Stafford et al., 2021)
Kelp	**40.03** ('low' range in literature: 17.94-78.82)	**403** ('high' range in literature: 220-750)	Low	Large range due to lack of evidence on long-term carbon sequestered from kelp biomass. High estimate based on productivity calculations for a UK site. Estimate of 10%-17% macroalgae carbon stock sequestered in shelf sediments used in low estimate (10%).	(Alonso et al., 2012; Gevaert et al., 2008; Duarte and Cebrián, 1996; Duarte et al., 2017; Krause-Jensen et al., 2018; Krause-Jensen and Duarte, 2016; Stafford et al., 2021; Burrows et al., 2017)
Shelf sediments	**1.5**	**<10**	Low	Values based on estimates from current C storage in shelf sediments from evidence outside the site. Evidence gaps exist on sedimentation rates and release through seabed disturbance. High estimate very low confidence as transferred from intertidal mud study.	(Luisetti et al., 2020; Luisetti et al., 2019; Smeaton et al., 2021; Alonso et al., 2012; Stafford et al., 2021)
Plankton communities	**0.001**	**0.006**	Low	Estimate based on percentage of carbon within plankton biomass estimated to reach seabed and become sequestered.	(Falkowski, 2012; Howard et al., 2017)
Rivers, estuaries water column~28% increase	**Potential for >20% increase in total contribution from habitats above** (not presently assessed in total)		Low	Contribution from global study that estimated transfer of carbon from terrestrial, freshwater and estuarine habitats, including sewage outlets to long term storage the coastal zone. Not UK specific and at relevant scale.	(Barrón and Duarte, 2015; Cauwet, 2002; Hansell, 2002; Saliot et al., 2002; Smith and Hollibaugh, 1993)
TOTAL in Plymouth site	**870.58**	**6910.64**	Low-Moderate		

A total value of 871 t/C/km²/yr was estimated from PSEC area habitats, based on low estimates and area (extent) of each habitat within the PSEC area (Table 7). A total value of 6911 t/C/km²/yr was estimated based on high estimates to be sequestered by habitats and associated algae and plant species communities within the PSEC area (Table 7).

Economic benefits associated with carbon sequestered by natural capital habitat and associated species community assets were calculated using UK Government current traded carbon values and also the social cost of carbon method previously used by the UK Government. Traded carbon values provide an assessment of the cost avoided of mitigating equivalent emissions to the carbon sequestered by habitats. Social Cost of Carbon metrics provide an assessment of the cost avoided of long-term damage from the sequestering of carbon by natural habits/species (Watkiss. et al., 2005; HM Government, 2018a). The estimated social cost of carbon was suggested as £19/tCO_2 in 2002, with an increase of £0.27/ tCO_2 per year to reflect the increasing marginal cost of emissions (HM Government, 2018a). A figure of £23.05/tCO_2 was, therefore used to calculate SCC for the baseline year of 2017.

The annual value calculated from low estimates was £3596, calculated as cost avoided of mitigation of emissions and £28227, calculated as cost avoided of long term damage by carbon (Table 8 a,b) and related to high estimates was £20067, calculated as cost avoided of mitigation of emissions and £159290 calculated as cost avoided of long term damage by carbon (Table 8 a,b).

Table 8 Value related to a) Low carbon sequestration calculations (t) for Plymouth SAC+NMP site and b) High carbon sequestration calculations (t) for Plymouth SAC+NMP site. Values are provided for 'cost avoided of mitigating emissions' (UKGOV 2017 cost (central)) and 'social cost of carbon': cost avoided of long term damage by carbon (total sequestered) (SCC).

a)

Natural Capital Asset	Benefit (Flow) (2020)		Monetary Benefit (2020)	
	Carbon sequestered (t)	Trend (2010-2020)	Cost avoided of mitigating emissions (UKGOV 2017 cost (central))	Cost avoided of long term damage by carbon (total sequestered) (SCC)
			Value (£)	Value (£)
Habitats reviewed to provide contribution to Benefit 'Healthy Climate'	**870.58**	↔	**3595.5**	**28227.07**

b)

Natural Capital Asset	Benefit (Flow) (2020)		Monetary Benefit (2020)	
	Carbon sequestered (t)	Trend (2010-2020)	Cost avoided of mitigating emissions (UKGOV 2020 cost (central))	Cost avoided of long term damage by carbon (total sequestered) (SCC)
			Value (£)	Value (£)
Habitats reviewed to provide contribution to the Benefit 'Healthy Climate'	**6910.64**	↔	**20066.92**	**159290.27**

The estimated values, provided in Tables 7 and 8 assume the entire extent of each habitat and associated species community asset are in a condition whereby structure and function of the asset is such that it provides the ecological processes required to support carbon capture and sequestration to reviewed levels. As Table 7 displays, there are also large uncertainties on the exact value for carbon sequestered (t).

Within the PSEC area habitats providing significant contributions to healthy climate benefits, saltmarsh (contribution to sequestration, low estimate: 120 t/c/km²/yr – high estimate: 550 t/c/km²/yr) (Table 7) and seagrass communities (contribution to sequestration, low: 45 t/c/km²/yr – high: 186 t/c/km²/yr) (Table 7) have limited confidence in good/favourable status assessments due to lack of recent assessment (saltmarsh), or were assessed in declining extent and condition (seagrass).

Littoral mud habitats, littoral and sublittoral biogenic reefs and water column assets reviewed to provide moderate contributions to the ES benefit healthy climate are also assessed in the baseline asset and risk registers to be in impaired condition.

Although infralittoral reefs, supporting kelp communities, assessed to provide moderate contribution to the ES benefit healthy climate, were assessed in favourable condition, and to meet policy targets with a stable trend within the risk register, these habitats provide only a carbon capture function. Long-term sequestration depends on detritus reaching the seabed in coastal and deeper ocean and being buried in soft substratum habitats.

Impaired condition of all sublittoral soft substratum habitats within the site is likely to impede expected contribution to healthy climate benefits from fucoid communities and kelp communities associated with rock

habitats. Bio-physical pathways in healthy soft substratum communities enable burial of detritus from water column primary productivity, coastal, intertidal, freshwater and terrestrial run-off sources (Luisetti et al., 2020; Burdige, 2007; Arndt et al., 2013; Teal et al., 2008). Impaired condition of sublittoral soft substratum communities is likely to reduce effectiveness of such pathways.

In relation to the status assessed within the asset and risk register, the habitat and associated species assets within the PSEC area are unlikely to be providing expected contributions to healthy climate ES benefits. Limiting benefits that are relevant at local and international scales.

RISKS TO HABITAT AND SPECIES ASSETS CONTRIBUTING TO HEALTHY CLIMATE ES BENEFIT

Key risks to habitat, water column and species assets contributing the ES benefit healthy climate in the PSEC area are:

a. Saltmarsh habitats within the PSEC area provide a significant contribution to the ES Healthy Climate but current extent and condition requires updated monitoring to improve confidence in the assessment of favourable condition and low risk to the ES benefit.
b. Seagrass habitats provide a significant contribution to carbon sequestration. However, anchoring and mooring pressures and water quality pressures adversely impact extent and condition of seagrass habitats in the site.
c. Sublittoral soft substratum habitats are in degraded condition due to interaction with pressures related to demersal fishing activity, anchoring and mooring, spread of invasive non-native species (slipper limpet) and elevated sediment contaminant levels.
d. Outside MPAs, there is reduced confidence in extent and condition of habitats, often with only modelled data of habitat type and extent. This limits confidence in assessment of contribution of these areas to ES benefits, including healthy climate.

EXISTING MANAGEMENT ACTIONS THAT REDUCE RISK TO ASSETS CONTRIBUTING TO HEALTHY CLIMATE ES BENEFIT

Existing management actions to reduce adverse impacts on habitats, water bodies and fish and shellfish populations have reduced risk to flow of ES Healthy Climate, these include:

a. IFCA byelaws prohibiting use of demersal towed gears reduce adverse impacts on habitats within Plymouth Sound and Estuaries SAC and Start Point to Plymouth Sound and Eddystone SAC. For instance, infralittoral rock habitats supporting macro-algae communities are in favourable condition and management measures through IFCA bye laws limit pressures from demersal fishing activity. As such, healthy climate benefits from these sources are likely to be contributed to at expected levels.
b. The MMO marine licensing process within the inshore and offshore area of the PSEC area requires impact assessment to consider implications of planned activities on designated features of MPAs and the wider marine environment (MMO, 2018). In particular the licensing process provides a means to reduce adverse impacts on offshore soft substratum habitats.
c. Mitigation activities to reduce adverse impacts from anchoring and mooring activities on seagrass beds are being undertaken at the time of writing within the REMEDIES project (Natural England., 2019). These include testing eco-moorings, no anchoring zones, seagrass bed re-seeding and undertaking awareness raising activities.

ES BENEFIT FLOW: SEA DEFENCE (FLOOD PREVENTION, STORM DEFENCE AND ALLEVIATION OF COASTAL EROSION)

Marine habitats play a valuable role in the defence of coastal regions, either through providing physical barriers to waves and water movement, by storing flood water within habitat extents or dampening wave energy and attenuating currents within the physical structure of vegetation. Within the PSEC area:

A. Physical barriers are provided by littoral rock habitats.
B. Saltmarsh habitats dampen wave energy, store large volumes of water and saltmarsh vegetation and seagrass habitats attenuate currents.
C. Soft substratum habitats dissipate wave energy and provide barriers reducing risk of damage to coastal defences and low lying land and infrastructure.
D. Intertidal habitats not only provide sea defence ES benefits in relation to present sea level (and sea conditions), but unlike man made defences, if unimpeded by coastal development, natural intertidal habitats such as saltmarsh will migrate with rising sea levels, predicted under future climate scenarios.

The total area of habitats reviewed to provide a moderate or significant contribution to ES Natural Hazard Regulation (Flood prevention/Sea defence) were calculated to be 19.48km² (Annex III). Saltmarsh and littoral rock provide significant contribution, comparatively by unit area, to other habitats. Intertidal soft substratum apart from intertidal mud habitats, infralittoral rock habitats, littoral and sublittoral seagrass and littoral and sublittoral biogenic reefs provide moderate contributions to Natural Hazard Regulation (Annex III). 18.59km² of habitat extent that provides moderate or significant contribution to Natural Hazard Regulation ES benefits are contained within MPAs (95% of total extent providing moderate to significant contribution).

RISKS TO HABITAT AND SPECIES ASSETS CONTRIBUTING TO SEA DEFENCE ES BENEFIT

a. Of the extent of habitats providing moderate to significant benefits to Sea Defence ES benefits, 3.2 km² (17%) of habitats have not met condition assessment targets (Annex III).
b. Recent evidence of saltmarsh extent and condition is unavailable, as a key habitat, providing significant contribution to sea defence ES benefit there is a lack of confidence in current contribution.
c. Adverse impacts on extent and condition of littoral and sublittoral seagrass habitats from pressures related to anchoring and mooring are likely to reduce benefits provided to attenuates currents. Extent of littoral rock and coarse, mixed, sand and muddy sand and mud habitats may reduce due to spread of invasive non-native species (Pacific oyster *M. gigas*) but the physical barrier provided, or dissipation of wave energy provided by this species community change is unlikely to affect sea defence benefits.
d. Prevention of inland migration of intertidal habitats under sea level rise scenarios due to urban infrastructure and existing coastal defences will lead to habitat loss and loss of Sea defence ES benefits from natural capital assets. Estimates of habitat areas lost under current sea level projections are calculated in Table 9.

Sea level projections were extracted from UKCP18 Marine Report (Palmer et al., 2018) and extent of each intertidal Eunis level 3 habitat, that, under predicted conditions would become permanently subtidal, were calculated within the Plymouth site. The assessment does not take into account presence of barriers to inland migration of habitats, or predicted change in terrestrial or shoreline habitat.

All intertidal habitat extents display a negative trend under all emissions scenario ranges. Greatest changes (loss) by area, under the lowest emissions scenario 0.5m sea level rise, were for littoral mud habitats (A2.3, 0.41km², 3.8% of total extent), littoral rock habitats (A1, 0.5m 0.1km², 7.9% of total extent), littoral sand and

muddy sand (A2.2, 0.09km², 2.2% of total extent), littoral mixed sediment (A2.4, 0.02km², 8.6% of total extent). All other intertidal habitats would decrease in extent by ≤0.1km² with a range in proportion of total extent of each habitats of between 1.4%-6.6%) (Table 9).

Littoral rock habitats provide significant contribution while littoral sand and muddy sand and littoral mixed sediment habitats provide moderate contribution to hazard regulation benefits, and thus, flow of ES benefit is reduced. The smallest loss of extent is for saltmarsh, the habitat that provides the greatest contribution to hazard regulation benefits, with greatest confidence in the association (A2.5, <0.1km², 1.4% of total extent). Under the highest sea level rise scenarios, associated with high emissions >75% of extent of all intertidal habitats are lost, apart from saltmarsh, which experiences a 37.5% decline (Table 9).

Mapping barriers to inland migration of habitats and modelling habitat extent lost where habitats are unable to migrate inshore is required to provide the confidence of this assessment.

Table 9 Habitats moved below lowest astronomical tide under different sea level rise projections (Palmer et al., 2018)(Palmer et al., 2018) related to low emissions rages and high emissions ranges.

Habitat	Current baseline (all habitats above LAT)	Habitats moved below lowest astronomical tide under different scenarios (i.e. changed to permanently subtidal, all areas in km²)							
		Low emissions scenario range				High emissions scenario range			
		0.5m	% lost	2.2m	% lost	1.4m	% lost	4.3m	% lost
A1.1	0.25	0.02	*7.7%*	0.11	*42.2%*	0.06	*24.9%*	0.22	*87.2%*
A1.2	0.55	0.04	*7.7%*	0.21	*38.2%*	0.12	*21.9%*	0.48	*85.7%*
A1.3	0.46	0.04	*9.4%*	0.18	*39.6%*	0.12	*27.0%*	0.32	*68.7%*
A2.1	0.14	0.01	*4.7%*	0.06	*42.0%*	0.03	*22.1%*	0.11	*84.5%*
A2.2	3.94	0.09	*2.2%*	1.62	*41.0%*	0.68	*17.1%*	3.57	*90.6%*
A2.3	10.82	0.41	*3.8%*	3.51	*32.4%*	1.60	*14.8%*	8.26	*76.3%*
A2.4	0.26	0.02	*8.6%*	0.18	*67.9%*	0.08	*31.2%*	0.24	*93.9%*
A2.5	0.21	0.00	*1.6%*	0.03	*12.7%*	0.01	*5.8%*	0.08	*37.5%*
A2.6	0.40	0.01	*1.4%*	0.07	*16.3%*	0.03	*6.5%*	0.38	*95.2%*
A2.7	0.14	0.01	*6.6%*	0.06	*46.6%*	0.04	*26.5%*	0.12	*82.9%*

EXISTING MANAGEMENT ACTIONS THAT REDUCE RISK TO ASSETS CONTRIBUTING TO SEA DEFENCE ES BENEFIT

a. Designation of habitat and species as features within MPAs within the PSEC area and regional seas.
b. IFCA byelaws prohibiting use of demersal towed gears reduce adverse impacts on benthic habitats within Plymouth Sound and Estuaries SAC, including habitats providing sea defence ES benefits.
c. Coastal realignment projects incorporating saltmarsh and saline reed bed habitat creation increase area of habitat providing natural hazard/sea defence ES benefits (Environment Agency, 2020b; Environment Agency, 2021a).
d. Mitigation activities to reduce adverse impacts from anchoring and mooring activities on seagrass beds are being undertaken at the time of writing within the REMEDIES project (Natural England., 2019). These include testing eco-moorings, no anchoring zones, seagrass bed re-seeding and undertaking awareness raising activities.

ES BENEFIT FLOW: CLEAN WATER AND SEDIMENTS

A significant amount of human waste is released into the oceans comprising of both organic (oil and sewerage) as well as inorganic (chemical) pollution. Marine habitats and species have a role in ecosystem processes that deliver the benefits of clean water and sediments (ANNEX III).

A. Vegetation within saltmarsh and seagrass habitats within PSEC the area has the ability to baffle water currents and stabilize sediments, resulting in organic matter and nutrients becoming stored within the accreting sediments, sequestering carbon, nitrogen and phosphorous, while the remaining organic material is recycled or exported.
B. Marine living organisms store, bury and transform waste though assimilation and chemical decomposition and re-composition. Bioturbation (biogenic modification of sediments through particle reworking and burrow ventilation) by benthic organisms living within soft substratum habitats provides a mechanism for nutrient cycling (Queirós et al., 2013; Sturdivant and Shimizu, 2017).
C. Filter feeding bivalves, such as mussels pump water and contaminants such as bacteria, algae, microplastics and detritus into their gill chambers, as they feed, effectively reducing concentrations within the water column (Viarengo and Canesi, 1991; Scott et al., 2019).
D. Extent of habitats in the site providing a moderate or significant contribution to the ES benefit of clean water and sediments is 236.58km² (ANNEX III).

Significant contributions are provided by littoral mixed sediment, saltmarshes and saline reedbeds and seagrass beds. Moderate contributions are provided by blue mussel beds, littoral sand and muddy sand, littoral seagrass beds, littoral biogenic reefs, sublittoral soft substratum habitats (ANNEX III).

Of the habitats providing a moderate or significant contribution to the ES benefit clean water and sediments 58.35km² (25%) occur within MPAs (ANNEX III).

RISKS TO HABITAT AND SPECIES ASSETS CONTRIBUTING TO CLEAN WATER AND SEDIMENTS ES BENEFIT

a. Of the extent of habitats providing a moderate or significant contribution to Clean Water and Sediments ES benefit, 1.29km² (2.2%) do not meet condition targets for habitat features (Annex III). Anchoring and mooring impacts on seagrass bed condition and spread of invasive non-native species within littoral mixed sediment habitats have reduced habitat condition.
b. Of the total extent of habitat providing moderate to significant contribution to the ES benefit of clean water and sediments within the PSEC area, 203.23km² (86%) was assessed to have LRC of moderate or below (Annex III).
c. In LRC assessments, large extents of soft substratum habitats inside and outside MPAs, and seagrass beds and littoral mixed sediments inside MPAs were assessed to be adversely impacted by historical demersal fishing activity and anchoring and mooring activity.

EXISTING MANAGEMENT ACTIONS THAT REDUCE RISK TO ASSETS CONTRIBUTING TO CLEAN WATER AND SEDIMENTS ES BENEFIT

a. Designation of habitat and species as features within MPAs within the PSEC area and regional seas.
b. IFCA byelaws prohibiting use of demersal towed gears reduce adverse impacts on benthic habitats within Plymouth Sound and Estuaries SAC, including habitats providing sea defence ES benefits.
c. The MMO marine licensing process within the inshore and offshore area of the PSEC area requires impact assessment to consider implications of planned activities on designated features of MPAs and the wider marine environment (MMO, 2018).

ES BENEFIT FLOW: RECREATION AND TOURISM

Marine Natural Capital Assets provide the basis for a wide range of tourism and recreational activities. Within the PSEC area there is high interest in activities that utilise beaches, and activities that access Tamar, Lynher, Plym and Yealm estuaries, coastal harbours and water bodies.

Examples from the Monitor of Engagement with the Natural Environment (MENE) survey and local studies include: watersports, wildlife watching, fishing, appreciating scenery (e.g. from a viewpoint), swimming outdoors, visits to a beach (sunbathing or paddling in the sea), walking with a dog or without a dog (e.g. walking the coast path) (Natural England, 2018; Natural England., 2020; Langmead et al., 2017). Langmead et al. (2017) identified the importance of the site to support specific interaction with the marine natural environment through wildlife watching, paddle boarding, kayaking, swimming and recreational boating activities.

The national MENE survey and PSEC area based studies of marine recreational activities illustrates the importance of these activities to local residents and visitors, and so, the importance of the waterbodies and natural assets that support them. There are also significant health benefits for people associated with interaction with healthy marine and intertidal environments (Britton et al., 2018). The considerable spend associated with these activities also supports businesses and communities within the PSEC area.

Recreation and tourism ES benefits are dependent on the condition of water body assets, intertidal and subtidal habitats.

