Understanding
Marine Science, Regulatory and Policy Frameworks

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This is a draft document which outlines ideas being developed by a working group. Please contact Bob Earll or Lissa Batey before using any information in this report.

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Summary

This report outlines the evolution of an idea to provide a clearer understanding of **Marine Science, Regulatory and Policy Frameworks** (The Frameworks Project); this idea is being developed into a project with a steering group. The idea originated in discussions in the spring of 2023 to use **tables** to illustrate the critical relationships between marine science, regulation, and policy. This idea has developed steadily and various examples are described here to describe its practical utility.

Historically, UK marine science and governance have operated in distinct **silos**. The deficiencies of silo-mentality in terms of business efficiency are well understood.

The aim of the Frameworks Project is to overcome the limitations of silo thinking by highlighting commonalities across the science, regulatory and policy frameworks by illustrating the relationships and alignments of people, organisations and expert groups. In achieving this we anticipate enhanced collaboration, communication and innovation with common tasks and improved financial support and efficiency by understanding the value chains that are highlighted. The project benefits are multifaceted and include:

- **Relationships, alignment, and context:** The project's foundational table (Table 1) clearly outlines the universal connections between marine and coastal environmental themes, the scientific research and monitoring undertaken on these themes, and the regulatory and policy initiatives that leverage this information.
- **People, organisations, and expert groups:** The project structure explicitly demonstrates how organisations and expert groups are interconnected, also pinpointing where specific groups of individuals operate. A straightforward outcome could be the creation of comprehensive directories.
- **Collaboration, improved communication and innovation and efficiencies:** By making relationships and groups of individuals clear, the project paves the way for effective partnerships and collaborative efforts.
- **Finance: Efficiencies and value chains:** Addressing common concerns about insufficient funding for scientific work and data shortages for regulators, the project promotes how the scientific processes support multiple regulatory regimes. This raises the question of whether a more collective approach to work on any given theme might lead to better design and funding to better serve the objectives of various organisations and agencies.
- **Providing a consistent structure to enable access to information on existing frameworks:** It is clear that this idea is not new and that valuable work and reports in this space are simply

lost over time. This project would seek to provide a point of reference for people working across silos.

The development of this report aims to support fundraising proposals, enabling a more systematic advancement and documentation of the Frameworks Project. As such, this report is not intended for wider circulation.

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1.How the UK Marine Science, Regulatory and Policy Frameworks idea developed

The aim of this section is to explain how this idea has evolved and developed since 2023 up until January 2026 not least by highlighting how this idea relates practically to programmes that have arisen during this period with which we have been involved; this is the third revision of this report.

1.1 Tabulating thematic topics between South-West Marine Ecosystem (SWME) and the UK Marine Strategy

The South-West Marine Ecosystem (SWME) project has evolved since 2020 to become focussed on annual reporting at a regional scale on the status of the south-west's seas across twelve thematic topics. In the spring of 2023 Abigail McQuattors-Gollop (Plymouth University) mapped the UK Marine Strategy (UKMS) thematic topics against those used by South-West Marine Ecosystem (SWME). This table can be seen in Version 3 of the SWME Model Paper (Page 8). This tabulation showed that there was a good correspondence between the thematic topics being covered by SWME and UKMS.

1.2 Elaborating the tabulation to include other regulatory reporting regimes

In discussions with a number of statutory nature conservation agencies during the Liaison Project for the East Marine Ecosystem (EASTME, 2023) a further table was developed (Appendix 1) where three further regulatory regimes, the Habitats Regulations, marine Natural Capital Project (Lauren Molloy, Joint Nature Conservation Committee (JNCC)) and the Water Regulations (Roger Proudfoot, Environment Agency) were mapped alongside the previous Table (See Appendix 1). These regulatory regimes have the common feature that they all have to undertake regular assessments ranging from three to five years. In addition to this it was clear that the Marine Management Organisation also report on thematic topics on a three yearly basis in relation to their regional marine plans – see Appendix 2. Table 1 illustrates this idea, which is further developed in Table 2 & 3.

TABLE 1: The UK Marine Reporting – Assessment Policy Landscape

Thematic Topics	Regulatory regimes 1.UK MS	2. Hab Regs	3.Water Regs	4. Planning	5.mNCEA	6. RME
Natural systems						
Oceanography						
Plankton						
Seabed						
Fish & Turtles						
Birds marine & coastal						
Seals						
Cetaceans						
Management						
Planning						
Marine Protected Areas						
Fisheries						
Water Quality						
Plastics						

Regulatory Reporting Regimes

1. The UK Marine Strategy
2. The Habitats Regulations
3. The Water Regulations
4. Planning (regional) MMO – 3 yr assmts
5. mNCEA – Assessments … recovery
6. Regional Marine Ecosystems e.g. SWME & EASTME
7. Specific Acts of Parliament e.g. the Seals Act
8. JNCC Biodiversity Indicators (marine)

There are a variety of other reporting frameworks or for specific themes, for example, the annual report to Parliament in relation to the Conservation of Seals Act (1970) undertaken by the Sea Mammal Research Unit (SMRU). A further example of a regulatory driver (column) is the JNCC Biodiversity indicator programme which produces reports on a number of marine themes including marine pollution, mammals and invasive species (https://jncc.gov.uk/our-work/uk-biodiversity-indicators/)

A simple point to be made is that there are many regulatory regimes which are reporting on similar or identical thematic topics albeit on different time scales (Table 1) with apparently little or no alignment. Staff working on these topics can be thought of as working in silos. Once this is understood a number of questions arise not least of which is whether there is already an overview table of reporting and assessment in the UK.

