What is the evidence that reports on the interactions between human resilience, human wellbeing and environmental sustainability in marine and coastal areas around the UK?

An evidence map protocol

Jacqualyn Eales[1][2] (j.f.eales@exeter.ac.uk)
Rachel Turner [2]
Stephen Simpson[3]
Tomas Chaigneau [2]
Matt Fortnam [2]
Matthew Witt [2,5]
Susan Kay [4]
Oceane Marcone[4]
Claire Szostek [2]
Ruth Thurstan [6]
Ruth Garside [1]
Louisa Evans[7]
  1. European Centre for Environment and Human Health, College of Medicine and Health, University of Exeter, Knowledge Spa, Truro TR1 3HD
  2. Environment and Sustainability Institute, Penryn Campus, University of Exeter, Penryn TR10 9FE
  3. School of Biological Sciences, University of Bristol, BS8 1TQ
  4. Plymouth Marine Laboratory, Prospect Place, Plymouth, PL1 3DH
  5. University of Exeter, College of Life and Environmental Sciences, Prince of Wales Road, Exeter, EX4 4PS
  6. Centre for Ecology and Conservation, College of Life and Environmental Sciences, Penryn Campus, University of Exeter, Penryn TR10 9FE
  7. Geography Department, University of Exeter, EX4 4RJ

Abstract

Background:
The UN Decade of Ocean Science for Sustainable Development (2021-2030) signifies a new level of policy and research attention on the ocean. Human uses of the ocean are accelerating and the ecological and climate crises are unfolding with significant and widespread impacts, leading to growing impetus to protect ocean health, promote sustainable use, and ensure the ocean's proven contributions to human health and wellbeing. Building resilience has also emerged as a central policy response to escalating risk and uncertainty. In the UK, marine and coastal zones face a set of unprecedented challenges, linked to climate change, the UK's exit from the European Union, and the Covid-19 pandemic. Resilience is a growing policy priority, alongside improvements in human health and wellbeing, and marine environmental health. Yet, globally and in the UK, the evidence base linking human resilience to human wellbeing and/or environmental sustainability is lacking. We aim to, for the first time, document the research undertaken in the UK that links the concepts of human resilience with human wellbeing and/or environmental sustainability. The relationships between these three

concepts are not fully understood, so our work will help shape our understanding of the interactions between them, what trade-offs and synergies exist, and where we need to direct future research effort to better understand these interactions.

Method:
We will use a systematic approach to creating an evidence map of the research. We will undertake a search of bibliographic databases to find published literature. Supplementary searching will include canvassing key informants and searching institutional and organisational websites, where we will look for both published and unpublished (grey) literature. All searches will be performed in English. Inclusion criteria will be applied in two stages, title and abstract and full text, with multiple reviewers and consistency checks. We will extract coded data on geographical location, study design and characteristics. The data will be embedded in an online, interactive evidence platform that will enable users to visualise and explore the evidence map findings, including knowledge gaps and clusters. The evidence map output can be used to inform on evidence gaps, and topic areas where the evidence base is strong and conducive for synthesis.

Keywords: Marine management, Resilience, Sustainability, Livelihood, Human health, wellbeing

<u>Background</u>

Problem statement
The UN Decade of Ocean Science for Sustainable Development (2021-2030) signifies a new level of policy and research attention on the ocean. Seas and coastal areas provide coastal communities and economies with numerous societal benefits. These range from the economic benefits of tourism and commercial fisheries, to the socio-cultural and human health benefits of leisure opportunities and access to open space, to vital regulatory services such as climate regulation and coastal defences from storm surges (Barbier, 2017, Fleming et al., 2019). Marine environments are one of the most valuable ecosystems, globally, yet are also among the most heavily exploited and vulnerable (Costanza et al., 2014).

Human uses of the ocean are accelerating, with exponential growth across numerous marine sectors including fisheries and aquaculture, tourism, shipping, energy and mining (Jouffray et al., 2020). Oceans are also impacted by climate change, including through ocean warming, sea-level rise and coastal flooding, more intense and frequent extreme events, and ocean acidification (IPCC, 2018). The ecological and climate crises play out in full view in the oceans, leading to growing impetus to protect ocean health, promote sustainable use, and ensure the ocean's proven contributions to human health and wellbeing.

Further, in this context of escalating risk and uncertainty, building resilience has become a central objective of international agreements on sustainable development (UN, 2015) and climate change (UNFCC, 2015). In the UN Sustainable Development Goals, the resilience of people, communities and ecosystems underpins action to sustainably manage aquatic ecosystems (SDG14), respond to climate change and natural disasters (SDG13), and deliver enduring development and improved wellbeing (SDG1+2). Enhancing resilience is thus

expected to occur alongside improvements in human wellbeing and sustainability in the face of global (environmental) change.

In the United Kingdom (UK), reflecting international concern for the oceans, a strategic priority fund of £12.4million has been dedicated to research into Sustainable Management of UK Marine Resources. Partly framed by the new 25yr Environment Plan, this investment focuses on the interdependencies between environmental and human health: the healthy state of the marine environment and sustainable use of resources is seen as vital for human health and wellbeing, sustainable food production and a thriving economy, and vice versa (Defra, 2018). It is also recognised that coastal communities in the UK are facing unprecedented levels of change and disturbance, including from marine degradation, climate change, exit from the European Union, and the Covid-19 pandemic (House of Lords, 2019). Building resilience to accelerating and multi-faceted risks is a nascent but growing policy priority.