A. Saltmarsh plant communities provide species of interest to foraging and support species of interest to recreational fishing and nature watching opportunities.
B. Beaches provide bathing water and coastal access points.
C. Seagrass, intertidal and subtidal rock habitats and intertidal and subtidal biogenic reefs provide nature watching opportunities to coastal walkers, swimming, snorkelling and scuba diving participants.
D. Littoral and subtidal biogenic reefs (mussel beds) provide species of interest to foraging, when water quality supports this activity.

The water column enables all marine recreation activities. The condition of the water column (water bodies) is essential to enable safe and healthy interaction with the marine environment and to support habitats and species communities of interest to nature watching and recreational fishing and foraging

FLOW: ASSET - BENEFIT

There are an estimated 15.5 million visitors to the Plymouth area per year (Visit Plymouth, 2019; Natural England., 2020) (Table 10). LEEP (2020) estimated annual visits of residents and visitors to shoreline and coastal paths and parks were between 6.8 and 9.2 million (Table 11). A large proportion undertake activities that benefit from the coastal scenery or access to water bodies (Table 12).

Table 10 Estimated annual visitors to Plymouth (upper tier local authority area) reproduced from MENE survey data summarised by Natural England (2018; 2021).

Year	No. visitors estimated annual visitors (y1-7 average 11830000)
2009	15599000
2010	12510000
2011	12739000
2012	14663000

2013	12551000
2014	17187000
2015	18938000
2016	15729000
2017	14329000
2018	19332000

Table 11 Estimated number of annual visits and associated welfare value provided by the LEEP (2020) ORVAL tool for sites with contact with marine and estuary sites in the PSEC area.

	Estimated Visits	**Welfare Value**
All paths, parks and woods on shoreline of SAC	6,772,101	26,259,324
Large inland parks with sea or estuary views: Central Park, Blockhouse Park, Freedom Fields.	1,440,375	3,725,232
Total	***8,212,476***	***29,984,556***
All paths, parks and woods on shoreline of SAC and within 500m	7,748,524	29036053
All paths, parks and woods on shoreline of SAC and within 500m and to settlements beyond tidal limits	9161324	32704248

Table 12 Proportion of respondents visitng the coast or beach in Plymouth LAA undertaking marine and coastal recreation activites, and associated annual spend, based on data provided in the MENE Local Authority Area dashboars (Natural England, 2021a).

Activity	**% of respondents visiting coast or beach in Plymouth LAA**	**Annual value (spend per day associated with each activity) (£million)**
Walking without a dog	48	20.87
Walking with a dog	15	6.52
Eating or Drinking Out	19	8.26
Appreciating scenery from a car	14	6.09
Beach, sunbathing or paddling	9	3.91
Watersports	7	3.04
Playing with children	7	3.04
Fishing	3.5	1.52
Wildlife Watching	3.5	1.52
Visiting an attraction	3.5	1.52
Picnicking	2	0.87
Swimming outdoors	1	0.43
Fieldsports	1	0.43

The MENE survey provided information on recreational activities undertaken by residents and visitors to coasts and beaches in Plymouth (upper tier local authority area (LAA)) (Natural England, 2021). Walking, without a dog or with a dog accounted for the most popular recreational activity interacting with Plymouth LAA coast

and beaches (48% and 15 % respectively). Appreciating coastal scenery from a car was also a popular activity (19%) (Table 12). Activities undertaken by visitors to the coast and sea highlight the importance of coastal scenery within the PSEC area being adjacent to an urban centre. For example for walkers, drivers and those eating or drinking out.

Specific water based activities and activities relying on interaction with species also accounted for activities undertaken by visitors such as: beach, sunbathing or paddling (9%), watersports (7%), fishing (3.5%), wildlife watching (3.5%) (Table 12). All these activities are supported by water quality species and habitat condition. For instance associated health and wellbeing benefits for participants require water bodies condition to not be impacted by pollution events, such as elevated bacteria contamination (Borja et al., 2020; Britton et al., 2018; Leonard et al., 2018). Habitats and species are also required to be in good / favourable condition to support activities, such as, recreational fishing, scuba diving, swimming and nature watching (Borja et al., 2020; Britton et al., 2018).

MENE survey data on participants motivations for undertaking activities interacting with coasts or beaches identified health and exercise provided the greatest motivation (all years) (73% of respondents). Relaxation related to viewing coastal scenery and experiencing fresh air also provided high motivation factors behind respondents visits (42-47% of respondents). Providing opportunity for interaction with family and entertaining children also provided motivation factors (23-27% of respondents), linked to social aspects of wellbeing as well as health aspects (Natural England, 2018; Natural England, 2021a).

SPEND OF RESIDENTS AND VISITORS UNDERTAKING COASTAL RECREATION AND WATERSPORTS ACTIVITIES

MENE survey data recorded an average spend per visit of £2.25 for visitors to Plymouth. For the estimated 19332000 visitors in 2018, this represents a spend on local services and businesses of £43,497,000.00 (Table 12). Although spend per day value can be split by activity based on the % of participation in the activity, the MENE data summarises this value across all activities (Table 12). Thereby, it is likely to provide a broad estimate and potentially an underestimation of value. In particular for specific recreational activities that participants may be involved in for half or full days, over shorter visits. For instance spend per day for each angler in a UK wide sea angling survey undertaken by Hyder et al. (2020a) was calculated to be on average £86 in 2017 (Hyder et al., 2020a; Hyder et al., 2020b; Hyder et al., 2018).

To increase confidence in economic values related to the site for specific water sports and recreational activities in Table 11 and Table 12, future studies would benefit from bespoke methods for relevant activities, such as those applied by Hyder et al (2020a), applied within the PSEC area.

The ORVAL tool also provided estimates welfare value related to visits to specific recreational spaces including paths, parks and woods. For all sections of paths, parks and woods directly on the shoreline of the related welfare value was estimated to be £26259324. This increases to £ 29036053 if visits to sections of parks within 500m inland of the coast or shore are included, and increases to £32704248 if estimated visits to large parks with sea or estuary views are included from the available spatial ORVAL data (LEEP, 2021) (Table 11).

The rare presence of a coastal path and beach access points within a UK city environment were identified by Faccioli and Zonneveld (2021) to provide considerable access opportunities and estimated welfare value. The existence of a coastal path, access points to the coastal path and the beaches in the Plymouth city waterfront area, alone, were estimated to generate £12,667,964 (per year) in terms of welfare for visitors and attract about 2,794,831 day visitors (per year) (Faccioli and Zonneveld, 2021).

RISKS TO HABITAT AND SPECIES ASSETS CONTRIBUTING TO RECREATION AND TOURISM ES BENEFIT

In relation to the status assessed within the asset and risk register, the habitat and associated species assets within the PSEC area are unlikely to be providing expected contributions to Recreation and Tourism ES benefits.

a. A moderate or significant contribution to the ES benefit 'Tourism and Recreation' is provided by habitats extending over 32.67 km² (11% of the entire PSEC area extent). A large proportion >90% of these habit extents are within MPAs within the PSEC area. Significant contributions are provided by intertidal habitats, littoral coarse, sand and muddy sand and mixed sediment habitats and saltmarsh (Table 2). All habitat extents providing a significant contribution other than littoral coarse sediment are assessed with 'recover' condition assessments, thus creating increased risk to provision of recreation and tourism ES benefits (Table 1; Figure 5; Annex III).
b. The water bodies within the site, extending over the entire extent (284km²) provide space for recreational and nature watching opportunities. All water bodies were assessed to fail to meet WFD targets, adversely impacting recreation and tourism ES benefits (Table 1; Figure 5; Annex III).
c. Poor water quality directly impacts in water recreational activities: swimming, paddle boarding, dinghy sailing, snorkelling, scuba diving, surfing, increasing health risks and access to participants.
d. Although bathing water monitoring and pollution incident alerts provide some mitigation in spring and summer months, during bathing water season monitoring, many participants undertake activities year round. Higher rainfall and frequency of storm events outside the bathing water season, in autumn and winter months are likely to increase combined sewer overflow (CSO) spills, negatively impacting health of participants.
e. Failure of Plymouth Sound and Plymouth Tamar water bodies to meet chemical and ecological status WFD targets increases risk to habitat assets providing predicted contribution to recreation and tourism benefits.
f. Elevated chemical contaminant levels in the Yealm estuary (TBT) adversely impact intertidal habitats, including littoral rock habitats, potentially reducing nature watching and foraging opportunities.
g. Nutrient enrichment leads to greater epiphytic algae on seagrass blades, reducing condition of seagrass beds, which support nature watching opportunities and provide nursery areas for species of interest to recreational anglers and divers.
h. Pressures relating to recreational anchoring and mooring activity also adversely impacts extent and condition of seagrass habitats and sublittoral habitats within the site. Reducing potential contribution to recreational and tourism ES benefits.
i. Spread of non-native invasive species (Pacific oyster *M.gigas*) reduces extent of native communities within intertidal habitats (eg. littoral mud, sand and muddy sand, biogenic reef (mussel beds) and littoral rock habitats) available for nature watching. Where dense Pacific oyster reefs have formed in areas of the Yealm estuary the sharp shells prevent access to the shoreline and safety risks for walkers, dogs and potentially damage small craft (Morgan et al., 2021).
j. Fish species of interest to specialist recreational anglers have shown declining trends or not met conservation targets, including bass *Dicentrarchus labrax,* salmon *Salmo salar*, sea trout *Salmo trutta* and eel *Anguilla Anguilla* (Table 3; Figure 5). Other species of interest to recreational anglers as well as nature watching interest to scuba divers and snorkelers have limited evidence to confidently assess stocks that interact with the PSEC area (Table 3; Figure 5).

EXISTING MANAGEMENT ACTIONS THAT REDUCE RISK TO ASSETS CONTRIBUTING TO RECREATION AND TOURISM ES BENEFIT

a. Designation of habitat and species as features within MPAs within the PSEC area and regional seas.

b. IFCA byelaws prohibiting use of demersal towed gears reduce adverse impacts on benthic habitats within Plymouth Sound and Estuaries SAC and Start Point to Plymouth Sound and Eddystone SAC. In particular infralittoral and circalittoral reef habitats of interest to scuba diving participants.
c. IFCA byelaws prohibiting use of nets within estuaries within the PSEC area reduce removal of fish species, in particular diadromous migratory species of conservation importance. Supporting populations of interest to specialist anglers and nature watching opportunities.
d. Regional IFCA landing sizes and EU minimum marketing standard 12 of the top 16 species landed by under 10m vessels to Plymouth Sound ports enhance potential recruitment and support stocks of those species. Species that are also of interest to recreational fishing, potting and nature watching.
e. Council Regulation (EU) 2020/123 introduced 27th January 2020 ensured bass caught by recreational fishers were released immediately if caught between months of December and February.
f. Regional IFCA regulations for recreational bass fishing, limit fishers to retain only 2 bass with a Minimum Conservation Reference Size (42cm) between March and November and prohibit use of fixed nets for recreational fishing.
g. Regional IFCA byelaws to protect wrasse stocks maintain populations of species of interest to recreational angling and nature watching.
h. Westcountry Rivers Trust, Environment Agency and Natural England have continued to work to monitor migratory species populations, remove or mitigate barriers to migration and improve spawning habitat.

SUMMARY

The Asset and Risk Registers demonstrate the importance of all habitat and species within a site being in sufficient condition, in order to deliver the expected suite of ES benefits, identified in reviews of potential contribution of assets (Figure 4; Annex III).

Existing management actions (IFCA byelaws) have reduced risk to delivery of ES from infralittoral reef and circalittoral reef habitats and reduced pressures from contact of demersal fishing gears with sublittoral soft substratum within Plymouth Sound and estuaries. However, water bodies and intertidal and sublittoral soft substratum habitat features within the site remain adversely impacted by chemical, bacterial and nutrient contamination and spread of invasive species, as well as pressures related to recreation activities. Habitats and water bodies are unlikely to be contributing to related ES benefits due to adverse impacts from these activities and related pressures within the PSEC area.

As a result, multiple ES benefits are impacted and the full potential delivery of ES benefits are not being achieved in the PSEC area. Likewise, no ES benefit relies just on the presence of one habitat or species asset, but instead on the combined functioning of multiple assets and species. Thus, management decisions are required that consider multiple actions to address the health of the whole site, to support the maximum potential contribution to each ES benefit as well as the combined suite of benefits from the site (Rees et al., 2020).

For instance, water bodies are adversely impacted by elevated chemical contamination (Yealm estuary) or elevated nutrient and bacterial contamination (Plymouth Sound and Tamar estuaries) due to run off from historical and current industry, agriculture and sewage infrastructure. This is likely to limit condition of habitat and species communities, such as seagrass beds and soft substratum habitats, in addition to pressures such as spread of INNS and abrasion from anchoring and mooring. In combination, these habitats provide nursery and adult habitats to fish and shellfish, healthy climate and clean water and sediment benefits. Thereby, addressing only one pressure on one asset is unlikely to restore or maintain flow of all ES benefits.

The pressures adversely impacting habitat and associated species assets within the PSEC area are challenges related to a site of high conservation importance adjacent to areas of agricultural land, historical and current mining and a large city with international commercial shipping, fishing and passenger ports, large naval ports and associated industry. As a result the PSEC area provides a unique challenge for management to achieve MSFD Good Environmental Status policy targets and associated natural capital and ES provision goals associated with the UK 25 Year Environment Plan.

The presence of a large urban areas directly adjacent to unique natural habitats within the PSEC area also provides potentially substantial health, economic and social wellbeing rewards as a result of meeting environmental status targets. Achieving policy targets that recover and maintain condition of habitat and species assets, reduces risk to ES benefits including access to fresh food, clean water and air and more directly relaxation and social benefits associated with interaction with heathy marine environments. These benefits are then not only available to visitors that arrive to seek them out but also local communities. Supporting economic, health and social wellbeing benefits to local communities (Britton and Coulthard, 2013; Britton et al., 2018).

Multiple local communities adjacent to the PSEC marine and estuarine area include lower-level super output areas (LSOAs) within 'Decline Category 1', the lowest 10% of the English national deprivation scale (Plymouth City Council., 2019). Improving accessibility for these communities to opportunities to interact with the natural marine and estuarine environment includes ensuring the water bodies and habitats are healthy and able to support such interaction. Access to marine recreation ES benefits have been displayed to show positive association with health and wellbeing indicators, and in particular mental health, especially psycho-social wellbeing, can be improved with investment in blue spaces (Britton et al., 2018). By ensuring the natural environment can support interaction and supply the greatest possible contribution to ES benefits, thereby, stands to provide significant social benefits, beyond biodiversity targets.

Development of the Plymouth National Marine Park aims to make the connection between enhancing the state of natural and cultural heritage assets and enabling awareness and access to them for local communities and visitors (Plymouth City Council, 2019). The benefits of successful management activities to address impacts on natural capital assets within the PSEC area are not only important for meeting policy targets, such as those in the risk register, but for meeting National Marine Park aspirations (Plymouth City Council, 2019; Pittman et al., 2019) and associated sustainable development goals (SDGs) (United Nations, 2015; United Nations, 2014).

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ANNEX I

Habitats and species features of designated sites within the study site

Habitat or species feature/subfeature (Eunis code)	**Designated site**	**Condition (X = unfavourable or recover)** (Plymouth and South West Devon Joint Local Plan Plymouth City Council HRA Assessment, 2017; Natural England, 2020)	**Management**
Littoral rock (high A1.1, moderate A1.2 and low energy A1.3, and features of littoral rock A1.4)	Plymouth Sound and Estuaries SAC	**X – Yealm: presence of invasive non-native *Magallana gigas (*formerly *Crassostrea gigas)* and contaminants including TBT.**	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Littoral coarse sediment (A2.1)	Plymouth Sound and Estuaries SAC, Tamar Estuary Sites MCZ	Maintain	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Littoral sand and muddy sand (A2.2)	Plymouth Sound and Estuaries SAC	**X – Tamar, Mudflats and sand flats not covered by seawater at low tide: not stated**	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Littoral mud (A2.3)	Plymouth Sound and Estuaries SAC	**X – Tamar: not stated**	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Littoral mixed sediments (A2.4)	Plymouth Sound and Estuaries SAC	**X – Yealm or Tamar estuary Mudflats and sand flats not covered by seawater at low tide: poor condition of infauna communities (IQI)**	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Littoral saltmarsh and saline reed beds (A2.5)	Plymouth Sound and Estuaries SAC,	Maintain	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Littoral seagrass beds (A2.6)	Plymouth Sound and Estuaries SAC	**X – Yealm or Tamar estuary Mudflats and sand flats not covered by**	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.

		seawater at low tide: opportunistic macroalgae which overlies the seagrass	
Littoral biogenic reefs (A2.7)	Tamar Estuary Sites MCZ	Maintain (Pacific oysters *C. gigas* are present on mussel beds)	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Infralittoral rock (high A3.1, moderate A3.2 and low energy A3.3)	Plymouth Sound and Estuaries SAC, Start Point to Plymouth Sound & Eddystone SAC	Maintain	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Circalittoral rock (high A4.1, moderate A4.2 and low energy A4.3)	Plymouth Sound and Estuaries SAC, Start Point to Plymouth Sound & Eddystone SAC	Maintain	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Subtidal coarse sediment (A5.1)	Plymouth Sound and Estuaries SAC	**X – Shallow inlets and bays: spread of non-native *Crepidula fornicata* and elevated sediment contaminent levels. Sandbanks which are slightly covered by seawater all the time: elevated contaminant levels and low infauna conditon (IQI score, north of breakwater)**	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Subtidal sand and muddy sand (A5.2)	Plymouth Sound and Estuaries SAC	Maintain	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Subtidal mud (A5.3)	Plymouth Sound and Estuaries SAC	**X – Tamar, Yealm, Shalow inlets and bays: spread of non-native *Crepidula fornicata* and elevated sediment contaminent levels.**	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Subtidal mixed sediments (A5.4)	Plymouth Sound and Estuaries SAC	**X – Tamar, Yealm, Shalow inlets and bays: spread of non-native *Crepidula fornicata* and elevated sediment**	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.

		contaminent levels.	
Subtidal seagrass bed (A5.5)	Plymouth Sound and Estuaries SAC	**X – Plymouth Sound and Yealm: exposure to anchoring and mooring.**	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Subtidal biogenic reefs (A5.6)	Tamar Estuary Sites MCZ (Mussel beds)	(Pacific oysters *C. gigas* are present on mussel beds)	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Shore dock (*Rumex rupestris*)	Plymouth Sound and Estuaries SAC	Maintain	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Allis shad (*Alosa alosa*)	Plymouth Sound and Estuaries SAC	**X – Gunnislake weir acts as a barrier to migratory fish**	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. River and Estuarine Fishing Nets Byelaw 2017. Devon and Severn IFCA: Mobile Fishing Permit Byelaw, Netting Permit Byelaw.
Smelt (*Osmerus eperlanus*)	Tamar Estuary Sites MCZ	**X – Gunnislake weir acts as a barrier to migratory fish**	Cornwall IFCA: Closed areas (European Marine Sites) No. 2.River and Estuarine Fishing Nets Byelaw 2017. Devon and Severn IFCA: Mobile Fishing Permit Byelaw, Netting Permit Byelaw.
Native oyster (*Ostrea edulis*)	Tamar Estuary Sites MCZ	**X - Nationwide population declines, with the native oyster population considered to be depleted**	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Blue mussel (*Mytilus edulis*) beds	Tamar Estuary Sites MCZ	(Pacific oysters *C. gigas* are present on mussel beds)	Cornwall IFCA: Closed areas (European Marine Sites) No. 2. Devon and Severn IFCA: Mobile Fishing Permit Byelaw.
Avocet (Recurvirostra avosetta)	Tamar Estuaries Complex SPA	Maintain	
Little egret (Egretta garzetta)	Tamar Estuaries Complex SPA	Maintain	

ANNEX II FULL ASSESSMENT OF EXTENT AND CONDITION OF HABITAT AND WATERBODY ASSETS INCLUDING REVIEW OF THE PRESSURES IMPACTING OR THREATENING CONDITION OF HABITAT AND WATER BODY ASSETS.