1.3 Project Development Prompts: November 2024 – January 2026

A report by Abigail McQuattors-Gollop on the social dynamics of South West Marine Ecosystems prepared for the mNCEA programme and published in the summer of 2024 raised the issue of how annual reporting might be aligned with the wider UK marine policy Framework. Ideas on this had also been developed in the EASTME project (Earll, 2023) – Appendix 1. Since the autumn of 2024 and in 2025 prompted by other a variety of other projects the *framework* ideas have developed further, as outlined below:

1. In the Autumn of 2024 there was a stakeholder consultation conducted by the consultants Mindfully Wired for the JNCC to explore whether there should be **a UK marine mammal group**. Table 1 clearly highlights the range of regulatory regimes that would be involved in such a group and the discussion also highlighted by the significant inputs of eNGOs and expert scientists involved in sea mammal assessment and reporting. At the end of 2025 a draft table highlighting over **140 projects** involving marine mammals in the UK, over 50 of which citizen science. This illustrates the utility of having access to such information in order to assess how research can be organised more effective.

2. A similar consultation prompted by **UK Marine Climate Change Impacts Partnership (MCCIP)** was both looking for contributors and informing contacts of a change of approach to more rapid appraisals of the thematic topics it covers. In discussions with Matt Frost the chair of MCCIP about the Framework approach the utility of a clearer understanding of the people involved with the science, regulatory and policy regimes became obvious. A listing of the scientific thematic topics is illustrated Appendix 4.

3. Prompted by a request to understand whether such a table existed Dickon Howell of Howell Marine Consulting (HMC) responded in December 2024. HMC completed a project mapping **Blue Marine Monitoring** – over 60 programmes - for the marine Natural Capital and Ecosystem Assessment (mNCEA) programme highlighted similar tabulation approaches. The report of this work has been published in the early summer of 2025 illustrating many key relationships https://randd.defra.gov.uk/ProjectDetails?ProjectId=21832 between current Government funded projects.

4. **Infographics – Environment Agency (EA):** In March 2025 in conjunction with EA work on Regional Marine Ecosystems two infographics were produced to illustrate the links between science and regulatory regime (Table 2) and science, regulation, licensing and policy (Table 3)

5. **Strategic approaches to the Marine Citizen science**: In October Earll *et al* (2025) had a paper published using the thematic topic framework to map the diversity of marine citizen science in the UK (Appendix 3). There are now well over 60 marine citizen science projects in the UK but virtually no strategic direction. The tabulation (Appendix 3) begins to highlight how this lack of strategic direction might be addressed.

6. **MMO: Marine planning and Regional Marine Ecosystem thematic topics:** In the autumn of 2025 South-West marine planning officials prepared a table (Appendix 2) demonstrating how the thematic topics covered by the South-West marine Ecosystem annual, regional reporting process mapped on to the topics covered by the MMO 3 year plans.

7. **JNCC Biodiversity Indicators Programme – Marine themes:** In discussion with Christine Maggs she highlighted the JNCC Biodiversity Indicator Programme which has a number of marine components. This in effects adds a further regulatory column to Table 1 and 2. https://jncc.gov.uk/our-work/uk-biodiversity-indicators/

Some key points:

- This table based approach even at its simplest has considerable utility.
- It is clear that there are lots of framework***s*** – tables of more or less size – which are inter-related.
- The tables demonstrate the regulations and policy to which the science applies or should apply
- This report speaks to the wider point made by many scientists of how their work informs government marine policy. This raises the question of which policies or regulatory regimes research is supposed to be informing, because this is often not clearly stated.
- Given these points and continuing parallel discussion, further steps were taken to develop this idea as a project with a steering group formed in 2025.