Research gap
The evidence base of research investigating links between ocean health and human health and wellbeing is substantial. In marine contexts, this includes studies documenting the human health risks and benefits of marine and coastal environments (White et al., 2020, Maclean et al., 2013), the positive and negative impacts of marine policy and management interventions on many different facets of human wellbeing (McKinnon et al., 2016, Cheng et al., 2018, Ban et al., 2019, Eales et al., 2021), and, of course, the vast literature documenting the impacts of human action and use of marine resources on ecosystem health (Barbier, 2017). This research reveals important synergies between human wellbeing and environmental sustainability interventions and outcomes. Humans can derive multiple health and wellbeing benefits from healthy ecosystems and thus positive impacts from interventions intended to improve ecosystem health, such as marine protected areas or fisheries regulations (Bennett, 2015, Christensen, 2004, Svarstad et al., 2008). It also highlights important trade-offs among human wellbeing and environmental sustainability across scales (Burke et al., 2011, Chaigneau and Brown, 2016). For instance, resource-users that are highly dependent on marine ecosystems for their livelihoods and food security can be adversely impacted by degraded environments as well as by environmental sustainability interventions, such as no-take protected areas, fish catch limits and/or offshore renewable energy installations (Daw et al., 2016, Galafassi et al., 2017).

The research investigating the relationship(s) between human resilience and human wellbeing, or human resilience and marine ecosystem health and sustainability is far less well developed. There is evidence that resilience and wellbeing can be mutually supportive. Many facets of material, relational and subjective wellbeing can be drawn on in times of hardship to help people cope and recover(Walker-Springett et al., 2017, Cinner et al., 2018). Importantly, there is also growing attention to potential (bi-directional) trade-offs among resilience and wellbeing (Armitage et al., 2012, Coulthard et al., 2011, Mguni et al., 2012). For instance, (Chaigneau et al., 2021) outline how improved wellbeing through specialisation of food production systems can leave producers less resilient to environmental or economic shocks, while disaster response policies that stipulate how and where populations build back their communities in an attempt to improve future resilience can have detrimental impacts on livelihoods and wellbeing.

With respect to human resilience and marine ecological health/ environmental sustainability, there is empirical evidence suggesting synergies; healthy and productive ecosystems (and stewardship and management actions that support this) can provide vital resources and a safety net for resource-users in times of crises, including recovery from the Covid-19 pandemic(Northrop et al., 2020), and; actions to build resilience, for instance climate resilience, can reduce adverse impacts on marine environments (Griscom et al., 2017, Sutton-Grier et al., 2018). As above, there is also emerging evidence of trade-offs; conservation interventions can reduce access to much needed resources in times of adversity (Cohen and Steenbergen, 2015), and resilience-building activities can exacerbate negative impacts on the environment (Espiner et al., 2017).

As outlined in trade-off research more generally, synergies and trade-offs among these key objectives of resilience, wellbeing and environmental sustainability can play out across spatial and temporal scales. For instance, negative impacts of a conservation intervention on human resilience may be temporary or short-term but become synergistic in the long-term as resources recover. Alternatively, the conservation intervention may adversely impact resource-users in one place but not another, or one group but not another (Daw et al., 2016, Davies et al., 2018). These spatial, temporal and disaggregated interactions are important to understand for their policy implications.

Furthermore, though it may be assumed that resilience-seeking actions will lead to resilience itself, this is not necessarily the case. If a fisher decides to explore new fishing grounds out at sea in order to avoid a fishing ban in an inshore area, this is a resilience seeking action. It may result in an increased or maintained household income to guard against economic shock. However, it may also require the investment in new or different fishing gear, additional fuel, and even a new vessel. These economic burdens may negate an increase in household income. In the same logic, actions to improve wellbeing do not always lead to positive wellbeing. For example, increasing a circle of friends to improve happiness and connectedness may not support these wellbeing goals if family, work or time pressures, or lack of transport prevents regular contact between new acquaintances.

This paper focuses on the gap in the evidence base analysing resilience and wellbeing, and resilience and environmental sustainability, and, indeed, the three concepts or policy objectives together. We will explore these interactions by undertaking an evidence map of empirical research that explores the trade-offs and synergies between the three concepts, with a focus on UK marine and coastal environments.

Operationalising concepts
In this systematic map, our core concept is human resilience, otherwise termed social or social-ecological resilience. We take this as the central concept because of the relative lack of systematic mapping of evidence investigating resilience, globally and in the UK. Resilience continues to be widely defined and debated (Allen et al., 2019). For the purposes of this research, we focus on resilience as a positive or neutral response to perturbation, reflecting its promotion as a desirable policy outcome (Box 1 and Table 3).

Human wellbeing is a multi-dimensional concept defined broadly as "the satisfaction of human needs to achieve a state of being well, both physically and mentally" (Bottrill et al., 2014). Comprehensive wellbeing frameworks, such as the three-dimensional social wellbeing framework, conceptualise wellbeing as comprising material, relational and subjective dimensions (White, 2010). The research into wellbeing may also analyse specific terms denoting a lack of wellbeing, for example, anxiety, depression, mental health problems, or physical injury.

In this protocol, we capture our concern for ocean health through the term environmental sustainability: "how interactions between social and natural systems can meet the needs of present and future generations while conserving the planet's life support systems" (Kates, 2011). We focus on the environmental pillars of sustainability to avoid conceptual overlap between aspects of social or economic sustainability and human wellbeing. Recognising the potentially disparate nature of research in this area (Bettencourt and Kaur, 2011), we consider both the health, or state of the environment and the human actions that impact (both positively and negatively) the health or state of the environment. This latter focus includes human use of the oceans as well as stewardship, management and conservation actions to improve ocean health and sustainability.