Intertidal habitats

Condition of intertidal habitats were most recently monitored in 2017/18 with conservation advice updates in 2021 (Curtis, 2018; Natural England, 2021b; Bunker and Green, 2020). Evidence from recent and historical monitoring as well as expert opinion informed condition monitoring (Natural England, 2021b; Curry et al., 2017).

Only littoral coarse sediment habitats and saltmarsh and reed bed habitats were assessed in favourable condition. However, most recent monitoring of saltmarsh habitats was from 8-12 years ago (2008 or 2012) (Natural England, 2021). Littoral biogenic reefs (mussel beds) within the Tamar Estuaries MCZ are assessed with a conservation objective of 'maintain'. However, beds within the Plymouth Sound and Estuaries SAC, are assessed under the SAC feature 'mudflats and sandflats not covered by seawater at low tide', which have an objective of 'recover/restore', due to damaging activities and presence of non-native species Pacific oyster (*Magallana gigas*) (Natural England, 2021).

Condition of littoral rock habitats, littoral mud and sand and muddy sand habitats in the Yealm were assessed as unfavourable due to Tributyltin contamination (TBT) and the increasing spread of invasive non-native species (INNS) (*M. gigas*) (Natural England, 2021b; Curry et al., 2017).

Littoral mixed sediments were assessed as unfavourable due to low infaunal quality index in Tamar estuary sites and wider littoral areas of mud and sand flats in MPAs (Natural England, 2021; Curry et al., 2017). Spread of invasive non-native species (INNS) (*M. gigas*) was also recorded to have reduced extent and condition of littoral mud and sand and muddy sand habitats in Tamar estuary sites (Curtis, 2018). Intertidal seagrass is considered to be in unfavourable condition, due to the presence of opportunistic macroalgae, which overlies the seagrass and prevents primary production (Natural England, 2021; Curry et al., 2017).

Only a very small proportion of the extent of intertidal habitats occurred outside MPAs (12% across all intertidal habitats) (Annex III). Similar pressures from elevated sediment and aqueous contaminants are likely to be adversely impacting condition of these habitat extents. LRC assessment only considered abrasion pressure related to demersal fishing and anchoring and mooring activity, so is likely to miss other habitat x pressure interactions (See Technical Methods Report and Supplementary Material 3). Pressure related to demersal fishing activity and anchoring and mooring activities inside and outside MPAs resulted in LRC of moderate to very poor for 9.5km² of littoral mud (46% of total extent), 0.28km² of littoral mixed sediment habitats (54% of total extent) and 4km² of sand and muddy sand habitats (68% of total extent) (Annex III). The entire extent of littoral seagrass habitat was also assessed with a LRC of moderate to very poor in relation to abrasion pressures. The LRC assessment is recognised to be highly precautionary, particularly where spatial data on activities is only available at broad scales, and spatial areas where detailed species community survey data is unavailable (Technical Methods Report).

Subtidal habitats

Infralittoral and circalittoral reef habitats throughout MPAs were assessed to be in favourable condition, as were subtidal sand habitats (Natural England, 2021; Curry et al., 2017). Recent monitoring of extent of subtidal (and intertidal) mussel beds by Curtis et al., (2018) identified that the blue mussel beds in the Tamar-Tavy, St Johns Lake and the Lynher Estuary sites, have not changed significantly in extent or distribution since 2010. However, mussel beds at Jupiter Point and Shillingham Point (Lynher estuary) were assessed to be of poor

quality from a fishery point of view, with a high percentage of shell and live mussel which appears to be dominated by a single year class (Jenkin et al., 2016). Two non-native species, Pacific oyster *Magallana gigas* and slipper limpet *Crepidula fornicata*, were found during surveys (Jenkin et al., 2016), suggesting limited confidence in current assessment of 'favourable' condition of blue mussel beds.

Condition of subtidal mixed sediments and subtidal mud habitats were assessed as unfavourable in Tamar estuary sites due to elevated levels of heavy metals (Mercury, Copper, Lead and Zinc), poly-aromatic hydrocarbons (PAHs) and poly-chlorinated biphenyls (PCBs) within the sediments (Natural England, 2021; Curry et al., 2017). In the Yealm estuary, subtidal mixed sediments and subtidal mud habitats are also assessed as unfavourable due to elevated sediment contamination levels, but also, elevated aqueous contaminants, primarily Tributyltin (TBT) and presence of the INNS, slipper limpet *Crepidula fornicate* (Natural England, 2021; Curry et al., 2017). Within shallow inlets and bays within MPAs across the wider site, subtidal coarse sediment habitats, subtidal mixed sediments and subtidal mud habitats were assessed to be in unfavourable condition, also due to the presence of the INNS, *Crepidula fornicate* and elevated sediment contaminant levels. Subtidal coarse sediment habitats within shallow inlets and bays were also recorded to have low infauna quality index, in sites to the north of the breakwater. There was limited evidence to conclude if sediment contamination was due to historical mining activities or current industrial activities (Natural England, 2021; Curry et al., 2017).

Subtidal seagrass beds are assessed as unfavourable due to interaction with abrasion pressure from anchoring and mooring activities (Natural England, 2021; Curry et al., 2017; Langmead et al., 2016).

Large proportions of subtidal habitats within the PSEC area occur outside MPAs (70% of all subtidal habitats across total extent in the site) (Annex III). Particularly, sublittoral coarse sediment, sublittoral sand and sublittoral mixed substratum habitats. Large proportions (72.3%-100%) of all soft substratum habitats across the site were assessed with a LRC of moderate to very poor in relation to abrasion pressures from demersal fishing activity and anchoring and mooring activity (Annex III).

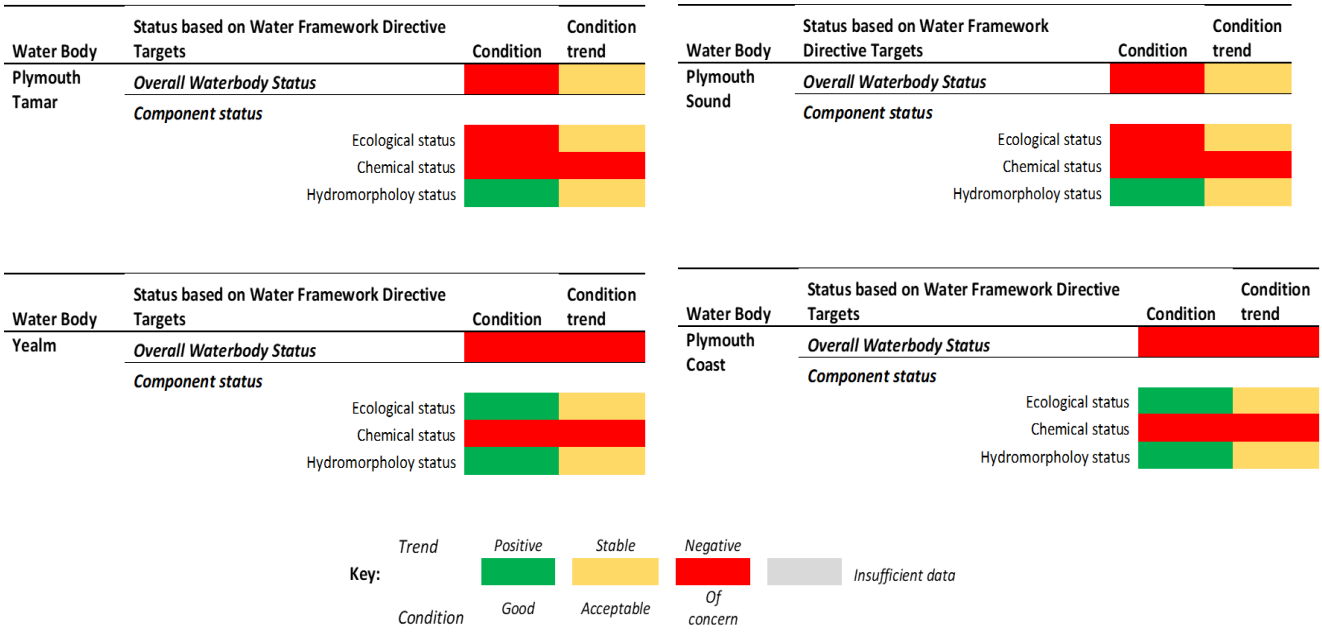
Water bodies

Although extent of water bodies in the PSEC area has not changed, condition is assessed as degraded with a declining trend (Table 1). Water Quality is identified to be impacted throughout the site from a range of sources, leading to failure to meet overall WFD targets in all water bodies in the site (Tamar Catchment Partnership, 2012; Curry et al., 2017; Environment Agency, 2020a).

Ecological status targets in Plymouth Sound and Tamar estuaries were failed in assessments due to diffuse pollution from agriculture practices occurs around the estuary, the addition of sewage inputs from water treatment works infrastructure and run off from combined sewer overflows (Table 6). These pollution sources add to nutrient enrichment and biological contamination (Tamar Catchment Partnership, 2012; Curry et al., 2017; Environment Agency, 2020a).

Chemical status targets were failed in assessments for all water bodies due to contamination from historic mining sites and major pollution incidents from industry within the estuarine and river catchments (TECF 2012; Environment Agency 2019; Plymouth and South West Local Plan, 2017) (Table 1). Contaminants are also locked into sediments within the estuary that if disturbed can be released into the water column, such as through dredging of shipping channels (TECF, 2012).

Table 1 Condition and condition trend of water body status from WFD monitoring within the Plymouth Sound and Estuaries SAC site and NMP Stage 1 (Environment Agency, 2021).



Bathing waters

The status of bathing waters was assessed from Environment Agency annual assessment of bathing water quality for sample sites (beach locations) (Environment Agency, 2018b; 2020). Classification thresholds represent the predicted bacteria concentrations of, Escherichia coli (EC) or Intestinal enterococci (IE) concentrations (colony forming units/100ml) using analysis of the most recent 4 years data sets from samples collected between April and September for a given site. The annual classifications for each site are:

- excellent – the highest cleanest seas
- good – generally good water quality
- sufficient – the water meets minimum standards
- poor – the water has not met the new minimum standards. (The Environment Agency state they plan work to improve bathing waters not yet reaching Sufficient (Environment Agency, 2018b).

Pollution alert events where temporary closure of a bathing water occurs, typically for 24-48 hours are also included in this assessment. Pollution alert events occur in relation to short term chemical pollution events, or sewage pollution incidents related, such as combined sewer overflow (CSO) events, between April and September 2020 (DEFRA, 2021b; Environment Agency, 2020a).

All bathing designated bathing waters in the PSEC area received good or excellent status in the baseline year (2020) (Table 2). A total of 19 pollution alerts occurred in 2020 across all designated bating waters in the site (Table 2).

Table 2 Bathing water status for designated bathing water sites in the PSEC area, including available trend and pollution alert events.

Designated Bathing Water Site	Status 2020	Trend 2013-2020	Alerts 2020	Trend
Plymouth Hoe East	Good	↓	5	unknown
Plymouth Hoe west	Excellent	↔	3	unknown
Bovisand	Excellent	↔	0	unknown

Wembury	Excellent	↑	7	unknown
Cawsand	Excellent	↔	5 (Cawsand Bay)	unknown
Kingsand	Excellent	↔	5 (Cawsand Bay)	unknown

Sampling data used to inform analysis of predicted bacteria concentrations and thereby designated bathing water status is only collected from April – September (typical bathing water season). Use of bathing waters by recreational activities such as swimming, paddle boarding, surfing and scuba diving is increasingly occurring year round. Outside of the April and September bathing season higher rainwater in autumn and winter is likely to lead to increased surface water run-off and pressure on drainage water infrastructure.

Within existing drainage infrastructure, rainwater, runoff from urban areas and adjoining farmland and waste from toilets, bathrooms and kitchens are conveyed in the same pipe/s. Combined sewer overflows (CSOs) are present within the network to release drainage water to prevent sewage flooding businesses and homes. Although the water quality within a given CSO spill is unknown the potential contaminants contained in drainage water could impact chemical and ecological water body status, including bathing water status from bacterial contamination.

Recent publication of CSO monitoring data allowed total duration (hours) and total number of counted spills using 12-24hr counting method to be calculated for the entire year (DEFRA, 2021b; The Rivers Trust, 2020). This data has been included as it reflects potential year round contamination, beyond the spring and summer bathing season (Table 3).

For the entire catchment of the PSEC area, including tributary rivers to estuaries, CSO events totalled 85141.70 hours duration, in relation to 10407 counted spills. For CSO locations adjacent to Plymouth Sound and the lower extent of estuaries within the site, CSO events totalled 19915.68 hours duration, in relation to 4264 counted spills (DEFRA, 2021b; The Rivers Trust, 2020) (Table 3). The total number of pollution alerts, annually would, thereby, likely exceed the 19 recorded during the 6 month bathing season.

Table 3 combined sewer overflow spills recorded for all CSO permit locations within the PSEC area catchment and CSO permit locations immediately adjacent to Plymouth Sound and lower reaches of estuaries (Tamar, Plym and Yealm) presented as Total Duration (hours) and counted spills using the 12-24hr counting method.

CSO Location	Total Duration (hours) of all spills prior to processing through 12-24 hour counting method	Counted spills using 12-24hr counting method	Average % of reporting period EDM's were operational
All permit locations within SAC and NMP catchment	85141.70	10407.00	88.97
Permit locations adjacent to Plymouth Sound and lower reaches of estuaries (Tamar, Plym and Yealm)	19915.68	4264.00	87.36

Shellfish waters

Bacterial contamination levels have also impacted all designated shellfish waters in the Tamar and Yealm estuaries. Shellfish waters in the site were assessed as 'negative/of concern' in most recent shellfish classifications (Food Gov UK and Cefas., 2020).

Shellfish waters in the Yealm estuary were limited to Class C due to potential for contamination due to high e.coli levels in most recent assessments (Food Gov UK and Cefas., 2020).

Class C limitations require Molluscs must contain ≤ 46,000 E. coli per 100 grams of flesh Molluscs and can only go for human consumption after strict purification measures (Food Gov UK and Cefas., 2020).

High contamination levels were present in Tamar estuary above Henn Point and Plym estuaries, leading to bivalve mollusc harvesting and production being prohibited in these areas (Food Gov UK and Cefas., 2020).

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ANNEX III EXTENT OF HABITATS (AGGREGATED TO EUNIS LEVEL 3) AND CONTRIBUTION OF HABITAT FEATURES AND ASSOCIATED SPECIES COMMUNITIES TO 5 KEY ES BENEFITS

The table summarises level of contribution to key ES benefits: 'Wild Food', 'Sea Defence', 'Clean Water and Sediments', 'Healthy Climate', 'Tourism including Recreation and Nature Watching'. The table includes habitat extents and extent in conservation objective 'recover' or likely relative condition of moderate (3) or below.

Scale of ecosystem service contribution relative to other features	
#	Significant contribution
#	Moderate
#	Low
#	No or neglibible
[Blank]	Not assessed

Confidence in evidence available to assign ES provision	
3	UK-related, peer-reviewed literature
2	Grey or overseas literature
1	Expert opinion
[Blank]	Not assessed

Broad scale habitat	Natural Capital Asset: Habitats in Plymouth Sound Estuaries and Coastal area		Extent in PSEC area (km²)	Extent in 'recover' conservation objective (km²)	Extent in LRC <3 (km²)	Contribution to ES Goods/Benefits				
						Food (wild food)	Tourism, nature watching and recreation	Sea Defence	Healthy climate	Clean water and sediments
Marine	Intertidal reef	A1: Littoral rock and other hard substrata	2.12	0.02	1.76	3	1	1	2	
	Subtidal reef	A3: Infralittoral rock and other hard substrata	9.24	0	0.12	3	1	1	2	
		A4: Circalittoral rock and other hard substrata	15.32	0	0.08	1	1	1		
	Intertidal sediments	A2.1 Littoral Coarse sediment	0.16	0	0	1	1	3		
		A2.2: Littoral sand and muddy sand	5.98	0.65	4	1	1	3	2	
		A2.3: Littoral mud	20.85	2	9.5	3	1	3	3	3
		A2.4: Littoral mixed sediment	0.52	0.49	0.28	1	1	3	2	
		A2.5 Coastal saltmarshes and saline reedbeds	0.4	0	0	3	3	3	3	3
		A2.6 Littoral sediments dominated by aquatic angiosperms (seagrass bed)	0.43	0.4	0.4	3	1	1	1	1
		A2.7 Littoral biogenic reefs (A2.72 Blue mussel beds)	0.2	0	0	2	1	1	1	1
	Subtidal sediment	A5.1: Sublittoral coarse sediment	84.54	22.23	64.68	2		3	2	3
		A5.2: Sublittoral sand	45.97	0	39.6	2		3	2	3
		A5.3: Sublittoral mud	14.27	10.32	10.32	2		3	2	3
		A5.4: Sublittoral mixed sediments	83.87	12.77	83.55	2		3	2	3
		A5.5: Sublittoral macrophyte dominated sediment	0.4	0.4	0.4	3	1	1	2	2
		A5.6 Sublittoral biogenic reefs (A5.62 Mussel beds)	0.02	0	0	1	1	1	1	1
	Water column	N/A Areas of high planktonic primary productivity				2	1	1	2	1
		N/A Tide swept channels					1			

SUPPLEMENTARY MATERIAL 1:

Justification for risk register scoring

We set out here assessment relating to the 173 asset benefit relationships identified in the first stage of the analysis as being most influential, where there is a link between the extent, condition or spatial configuration of the habitat or species assets and the flow of benefits. In total there were 233 low – significant contributions to the 5 key ES benefits considered, of these, 173 components were assessed to have a moderate or high contribution to the 5 key ES benefits. The Extent, Condition or Spatial Configuration status and trend of the habitat or species assets are assessed in relation to a defined target. These are the relationships that received a Red, Amber or Green rating according to their risk rating. The Table below explains out how the following Tables can be read, adapted from Mace et al., (2015).

The R (Red), Amber (A), Green (G) score is shown in the RAG key table (below). Evidence for each assessment is shown in the Table and an Uncertainty score for each Status and Trend measurement is estimated (1 to 4). These individual scores are added in the final column to give an overall uncertainty for the RAG rating (Low uncertainty <=4; high uncertainty >=5).