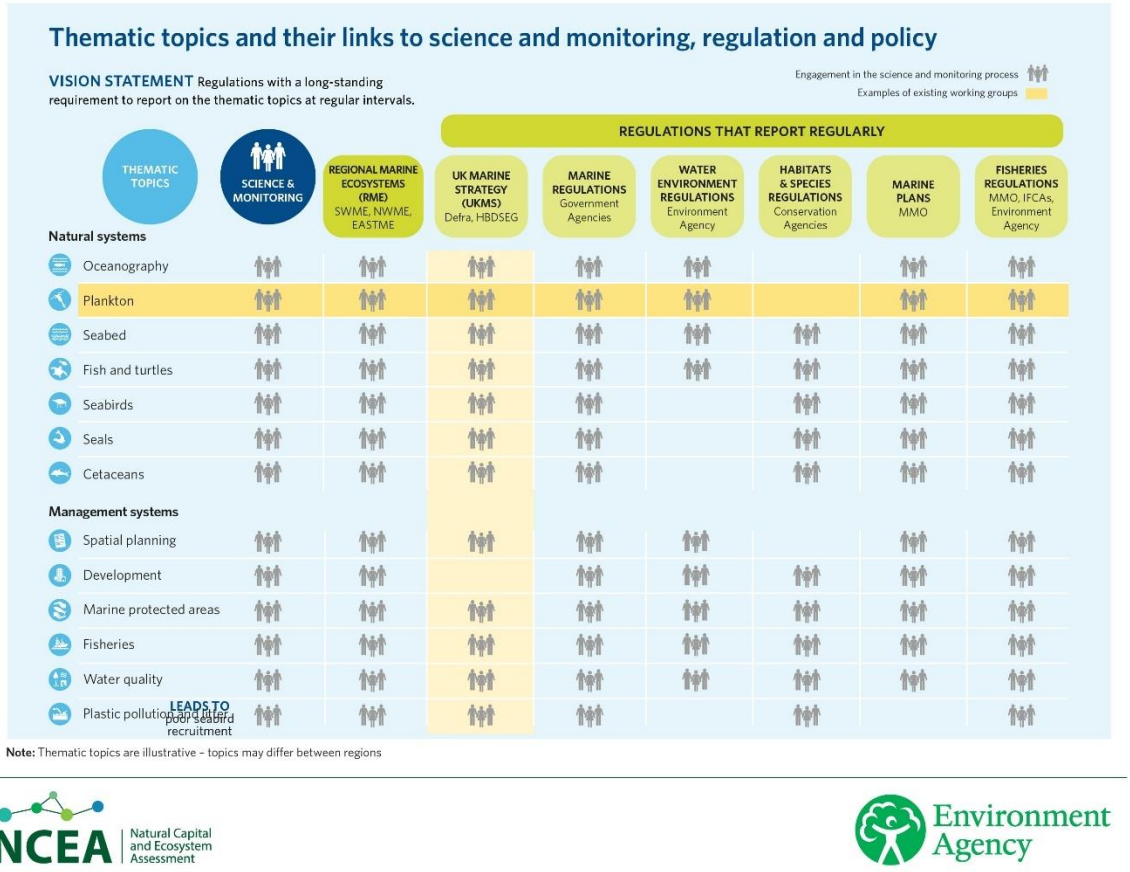
2. The relationship between marine science and statutory reporting regulations

Since December 2024 we have been discussing Table 1 in a variety of forms. This has now been developed into Table 2 (see below) which presents the information is a clear manner and elaborates on the key elements. Conceptually this is a simple table of thematic topics (e.g. benthos, cetaceans, fisheries etc) mapped against the regulatory regimes. (See a detailed breakdown in Appendix 1)

The points below develop the thinking behind this table. In particular the Table (or a series of tables) can be used to illustrate and identify who is involved in working on particular themes and the groups that are often used to do this work whether they be within agencies or multi-agency groups (e.g.

Healthy and Biologically Diverse Seas Evidence Group (HBDSEG) & MMO Planning). The table also illustrates financial value chains since in many cases budgets will be linked to each of boxes.

Table 2: Regulations covering major marine environmental sectors require routine monitoring, reporting and assessment. For example The UK Marine Strategy, The Habitats Regulations, The Water Regulations, and MMO planning.



NCEA Natural Capital and Ecosystem Assessment

Environment Agency

2.1 Thematic topics and marine science

The way we describe the marine environment is broken down into many discrete compartments which here we have described as thematic topics. This is a classification. In part this compartmentalisation has occurred because of the many different methods used to study these topics and the scientists involved in these measurements require specific training.

Section 4 of this report provides a greater elaboration of thematic topics. The thematic topics can be presented as sets and subsets which fall into two major categories *natural systems* and *management* themes.

The rows in the Table 2 link the classification of the thematic topics, the scientific expert groups that cover these topics and the people who are responsible for the assessment and reporting of these topics for these regulations. The work of the scientists in the topics underpins the assessment and reporting process.