Box 1. Working definitions of key concepts used in this evidence map. These definitions are derived from theory and may represent only part of a concept that may have a wider definition elsewhere.	
Human resilience	The ability of an individual, group or community to respond positively (or neutrally) to disturbance or change whether by maintaining a set of functions, values and identities or purposefully transitioning to a new 'state'. In practice, this may be the "ability to absorb disturbance, adapt, and re-organise while undergoing change" or the "capacity to adapt or transform in response to a disturbance". Resilience can be both a process, e.g., a fisher moving to further seas to fish more stable stocks, and an outcome, e.g. the increased financial resilience resulting from fishing income.
Human wellbeing	The ability of an individual, group or community to satisfy their human needs and achieve a state of being well, physically and mentally. This includes material, relational and subjective elements of what it means to live well. Wellbeing can be both a process, e.g., an individual taking action to increase their network of friends, and outcome, e.g. a larger and wider network of friends that brings added quality of life and sense of wellbeing.
Environmental sustainability	For the purpose of this evidence map, we use this term to encompass both the health or state of the environment in the context of being an environment that can sustain itself into the future (this equates to an "outcome"), and the human actions that impact (both positively and negatively) the health or state of the environment, which

		demonstrates how environmental sustainability is also a process.
Disturbance/ "Resilience to what?"		Resilience is a response to sudden and discrete shocks as well as more slow-onset and chronic change events. The literature refers to adversity, risk, disturbance and perturbations, among other terms, and includes environmental, economic, political and socio-cultural changes. For example, resilience to climate change, extreme weather events, environmental degradation, resource decline, policy and regulatory change, price and currency fluctuations, supply chain interruptions, pandemics, political change or unrest, changing demographics. The literature might focus on resilience to a singular disturbance or might refer to a more general resilience to multiple and compound disturbance. We will collect meta-data on the forms of disturbance researched in the UK marine literature or note the absence of clear reference to a particular type of disturbance.
Marine environment		The species, habitats and ecosystems that make up seas and oceans.
Coastal areas		Areas adjacent to and heavily dependent on or impacted by the sea, in economic, socio-cultural or ecological terms.
Coastal communities		Individuals, households or communities, living or working within coastal areas.

Table 1 provides some high-level examples of the kinds of relationships that we would expect to find in the available scientific evidence.

Table 1. Examples of potential relationships between resilience and i) environmental sustainability (including marine environmental health and human actions that impact the environment) and ii) human wellbeing. For human actions, we have separated "use" and "stewardship/ management" because they represent different perspectives.

Health or state of the environment & Resilience	Synergy	Productive marine ecosystems can support new local food supply chains that can buffer future economic shocks Using nature-based solutions for coastal protection to build resilience to climate change can extend and introduce important marine habitats
	Trade-off	High biodiversity can encourage second home ownership, which in turn can slow recovery of tourism operators impacted by Covid-19 pandemic Engineered solutions to coastal protection to build resilience to climate change can destroy coastal and marine habitats
Human actions that impact on	Synergy	Fishing of alternative inshore stocks can support livelihoods in periods of stormy weather

the environment – Use & Resilience		Building resilience by changing to low impact fishing gears can reduce fishing effort and target less vulnerable species
	Trade-off	Overfishing can limit the capacity to move to new areas to fish in times of adversity Building resilience by investing in bigger boats and new gears to go further offshore for longer can increase effort and use of destructive gears.
Human actions that impact on the environment - Stewardship and management & Resilience	Synergy	Conservation actions e.g., MPAs can promote recovery of resources that support livelihoods in times of hardship. Building resilience through establishment of temporary closures can enhance wider commitment to sustainability activities
	Trade-off	Conservation actions can prevent access to resources in times of hardship Resources spent recovering from disturbance events can reduce capacity to invest in additional stewardship activities
Wellbeing & Resilience	Synergy	Financial savings can be drawn on in times of adversity Moving to an alternative livelihood to better cope with climate change can improve income
	Trade-off	High value possessions can be damaged in a storm, and require replacement Moving to an alternative livelihood to cope with climate change can reduce job satisfaction and adversely impact identity

Stakeholder engagement to inform this evidence map

This evidence map will inform ongoing research undertaken by partners from institutions in the UK, for the ROCC (Sustainable Development and Resilience of Coastal Communities in the UK) project as part of the UKRI SMMR (Sustainable Management of UK Marine Resources) programme of research. The goal of the wider ROCC project is to systematically evaluate synergies and trade-offs between human resilience, wellbeing and environmental sustainability across scales and sectors, and to identify opportunities to improve these outcomes together (SMMR, 2021). Researchers for the project working in the South-West UK region and other stakeholders from the project team (bulleted below) were involved in the discussions that focused the scope of this evidence map.

- Marine Management Organisation
- Devon Maritime Forum
- Cornwall Rural Community Charity
- Sole of Discretion
- Cornwall County Council
- Devon County Council

Stakeholders have been invited to suggest search terms for the search strategy and to provide comment on various other parts of the evidence map, as it progresses, for example, the appropriateness of the meta-data extraction spreadsheet.

Objectives

The aim of the evidence map is to identify and map empirical research on the interactions of human resilience with human wellbeing and/or environmental sustainability, around the UK's marine and coastal waters. This will serve to highlight knowledge gaps and identify areas

where research has been undertaken. We are interested in linkages (synergies and trade-offs) which operate within the same marine social-ecological system i.e., each concept affects another concept directly. **To emphasise, we are primarily interested in socio-ecological resilience, and will focus on how any aspects of human wellbeing and/or environmental sustainability interact with resilience.**

Evidence Map questions
Our evidence map constitutes three research questions, two which address pairs of the concepts (both involving human resilience as our defined central research gap), and one looking at the three concepts together, Table 2.