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (A-C)
		• **Bold text = med to significant contribution.** • Light text = low contribution	Characteristic of the asset being assessed: Extent, Condition or Spatial Configuration. Condition sets out production functions, within underlying natural capital assets. Where available indicators were assessed that can be influenced and are important to provision of ES benefits.	What is the status of the relationship relative to a defined target? RAG rating for trend Uncertainty of Trend		What is the trend in the relationship? RAG rating for Status Uncertainty of Status	RAG (Overall RAG based on status and trend) Total Uncertainty (Summation of Uncertainty)

		Status		
		Above, at or just below target	Below target	Substantially below target
Trend in Status	Positive or not discernible	*A*	*B*	*B*
	Negative	*B*	*B**	*C*
	Strongly negative	*C*	*C*	*C*

		Status		
		Above, at or just below target	Below target	Substantially below target
Trend in Status	Positive or not discernible	*Low*	*Medium*	*Medium*
	Negative	*Medium*	*Medium**	*High*
	Strongly negative	*High*	*High*	*High*

		Agreement	
		High	Low
Robustness	*Significant evidence*	**1**	**3**
	Limited evidence	**2**	**4**

	High confidence	Low confidence
Low risk	*A*	*A*
High risk (or risk unknown)	*B-B**	*B – B**
Very high risk	*C*	*C*

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
Coastal Margin	Saltmarsh	• **Food (Wild Food - fish and shellfish).** • **Healthy climate (carbon sequestration).** • **Sea defence. (natural hazard regulation).** • **Tourism/nature watching.** • **Clean water and sediments.**	Quantity/Extent	Saltmarsh extent in Plymouth Sound and Estuaries SAC up to the high water mark is 0.29km², area within an MPA is 0.29km² and area intersecting a management measure (for benthic activity) is 0.29km². Saltmarsh habitats support nursery areas for multiple commercially targeted fish species and provide a significant level of contribution to all key ES. Saltmarsh extent had not been monitored since 2012 and Natural England condition assessments state it is being reviewed, extent including that beyond the high water mark was recorded as 1.97km² (Natural England, 2021). The extent is assessed in favourable condition. Between 2008-2012 no change in extent was recorded in Plymouth Tamar waterbody, a decrease of 0.026 km² was recorded in Yealm. Comparison to OS map extents in 1860 suggest a decline (-0.3km²) despite a 0.03km² increase through land claim across the site (Environment Agency, 2021). Ongoing actions include updating monitoring and 0.11km² increase in extent saline reed bed in relation to habitat creation and managed realignment projects (Environment Agency, 2021).	Extent to be stable or increasing and ≥95% SSSI favourable / recovering (GES). This target is also recognised as needing to be reached by 2020 in Biodiversity Strategy 2020. MSFD, GES: **Extent: (Inside MPAs):** extent is stable or increasing (>95% conservation objective 'maintain').	Saltmarsh extent has decreased by a small extent between 2008-2012 in Yealm (0.03km²).. Confidence is limited as monitoring has only been undertaken between 2008 and 2012/13 (Natural England, 2021). In long term since 1860 a decline of -0.3km² is estimated. Non discernible change (positive through habitat creation but limited confidence in change in extent of natural marsh and reed bed)	**A (8)**
				A (low confidence/unknown) - last assessment 2012		A	
				(4)		(4)	
	Saltmarsh	• **Food (Wild Food - fish and shellfish).** • **Healthy climate (carbon sequestration).** • **Sea defence. (natural hazard**	Quality/Condition	Saltmarsh assessed in favourable condition. Saltmarsh in the Tamar Estuary is not particularly species diverse when compared with some other estuaries. (Condition currently relies on outdated evidence). Ongoing actions include updating monitoring and potential increase in extent in relation to habitat restoration and managed realignment projects, condition evidence will be	≥95% SSSI favourable/recovering (GES). This target is also recognised as needing to be reached by 2020 in Biodiversity Strategy 2020. MSFD, GES: Condition **(Inside MPAs):** >95% of extent in MPAs in favourable condition (maintain)	Natural England (2021) identify a high degree of consistency in species composition across all	**A (8)**

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
		regulation). **• Tourism/nature watching.** **• Clean water and sediments.**		updated under planned monitoring (Natural England, 2021)		surveyed units when comparing 2013 to the previous condition monitoring survey in 2009/2010.	
				A – last assessment >6 years ago		A	
				(4)		(4)	
	Saltmarsh	**• Food (Wild Food - fish and shellfish).** **• Healthy climate (carbon sequestration).** **• Sea defence. (natural hazard regulation).** **• Tourism/nature watching.** **• Clean water and sediments.**	Spatial configuration	Assessment of spatial biological communities and habitat use by juvenile fish species has not been assessed. Species communities assessed as favourable condition. Saltmarsh in the Tamar Estuary was not particularly species diverse when compared with some other estuaries (Natural England 2021). Tamar-Tavy SSSI and Lynher SSSI had highest diversity (21-22 species), St Johns Lake SSSI had lower diversity (14 species) (Natural England, 2021).	Extent and distribution of saltmarsh to be stable or increasing.	Unknown	**A (8)**
				A		A	
				(4)		(4)	
	Littoral rock	**• Food (Wild Food - fish and shellfish).** **• Sea defence. (natural hazard regulation).** **• Healthy Climate.** **• Tourism/nature watching.**	Quantity/Extent	Littoral rock (low, moderate and high energy) extent in Plymouth Sound and Estuaries SAC to high tide mark is 1.84km², area within an MPA is 1.53km² and area intersecting a management measure (for benthic activity) is 1.53km². Extent is stable in MPAs. Although extent of underlying littoral rock may not change, native species communities may reduce as Pacific oyster populations spread. Continues monitoring and removal has shown removal for beneficial means is difficult from rock, as the oyster shells have to be broken. There is a risk this may limit maintaining risk at 'low' long term.	MSFD, GES: **Extent: (Inside MPAs):** extent is stable or increasing (>95% conservation objective 'maintain'). **Extent: (outside MPAs)** area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC below 3) ≤ 10% for entire PSEC.	Limited evidence but assumed to have not changed as condition has remained favourable. Non discernible. (Requires continued monitoring of Pacific oyster populations to record impact on extent of native	**A (6)**

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
						littoral rock communities.	
				A		A	
				(2)		(4)	
	Littoral rock	• **Food (Wild Food - fish and shellfish).** • **Sea defence. (natural hazard regulation).** • Healthy Climate. • Tourism/nature watching.	Quality/Condition	Littoral rock features in designated MPAs are, overall, assessed to be in 'favourable' condition, apart from in Yealm estuary where the feature and native species community is adversely impacted by invasive non-native species. There is limited information on condition of littoral rock habitats outside designated MPAs, and impact of INNS outside the Yealm. Littoral rock communities are also adversely impacted by high levels of aqueous contaminant levels TBT and its compounds, in the Yealm. Of extent outside the MPAs, 0.15km² (50%) is in LRC of 3 or below. Assessed as below target inside and outside MPAs. Continued monitoring of spread of Pacific oyster populations and impact on native communities is required, as well as monitoring of effectiveness of removal activities. Likely to remain 'below target' due to presence of Pacific oyster and continued chemical contaminant pressures.	MSFD, GES: Condition **(Inside MPAs):** >95% of extent in MPAs in favourable condition (maintain) Condition: **(outside MPAs)** Area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC below 3) ≤ 10% for entire PSEC.	Limited evidence of extent impacted but condition decreased related to invasive non-native species, Yealm INNS populations may have impacted ~11% of littoral rock habitats in Yealm and populations are likely to increase at other sites within the EMS.	**B* (6)**
				B		B	
				(2)		(4)	

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
	Littoral rock	• **Food (Wild Food - fish and shellfish).** • **Sea defence. (natural hazard regulation).** • Healthy Climate. • Tourism/nature watching.	Spatial configuration	Extent of habitat feature unlikely to have changed. Changes in spatial distribution of communities are unknown, but there is evidence of loss of native communities related to increased extent of Pacific oyster communities on littoral rock substratum especially in Yealm. Low energy intertidal rock is typically dominated by native fucoid communities, moderate energy by barnacles and fucoid communities and high energy by barnacles, periwinkle and mussel communities (Natural England, 2021).	MSFD, GES: extent is stable or increasing.	Extent and spatial distribution of native species communities are likely to be adversely impacted by invasive non-native Pacific oyster populations, particularly in the Yealm estuary.	**B*** **(6)**
				B		B	
				(2)		(4)	
	Littoral coarse sediment	• **Sea defence. (natural hazard regulation).** • **Tourism/nature watching.** • **Food (Wild Food - fish and shellfish).**	Quantity/Extent	Littoral coarse sediment extent in Plymouth MPAs is 0.16km², area within an MPA is 0.16km² and area intersecting a management measure (for benthic activity) is 0.16km². Extent assessed as stable apart from Yealm, where spread of Pacific oyster populations may reduce extent of coarse sediment communities.	MSFD, GES: **Extent: (Inside MPAs):** extent is stable or increasing (>95% conservation objective 'maintain') **Extent: (outside MPAs)** area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC below 3) ≤ 10% for entire PSEC.	Limited evidence but small extents, particularly in Yealm estuary are recorded to interact with spread of Pacific oyster populations. Thereby assessed as negative trend.	**B** **(6)**
				A		B	
				(2)		(4)	

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
	Littoral coarse sediment	**• Sea defence. (natural hazard regulation).** **• Tourism/nature watching.** **• Food (Wild Food - fish and shellfish).**	Quality/Condition	Littoral coarse sediment features in designated MPAs are assessed to be in 'favourable' condition. but as 'restore' in relation to Yealm, where spread of Pacific oyster populations may reduce condition of coarse sediment communities. Outside MPAs no area is in LRC of 3 or below.	MSFD, GES: Condition **(Inside MPAs):** >95% of extent in MPAs in favourable condition (maintain)Condition: **(outside MPAs)** Area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC below 3) ≤ 10% for entire PSEC.	Limited evidence but small extents, particularly in Yealm estuary are recorded to interact with spread of Pacific oyster populations.	**B (6)**
				A		B	
				(2)		(4)	
	Littoral coarse sediment	**• Sea defence. (natural hazard regulation).** **• Tourism/nature watching.** **• Food (Wild Food - fish and shellfish).**	Spatial configuration	Littoral coarse sediment features in designated MPAs are assessed to be in 'favourable' condition. but as 'restore' in relation to Yealm, where spread of Pacific oyster populations may reduce condition of coarse sediment communities.	Current extent and condition in MPAs: stable or increasing (80% of all PSEC extent is contained in MPAs)	Limited evidence across entire site but increasing Pacific oyster populations have led to a negative trend.	**B (6)**
				A		B	
				(2)		(4)	
	Littoral sand and muddy sand	**• Sea defence. (natural hazard regulation).** **• Tourism/nature watching.** • Heathy Climate	Quantity/Extent	Extent in MPAs is assessed as 'restore'. Littoral sand and muddy sand extent in Plymouth Sound and Estuaries SAC is 4.06km², area within an MPA is 4.00km² and area intersecting a management measure (for benthic activity) is 4.00km². Invasive non-native Pacific oysters have altered the composition of component communities, thus reducing extent of native communities, especially where reefs of Pacific oysters have formed in the Yealm estuary. Whilst NE identify this affects only a small proportion of the feature at present, the affected area may increase in the future. Curtis (2018) identify 11% of littoral sand and muddy sand as well as littoral mud habitat are noticeably	MSFD, GES: **Extent: (Inside MPAs):** extent is stable or increasing (>95% conservation objective 'maintain') **Extent: (outside MPAs)** area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC below 3) ≤ 10% for entire PSEC.	Limited evidence across entire site but increasing Pacific oyster populations have led to a negative trend in extent and condition of native habitats.	**B * (6)**

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
				impacted by Pacific oyster populations. Assessed as 'below target'.			
				B		B	
				(2)		(4)	
	Littoral sand and muddy sand	• **Sea defence. (natural hazard regulation).** • **Tourism/nature watching.** • Heathy Climate	Quality/Condition	Littoral sand and muddy sand features in designated MPAs are assessed to be in 'restore' condition. Invasive non-native Pacific oysters have altered the composition of component communities, thus reducing extent of native communities, especially where reefs of Pacific oysters have formed in the Yealm estuary and populations extend over large extents of littoral sand and muddy sand in St Johns Lake. Whilst NE identify this affects only a small proportion of the feature at present, the affected area may increase in the future. 0.01km² outside MPAs was assessed in LRC of 3 or below (17% of extent outside MPAs, 0.24% of entire extent).Habitat assessed as below target.	MSFD, GES: Condition **(Inside MPAs):** >95% of extent in MPAs in favourable condition (maintain) Condition: **(outside MPAs)** Area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC below 3) ≤ 10% for entire PSEC.	Limited evidence but assumed to have not changed as condition has remained favourable. Increasing Pacific oyster populations have led to a negative trend in extent and condition of native habitats.	**B* (6)**
				B		B	
				(2)		(4)	
	Littoral sand and muddy sand	• **Sea defence. (natural hazard regulation).** • **Tourism/nature watching.** • Heathy Climate	Spatial configuration	Extent in Yealm and potentially other areas in MPAs assessed as 'restore'. Main pressure on spatial configuration of native species communities is due to expansion of Pacific oyster populations, particularly in the Yealm and St Johns Lake.	Current extent and condition in MPAs: favourable (stable or increasing) (97% of all PSEC extent is contained in MPAs)	Limited evidence but assumed to have not changed as condition has remained favourable.	**B * (6)**
				A		B	
				(2)		(4)	

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
	Littoral mud	• **Food (Wild Food - fish and shellfish).** • **Healthy climate (carbon sequestration).** • **Clean water and sediments.** • Sea Defence • Tourism/nature watching	Quantity/Extent	Extent in MPAs stable or increasing. Extent of littoral mud in the site is 12.93km², extent within an MPA is 9.89km² and area intersecting a management measure (for benthic activity) is 9.89km².	MSFD, GES: **Extent: (Inside MPAs):** extent is stable or increasing (>95% conservation objective 'maintain'. **Extent: (outside MPAs)** area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC below 3) ≤ 10% for entire PSEC.	Limited evidence but decreasing trend as Pacific oyster populations have expanded. Feature in MPAs 'restore / unfavourable' due to Pacific oyster density and high TBT levels in Yealm.	**B* (6)**
				B		B	
				(2)		(4)	
	Littoral mud	• **Food (Wild Food - fish and shellfish).** • **Healthy climate (carbon sequestration).** • **Clean water and sediments.** • Sea Defence • Tourism/nature watching	Quality/Condition	Littoral mud features in designated MPAs are assessed to be in 'restore' condition, relating to Invasive non-native Pacific oyster populations, especially in the Yealm, and St Johns Lake and in relation to elevated TBT compounds in the Yealm. Activities/pressures likely to have a greater impact on condition for intertidal habitats include bait digging and crab tiling. Condition in relation to these activities is assessed by IFCA and Natural England to not be excessively impacted, due to limited extent of the activities. 9.5km² of extent inside MPAs were assessed to have an LRC of 3 or below, based on evidence in condition assessments and anchoring and mooring pressure. Outside MPAs 0km² were assessed to have a LRC of 3 or below. Assessed as below target due to degraded condition inside MPAs.	MSFD, GES: Condition **(Inside MPAs):** >95% of extent in MPAs in favourable condition (maintain) Condition: **(outside MPAs)** Area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC below 3) ≤ 10% for entire PSEC.	Limited evidence but decreasing trend as Pacific oyster populations have expanded. Feature in MPAs 'restore / unfavourable' due to Pacific oyster density in and high TBT levels in Yealm.	**B* (6)**
				B		B	
				(2)		(4)	
	Littoral mud	• **Food (Wild Food - fish and shellfish).**	Spatial configuration	Spatial distribution of species communities associated with littoral mud habitats impacted by spread of Pacific oyster populations.	Current extent and condition in MPAs: stable and condition	Limited evidence but assumed to have been	**B* (8)**

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
		• **Healthy climate (carbon sequestration).** • **Clean water and sediments.** • **Sea Defence.** • **Tourism/nature watching.**			favourable (43% of all PSEC extent is contained in MPAs)	impacted by spread of Pacific oyster and chemical contamination.	
				B		B	
				(4)		(4)	
	Littoral mixed sediments	• **Sea defence. (natural hazard regulation).** • **Food (Wild Food - fish and shellfish).** • Healthy Climate.	Quantity/Extent	Extent of littoral mixed sediments in the site is 0.31km², extent within an MPA is 0.3km² and area intersecting a management measure (for benthic activity) is 0.3km². Current extent in MPAs is likely to be adversely impacted by spread of invasive non-native Pacific oyster populations, especially in the Yealm. Trampling related to recreational activities and crab tiling are also risks to the habitat.	MSFD, GES: **Extent: (Inside MPAs):** extent is stable or increasing (>95% conservation objective 'maintain') **Extent: (outside MPAs)** area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC below 3) ≤ 10% for entire PSEC.	Limited evidence but assumed to have declined in locations such as the Yealm estuary where Pacific oyster populations have spread.	**B * (6)**
				B		B	
				(2)		(4)	
	Littoral mixed sediments	• **Sea defence. (natural hazard regulation).** • **Food (Wild Food - fish and shellfish).** • Healthy Climate.	Quality/Condition	Littoral mixed sediment features in designated MPAs are assessed to be in 'favourable' condition. There is limited information on condition of littoral mud habitats outside designated MPAs. Inside MPAs area impacted by invasive species and interacting with anchoring and mooring pressures relates to LRC of 3 or below for 0.28km² (93% of extent in MPAs). No extent of littoral mixed sediment are adversely impacted outside MPAs. Due to extent adversely impacted within Yealm area of SAC, assessment is 'below target'.	MSFD, GES: Condition **(Inside MPAs):** >95% of extent in MPAs in favourable condition (maintain) Condition: **(outside MPAs)** Area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC below 3) ≤ 10% for entire PSEC.	Limited evidence but adversely impacted by spread of Pacific oyster populations.	**B* (6)**
				B		B	
				(2)		(4)	

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
	Littoral mixed sediments	**• Sea defence. (natural hazard regulation).** **• Food (Wild Food - fish and shellfish).** **• Healthy Climate.**	Spatial configuration	Spatial distribution of species communities associated with littoral mixed sediment habitats are unknown.	Current extent and condition in MPAs: stable and condition favourable	Limited evidence but adversely impacted by spread of Pacific oyster populations.	**B* (8)**
				B		B	
				(4)		(4)	
	Littoral seagrass beds	**• Food (Wild Food - fish and shellfish). • Healthy climate (carbon sequestration).** **• Sea defence. (natural hazard regulation).** **• Tourism/nature watching.** **• Clean water and sediments.**	Quantity/Extent	Littoral seagrass bed extent in the site is 0.4km², area within an MPA is 0.4km² and area intersecting a management measure (for benthic activity) is 0.4km². Seagrass extent had decreased in long term monitoring in all sites but Cawsand in monitoring focusing on sublittoral seagrass. Less data is available on change in littoral seagrass. Assessed as below target as a precautionary approach, due to known invasive species presence and high levels of contaminants, particularly in the Yealm. Anchoring and mooring also impact littoral seagrass.	Extent to be stable or increasing and ≥95% Condition assessment favourable.	Limited data is available on trend in extent for littoral seagrass, likely to have declined due to known invasive species presence and high levels of contaminants, particularly in the Yealm. anchoring and mooring also impact littoral seagrass.	**B* (8)**
				B		B (4)	
				(4)		(4)	
	Littoral seagrass beds	**• Food (Wild Food - fish and shellfish). • Healthy climate (carbon sequestration).** **• Sea defence. (natural hazard**	Quality/condition	Seagrass assessed in favourable condition. Wasting disease identified in monitoring of subtidal sites. Little evidence on littoral seagrass. Invasive seaweed *Sargassum muticum* is known to be common in the inshore periphery of the seagrass beds in Cellars Cove at the mouth of the Yealm. Condition assessment indicates 0.4km² of littoral	MSFD, GES: **Extent: (Inside MPAs):** extent is stable or increasing (>95% conservation objective 'maintain') **Extent: (outside MPAs)** area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC below 3) ≤ 10% for entire PSEC.	Increase in wasting disease identified in annual monitoring sites. (as a precautionary measure:	**B* (8)**

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
		regulation). **• Tourism/nature watching.** **• Clean water and sediments.**		seagrass having an LRC of 3 or below (as a precautionary measure: assessed as below target).		assessed as below target). Compared to other UK sites, seagrass habitat is in top 10 impacted by anchoring and mooring and recreational pressures.	
				B		B (4)	
				(4)		(4)	
	Littoral seagrass beds	**• Food (Wild Food - fish and shellfish). • Healthy climate (carbon sequestration).** **• Sea defence. (natural hazard regulation).** **• Tourism/nature watching.** **• Clean water and sediments.**	Spatial configuration	Assessment of spatial biological communities and habitat use by juvenile fish species has not been assessed. Species communities assessed as favourable condition. Although decrease in extent and wasting disease presence has been detected in annual monitoring.	MSFD, GES: **Extent: (Inside MPAs):** extent is stable or increasing (>95% conservation objective 'maintain') **Extent: (outside MPAs)** area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC below 3) ≤ 10% for entire PSEC.	Increase in wasting disease identified in annual monitoring sites. Compared to other UK sites, seagrass habitat is in top 10 impacted by anchoring and mooring and recreational pressures.	**B* (8)**
				B		B (4)	
				(4)		(4)	