2.2 Marine Science and monitoring

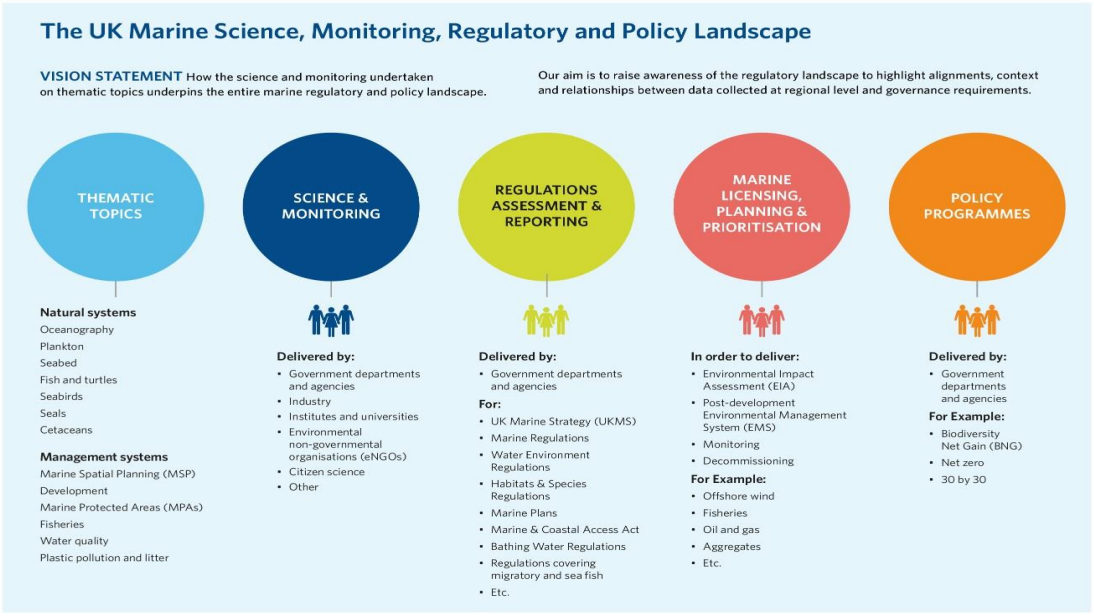
For the purposes of this report we have used the term *marine science* to include the entirety of this topic. There are, of course, many facets to this including:

- Monitoring is one type of scientific process used a great deal in the context of many of the regulatory regimes to collect information on change over time periods.
- For these thematic topics both formal, official - government and industry funded - science *and* citizen science programmes exist.
- In some settings citizen science is the principal source information, where no official science is undertaken.
- Scientific studies undertaken to support applied ecology with regard to fisheries or development use identical techniques that are applied to understanding natural systems
- The thematic topics often involve discrete, specialist expert communities – communities of practice e.g. for cetaceans or Marine Protected Areas or plastic pollution.
- The same information these thematic experts (groups) provide can be used by all regulatory systems, i.e. the rows highlight the alignment of interests in a particular theme.
- Groups such as RME (SWME, EASTME) or HBSEG are groups that are looking at a wide cross section of thematic topics. This also applies to Natural England staff engaged with the Habitats Regulations or Environment Agency staff engaged with the Water Regulations.

3. The wider relationship between the thematic topics covered by marine science, the science community and the broader UK marine governance framework.

In discussion with a number of interested parties it was clear that the table format could also be extended to include the marine licencing regimes related to the major sea uses such as fisheries, oil and gas developments, offshore wind and aggregate extraction. Similarly government policy initiatives including 30 by 30 with regard to marine protected areas, biodiversity net gain and net zero. These relationships are illustrated in Table 3. The same key ideas apply.

Table 3: Many government regulations and polices are supported by the same science community



4. Thematic topics covered by marine science

4.1 Thematic topics – a classification

The way scientists have traditionally described the marine environment falls into discrete thematic topics. Table 4 provides a classification – a theoretical construct - of these thematic topics in terms of sets and subsets. These classifications have evolved and developed significantly over the last 50 years driven by the different regulations and our understanding of marine environmental science. The techniques, methodologies and expertise applied to study these thematic topics varies considerably between topics. The classifications and terminologies used by different regulatory and policy measures has also led to nuanced preferences in relation to the sets and sub-sets of what is measured. In this paper we are using science as a collective term covering scientific process in its many forms which includes monitoring.

Table 4 breaks into two main parts – natural systems and human (management) activities. Many of the techniques used to assess human activities are broadly the same as with natural systems, however there are also a range of measures applied to the scale and rates of any development or activity e.g. the amount of aggregate dredged or number of tourists visiting a site. To put it another way a benthic ecologist studying a marine protected area or the recovery of an aggregate extraction area for an applied study is using the same techniques as benthic ecologists covered in the natural systems listing.

Despite our activities in describing individual topics in the natural environment it is widely understood that these thematic topics interact to produce *ecosystem* based outcomes. We need to become better at integrating the science of the individual topics with the need for ecosystem assessments.

4.2 Scientists and scientific expert groups for thematic topics - Communities of Practice

Whilst the first column in the tables (Table 1,2,3) is simply a classification the second column relates to the scientists, the people that operate in the distinct themes. The distinct and differing methodological requirements used for measuring the different thematic topics has led to specialist scientific expert groups developing for many of these topics. Another term that is increasingly being applied to such expert groups is communities of practice, a term commonly used in the social sciences.

4.3 The generic power of thematic topics

The generic power and utility of the classifications of thematic topics spans the entirety of marine science and means that it can be used in many applications, for example:

- To cover the variety of regulations that are applied to the monitoring of the marine environment e.g. UK Marine Strategy, Habitats Regulations and Water Regulations
- The Regional Marine Ecosystem (RME model) is exploring annual reporting on a regional scale. Currently groups are covering SWME, EASTME and the north-west coast – North West Marine Ecosystems (NWME). Sets of thematic topics have been used to facilitate annual reporting by the Regional Marine Ecosystem programme. In the RME Model thematic topics there are and will be nuanced differences in those thematic topics which are used by the different regions (RMEs) given the different nature of these regions. Each thematic topic in SWME has a distinct group of experts, i.e. a community of practice that contribute.
- Recently Earll, *et al* (2025) has used the thematic table sets to describe the inputs of citizen science in the marine environment (Appendix 3)
- The Marine Climate Change Impact Partnership (MCCIP) thematic topic classification is shown in Appendix 4. Coasts and Seas Evidence Working Group (CASE-WG)' supports delivery of the 'rolling' evidence updates, keeping MCCIP at the cutting edge of knowledge exchange.