We are interested in how human resilience may be related to changes in marine environmental sustainability, for example, where changes in human resilience impact environmental sustainability in a positive or negative way, declines in the state of the marine environment affect resilience and/or efforts to improve the marine environment affect human resilience (Research question 1). We are also interested in how resilience may be affected by aspects of human wellbeing and vice-versa (Research question 2). Finally, we are interested in how all three concepts, human resilience, human wellbeing and marine environmental sustainability may all interact with each other (Research question 3). We do not include the pairing of environmental sustainability and human wellbeing because this topic area has been relatively well characterised (McKinnon et al., 2016).

Table 2. Research questions addressed in the evidence map

Research question	Population	Concepts
1. What is the extent of the available primary research that reports on both i) environmental sustainability and ii) human resilience of people, communities or businesses around the UK coast?	Marine and coastal areas in the UK, and the people, communities or businesses that live and operate there	Human resilience Environmental sustainability
2. What is the extent of the available primary research that reports on both i) human resilience and ii) the wellbeing of people, communities or businesses around the UK coast?	People, communities or businesses around the UK coast	Human resilience Human wellbeing

3. What is the extent of the available evidence on the relationship between the following three facets: i) environmental sustainability ii) human resilience and iii) wellbeing of people, communities and businesses around the UK coast?	Marine and coastal areas in the UK, and the people, communities or businesses that live and operate there	Human resilience Human wellbeing Environmental sustainability

Secondary questions

What are the characteristics of the evidence base (frequency of intervention/ outcome type, scale, geographic location, and study design)?

Where do gaps exist in the evidence base, indicating potential research priorities?

What are promising areas for synthesis of the evidence?

<u>Methods</u>

We will follow the Collaboration for Environmental Evidence guidelines and standards for evidence synthesis in environmental management (CEE, 2018) wherever possible. However, due to the nature of this topic, which involves interrelated and overlapping concepts, and the unknown extent and type of evidence we will encounter, we anticipate taking an iterative approach to evidence retrieval, and for modifications to be made to the protocol during the evidence mapping.

Searches:
Because we expect to find a limited amount of evidence (research on human resilience interactions is relatively new, *c.* the past 20 years (Brown, 2014) and there are several key papers that we expect empirical research to cite, we will use a range of approaches alongside bibliographic database searching to capture the extent of the evidence on the topic. We aim to find both published and unpublished (grey) literature, to be as comprehensive as possible.

Bibliographic Database Searches
We undertook scoping (testing) to arrive at an optimal search strategy for this evidence map. The search strategy was tested in Web of Science Core Collections with the goal of maximising both i) precision - the proportion of retrieved articles that are relevant, and ii) sensitivity - the proportion of relevant articles retrieved.

To facilitate sensitivity testing of the search strategy, an initial set of 10 test articles was used. These articles were suggested as potentially relevant by the project research team, they consider the concepts of interest to us, though some have an international scope. The retrieval of these test articles by the searches (excluding a term set with a UK geographical focus) was used to determine the sensitivity of the strategy (how likely the strategy was to

return relevant hits, detailed in Appendix 1). Search terms to be used in the strategy were sourced from reviews in similar topic areas (McKinnon et al., 2016, Ban et al., 2019, Eales et al., 2021, Chaigneau et al., 2021), the test articles, and from project research team and stakeholder suggestions. Each potential search term was considered by the project team for usefulness as part of the search strategy. Those which we were unsure of (in terms of their usefulness) were tested for retrieval of relevant hits during the Web of Science scoping phase. Precision of the search string (the number of relevant hits retrieved as a proportion of the total number of hits returned) was maximised by using operators such as truncation operators (*), proximity operators (e.g. "w/5" meaning within 5 words) and by further refining and discussions of the search terms with the whole team, which took place across at least 5 team meetings. Appendix 1, presents our rationale for search terms chosen for each concept.

The search strings were composed of combinations of up to 4 of 5 concepts, and we will search within title/abstract/keywords where possible, or as similar as possible (e.g. "topic"). For the UK concept, we will also search within the country of the authors' affiliation, using the rationale that for this UK focused topic, it is highly likely that at least one of the authors is based in a UK institution. We designed two search strings, the first to find evidence for research question 1, and the second to find evidence for research question 2. For research question 3, where we are interested only in articles that report on all three concepts, we will obtain the evidence from the other strings and screen for studies that include the third concept.

The two search strings are below:

Research question 1: UK AND marine/coast AND human resilience AND environmental sustainability

Research question 2: UK AND marine/coast AND human resilience AND human wellbeing

We tested the following databases for their relevance and coverage of the topic:
- Web of Science Core Collections (WOSCC)
- Scopus
- Medline (via Ovid)
- CAB abstracts
- BIOSIS
- ASSIA
- Psycinfo

The latter two databases were suggested by a librarian because of their social sciences coverage. However, we found that there were a small number of articles returned from these databases, that none of the test articles were found, and a test screen of the first 50 articles retrieved revealed that none were relevant. Thus, we decided to remove them as databases from our searching strategy.

We have translated the WOSCC search strategies to be used in the first five databases above. All databases will be searched using the University of Exeter subscription. The search strategies are given in Appendix 2. In the Medline database, we chose to include articles listed

under the setting "*epub ahead of print and in process, in review and non-indexed citations*", to capture hits that were recently accepted into journals. The language used for bibliographic database searches will be English. This is because most research in the topic area is likely to be in English, given that the geographical research focus is the UK. The final strategies used, along with the date the search was undertaken, will be presented in an Appendix in the evidence map report. We do not plan to update the searches during the map because we anticipate publishing the map report within 12 months of the searches.