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
	Littoral biogenic reefs	**• Sea defence. (natural hazard regulation).** **• Food (Wild Food - fish and shellfish).** **• Healthy climate (carbon sequestration).** **• Clean water and sediments.** **•Tourism/ nature watching**.	Quantity/Extent	Extent of littoral biogenic reef in the site is 0.2km², extent within an MPA is 0.1km² and area intersecting a management measure (for benthic activity) is 0.1km². Recent monitoring of extent of mussel beds by Curtis et al., (2018) identified that the blue mussel beds in the Tamar-Tavy, St Johns Lake and the Lynher Estuary sites, have not changed significantly in extent or distribution since 2010. Gathering of shellfish is prohibited due to high bacterial contamination levels present in Tamar estuary above Henn Point and Plym estuaries (Cefas, 2020). This limits flow of food benefits to 'below target'.	MSFD, GES: **Extent: (Inside MPAs):** extent is stable or increasing (>95% conservation objective 'maintain') **Extent: (outside MPAs)** For 95% extent in PSEC assessed to be un-impacted by anthropogenic activities (in LRC >3).	Extent is likely to be adversely impacted if spread of Pacific oyster continues in the site.	**B* (6)**
				B		B	
				(2)		(4)	
	Littoral biogenic reefs	**• Sea defence. (natural hazard regulation).** **• Food (Wild Food - fish and shellfish).** **• Healthy climate (carbon sequestration).** **• Clean water and sediments.** •Tourism/ nature watching.	Quality/Condition	Mussel beds at Jupiter Point and Shillingham Point (Lynher estuary) were assessed to be of poor quality from a fishery point of view, with a high percentage of shell and live mussel which appears to be dominated by a single year class (Jenkin et al., 2016).Two non-native species, Pacific oyster *Magallana gigas* and slipper limpet *Crepidula fornicat*a, were found during surveys (Jenkin et al., 2016), suggesting limited confidence in current assessment of 'favourable' condition of blue mussel beds.	MSFD, GES: **Condition: (Inside MPAs):** favourable/maintain (>95% conservation objective 'maintain') **Condition: (outside MPAs)** For 95% extent in PSEC assessed to be un-impacted by anthropogenic activities/pressure habitat is sensitive to (in LRC >3).	Condition is likely to be adversely impacted if spread of non-native species continues in the site.	**B* (6)**
				B		B	
				(2)		(4)	

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
	Littoral biogenic reefs	**• Sea defence. (natural hazard regulation).** **• Food (Wild Food - fish and shellfish).** **• Healthy climate (carbon sequestration).** **• Clean water and sediments.** **•Tourism/ nature watching.**	Spatial configuration	Mussel beds at Jupiter Point and Shillingham Point (Lynher estuary) were assessed to be of poor quality from a fishery point of view, with a high percentage of shell and live mussel which appears to be dominated by a single year class (Jenkin et al., 2016).Two non-native species, Pacific oyster *Magallana gigas* and slipper limpet *Crepidula fornicat*a, were found during surveys (Jenkin et al., 2016), suggesting limited confidence in current assessment of 'favourable' condition of blue mussel beds.	Current extent and condition in MPAs: stable and condition favourable (100% of all PSEC extent is contained in MPAs)	Spatial configuration of native mussel communities is likely to be adversely impacted if spread of non-native species continues in the site.	**B* (8)**
				B		B	
				(4)		(4)	
	Infralittoral rock	**• Food (Wild Food - fish and shellfish).** **• Healthy climate (carbon sequestration).** **• Sea defence. (natural hazard regulation).** **• Tourism/nature watching.**	Quantity/Extent	Extent of infralittoral rock in the site is 9.24km², extent within an MPA is 8.97km² and area intersecting a management measure (for benthic activity) is 8.97km². Extent in MPAs is assessed as stable or increasing. Assessed as 'maintain in latest conservation advice. Outside MPAs, 0.12km² is assessed in LRC at or below 3 (1.3% of total extent and 40% of the extent outside MPAs). Assessed as just below target for whole site.	MSFD, GES: **Extent: (Inside MPAs):** extent is stable or increasing (>95% conservation objective 'maintain') **Extent: (outside MPAs)** For 95% extent in PSEC assessed to be un-impacted by anthropogenic activities (in LRC >3).	Limited evidence but assumed to have not changed as condition has remained favourable. Assessed as not discernible	**A (6)**
				B		B	
				(2)		(4)	
	Infralittoral rock	**• Food (Wild Food - fish and shellfish).** **• Healthy climate (carbon sequestration).** **• Sea defence. (natural hazard regulation).**	Quality/Condition	Infralittoral reef features in designated MPAs are assessed to be in 'favourable' condition. There is limited detailed information on condition of infralittoral reef. Assessed as 'maintain in latest conservation advice. Outside MPAs, 0.12km² is assessed in LRC at or below 3 (1.3% of total extent and 40% of the extent outside MPAs). Assessed as just below target for whole site.	MSFD, GES: **Condition: (Inside MPAs):** favourable/maintain (>95% conservation objective 'maintain'). **Condition: (outside MPAs)** For 95% extent in PSEC assessed to be un-impacted by anthropogenic activities/pressure habitat is sensitive to (in LRC >3).	Limited evidence but assumed to have not changed as condition has remained favourable. However there is concern for 40%	**A (6)**

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
		• **Tourism/nature watching.**				of the small proportion of total extent outside MPAs. Assessed as not discernible.	
				A		A	
				(2)		(4)	
	Infralittoral rock	• **Food (Wild Food - fish and shellfish).** • **Healthy climate (carbon sequestration).** • **Sea defence. (natural hazard regulation).** • **Tourism/nature watching.**	Spatial configuration	Extent stable. Assessed as 'maintain' in latest conservation advice. Outside MPAs, 0.12km² is assessed in LRC at or below 3 (1.3% of total extent and 40% of the extent outside MPAs). Assessed as just below target for whole site.	Current extent and condition in MPAs: stable and condition favourable (72% of all PSEC extent is contained in MPAs)	Limited evidence but assumed to have not changed as condition has remained favourable. However there is concern for 40% of the small proportion of total extent outside MPAs. Spatial configuration of species communities may be impacted outside MPAs. Assessed as not discernible.	**A (6)**
				A		A	
				(2)		(4)	

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
	Circalittoral rock	• **Food (Wild Food - fish and shellfish).** • **Tourism/nature watching.** • Sea Defence.	Quantity/Extent	Extent of circalittoral rock in the site is 15.32km², extent within an MPA is 15.17km² and area intersecting a management measure (for benthic activity) is 15.17km². 100% of circalittoral rock habitats within MPAs is in favourable condition. Outside MPAs 0.08km² are assessed in LRC of 3 or below, 0.5% of total circalittoral reef extent and 53% of extent outside MPAs. Due to small proportion of overall extent adversely impacted by pressures related to human activity, quantity and quality (extent and condition) assessed as just below target.	MSFD, GES: **Extent: (Inside MPAs):** extent is stable or increasing (>95% conservation objective 'maintain'). **Extent: (outside MPAs)** For 95% extent in PSEC assessed to be un-impacted by anthropogenic activities (in LRC >3).	Limited evidence but assumed to be positive in MPAs as pressures from bottom towed fishing activity reduced since IFCA and MMO byelaws. Potential for changes in extent due to reef/sand veneer masking reef extents in previous surveys.	**A (6)**
				A		A	
				(2)		(4)	
	Circalittoral rock	• **Food (Wild Food - fish and shellfish).** • **Tourism/nature watching.** • Sea Defence.	Quality/Condition	100% of circalittoral reef within MPAs is in favourable condition. Outside MPAs 0.08km² are assessed in LRC of 3 or below, 0.5% of total circalittoral reef extent and 53% of extent outside MPAs. Due to small proportion of overall extent adversely impacted by pressures related to human activity quantity and quality (extent and condition) assessed as just below target). Historical fishing activity may have impacted Eddystone reefs and these features high risk in relation to revised MPA approach but recovery likely due to IFCA and MMO byelaws. Assessed as just below target.	MSFD, GES: **Condition: (Inside MPAs):** favourable/maintain (>95% conservation objective 'maintain') **Condition: (outside MPAs)** For 95% extent in PSEC assessed to be un-impacted by anthropogenic activities/pressure habitat is sensitive to (in LRC >3).	Expected to be positive due to implementation of byelaws reducing bottom towed fishing activity pressure.	**A (6)**
				A		A	
				(2)		(4)	

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
	Circalittoral rock	• **Food (Wild Food - fish and shellfish).** • **Tourism/nature watching.** • Sea Defence.	Spatial configuration	100% of circalittoral reef within MPAs is in favourable condition. Outside MPAs 0.08km² are assessed in LRC of 3 or below, 0.5% of total circalittoral reef extent and 53% of extent outside MPAs. Due to small proportion of overall extent adversely impacted by pressures related to human activity quantity and quality (extent and condition) assessed as just below target). Historical fishing activity may have impacted species communities on Eddystone reefs and these features high risk in relation to revised MPA approach but recovery likely due to IFCA and MMO byelaws. Assessed as just below target.	Current extent and condition in MPAs: stable and condition favourable (21% of all PSEC extent is contained in MPAs).	Expected to be positive due to implementation of byelaws reducing bottom towed fishing activity pressure.	**A (4)**
				A		A	
				(2)		(2)	
	Sublittoral coarse sediment	• **Food (Wild Food - fish and shellfish).** • **Clean water and sediments.** • Healthy Climate. • Sea Defence.	Quantity/Extent	Sublittoral coarse sediment extent in the site is 84.54km², area within an MPA is 22.23km² and area intersecting a management measure (for benthic activity) is 22.23km². The extent within an MPA has a conservation objective of maintain, although appears within the wider feature 'shallow inlets and bays' which a recent HRA identified risk from invasive non-native, slipper limpet *Crepidula fornicata.* 5.7km² (25.6%) of the proportion inside MPAs were assessed to interact with pressures related to invasive species, elevated contaminant levels or physical pressure from anchoring and mooring with an LRC of 3 or below. Outside MPAs 59km² have an LRC below level 3, 70% to total extent. Assessed as below target.	MSFD, GES: **Extent: (Inside MPAs):** extent is stable or increasing (>95% conservation objective 'maintain') **Extent: (outside MPAs)** area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC below 3) ≤ 10% for entire PSEC.	Unknown as a precautionary measure, until trend is known the trend is assessed as negative (with low confidence).	**B* (4)**
				B		B	
				(2)		(2)	

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
	Sublittoral coarse sediment	• **Food (Wild Food - fish and shellfish).** • **Clean water and sediments.** • Healthy Climate. • Sea Defence.	Quality/Condition	The extent within an MPA has a conservation objective of maintain, although appears within the wider feature 'shallow inlets and bays' which a recent HRA (Curry et al., 2014) identified risk from invasive non-native, slipper limpet Crepidula fornicata. 5.7km² (25.6%) of the proportion inside MPAs were assessed to interact with pressures related to anchoring and mooring with an LRC of 3 or below. Outside MPAs 59km² have an LRC of level 3 or below, 70% of total extent. Assessed as substantially below target, with limited confidence in LRC assessment of impact of bottom towed fishing on condition outside MPAs.	MSFD, GES: Condition **(Inside MPAs):** >95% of extent in MPAs in favourable condition (maintain)Condition: **(outside MPAs)** Area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC 3 or below) ≤ 10% for entire PSEC.	Unknown as a precautionary measure, until trend is known the trend is assessed as negative (with low confidence).	**C (6)**
				C		B	
				(4)		(2)	
	Sublittoral coarse sediment	• **Food (Wild Food - fish and shellfish).** • **Clean water and sediments.** • Healthy Climate. • Sea Defence.	Spatial configuration	Currently there is no site-specific evidence on the presence and spatial distribution of the biological communities (Natural England, 2018). In relation to LRC assessment spatial configuration of communities are likely to be adversely impacted and assessed as 'substantially below target'.	Current extent and condition in MPAs: stable and condition favourable (% of all PSEC extent is contained in MPAs)	Unknown as a precautionary measure, until trend is known the trend is assessed as negative (with low confidence).	**C (6)**
				C		B	
				(4)		(2)	
	Sublittoral sand	• **Food (Wild Food - fish and shellfish).** • **Clean water and sediments.** • Healthy Climate. • Sea Defence.	Quantity/Extent	Sublittoral sand extent in the site is 46km², area within an MPA is 5.3km² and area intersecting a management measure (for benthic activity) is 5.3km². Wider features are assessed as maintain but spread of non-native Crepidula fornicata and elevated sediment contaminant levels are identified in the site to adversely affect the habitat. Currently extent in LRC of 3 or below in MPA, interacting with anchoring and mooring pressures, invasive species pressure, or elevated contamination levels is 0.2km² (3.8% of extent in an	Marine Strategy Framework Directive (2008) - achieve Good Environmental Status(GES) in all UK marine waters by 2020. Current extent in MPAs: stable or increasing (2 MPAs were only recently designated (2016).	Unknown (2 MCZs were only designated in 2016). As a precaution trend is assessed as 'negative'	**B* (4)**

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
				MPA), extent outside MPAs in LRC of 3 or below, primarily linked to bottom towed fishing activity is 39.4km² (85.6% of entire extent, 92% of extent outside MPAs). Assessed as below target.			
				B		B	
				(2)		(2)	
	Sublittoral sand	• **Food (Wild Food - fish and shellfish).** • **Clean water and sediments.** • Healthy Climate. • Sea Defence.	Quality/Condition	Wider features are assessed as maintain but spread of non-native *Crepidula fornicata* and elevated sediment contaminant levels are identified in the site to adversely affect the habitat. Currently extent in LRC of 3 or below in MPA, interacting with anchoring and mooring pressures, invasive species pressure, or elevated contamination levels is 0.2km² (3.8% of extent in an MPA), extent outside MPAs in LRC of 3 or below, primarily linked to bottom towed fishing activity is 39.4km² (85.6% of entire extent, 92% of extent outside MPAs). Assessed as below target. Due to high extent in LRC of 3 or below, condition is assessed as substantially below target.	Good Environmental Status (GES) in all UK marine waters by 2020. Current extent and condition in PSEC MPAs: >95% of extent in MPAs to be in favourable condition, <10% of extent in PSEC impacted by anthropogenic activities.	Limited evidence of substratum habitat and community distribution to assess trend. Assessed as negative in MPAs (but some Limited evidence of substratum habitat and community distribution to assess trend	**C (6)**
				C		B	
				(4)		(2)	
	Sublittoral sand	• **Food (Wild Food - fish and shellfish).** • **Clean water and sediments.** • Healthy Climate. • Sea Defence.	Spatial configuration	Currently there is no site-specific evidence on the presence and spatial distribution of the biological communities (Natural England, 2018). As a precautionary measure this is just assessed as substantially below below target as native infauna are likely impacted by spread of non-native Crepidula fornicata and elevated sediment contaminant levels are identified in the site to adversely affect the habitat. Currently extent in LRC		Limited evidence of substratum habitat and community distribution to assess trend	**C (6)**

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
				of 3 or below in MPA, interacting with anchoring and mooring pressures, invasive species pressure, or elevated contamination levels is 0.2km² (3.8% of extent in an MPA), extent outside MPAs in LRC of 3 or below, primarily linked to bottom towed fishing activity is 39.4km² (85.6% of entire extent, 92% of extent outside MPAs).			
				C		B	
				(4)		(2)	
	Sublittoral mud	• **Food (Wild Food - fish and shellfish).** • **Clean water and sediments.** • Healthy Climate. • Sea Defence.	Quantity/Extent	Sublittoral mud extent in the site is 14.2km², area within an MPA is 13.45km² and area intersecting a management measure (for benthic activity) is 10.31km². Wider features are assessed as maintain but spread of non-native *Crepidula fornicata* and elevated sediment contaminant levels are identified in the site to adversely affect the habitat. Currently extent in LRC of 3 or below in MPA, interacting with anchoring and mooring pressures, invasive species, or elevated contaminant levels is 10.32km² (78% of extent in an MPA), extent outside MPAs in LRC of 3 or below in is <0.001km². Assessed as below target due to interaction with pressures from invasive non-native species, elevated contaminant levels and physical pressures related to anchoring and mooring within the MPAs.	Marine Strategy Framework Directive (2008) - achieve Good Environmental Status (GES) in all UK marine waters by 2020. <10% of extent in PSEC impacted by anthropogenic activities.	Limited evidence of substratum habitat and community distribution to assess trend	**B* (4)**
				B		B	
				(2)		(2)	
	Sublittoral mud	• **Food (Wild Food - fish and shellfish).** • **Clean water and sediments.** • Healthy Climate. • Sea Defence.	Quality/Condition	Wider features are assessed as maintain but spread of non-native *Crepidula fornicata* and elevated sediment contaminant levels are identified in the site to adversely affect the habitat. Currently extent in LRC of 3 or below in MPA, interacting with anchoring and mooring pressures, invasive species, or elevated contaminant levels is 10.32km² (78% of extent in an MPA), extent outside MPAs in LRC of 3 or below in is <0.001km². Assessed as below target due to interaction with pressures from invasive non-native species, elevated contaminant levels	Good Environmental Status (GES) in all UK marine waters by 2020. Current quality in PSEC: Although not a named designated feature, habitat maps show 0.21km² of subtidal mud intersects with MPAs: Condition unknown.	Limited evidence of substratum habitat and community distribution to assess trend. Assessed as negative in MPAs (but some contaminant pressures have	**C (6)**

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
				and physical pressures related to anchoring and mooring within the MPAs.		been present for long periods). Trend outside MPAs not discernible.	
				C		B	
				(4)		(2)	
	Sublittoral mud	• **Food (Wild Food - fish and shellfish).** • **Clean water and sediments.** • Healthy Climate. • Sea Defence.	Spatial configuration	Currently there is no site-specific evidence on the presence and spatial distribution of the biological communities (Natural England, 2018). As a precautionary measure this is assessed as below target due to adversely impacted condition.		Limited evidence of substratum habitat and community distribution to assess trend	**C (6)**
				C		B	
				(4)		(2)	
	Sublittoral mixed sediments	• **Food (Wild Food - fish and shellfish).** • **Clean water and sediments.** • Healthy Climate. • Sea Defence.	Quantity/Extent	Sublittoral mixed sediment extent in the site is 83.8km², area within an MPA is 12.9km² and area intersecting a management measure (for benthic activity) is 12.9km². Condition of wider feature is maintain but feature fails condition assessment targets on secondary attributes due to spread of invasive non-native slipper limpet populations and elevated contaminant levels. Habitat within MPAs has an LRC of level 3 or below for 12.8km² (99.2% of extent within MPAs). Outside MPAs, of the 70.9km² of sublittoral mixed sediments, 70.7km² are assessed in LRC of 3 or below in relation to pressures related to bottom towed fishing activities.	Marine Strategy Framework Directive (2008) - achieve Good Environmental Status(GES) in all UK marine waters by 2020. >10% of extent in PSEC un-impacted by anthropogenic activities.	Limited evidence of substratum habitat and community distribution to assess trend. Due to spread of invasive non-native species populations, expected to be negative.	**B* (4)**

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
				B		B	
				(2)		(2)	
	Sublittoral mixed sediments	• **Food (Wild Food - fish and shellfish).** • **Clean water and sediments.** • Healthy Climate. • Sea Defence.	Quality/Condition	Condition of wider feature is maintain but feature fails condition assessment targets on secondary attributes due to spread of invasive non-native slipper limpet populations and elevated contaminant levels. Habitat within MPAs has an LRC of level 3 or below for 12.8km² (99.2% of extent within MPAs). Outside MPAs, of the 70.9km² of sublittoral mixed sediments, 70.7km² (99.7%) are assessed in LRC of 3 or below in relation to pressures related to bottom towed fishing activities. Due to impacts with the MPA and the large extents outside the MPAs in LRC of 3 or below, assessed as substantially below target.	Good Environmental Status (GES) in all UK marine waters by 2020. Current quality in PSEC: Although not a named designated feature, habitat maps show 2.04km² of sublittoral mixed sediments intersects with MPAs: Condition unknown. Target of less than 10% of habitat extent in PSEC to be impacted by anthropogenic activities.	Limited evidence of substratum habitat and community distribution to assess trend	**C (6)**
				C		B	
				(4)		(2)	
	Sublittoral mixed sediments	• **Food (Wild Food - fish and shellfish).** • **Clean water and sediments.** • Healthy Climate. • Sea Defence.	Spatial configuration	Currently there is no site-specific evidence on the presence and spatial distribution of the biological communities (Natural England, 2021).		Limited evidence of substratum habitat and community distribution to assess trend	**C (8)**
				C		B	
				(4)		(4)	
	Sublittoral seagrass	• **Food (Wild Food - fish and shellfish).** • **Healthy climate (carbon sequestration).** • **Sea defence. (natural hazard**	Quantity/Extent	Seagrass extent in the site is 0.4km², area within an MPA is 0.4km² and area intersecting a management measure (for benthic activity) is 0.4km². Area impacted by pressures habitat is sensitive to 0.4km². Seagrass habitats support nursery areas for multiple commercially targeted fish species and contributes to multiple ES. Seagrass extent had decreased in long term monitoring. Condition	MSFD, GES: **Extent: (Inside MPAs):** extent is stable or increasing (>95% conservation objective 'maintain') **Extent: (outside MPAs)** area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC below 3) ≤ 10% for entire PSEC.	Seagrass extent had decreased in long term monitoring, assessed as declining trend	**C (4)**