Table 4 Thematic Topics, Sets, Sub-sets and Notes for Natural and Human Activity and Management

Thematic Topics	Sets	Sub-sets
Natural Systems or Natural capital		
Oceanography		
	Energy	Sound Electromagnetic radiation Radioactivity

	Individual elements & molecules	Oxygen, Carbon (sequestration), CO2 Methane Toxic chemicals (red list) Chlorophyll
	Combinations	pH (ocean acidification) Salinity rainfall events, hypersaline plumes – desalination; Nutrient fluxes – seasonality Organic matter Sewage Silt oil Plastics Marine Litter
	Physical oceanography	
	Land-sea interactions	
	Water temperature	Sea surface temperatures, stratification, fronts, thermal plumes
	Water movement	Currents, tides, sea level, wave action, storms
Plankton	Phytoplankton	Algal species (blooms) – size ranges
	Zooplankton	Size ranges, planktonic species, and life cycle stages of benthic species
		Gelatinous zooplankton - Jellyfish, salps
Seabed & Seashore	Geomorphology: Rock & Sediments: distribution & composition	
	Coastal habitats (terrestrial)	
	Estuarine species	
	Estuarine habitats	Example: saltmarsh, restoration projects e.g. managed realignment
	Marine intertidal species	
	Marine intertidal (biotopes)	e.g. under-boulder communities

	Sublittoral plant – species	
	Sublittoral animal species	e.g. oysters, restoration projects
	Sublittoral biotopes	e.g. kelp, maerl, seagrass. Restoration
	Geomorphology Sediments	
Fish		
Taxonomic approaches	Agnaths (e.g. lampreys) Elasmobranchs (Sharks and rays) & Teleosts (bony fish)	
Ecosystem classification	Pelagic	e.g. Mackerel, sardines, bluefin tuna
	Demersal – seabed, benthic species	e.g. conger eels, gadoids,
	Species with estuarine & marine life cycle elements	e.g. Salmon, trout, lampreys
	Fisheries science	Stock assessment
Turtles		
Birds	Estuarine species	e.g. Waders
	Coastal breeding species	Rock (e.g.kittiwakes, auks) and sediment (e.g.plovers, terns)
	Marine species & Seawatching	e.g. Shearwaters & petrels
Seals & otters	Grey & Harbour Seals	
	Visitors: Ringed & Hooded seals & Walrus	
	Otters	
Cetaceans	Toothed whales	Dolphins & sperm whales
	Baleen whales	
Human (Societal) activities & Management Measures		
Thematic Topic Set	**Thematic topic subset**	**Notes**
Marine Planning	Spatial planning	MSP provides the spatial context for all development and management measures in the marine environment. The measurement of plan measures and process
	Licencing	

Marine Protected Areas		Measuring human activities within MPAs
Fisheries		Research and monitoring fishermen and fishing intensity
Water Quality		Management
		storm water overflows
		Treatment works management
Marine Plastic Pollution and litter	Plastic pollution	Collection metrics – management removal costs
	Marine litter (non plastic)	Collection metrics – management & removal costs
Marine Developments		The scientists who study the effects of these activities – often by studying the natural systems outlined above
Energy	Coastal power stations	
	Offshore wind	
	Offshore oil and gas	
Aggregates	Sand and gravel extraction	Intensity of removal

5. Questions arising

This section summarises a number of the questions that have arisen through discussions about the Framework project:

- Do 'official' tables, like Table, 1,2,3, exist already? Our discussions thus far suggest that they do not exist.

- If 'yes' how can they be accessed?

- Do versions of this table exist for particular regulations and/or policy?

- The question of money. Often the scientists will say that they don't have money to undertake science or monitoring – whilst at the same time their efforts underpin many regulatory and policy regimes. What are the levels of investment across the table themes?

- Are these levels of investment in science adequate to provide the basis for the policy and regulatory requirements?

- Could there be better co-ordination within thematic topics? Not least between official and citizen science inputs?

- How can clarity be provided concerning how science is contributing to specific policy and regulatory drivers?

6. Conclusions

This report has outlined how the *frameworks* idea has developed prompted by a variety of practical inputs. Even the simplest tabulations reveal a host of interesting relationships.

The current system of regulations and policies have arisen from a huge number of initiatives over the years. We are not starting with a blank sheet of paper and nor can we change what has happened in the past. Silos have developed for all sorts of pragmatic reasons but they do exist. Even a cursory understanding of the business and organisational limitations of silo mentality reveal that many benefits arise from helping to break down the silos.

Moving forward we anticipate two main processes will help to develop a greater understanding of the current frameworks leading to considerable benefits.

1. To provide greater access to and information on the particular elements of the scientific, regulatory and policy framework. It is clear that much valuable information is lost simply because there is no easy access to it in a structured way; we think the tables provide this structure.