Supplementary searching methods

Google Scholar search

We will search Google Scholar (www.scholar.google.co.uk), because previous work has shown it to identify additional grey literature in excess of that found by other supplementary search methods (Haddaway et al., 2015). The functionality of Google Scholar's search, particularly using Boolean operators has increased since the most recent analysis of its utility for evidence syntheses (Haddaway et al., 2015). We will use a modified version of the database search strings and use the first 200 records retrieved by the search for title and abstract screening. These records will be integrated with those retrieved by the bibliographic database searches using the software Publish or Perish (Harzing, 2007).

Organisational websites and online catalogues

We will maximise our coverage of the evidence base by extending our search to relevant organisational websites and topical catalogues for any additional literature. These were suggested by the research team and stakeholders as potentially useful sources of evidence, and the list may expand if further suggestions are made during the evidence mapping. Any additions to the list will be recorded and noted as later additions in the final report. Search strings for these sources will be adapted from the database search string and will reflect the search capabilities of each website. The websites are listed in Box 2.

Box 2. List of websites and online catalogues to be searched

DEFRA Science and Research Projects portal
http://randd.defra.gov.uk

Marine Management Organisation Evidence Projects Register
https://www.gov.uk/government/publications/evidence-and-the-marine-management-organisation-mmo/evidence-projects-register

Marine Environmental Data and Information Network
https://medin.org.uk

Marine Ecosystem Services Partnership Database
https://www.icriforum.org/members/marine-ecosystem-services-partnership/

National Ocean Economics Program
https://www.oceaneconomics.org/

Environmental Valuation Reference Inventory
https://www.evri.ca/

Eftec
https://eftec.co.uk/

TEEB (The Economics of Ecosystems and Biodiversity)
http://teebweb.org/

Plymsea (Research repository for Plymouth Marine Laboratory and the Marine Biological Association)
https://plymsea.ac.uk/

We will search the thesis and technical/research report repositories listed in Box 3, chosen to reflect repositories where a UK themed topic would be most likely to be held. The search string from the database searches will be adapted to reflect the search functionality of each repository.

Box 3. List of thesis and technical/ research report databases
- DART-Europe   - Ethos dissertation repository   - Proquest Dissertations and Theses Global   - EBSCO Open Dissertations   - Open Grey literature database (via the Easy platform)

For all website and catalogue searches we will record the URL, the strategy or search terms used, the date the search was undertaken, the results, and the name of the reviewer undertaking the search. The information will be collated in an Appendix for the evidence map report.

Other methods of obtaining evidence
Key informants who are identified as being relevant to the topic area will be contacted for any known sources of evidence, including the SMMR-Net, a network of interdisciplinary marine scientists in the UK. Authors will use Twitter to make an open call to their professional networks for submission of evidence to the evidence map.

We will use the "pearl-growing" technique using key articles as a further method to capture relevant articles not retrieved by our bibliographic searches. We will undertake forward and backward citation searching of test articles, key reviews in the topic area and included studies using the facility in SCOPUS. We will also use the web-based tool connectedpapers.com to visualise the connections between papers and key authors. This will aim to find further relevant studies, and additional information relevant to the same study provided in linked papers e.g., information about other outcomes for the same study. From any relevant articles that are found through this process, we will repeat the forward and backward citation searching, and continue in this manner until we reach a point where no further relevant articles are retrieved.

We will use a reference management software, such as Endnote, to store and collate the results from the search methods where exports in RIS/Endnote format are possible (Bibliographic databases, Google Scholar). We will de-duplicate the results and screen them for relevance (either in Endnote, or in a separate systematic review tool, such as EPPI-Reviewer (https://eppi.ioe.ac.uk/CMS/Default.aspx?alias=eppi.ioe.ac.uk/cms/er4) using the methods described below. For articles found through the organisation websites, catalogues, thesis repositories, key informants, Twitter and "pearl-growing", we will use Excel to collate, de-duplicate and screen.

Article Screening and Study Eligibility Criteria

Search results from the bibliographic databases, and from Google Scholar will be de-duplicated and each article will be assessed for relevance based on its title and abstract (the latter being used where articles cannot be excluded based on title alone). Reviewers will be inclusive wherever there is doubt as to the relevance of an article. Each article will be assessed by one of at least two trained reviewers, who will undertake a consistency check between them, using a subset of double-screened articles (minimum 10%) to maximise the consistency of applying the eligibility criteria. We will use Kappa tests and percentage agreements to assess inter-reviewer consistency of the subset of articles. Discrepancies will be discussed and clarifications in interpreting the eligibility criteria to maximise the consistency for remaining studies. A third reviewer will be consulted if a decision cannot be reached, and clarification on eligibility criteria will be added to aid further decision making. If the inter-reviewer consistency is low, the consistency checking will be repeated using a further subset of articles (minimum 10%), until a good inter-reviewer agreement is achieved (e.g. Kappa score of "Good agreement"), at which point, the rest of the articles will be screened independently, with spot checks to identify any decision drift. Borderline articles will be flagged to other reviewers for discussion.

Full texts of articles that pass the screening at title and abstract will be retrieved and screened based on the full text and supplementary material. Again, each article will be assessed by one of at least two trained reviewers. The same procedure for consistency checking will be employed as for title and abstract screening (a subset of at least 10% of articles), and discrepancies dealt with using the same procedure as for title and abstract discrepancies.

Screening of search results from the supplementary searches will be undertaken by one reviewer, with a second reviewer checking the decisions from a minimum of 10% of the search results. Any discrepancies in agreement will be discussed and refinements made to clarify eligibility criteria.