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
		regulation). • Tourism/nature watching. • Clean water and sediments.		assessment and investigation into recent changes in extent are assessed in NE conservation advice as 'restore' and thereby 'below target'. LRC assessment within MPAs has 100% at or below level 3.			
				C		C	
				(2)		(2)	
	Sublittoral seagrass	**• Food (Wild Food - fish and shellfish). • Healthy climate (carbon sequestration). • Sea defence. (natural hazard regulation). • Tourism/nature watching. • Clean water and sediments.**	Quality/Condition	Seagrass assessed as 'restore the species composition of communities'. Anchoring and mooring pressure assessed to effect large extents. Wasting disease also identified in monitoring sites (Bunker and Green, 2018). Thereby assessed as below target.	MSFD, GES: Condition (Inside MPAs): >95% of extent in MPAs in favourable condition (maintain) Condition: (outside MPAs) Area of habitat lost + area of habitat below GES (in condition recover or impacted by unacceptable impact (LRC below 3) ≤ 10% for entire PSEC.	Impact of mooring abrasion identified in monitoring and wasting disease identified in monitoring sites. Declining trend.	**C (4**
				C		C	
				(2)		(2)	
	Water bodies	**• Food (Wild Food - fish and shellfish). • Tourism/nature watching. (• Healthy climate (carbon sequestration). • Sea defence. (natural hazard regulation). • Clean water and sediments).**	Quality/Condition	Water quality (water body status and bathing water quality) is monitored for km² of water bodies that intersect with the site. All water bodies are assessed to fail overall water body status condition. Chemical status fails in 4/4, ecological status fails in 2/4. Trend is negative	Water Framework Directive: Water quality is assessed in relation to ecological, chemical and hydro morphology targets.	Classifications current at time of writing from the waterbody classifications in Environment Agency 2020 catchment data explorer. And have declined in 2/4 water bodies in the site	**C (2)**
				C		B	

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
				(1)		(1)	
	Water Bodies: Bathing waters	• **Tourism/nature watching.** • **Food (Wild Food - fish and shellfish).** • Clean water and sediments.	Quantity/Extent	Number of designated bating waters with sufficient status or above has not changed. All bathing designated bathing waters in the PSEC area received good or excellent status in the baseline year (2020). A total of 19 pollution alerts occurred in 2020 across all designated bating waters in the site.	Under the Bathing Waters Directive: all designated bathing waters to be classified as 'sufficient' or above: Total number of designated beaches has not changed, however, 4 are classified as bathing waters 'poor' (below target) in 2017/18	Number of designated bathing waters classified as sufficient or above has not changed.	**A (3)**
				A		B	
				(1)		(2)	
	Water Bodies: Bathing waters	• **Tourism/nature watching.** • **Food (Wild Food - fish and shellfish).** • Clean water and sediments.	Quality/Condition	All bathing designated bathing waters in the PSEC area received good or excellent status in the baseline year (2020). A total of 19 pollution alerts occurred in 2020 across all designated bating waters in the site. Recent publication of CSO monitoring data allowed total duration (hours) and total number of counted spills using 12-24hr counting method to be calculated for the entire year Westcountry Rivers Trust, (2021). This data has been included as it reflects potential year round contamination, beyond the spring and summer bathing season For the entire catchment of the PSEC area, including tributary rivers to estuaries, CSO events totalled 85141.70 hours duration, in relation to 10407 counted spills. For CSO locations adjacent to Plymouth Sound and the lower extent of estuaries within the site, CSO events totalled 19915.68 hours duration, in relation to 4264 counted spills Westcountry Rivers Trust, (2021). The total number of pollution alerts, annually would, thereby, likely exceed the 19 recorded during the 6 month bathing season.	Under the Bathing Waters Directive: all designated bathing waters to be classified as 'sufficient' or above:	Pollution alerts have remained stable however the total number of pollution alerts, annually would, thereby, likely exceed the 19 recorded during the 6 month bathing season.	**B* (3)**
				B		B	
				(1)		(2)	

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
	Shellfish waters	• **Tourism/nature watching.** • **Food (Wild Food - fish and shellfish).** • Clean water and sediments.	Quantity/Extent		Shellfish waters are considered 'Shellfish Water Protected Areas' under the Water Framework Directive. Quantity target: Unknown	Unknown	Not assessed
		• **Tourism/nature watching.** • **Food (Wild Food - fish and shellfish).** • Clean water and sediments.	Quality/Condition	Condition of classified shellfish waters reduced due to Bacterial contamination levels which have impacted all designated shellfish waters in the Tamar and Yealm estuaries. Shellfish waters in the site were assessed as 'negative/of concern' in most recent shellfish classifications (Cefas, 2020). Shellfish waters in the Yealm estuary were limited to Class C due to potential for contamination due to high e.coli levels in most recent assessments (Cefas 2020). Class C limitations require Molluscs must contain ≤ 46,000 E. coli per 100 grams of flesh Molluscs and can only go for human consumption after strict purification measures (Cefas, 2020). High contamination levels were present in Tamar estuary above Henn Point and Plym estuaries, leading to bivalve mollusc harvesting and production being prohibited in these areas (Cefas, 2020).	Shellfish waters or 'Shellfish Water Protected Areas' under the Water Framework Directive. Quality target (2013-2018): *reduce pollution in designated shellfish water*. Current target in SW River Basin Management Plan (2015) <300 E.coli/100ml in the shellfish flesh and intravalvular fluid: 0 bivalve harvesting areas of 7 in Taw Torridge, 1 of 1 in Porlock met the target.	Decline	**C (2)**
				C		C	
				(1)		(1)	

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
	Fish species (Quota species)	• **Food (Wild Food - fish and shellfish).** • **Tourism/nature watching.**	Quantity/Extent	Of 12 Quota species: SSB was below target for 2 species Bass, Whiting. Meeting target for plaice, sole, monkfish. Limited data for majority of species (7 species). Assessed as below target for bass, whiting and 'below target' overall as precaution due to lack of data on other species.	The MSFD requires 'Good Environmental Status' by 2020 (EC, 2008) for fish stocks (Descriptor 3). Three criteria apply to determine if a fish or shellfish stock achieves GES (fishing mortality, reproductive biomass, healthy age and size structure). Spawning Stock Biomass (abundance of reproductive age fish) is required to be above Maximum Sustainable Yield B Trigger. ICES assessments are undertaken over entire ICES areas, and so MSY triggers are calculated over greater spatial scales than a single MPA or NMP site). Confidence limited for species with smaller ranges and in relation to ES benefit delivery linked to Plymouth site habitats.	Positive trends in SSB, TAC were only available for plaice and sole. Landings increase likely to relate to increased effort and not represent increase in stocks. Although may suggest stability.	**B-B* -C (4)**
				B		B	
				(2)		(2)	

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
	Fish species (Quota species)	• **Food (Wild Food - fish and shellfish).** • **Tourism/nature watching.**	Quality/Condition	Comparison of recommended TAC moving averages (3year) (2012-2014, and 2015-2017) showed an increase for plaice, sole, monkfish. A decrease for bass, whiting, gurnard species, and under MSY for mackerel. No data were available for other species such as skates and rays, turbot and john dory.	Healthy age and size structure is a recognised criteria for assessing GES of fish stocks. Under the Common Fisheries Policy species targets are for fishing to be at or under maximum sustainable yield (recommended TAC is the scientific advice on catch limits to achieve MSY). A decrease in TAC between years suggests a decline in the stock (in relation to the fishing effort it can support).	Comparison of recommended TAC moving averages (3year) (2012-2014, and 2015-2017) showed an increase for plaice, sole, monkfish. A decrease for bass, whiting, gurnard species, and under MSY for mackerel. No data were available for other species such as skates and rays, turbot and john dory.	**B-B* (4)**
				B		B	
				(2)		(2)	
	Fish species (Quota species)	• **Food (Wild Food - fish and shellfish).** • **Tourism/nature watching.**	Spatial configuration	Not assessed as stocks move over greater distances than PSEC. Habitat use as nursery areas by juveniles not assessed. Current projects are underway at the time of writing (2018) and assessment of condition of nursery and adult habitat and population structure and habitat association of species will be important to consider in the future.	Abundance, age and size structure (recruitment (yr1), SSB), in relation to PSEC habitats to inform GES.	Not assessed	**Not assessed**

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
	Fish species (Non-Quota species)	• **Food (Wild Food - fish and shellfish).** • **Tourism/nature watching.**	Quantity/Extent	As lobster and crab are not limited by quotas, landings per unit effort provides an indicator to assess changes in biomass or abundance. Landings (live weight) of crabs, lobsters and crawfish to Plymouth ports have displayed positive trends between 2010-2019 but this also reflects an increase in 87 under 10m vessels. Effort data were unavailable to confidently assess this indicator. Cefas report stable crab and lobster stocks with limited confidence at site level. Cornwall IFCA report stable or declining LPUE (decline for lobster and crawfish). Landings of lemon sole have displayed a negative trend 2010-2019. LPUE from IFCA provide data with greatest confidence to reflect stocks. A positive trend in landings weight 2010-2019 is evident for all non-quota species aside from lemon sole (significant positive trend for cuttlefish, lobster, and pollack). However effort data is unavailable for research purposes and thereby LPUE cannot be calculated from publically available MMO data, although an increase in effort is likely as under 10 registered vessel numbers in Plymouth ports increased by 87 vessels.	Not assessed. Stable or increasing CPUE.	Cefas report stable crab and lobster stocks with limited confidence at site level. Cornwall IFCA report stable or declining LPUE 2016-2018 (decline for lobster and crawfish, smaller decline for brown crab, stable or small increase for spider crab).	**B*** **(8)**
				B		B	
				(4)		(4)	
	Fish species (Non-Quota species)	• **Food (Wild Food - fish and shellfish).** • **Tourism/nature watching.**	Quality/Condition	Crab and lobster stock assessments (published by Cefas), indicate crab (C.pagurus) stocks in the South West UK, are likely to be sustainable and support the current level of harvesting (which is moderate: between minimum reference point and MSY). Harvesting of Lobster (H. gammarus) stocks was assessed to be moderate, but above rates consistent with MSY (although below maximum reference point limit). Effort data were unavailable to confidently assess this indicator. Cefas report stable crab and lobster stocks with limited confidence at site level. Cornwall IFCA report stable or declining LPUE 2016-2018 (decline for lobster	Fishing mortality at or below MSY	no change in assessment between 2010-2017. Unknown for P.elephas.	**Lobster** **B** **(6)** **crab** **A** **(6)**

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
				and crawfish, smaller decline for brown crab, stable or small increase for spider crab).			
				crab +/- (A), Lobster (-) (B)		A-B	
				(2)		(4)	
	Fish species (migratory fish)	• **Food (Wild Food - fish and shellfish).** • **Tourism/nature watching.**	Quantity/Extent	CPUE, number caught per license day (commercial net) available for Tamar only up to 2017, number (rod and line recreational catch) to 2019. Net catch 0.2 per license day in 2017. Rod catches on the Tamar returned 52 1SW (grilse) and 50 MSW salmon in 2019. Rod fishing on the Lynher returned 19 1SW (grilse) and 6 MSW salmon in 2019. Validated counts and run estimates of salmon smolts and adults in Tamar have declined from 7'230 in 2010 to 2,763 in 2019 (Cefas, Environment Agency, NRW, 2019; 2020).	Better Sea Trout and Salmon Fisheries – Our Strategy for 2008-2021, "more sea trout and more salmon in more rivers bringing more benefit" (Environment Agency, 2008).	Trends in Atlantic salmon (Salmo salar) % of conservation limit (CL) attained 2010-2019 have shown a decrease, as have validated counts and run estimates of salmon smolts and adults (Cefas, Environment Agency, NRW, 2020)	**C (3)**
				C		B	
				(2)		(1)	

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
	Fish species (migratory fish)	• **Food (Wild Food - fish and shellfish).** • **Tourism/nature watching.**	Quality/Condition	Fish population supported by river/estuary measured by estimated egg deposition (performance against conservation limit). Data available for Tamar and Lynher. Tamar achieved 77% of conservation limit and Lynher 44% in most recent assessment, a decline from 139 and 266% respectively. All rivers are classified as 'at risk' in relation to meeting management objectives.	Management objectives linked to fish population thresholds (Conservation Limits (CL)). North Atlantic Salmon Conservation Organization target: All salmon populations to be maintained above their conservation limits. 1. For PSEC rivers, each river/estuary to meet CL in 4 out of 5 years. 2. Rivers to be not at risk of meeting management objectives.	Trends in Atlantic salmon (Salmo salar) % of conservation limit (CL) attained 2010-2019 have shown a decrease, as have validated counts and run estimates of salmon smolts and adults (Cefas, Environment Agency, NRW, 2020)	**C (2)**
				C		B	
				(1)		(1)	

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
	Fish species (migratory fish)	• **Food (Wild Food - fish and shellfish).** • **Tourism/nature watching.**	Spatial configuration	CPUE and egg deposition per river/estuarys in the site have shown declines across populations.	Better Sea Trout and Salmon Fisheries – Our Strategy for 2008-2021, "more sea trout and more salmon in more rivers bringing more benefit" (Environment Agency, 2008).	Trends in Atlantic salmon (Salmo salar) % of conservation limit (CL) attained 2010-2019 have shown a decrease, as have validated counts and run estimates of salmon smolts and adults (Cefas, Environment Agency, NRW, 2020)	**C (2)**
				C		B	
				(1)		(1)	
	Fish of conservation importance - Shad	• **Food (Wild Food - fish and shellfish).** • **Tourism/nature watching.**	Quantity/Extent	Conservation advice within Plymouth Sound and estuaries SAC is 'restore' due to the potential impact of Gunnislake Weir on population size. On the Tamar, the number of returning adult Allis shad is unknown but reported counts of fish migrating upstream and egg deposition suggests relatively low population size. There are no other known Allis shad spawning populations in the UK (Maitland & Hatton Ellis, 2003). On the Tamar, the number of returning adult Allis shad is unknown.	Condition assessment under Habitats Directive (Annex II species).	Gunnislake fish trap records suggest that between 2004 and 2011, there were reasonable shad numbers migrating upstream at Gunnislake Weir but these appear to have declined in later years Cotterell and Hillman 2015.	**B* (8)**
				B		B	

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
				(4)		(4)	
	Fish of conservation importance - Shad	• **Food (Wild Food - fish and shellfish).** • **Tourism/nature watching.**	Quality/Condition	The number of returning adult Allis shad is unknown but reported counts of fish migrating upstream and egg deposition suggests relatively low population size.	Condition assessment under Habitats Directive (Annex II species).	Long term likely to be a decline although on the Tamar, the number of returning adult Allis shad is unknown. Confidence is poor in the assessment.	**B* (8)**
				B		B	
				(4)		(4)	
	Fish of conservation importance - Shad	• **Food (Wild Food - fish and shellfish).** • **Tourism/nature watching.**	Spatial configuration	The number of eggs found per kick sample was relatively low, compared to other European spawning sites, with a maximum recorded catch per unit effort of 2.8 eggs per 30-second kick sample at Gunnislake Weir Pool. Spawning habitat is characterized by an area of coarse substrate limited upstream by a pool and downstream by shallow water with fast-moving currents. The spawning substrate varies from sand (2µ - 2mm) to pebble/cobble (2 - 20cm). Eggs are deposited in water 0.5 to 3.0m deep where the current ranges from 0.5 to 1.5m/s Allis shad spawning sites have been reported from channel widths between 15m and 200m (Aprahamian et al., 2003).	Condition assessment under Habitats Directive (Annex II species).	Unknown	**B* (8)**
				B		B	
				(4)		(4)	
	Fish of conservation importance - European eel	• **Food (Wild Food - fish and shellfish).** • **Tourism/nature watching.**	Quantity/Extent	European Eel stocks are recognised to have declined across Europe.	2007 Eel Regulation, Convention of Migratory Species of Wild Animals (CMS)	Decline	**C (8)**

Broad Habitat type	Habitat / Species Asset	Benefit	Characteristic	Current Status	Target	Trend	RAG (2019/ 2020)
				C		B	
				(4)		(4)	
	Fish of conservation importance - European eel	**• Food (Wild Food - fish and shellfish). • Tourism/nature watching.**	Quality/Condition	European Eel stocks are recognised to have declined across Europe	2007 Eel Regulation, Convention of Migratory Species of Wild Animals (CMS)	Decline	**C (8)**
				C		B	
				(4)		(4)	
	Fish of conservation importance - European eel	**• Food (Wild Food - fish and shellfish). • Tourism/nature watching.**	Spatial configuration	European eel stocks have been declining in recent years, with the EU adopted Eel Regulation providing a framework for the recovery of eel stock. Council Regulation (EC) No 1100/2007 of 18 September 2007 establishing measures for the recovery of the stock of European eel.	2007 Eel Regulation, Convention of Migratory Species of Wild Animals (CMS)	Not assessed	**Not assessed**
				Decline across range		Decline across range	

Supplementary Material 2

Baseline and Trends in Habitat and Species Asset Metrics

Species Asset Extent (Quantity)

Table 1 Spawning Stock Biomass calculated in ICES advice for area 7.e or the next most relevant area for commercial species in Plymouth MPAs and NMP fisheries **bold** indicates significant monotonic trend correlation at 95%.

Natural Capital Assets	Indicator		Unit	Baseline year 2019	Baseline Trend 2010-2019	Correlation coefficient (Kendall's tau-b)	Significance
Species stocks (for fish and shellfish stock used for food: Quota Species)	Extent: SSB in 7e or next appropriate spatial area	Sole: SSB area7e	(t)	3974	↑	**0.722**	**0.007**
		Plaice: relative SSB area 7d+e	(t)	2200	↑	**0.873**	**0.001**
		Anglerfish: SSB area7	(t)	59751	↑	**0.889**	**0.001**
		Mackerel: SSB all ICES areas	(t)	4186496	↑(↔)	0.389	0.144
		Bass: SSB ICES area 7e (4b-c,7.d-h)	(t)	11007	↓	**-0.82**	**0.001**
		Whiting: SSB ICES area 7e (7.b,c,e-k)	(t)	31034	↓	**-0.73**	**0.004**

Species Asset Condition

Table 2. TAC from ICES Advice for commercial species targeted by Plymouth MPAs and NMP fisheries, for area 7.e or next most relevant area **bold** indicates significant monotonic trend correlation at 95%.

Natural Capital Assets	Indicator		Unit	Baseline year 2019	Baseline Trend 2010-2018	Correlation coefficient (Kendall's tau-b)	Significance
Species stocks (for fish and shellfish stock used for food: Quota Species)	Condition: TAC in 7e or next smallest spatial area	Pollack: Advised TAC for area 7e	(t)	12163	↓	**-0.691**	**0.017**
		Sole: Advised TAC for area7e	(t)	1202	↑	**0.889**	**0.001**
		Plaice: Advised TAC for area 7d+e	(t)	10360	↑	**0.778**	**0.004**
		Anglerfish: Advised TAC for area 7	(t)	42496	↑	0.458	0.107
		Bass Advised TAC	(t)	1806	↓	**-0.5**	**0.05**
		Mackerel: Advised TAC for all ICES areas	(t)	1194000	↑	0.423	0.116
		Whiting: SSB ICES area 7e (7.b,c,e-k)	(t)	11619	↑	-0.46	0.07

Table 3 Assessment of crab and lobster stocks for the south west UK region (Cefas, 2020)

Natural Capital Assets	Indicator		Unit	Baseline year (2019)	Trend 2010-2019
Species stocks (for each fish and shellfish stock used for food: Non- Quota Species)	Condition (Cefas stock status report)	Crab (*Cancer pagurus*)	classification (exploitation level)	Moderate, likely to be sustainable, between minimum reference point and MSY.	↔
		Lobster (*Homarus gammarus*)	classification (exploitation level)	Moderate, above critical levels but not yet at the MSY.	↔

Species - flow of asset to ES benefit

Table 4 Landings weight per year (tonnes) by under 10m vessels to Plymouth ports from MMO fisheries data **bold** indicates significant monotonic trend correlation at 95%.