2. By organising meetings which seek to explain what we are finding, better understand existing arrangements and engaging with people to help them work within the existing frameworks.

7. References

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Marine Climate Change Impact Partnership – Scientific Thematic Topics – https://www.mccip.org.uk/all-uk/uk-impacts/hub

McQuattors-Gollop, A (2024) Who benefits from South-West Marine Ecosystems community, and how? Final Report https://swmecosystems.co.uk/swme-organisation

8. Appendices

Appendix 1 Comparable terminology across four major programmes: UK Marine Strategy, the mNCEA programme, Habitats Regulations, and WFD, and their links with SWME thematic topics.

Please Note: Update: In Table 5. The following point needs to be noted. Paragraphs on cetaceans, birds and seal. Sentence starting "Where cetaceans (birds/seals) are part of SPA/SAC then River Basin Management Plans: replace the word *objectives* with River Basin Management Plans (as there are no specific objectives for these components).

	UK Marine Strategy & OSPAR Quality Status Report	Marine Natural Capital Ecosystem Assessment programme (mNCEA)	Habitat Regulations	WFD (now Water Environment Regulations)
	Good Environmental Status	Not an official equivalent but looking at how status affects ecosystem service delivery	Favoural Conservation Status	Good Ecological Status or Good Ecological Potential for heavily modified water bodies/artificial water bodies.
		JNCC is constructing a universal asset-service matrix to allow for easy conversion between assets and the services that they provide. The test version is on the marlin website - https://www.marlin.ac.uk/asm		Risk assessment to characterise pressures that potentially put at risk achieving the GES/GEP objectives
	D1 is Biodiversity, D4 is Foodwebs			
SWME Thematic Topics	***UKMS Descriptors***	**Assets & Services**	**Features**	
		The UKMS descriptors in NC terms are either assets (biodiversity and food webs) or pressures. All of these assets provide multiple ecosystem services including the maintenance of biodiversity in itself. The services fall under three broad categories - provisioning, regulating and cultural. Not all services are monetary. My project 'ANC Approach to GES' is working on ways to list, quantify and communicate those services as part of the UKMS.		WER sets out the need for periodic status classification of biological elements to assess the status of water bodies out to 1nm and to monitor sensitive elements where there are significant pressures. Objectives are set to achieve GES or GEP using a range of indicators to assess status and whether objectives have been met. These indicators are set out in the regulations. Where water bodies are failing measures to imrpove the status of water bodies are agreed through the river basin management process which includes public consultation.
Natural systems				
Oceanology & Meteorology	*D7 Permanent alteration of hydrographical conditions*	D7 is a pressure	n/a	Hydromorphology - describes the hydrological and geomorphological processes and attributes of surface water bodies. It includes the size, shape and structure of the water body, and the flow and quantity of water and sediment.
Plankton	*D1 & D4 Pelagic habitats*	Asset (D4 Food webs is a regulating service).	n/a	Phytoplankton is one of the biological quality elements included in the WER. Zooplankton is not included as a quality element.
Seashore & Seabed	*D1 & D6 Benthic habitats (biotopes); also D4*	Asset (D4 Food webs is a regulating service).	Annex I habitats (Estuaries, Large Shallow Inlets and Bays, Mudflats and Sandflats, Sandbanks, Reefs, Sea Caves, Submarine Structures Made by Leaking Gases, Coastal Lagoons); Annex V species (2 maerl species).	Morphology, chemical quality and benthic biological quality elements (macroalgae, angiosperms and benthic invertebrates) are all attributes considered within WER that are of relevance to the seashore and seabed
	D2 Non-indigenous species	Pressure	Pressure	The presence of invasive non native species can prevent a coastal water or estuary from achieving High Ecological Status. If significant, they could also be considered when assessing risks in a waterbody and developing a program of measures.
Fish & Turtles	*D1, D4 - AMG I think turtles is going to end up as part of pelagic habitats*	Asset (D4 Food webs is a regulating service).	Annex II, IV and V species	Biological quality element (fish in transitional waters)
Coastal & Marine birds	*D1 & D4 Birds*	Asset (D4 Food webs is a regulating service).	Covered by Birds Directive (not sure of UK name)	Whilst birds are not specifically mentioned in the WER regulations the integrated approach of the WERs helps to protect birds that are dependent on water. For example, by maintaining and improving water quality, it will directly protect birds that live and feed on water. It will also protect the habitats that serve as feeding and roosting sites for birds and protect fish and invertebrate prey species, and the overall food web. Birds are an important part of the overall health of source to sea ecosystems. Where water dependent birds are part of an SPA then WER objectives need to ensure the water environment is of sufficient quality to meet those objectives.