During screening, we will retain any reviews, commentaries or perspectives that are in the topic area for pearl-growing. Table 3 presents the eligibility criteria that will be used in this evidence map, noting that for each research question, only the concepts relevant to each question will be used as criteria.

Table 3. Eligibility criteria

Relevant population	Individuals (e.g., residents, tourists), communities (e.g., village communities, birdwatching groups) and businesses (e.g., renewable energy business, surf school, beachside cafe), including employees of businesses, living or working within coastal areas in the UK (the coasts and seas in or surrounding the countries of England, Northern Ireland, Scotland or Wales). We are only interested in individuals and social groups. We are not interested in businesses that are national or multinational which have an operation in the UK coast/seas (but we will include their employees if they live/work there) We define coastal areas as those adjacent to the sea, in economic, socio-cultural or ecological terms. Studies must clearly be focussed on the coastal region. Where articles refer to an area or community as coastal, we assume that their area of interest is as per our definition above. We are not interested in studies undertaken in areas not connected to the sea or coast, where the authors do not mention terminology to describe the seas and coastal areas.
Relevant concept	<u>Environmental sustainability</u> We will include studies that report on either (or both) of two facets of environmental sustainability (outcomes and processes): I) Measures or descriptions of the status, change or trend in marine and coastal environmental health. Examples include the biodiversity, levels of indicator or key species, pollution, eutrophication, contamination and sewage. Any measures that are not direct measures of current ecosystem state or of an ecosystem service (i.e., that are indirect measures) are ineligible, e.g., sales of seafood caught in the coastal area, where authors do not make a link to ecosystem health. II) Local establishment, adoption, or implementation of a specific, discrete human action that affects (positively or negatively) the health or state of the local marine or coastal environment. Examples include conservation of marine habitats and species, fisheries management, coastal development, pro-environmental behaviour such as beach cleans and plastic free initiatives, voluntary agreements and initiatives. Activities that negatively impact the marine environment are also eligible, including destructive fishing practices, overexploitation of marine stocks,

	activities that erode coastal land, pollute and contaminate the coast and sea. Ineligible activities include those that have an indirect effect on the coastal/marine environment, e.g., installation of heat pump heating systems in coastal homes, or that have a direct impact but do not clearly take place in the marine or coastal zone, e.g., upstream agricultural run-off from farmland.
Relevant concept	Human Resilience: We include studies that report on human resilience (including social- and social-ecological resilience) as a key concept of the study, which we define as *the ability to respond positively (or neutrally) to disturbance or change whether by maintaining a set of functions, values and identities or purposefully transitioning to a new 'state'*. In practice, this may be the "ability to absorb disturbance, adapt, and re-organise while undergoing change" or the "capacity to adapt or transform in response to a disturbance". To be included, studies must mention the word "resilience" in the full text, or clearly describe the concept above. Where a study only refers to resilience in an author's discussion or conclusion and does not refer to resilience in the methods or results, we will exclude the study. We are interested in both resilience *processes*, i.e., (capacity to undertake) actions to buffer against disturbance, and *outcomes*, i.e., the resilience gains from the actions. Studies on resilience aspects which might be very closely related to human wellbeing, such as financial resilience, are eligible only if they refer to the ability to respond to a disturbance or change, for instance, by converting or redeploying assets. So, for example, a study that investigates financial resilience and relates this to income or economic assets would be included for covering aspects of both resilience and wellbeing. We will exclude studies that only include ecological resilience (i.e., the capacity of an ecosystem to respond to a perturbation or disturbance by resisting damage and recovering quickly), institutional resilience, or resilience of a governance system. We exclude human stability, where there is no clear disturbance or change to respond to. We anticipate many resilience focused studies will be qualitative, but there may be some resilience data presented quantitatively (Jones et al., 2021) e.g., via remote data collection / surveys.

Relevant concept	Human wellbeing:
	We define wellbeing as the material, relational and subjective dimensions to people's lives. Eligible studies will refer to one or more of the concepts in the table below, which derive from theoretical understandings of wellbeing, or synonyms for wellbeing itself. We include both wellbeing *process*, i.e., the actions undertaken to improve wellbeing, and *outcome*, i.e., improvements in wellbeing aspects. Human wellbeing may be measured qualitatively or quantitatively, and we are including both.

Origin of concept	Description/ examples:
Theory of human need	Health, autonomy, safety, relationships, respect, security, employment, education, food security, basic need, human need, freedom, empowerment
Utilitarian/Economic	Income, poverty, savings, welfare, utility, debt, wealth, prosperity
Livelihoods Framework	Livelihood, employment, employment opportunities
Capability Approach	Freedom, agency, empowerment
Wellbeing synonyms and antonym	Wellbeing, poverty, wellness, welfare, standard of living, poverty
Subjective wellbeing	Happiness, quality of life, satisfaction, contentment, emotions

| Relevant types of study design and study characteristics | Primary (empirical) research studies reporting observational or experimental data, or descriptions of people's perceptions, experiences and beliefs. Any material that doesn't state a defined empirical research method is not eligible.

We are only interested in linkages (synergies and trade-offs) between the concepts which are described or evident as operating within the same socio-ecological system, local or regional to the UK marine or coast. For example, we would exclude a renewable energy project in Scotland which provides affordable energy for residents in Devon. |

	Quantitative, qualitative and mixed methods studies will be eligible, and must report their methods, indicating that it is a piece of primary research[1].
	Reviews of evidence, theoretical articles, commentaries, editorials are not eligible (but may be used for pearl growing).
	Only studies in English are eligible, given the UK focus of this evidence map.