Natural Capital: Flow from Assets to Physical Benefits	Indicator	Species	Unit	Port	Baseline year 2019	Baseline Trend 2010-2019	Correlation coefficient (Kendall's tau-b)	Signifi-cance
Species stocks (for each fish and shellfish species used for food)	MMO Fishing Activity data: Landings, to Plymouth & Cawsand (under 10m)	Scallops	t/yr	Plymouth & Cawsand	145.12	↑	0.244	0.3
		Cuttlefish	t/yr	Plymouth & Cawsand	103.23	↑	0.422	0.09
		Crab	t/yr	Plymouth & Cawsand	56.1	↓	-0.67	0.79
		Lobster	t/yr	Plymouth & Cawsand	13.7	**↑**	**0.822**	**0.001**
		Pollack	t/yr	Plymouth & Cawsand	62.94	↑	0.333	0.18
		Monks or Anglers	t/yr	Plymouth & Cawsand	17.5	↓	-0.156	0.53
		Bass	t/yr	Plymouth & Cawsand	29.6	**↑**	**0.644**	**0.009**
		Plaice	t/yr	Plymouth & Cawsand	29.06	↑	0.2	0.42
		Lemon sole	t/yr	Plymouth & Cawsand	26.7	↓	-0.333	0.18
		Sole	t/yr	Plymouth & Cawsand	16.75	**↑**	**0.644**	**0.009**
		Skates and rays	t/yr	Plymouth & Cawsand	18.63	↑(↔)	0.16	0.6
		Whiting	t/yr	Plymouth & Cawsand	13.53	↔	0.02	1
		Gurnard (all sp.)	t/yr	Plymouth & Cawsand	13.14	**↑**	**0.511**	**0.05**
		John dory	t/yr	Plymouth & Cawsand	8	↑	0.42	0.23
		Turbot	t/yr	Plymouth & Cawsand	7.7	**↑**	**0.6**	**0.016**

Value of benefit (monetary value to fishers)

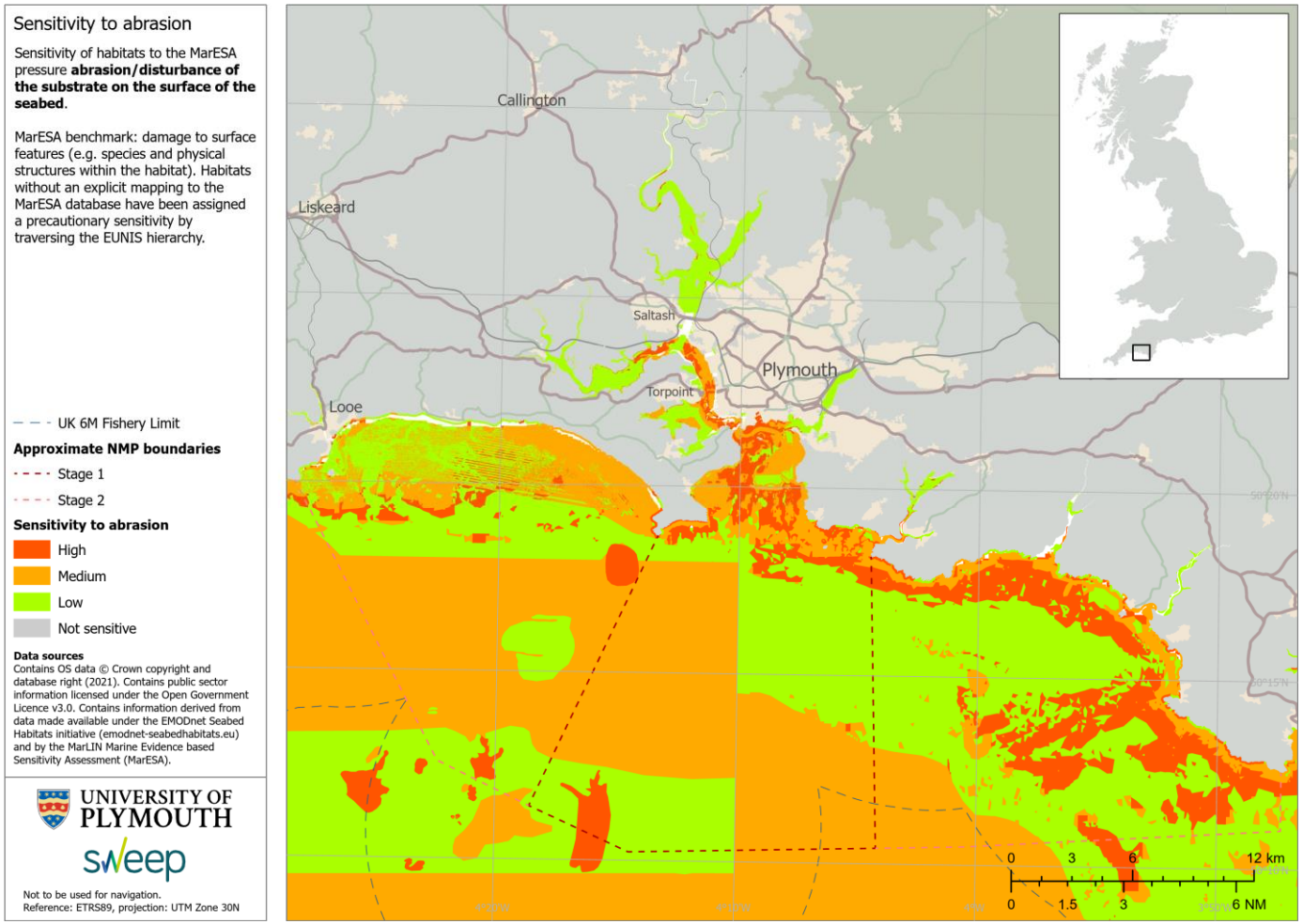
Table 5 Landings value per year (£) by under 10m vessels to Plymouth ports from MMO fisheries data **bold** indicates significant monotonic trend correlation at 95%.

Natural Capital: Flow from Assets to Physical Benefits	Indicator	Species	Unit	Port	Baseline year 2019: value (£)	Baseline Trend 2010-2019	Correlation coefficient (Kendall's tau-b)	Signifi-cance
Species stocks (for each fish and shellfish species used for food)	MMO Fishing Activity data: Landings, to Plymouth & Cawsand (under 10m)	Scallops	£/yr	Plymouth & Cawsand	276,651	↑	0.333	0.18
		Cuttlefish	£/yr	Plymouth & Cawsand	252,482	↑	**0.511**	**0.04**
		Crab	£/yr	Plymouth & Cawsand	138,370	↑	0.67	0.79
		Lobster	£/yr	Plymouth & Cawsand	119,592	↑	**0.867**	**<0.001**
		Pollack	£/yr	Plymouth & Cawsand	225,290	↑	**0.644**	**0.009**
		Monks or Anglers	£/yr	Plymouth & Cawsand	149,624	↑	0.244	0.325
		Bass	£/yr	Plymouth & Cawsand	361,306	↑	**0.822**	**0.001**
		Plaice	£/yr	Plymouth & Cawsand	79,817	↑	**0.511**	**0.04**
		Lemon sole	£/yr	Plymouth & Cawsand	132,413	↓	-0.156	0.53
		Sole	£/yr	Plymouth & Cawsand	231,536	↑	**0.689**	**0.006**
		Skates and rays	£/yr	Plymouth & Cawsand	41,166	↑	0.11	0.75
		whiting	£/yr	Plymouth & Cawsand	23,673	↑	0.24	0.37
		Gurnard (all sp.)	£/yr	Plymouth & Cawsand	17,357	↑	0.333	0.21
		John dory	£/yr	Plymouth & Cawsand	63,093	↑	0.61	0.07
		Turbot	£/yr	Plymouth & Cawsand	102,475	↑	**0.556**	**0.03**

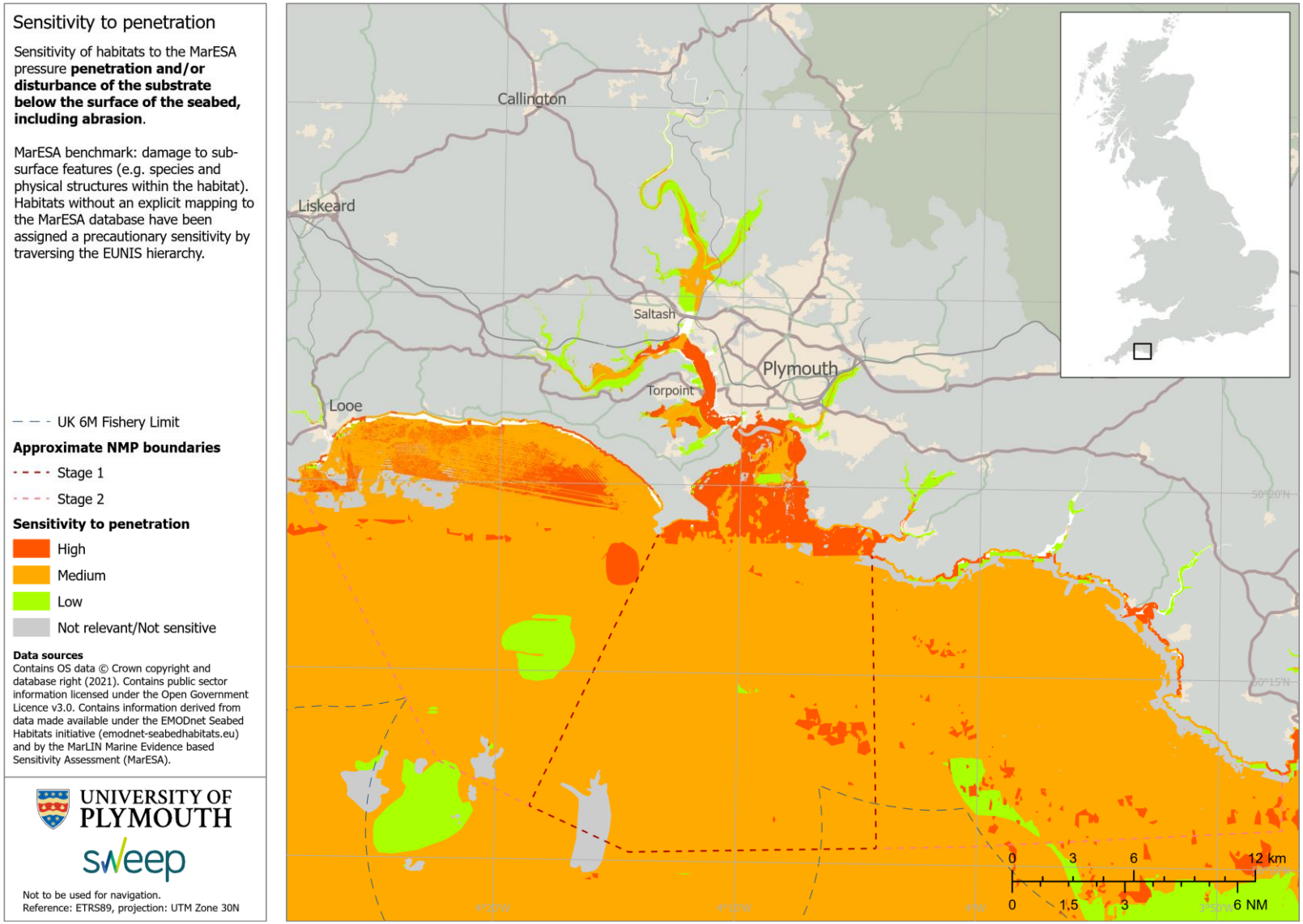
Supplementary Material 3

Mapped Sensitivity of Habitat Assets to Pressures in the Plymouth Sound, Estuaries and Coastal Area.

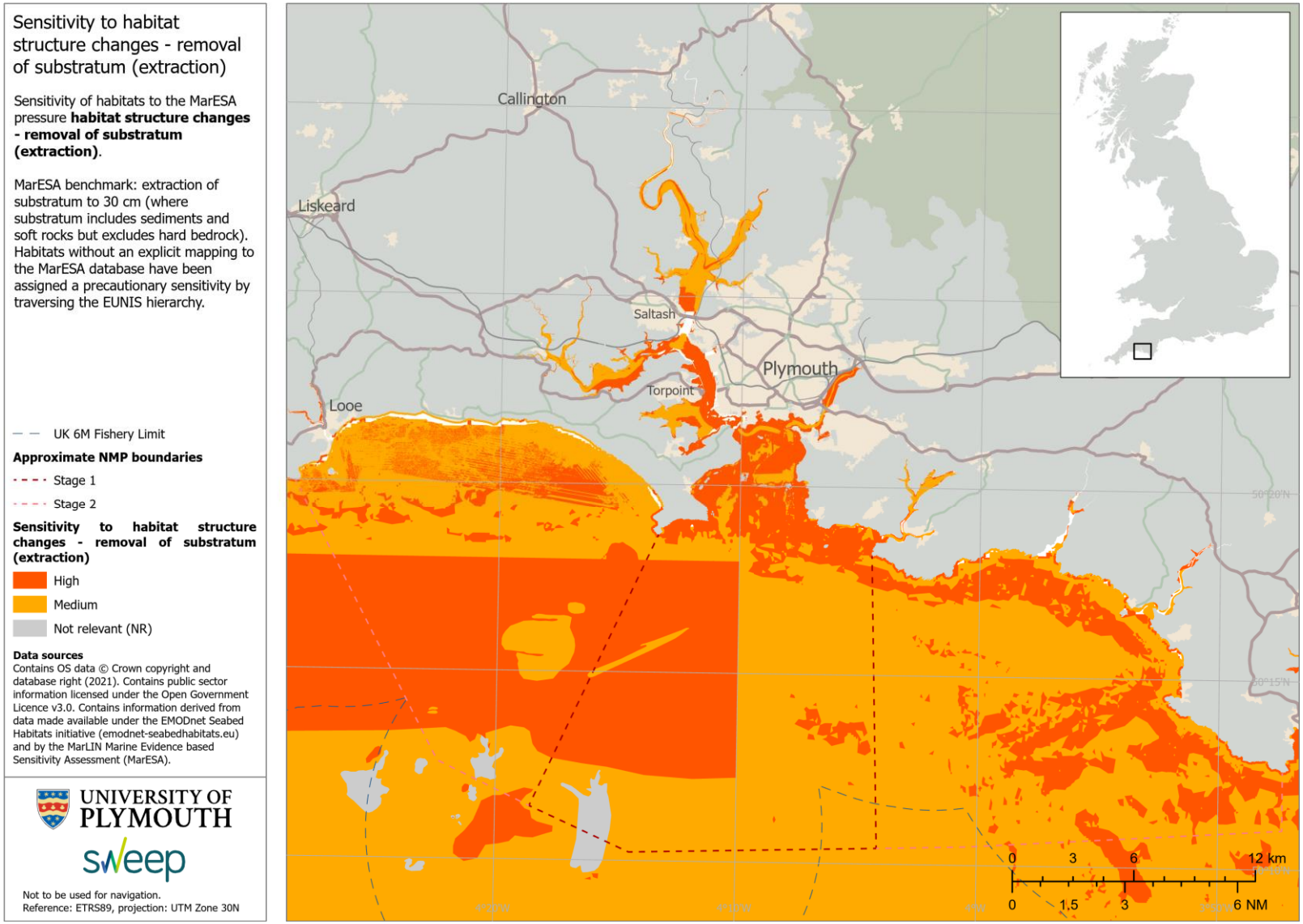
1. Sensitivity to Abrasion



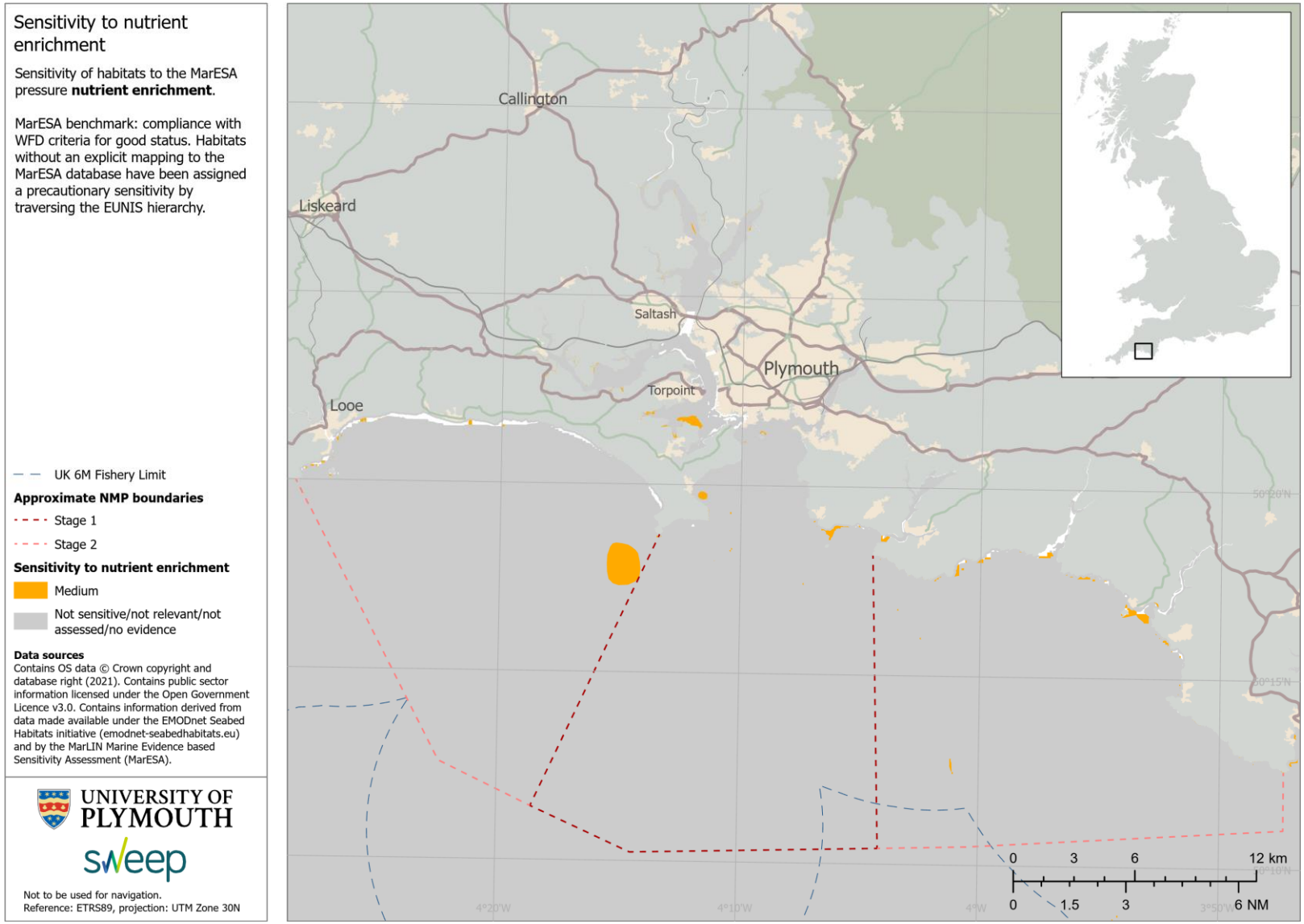
2. Sensitivity to Sub- Surface Disturbance