SWME Thematic Topics	*UKMS Descriptors*	Assets & Services	Features	
Natural systems cont.				
Seals	*D1 & D4 Seals*	Asset (D4 Food webs is a regulating service).	Annex II and V species	Whilst seals are not specifically mentioned in the WER regulations the integrated approach source to sea helps to protect seals. For example, by maintaining and improving water quality, it will directly protect seals that live and feed in coastal waters. It will also protect the habitats that seals depend upon for food, protecting fish and invertebrate prey species, and the overall food web. Seals are an important part of the overall health of source to sea ecosystems. Where seals are part of an SAC then WER objectives need to ensure the water environment is of sufficient quality to meet those objectives.
Cetaceans	*D1 & D4 Cetaceans*	Asset (D4 Food webs is a regulating service).	Annex II and IV species	Whilst cetaceans are not specifically mentioned in the WER regulations the integrated approach source to sea helps to protect cetaceans. For example, by maintaining and improving water quality, it will directly protect cetaceans that live and feed in coastal waters. It will also protect the habitats that cetaceans depend upon for food, protecting fish and invertebrate prey species, and the overall food web. Cetaceans are an important part of the overall health of source to sea ecosystems. Where cetaceans are part of an SAC then WER objectives need to ensure the water environment is of sufficient quality to meet those objectives.
Human activities and management responses thematic	***Policy Response - UKMS Part III Programme of Measures. mNCEA looking at how NC Approaches may inform these.***	mNCEA looking at incorporating ecosystem services into existing management frameworks.	**Measures**	Evidence on human activities and management is important when determining which water bodies are heavily modified. Human activity will also shape how challenges and choices vary across river basin districts and how objectives are set and programmes of measures are developed.
Marine planning				River basin management planning
Marine Protected Areas & Recovery & Restoration	*MPAs are policy responses*	Marine Strategy Part III - UK Programme of Measures	MPA network is reported on	Protected areas are given specific consideration when carrying out a WER compliance assessment on a new activity or project. Restoration activities could be included in a programme of measures for a water body/be a mitigation measure for a heavily modified water body.
Fisheries	*D3 Commercial fish*	An exploitable fish stock = an ecosystem service . It's a pressure descriptor in the UKMS but yes fisheries products and industry are ecosystem services.	Pressure	Pressure
		Fishery - produced goods and benefits		
Water Quality - pollution	*D5 Eutrophication*	Pressure	Pressure	Assessed as supporting parameters that support Ecological Status (e.g. nitrogen and dissolved oxygen). Also can be a pressure on biological elements. there may be a local or national investigation and programme of measures to respond to failures.
	Overlap with Pelagic Habs - we are trying to work together more closely			
Mainly Coastal e.g. sewage	*D8 Contaminants*	Pressure	Pressure	Some pollutants are assessed under Chemical Status using EQSs and Maximum Allowable Concentrations and others are part of the assessment as supporting parameters that support Ecological Status. Also can be a pressure on biological elements. Depending on the chemical, there may be a local or national investigation and programme of measures to respond to failures.
	D9 Contaminants in seafood	Pressure	Pressure	Some chemicals are monitored and assessed using biota samples as well as water samples
Plastics pollution	*D10 Marine litter*	Pressure	Pressure	Pressure but not assessed for WER
Not covered	*D11 Underwater Noise*	Pressure	Pressure	Noise as a pressure is not assessed under WER but has potential to impact in transitional waters on fish but also protected area objectives for other compoenents of the ecosystem not directly specified by WERs e.g. cetaceans
Climate change Not covered systematically but a major interaction between topics	*Climate change goes throughout all the biodiv descriptors (D1,4,6)*	Pressure	Pressure	Very relevant to setting of reference conditions for all classification tools. They may all need adapting over time. Also relevant to consider when developing programmes of measures

Appendix 2 Tabulation of SWME Thematic Topics with MMO planning categories

This table is not to be used without the express permission of the authors & MMO.

This table has been created to demonstrate linkages between marine plan policies and SWME thematic topics. This table should not be used as an alternative to the Marine Plan Policy Assessment when completing a marine license application. This policy table includes policy names e.g. 'Climate Change' and corresponding policy codes e.g. 'SW-CC-1' for the South West and South Marine Plans. The MMO recommend taking a whole plan approach, including consideration of all policies and linkages between them when interpreting marine plans.

The table below sets out the policy names in addition to their codes. The Policies can be found within pages 21-56 of the South West Marine Plan and pages 13-27 in the South Marine Plan. You can either control F search for the policy name e.g. 'Climate Change' or the corresponding policy code e.g. 'SW-CC-1' to locate the policy information. It is recommended to use the policy code here as it will take you directly there. Further info on implementing the policy can be located within the technical annexes of both marine plans which gives detail on how to use the policy effectively.