We will provide a list of articles excluded at full text with reasons for exclusion. Should an article authored by one of the reviewers require screening, the reviewer in question will not make inclusion decisions for any of their own work. We will report the outcomes of screening in a ROSES flow diagram (Haddaway et al., 2018), along with a list of eligible articles at full text.

Meta-data coding and data extraction
Studies that pass the relevance assessment at full text will have data extracted into a spreadsheet by a trained reviewer and coded into meta-data where possible. The data we anticipate extracting will include (but is not limited to):

- Citation
- Geographical location (latitude and longitude)
- Study design
- Description of how each of the concepts are represented or analysed (e.g., perception of coastal pollution; quality of life; description of resilience), using both categories and free text description where useful
- Description of the disturbance event/s in the study or an indication of the absence of an identified disturbance
- Data collection method
- Data analysis method
- Temporal scale (length of intervention)
- Data type (quantitative, qualitative, mixed)
- Hyperlink to article

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[1] As an ideal, qualitative research reports would give methodological information about how the research was conducted, including information about (but we will accept incomplete versions of the following, if a research methodology was clearly followed):
- Participants (who were they, how were they recruited)
- Data collection methods (interviews, observations, focus groups etc)
- What data was analysed (transcribed recordings, field notes etc)
- How it was analysed (thematic analysis, framework, IPA etc)

Outcome data may be direct quotes i.e. first order, e.g. from transcripts, or author interpretation i.e. second order, e.g. what the consensus from the community was.

For each article, we will also include a structured statement summarising the study design, setting and the intervention/outcomes present.

A random subset of studies (minimum 10%) will be double checked by a second reviewer for consistency in the completion of the coding spreadsheet. Discrepancies will be discussed and clarifications in interpreting the coding documented to maximise the consistency in the coding for remaining studies. Should a study authored by one of the reviewers require meta-data extraction, the reviewer in question will not undertake this for their own work.

Study quality assessment

To maximise the resource efficiency of this evidence map, we will not undertake a formal quality assessment for each study. Meta-data coding will include the recording of study design elements, such as the type of comparator and the assignment method for intervention and comparators. This information will be used to indicate the relative numbers of studies that fall into a typology of study design categories that are of different rigour, though such a classification does not in itself allow studies to be defined as a particular quality. The coding will take place as part of the meta-data extraction, and repeatability of the study design categorisation will be assessed during that process.

The categorisation of study designs will be one of the elements of meta-data that will be included in the data portal (meta-data extraction tables and geographical map) that will be the outputs of this evidence map.

Study mapping and presentation

A freely accessible online data portal will present the studies and the meta-data that accompanies them. The software used to create the data portal may use EviAtlas (https://github.com/ESHackathon/eviatlas), or a similar mapping software. The data portal will include a structured matrix, which provides a graphical illustration of the distribution of studies across the pairings of concepts. This will show which linkages have been studied, and to what extent. We will plot the geographical location of each study (along with meta-data associated with each study) using the available information (latitude and longitude), in an interactive map, providing another format by which a user can access the evidence base covered in this evidence map.

We will provide a narrative summary of the evidence, comparing the extent of the evidence base for each concept pairing, and the three concepts together. The summary will describe the types of studies, their foci and we will summarise any information in graphs and tables wherever possible (e.g. duration of intervention, data type, data collection and analysis methods). This will be used to identify and prioritise key knowledge gaps and clusters.

Declarations

Ethics approval and consent to participate

Not applicable

Consent for publication

Not applicable

Availability of data and material

Not applicable

Competing interests

The authors declare that they have no competing interests.

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Appendix 1
Rationale for search terms

Overall

Searching for papers that deal with the nexus will involve trawling through a large dataset. For each Nexus term a conceptual justification of broad search terms is included below. However, at times, searching for synonyms, antonyms of different aspects of these broad concepts can lead to inclusion of very general terms that embody meanings unrelated to our definitions. These were excluded in each case, and often justified as the authors felt the paper would be captured by some of the other more specific search terms already added (and quite exhaustive!).

Environmental sustainability

Environmental sustainability can be seen as the responsibility to conserve natural resources and protect global ecosystems, now and in the future. In more detail, we see this outcome as: i) the stewardship actions, on-the-ground solutions, and policy interventions undertaken by resource-users, practitioners and policy-makers, respectively, to improve sustainability of marine ecosystems, and; ii) the integration of environmental feedbacks, ecological knowledge and data signalling a healthy or degraded environment into the decisions made by these actors to respond to change.

It therefore involves conservation, management and stewardship plus a concern for marine environmental health. We therefore include

    i.   General sustainability terms e.g. environmental sustainability
    ii.   Human activities that impact on the coastal/marine ecosystem state:
        Marine conservation & habitats
        Fisheries activity & management
        Coastal development
        Pro-environmental behaviour and advocacy
        Voluntary and non-voluntary agreements and initiatives
    iii.   Health of coastal/ marine ecosystem:
        Descriptions of state

Changes in state
Aspects of marine/coastal system & their benefits
Drivers of environmental change

Human resilience search terms

For our nexus perspective we focus on forms of social resilience and are therefore not focusing on ecological resilience in and of itself. Our definition comes from development psychology amalgamated with social-ecological systems thinking and specifies resilience as the ability to respond positively to disturbance whether by maintaining a set of functions, values and identities or purposefully transitioning to a new 'state'.

This is in line with SES language and can therefore include the "ability to absorb disturbance, adapt, and re-organise while undergoing change" (Walker et al. 2014) as well as the "capacity to adapt or transform in response to…" (Carpenter et al. 2012).