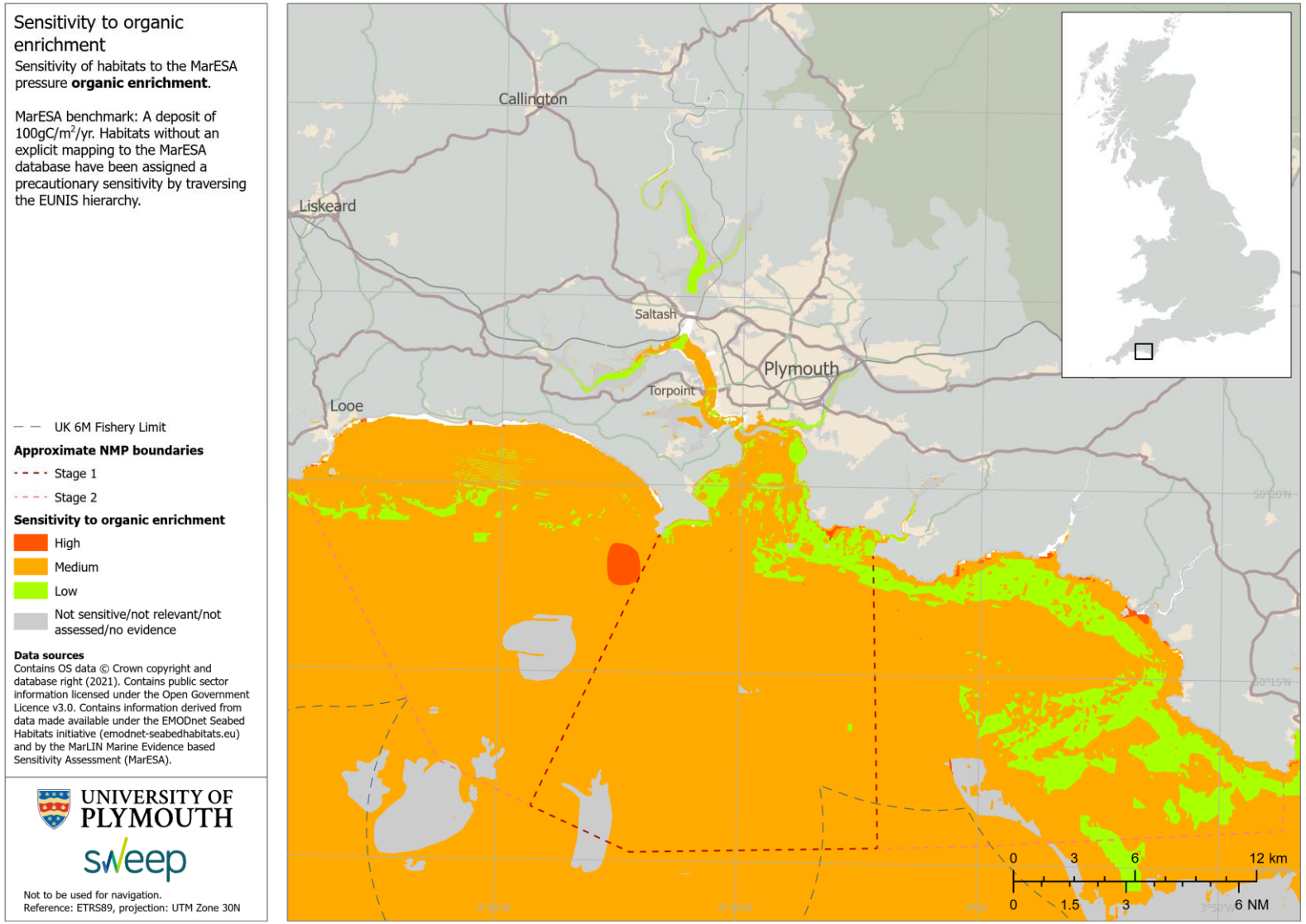
3. Sensitivity to Habitat Structural Change (eg removal of substratum/extraction)



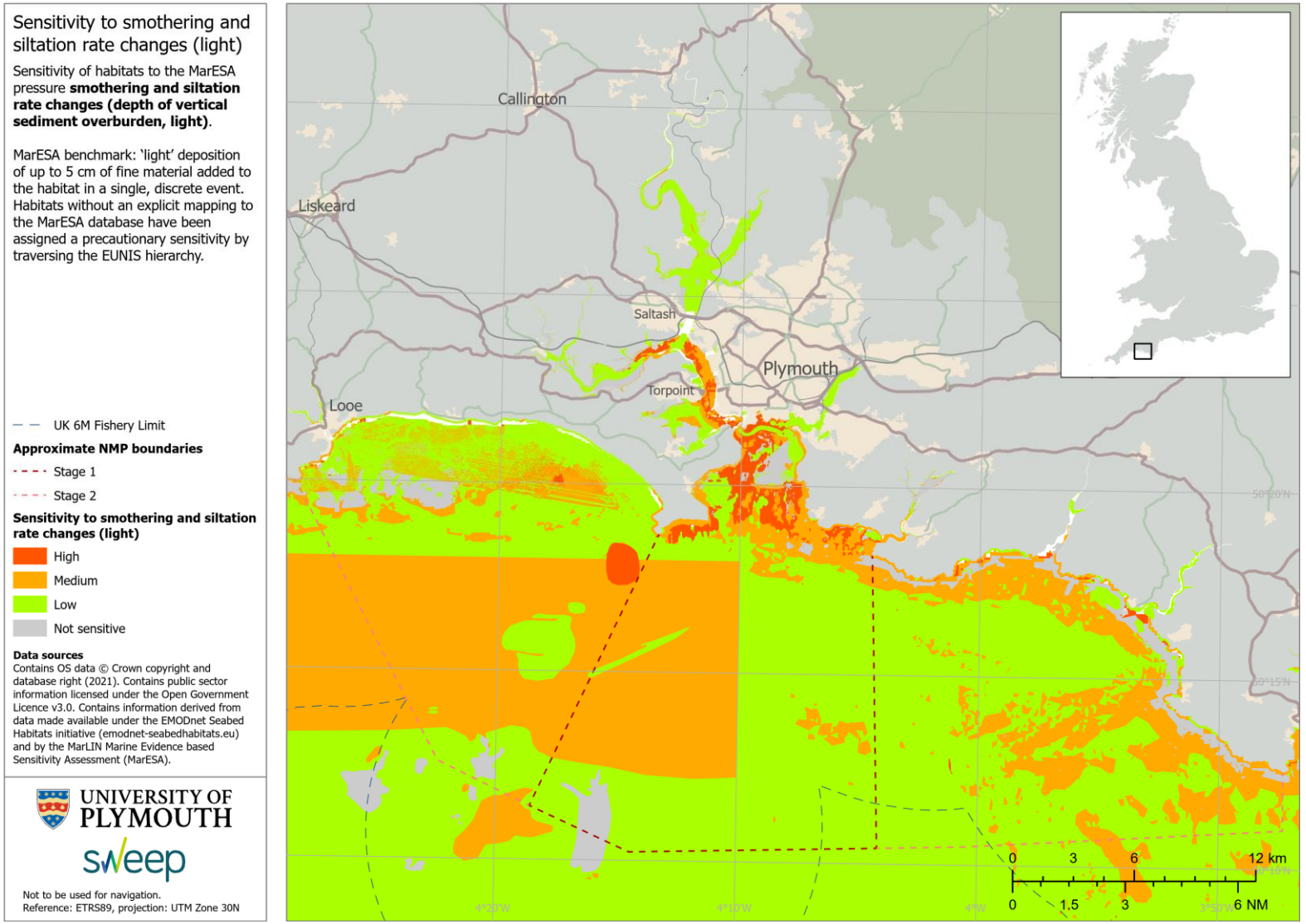
4. Sensitivity to Nutrient Enrichment



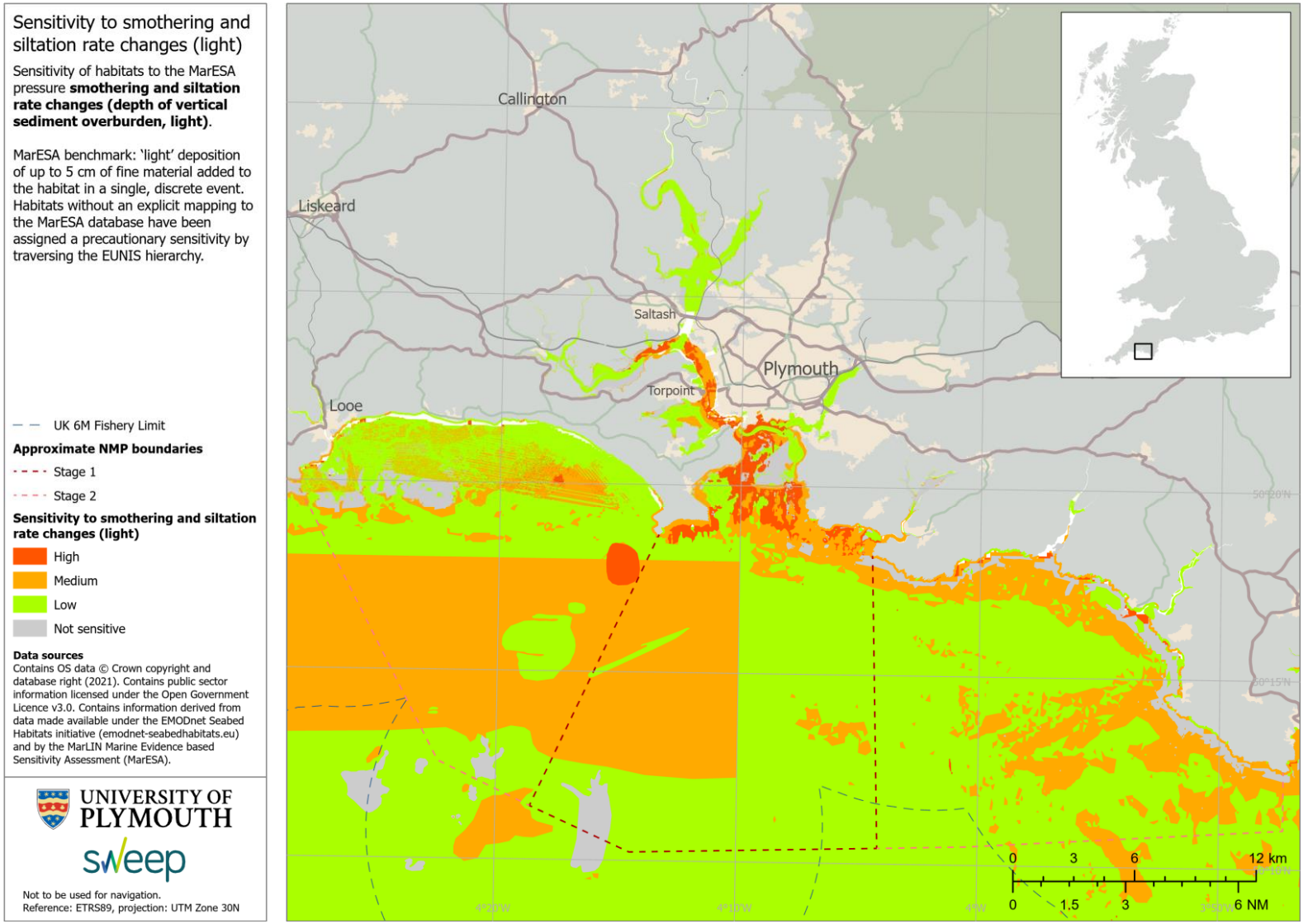
5. Sensitivity to Organic Enrichment



6. Sensitivity to Siltation (light siltation)

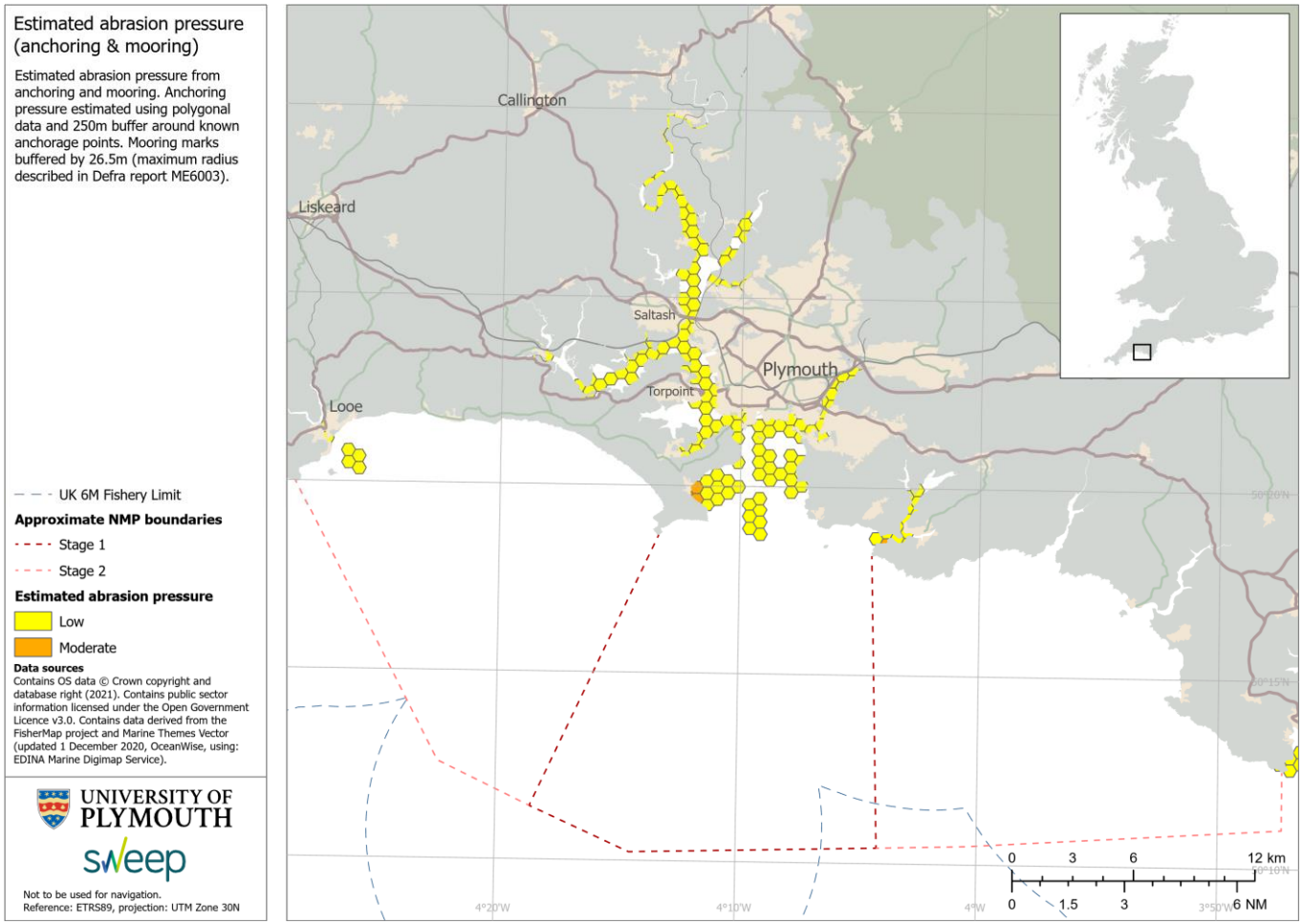


7. Sensitivity to Siltation (heavy siltation)



Supplementary Material 4
Mapped Demersal fishing Activity and Anchoring and Mooring Activity and Resulting Likely Relative Condition from Habitat Exposure to Abrasion and Sub – Surface Disturbance Pressures

1. Estimated abrasion pressure related to anchoring and mooring activity



2. Habitat Likely Relative Condition based on abrasion pressure related to fishing activity and anchoring and mooring activity

Estimated abrasion pressure

Estimated abrasion pressure generated from FisherMap activity data and estimated anchoring/mooring intensity.

MPA designations post-FisherMap are assumed to exclude demersal towed fishing gear.

Low potting pressure is <60 pots/km^2, moderate >= 60/km^2 and high pressure >= 120/km^2.

Low demersal trawling pressure is same ground trawled <= 1 times/year, moderate 2 times/year and high >2 times/year.

Anchoring pressure estimated using polygonal data and 250m buffer around known anchorage points. Mooring marks buffered by 26.5m (maximum radius described in Defra report ME6003).

UK 6M Fishery Limit

Approximate NMP boundaries

Stage 1

Stage 2

Estimated abrasion pressure

Low

Moderate

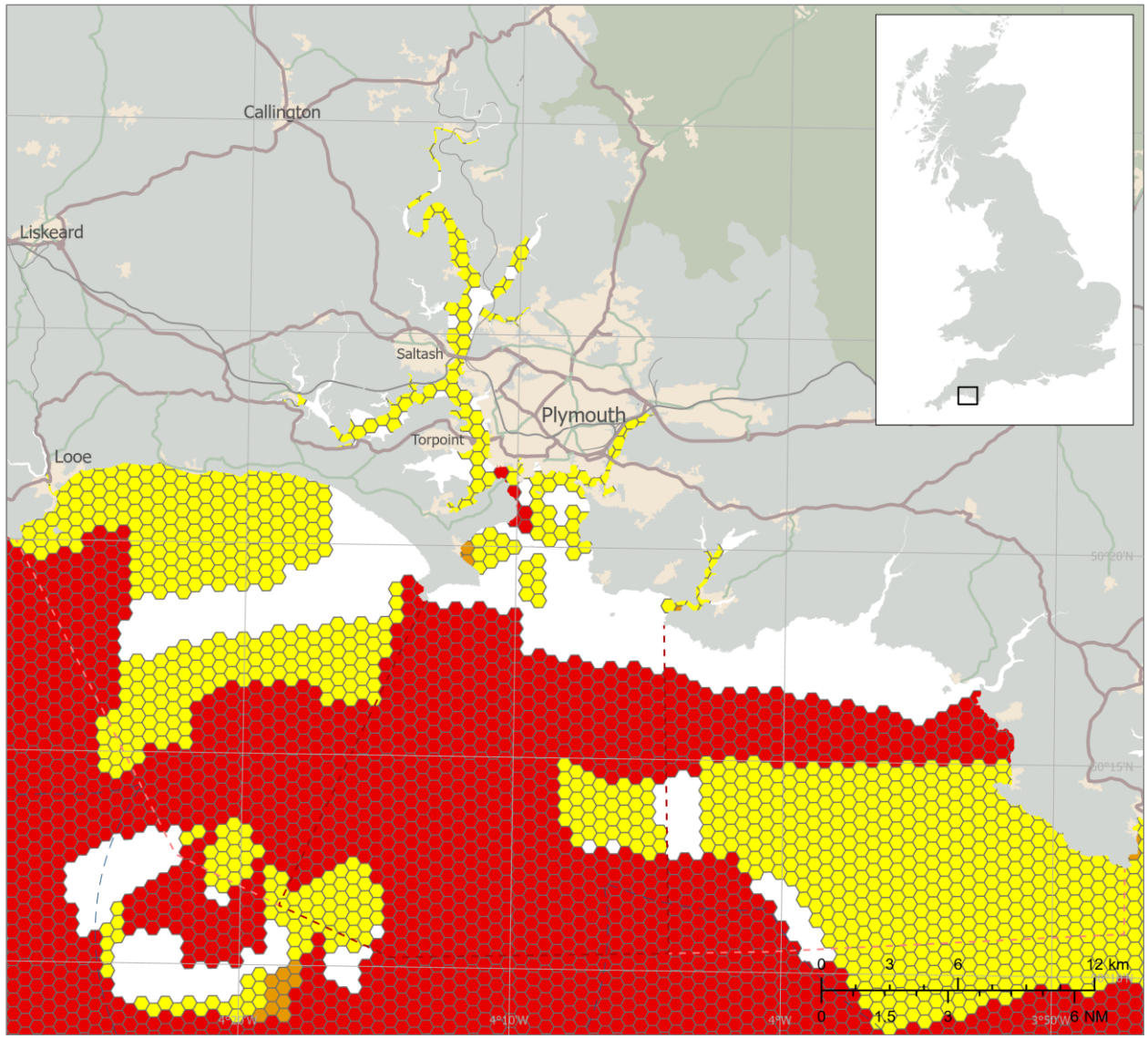
High

Data sources

UNIVERSITY OF PLYMOUTH

sweep

Not to be used for navigation.
Reference: ETRS89, projection: UTM Zone 30N



3. Habitat Likely Relative Condition based on sub-surface disturbance pressure related to fishing activity and anchoring and mooring activity.