We feel that these definitions of resilience are broad enough to encapsulate many articles that look at resilience specifically or the different forms of it relevant to our nexus thinking. We focus therefore on the term resilience synonyms or antonyms and words/concepts that describe the term but not the factors that help build or undermine resilience. For example, we use the term adaptive capacity as this can be understood as resilience to social-ecological change but not assets, learning and network (Cinner et al 2018). Resilience can be thought of as bouncing back, as adapting, as coping, self-sufficiency, and these terms and their synonyms are therefore included in our search. Vulnerability has a close relationship with resilience thinking, and we include it in the search terms. Others, such as transforming, threshold, transition, capacity, absorb and others are very generic and bring in many irrelevant search hits, a sensitivity reduction in the search strategy which is not efficient within the resources we have for the project.

Human wellbeing search terms

Wellbeing is a very broad and holistic concept. Our nexus approach embraces this and takes a 3-dimensional approach to measuring wellbeing and as such defines it as the material, relational and subjective dimensions to people's efforts to live well. To sufficiently capture this breadth, we have used some of the key theoretical origins behind wellbeing measurement to derive words associated with them, which provide a structure for our search terms for this concept. We have removed some terms which do not strongly describe wellbeing in the global north (our work is UK focused).

Theoretical origin	Search term
Theory of Human Need	Health (ill-health, mental health, depression), autonomy, safety, relationship respect, security, employment, education, food security, basic need, human need, freedom, empowerment
Utilitarian/Economic	welfare, income, utility, debt, wealth, prosperity,
Livelihoods Framework	livelihood, wealth, employment, income
Capability Approach	freedom, agency, empowerment
Wellbeing synonyms and antonyms	Wellbeing, poverty, wellness, welfare, standard of living, poverty,
Subjective wellbeing	Happiness, quality of life, satisfaction, depression, anxiety

Appendix 2
Search strategy as adapted for Web of Science Core Collections database

Search concept	String
UK	**(gb or "g.b." or britain or (british not "british columbia") or uk or "u.k." or "united kingdom*" or (england not "new england") or "northern ireland*" or "nothern irish*" or scotland* or scottish* or ((wales or "south wales") not "new south wales") or welsh*)**

Marine	("wave energy" OR "wave power" OR "wind energy" OR "wind power" OR "tidal energy" OR "tidal power" OR "offshore wind" OR coast* OR marine* OR beach* OR fisher* OR seas OR sea OR reef* OR ocean* OR seagrass* OR estuar* OR fishing OR inshore OR offshore OR fishery OR seascape OR kelp OR mudflat OR "mud flat" OR saltmarsh OR "salt marsh" OR "sand dune" OR aquaculture OR "fish farm*" OR mariculture OR "blue space" OR "blue health" OR "blue economy")
Human resilience	(vulnerab* OR resilien* OR Cope OR coping OR "self suffic*" OR self-suffic* OR self-relia* OR "self relia*" OR adapt* OR "bounce back" OR "bounce forward" OR "build back better" OR "tipping point*" OR panarchy)
Human wellbeing	("human right*" OR Marginalis* OR Equit* OR Inequality OR Equality OR well$being or well-being or wellness or welfare or happiness or happy or satisfaction or satisfied or " quality of life " or " good life " or poverty or depriv* or " basic need* " or " human need* " or livelihood or employ* or income or wealth or " food security " or " nutritional security " or " standard of living " or " personal safe* " or freedom or " social relation* " or " human relation " or " social interact* " or participat* or empower* or " place attachment " or place-attachment or " sense of place " or autonomy or identity or education or dissatisf* or disempow* or anxiety or depress* or unemploy* or un-employ* or debt or ill-health or illness or " ill health " or unhapp* or un-happ* or conflict or " social capital " or " mental health " or " physical health " or " human health ")
Environmental sustainability	("environmental* sustain*" OR "environmental* un$sustain*" OR "environmental* un-sustain*" OR "marine conserv*" OR "marine protected area" OR

| | "marine park" OR MPA OR MCZ OR "environmental protection" OR "shifting baseline*" OR "habitat restoration" OR "ecological restoration" OR "habitat destruction" OR "shifting environmental baselines" OR "shifting ecological baselines" OR "fisheries regulation*" OR "fisheries manage*" OR quota* OR by$catch OR by-catch OR discard* OR over$exploit* OR over-exploit* OR over-fish* OR over$fish* OR "destructive fish*" OR "destructive gear*" OR trawl* OR dredg* OR "low impact fish*" OR "low-impact fish*" OR "coastal protection" OR "coastal development" OR "sea defence*" OR "coastal defence*" OR pro$environmental OR pro-environmental OR "marine steward*" OR "ocean steward*" OR "environmental steward*" OR "ocean literacy" OR "marine citizen*" OR "ocean citizen*" OR "beach clean*" OR no-plastic OR "no plastic" OR plastic-free OR "plastic free" OR mitigat* OR "code* of conduct" OR "voluntary guidelines" OR enforcement OR compliance OR certification OR accreditation OR "nature based solution" OR "nature-based solution" OR "environmental regulation*" OR "marine regulation*" OR "environmental health" OR "marine health" OR "environmental quality" OR "water quality" OR "ecosystem recovery" OR "ecosystem health" OR "environment* impact*" OR "ecological impact*" OR "environmental degrad*" OR "eco* degrad*" OR "habitat degrad*" OR "environmental decline" OR "ecosystem decline" OR "ecosystem recovery" OR biodiverse* OR "fish stock*" OR "natural capital" OR "ecosystem service*" OR "ecosystem benefit" OR "sea level rise" OR "sea-level rise" OR storm* OR flood* OR sewage OR "coastal erosion" OR sedimentation OR pollution OR eutrophication) |

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