SWME Topic / Theme	Relevant South West Marine Plan Policies	Relevant South Marine Plan Policies
Oceanography	Climate Change (SW-CC-1-4) and Water Quality Policy (SW-WQ-1)	Climate Change (S-CC-1-4) and Water Quality Policy (S-WQ-1)
Plankton	Biodiversity (SW-BIO 1 & 2) and Water quality (SW-WQ-1)	Biodiversity policies 1 & 2 (S-BIO-1 & 2) and Water quality (S-WQ-1)
Seabed & Seashore	Biodiversity (SW-BIO-1 to 4), Invasive Non-Native Species (SW-INNS-1 & 2), Access (SW-ACC-1), Habitat (SW-HAB-1), Marine Protected areas (SW-MPA-1) and Aggregates Policy (SW-AGG-1 to 3)	Biodiversity (S-BIO-1 to 4), Invasive Non-Native Species (S-NIS-1), Access (S-ACC-1), Marine Protected Area (S-MPA-1) and Aggregates (S-AGG 1 to 3)
Fish	Fisheries (SW-FISH-1 to 3), Biodiversity (SW-BIO-1 & 2) and Disturbance policies (SW-DIST-1)	Fisheries (S-FISH-1 to 4 and S-FISH-4-HER), Biodiversity (S-BIO-1 & 2), and Disturbance policies (S-DIST-1)
Seabirds	Biodiversity (SW-BIO-1 & 2), Social (SW-SOC-1), Access (SW-ACC-1) and Disturbance (SW-DIST-1)	Biodiversity (S-BIO-1 & 2), Social (S-SOC-1), Access (S-ACC-1 & 2) and Disturbance (S-DIST-1)
Seals	Disturbance (SW-DIST-1), Biodiversity (SW-BIO-1 & 2), Social (SW-SOC-1), Underwater Noise (SW-UWN-2),	Disturbance (S-DIST-1), Biodiversity (S-BIO-1 & 2), Social (S-SOC-1), Underwater Noise (S-UWN-2), Access

	Access (SW-ACC-1) and Tourism and Recreation (SW-TR-1)	(S-ACC-1 & 2) and Tourism and Recreation (S-TR-1)
Whales & Dolphins	Disturbance (SW-DIST-1), Biodiversity (SW-BIO-1 & 2), Social (SW-SOC-1) and Underwater Noise (SW-UWN-2)	Disturbance (S-DIST-1), Biodiversity (S-BIO-1 & 2), Social (S-SOC-1) and Underwater Noise (S-UWN-2)
Planning	All – Strategic policies including Cumulative effects (SW-CE-1), Coexistence (SW-CO-1) and Cross Border Cooperation (SW-CBC-1)	All – Strategic policies such as Coexistence (S-CO-1)
Protected Areas	Marine Protected Areas (SW-MPA-1 to 4) and Biodiversity (SW-BIO-1 & 2)	Marine Protected Areas (S-MPA-1 to 4) and Biodiversity (S-BIO-1 & 2)
Fisheries	Fisheries (SW-FISH-1 to 3), Biodiversity (SW-BIO-1 & 2), Climate change (SW-CC-1 to 4), Aquaculture (SW-AQ-1), Employment (SW-EMP-1) and Social (SW-SOC-1)	Fisheries (S-FISH-1 to 4 and S-FISH-4-HER), Biodiversity (S-BIO-1 & 2), Climate Change (S-CC-1 to 4), Aquaculture (S-AQ-1), Employment (S-EMP 1 & 2) and Social (S-SOC-1)
Water Quality	Water Quality (SW-WQ-1), Climate Change (SW-CC-1) and Marine Litter (SW-ML-1)	Water Quality (S-WQ-1), Climate Change (S-CC-1) and Marine Litter (S-ML-1 & 2)
Plastic Pollution	Marine Litter (SW-ML-1), Social (SW-SOC-1 and Invasive Non-Native Species (SW-INNS-1)	Marine Litter (S-ML-1), Social (S-SOC-1) and Invasive Non Native Species (S-NIS-1)

Appendix 3 UK Marine Citizen Science: The use of thematic topics to map the diversity of projects (Text from Earll et al (2025)

4. What are the marine environmental thematic topics covered by Marine Citizen Science?

The marine science community categorise the way they describe and study the marine environment in a systematic way. Table 2 illustrates the sets and subsets of this classification in terms of the thematic topics covered. A number of key points can be made about this classification including:

i) There are two main categories of the thematic topics:

- Natural systems/natural capital topics: oceanography, plankton, seashore and seabed, fish, coastal birds, turtles, seals, cetaceans. Single species, species groups, biotopes and multi-species site assessments
- Management topics: Plastic pollution and marine litter, water quality, site assessment re development or MPAs

i) **Thematic topics - the basis of statutory regulatory and policy requirements** The sets and subsets of the thematic topics outlined in Table 2 are also used to assess the various regulatory and policy requirements. Work underway on the UK marine science, policy and regulatory Framework is building a coherent view of this relationship (Earll, in press).

ii) **Scientists and methodologies** It might seem obvious but it is clear that the scientific methodologies to study thematic groups are often very topic specific, and the community of scientists working on these themes are often highly specific to those topics. In relation to citizen science this means that methodologies and data requirements will be closely linked to professional marine scientists working on these topics.

iii) **Citizen science and thematic topics** As was amply illustrated by the programme content of the Porcupine St Andrews (2025) conference Marine Citizen Science covers the full range of taxa, biotopes and a number of 'management' issues. Earll (2024) described how marine citizen science covering all the major natural system sets is being used by South-West Marine Ecosystems to describe annual changes in the marine environment.

iv) **Recognising Bias** Given how individuals view their specific interests in marine biology and Citizen Science projects it is not surprising that there is often a bias in the perspectives of what constitutes marine citizen science. This bias is real. It is much less helpful when it is nature conservation agencies that seem not to understand the full scope of the thematic topics that marine citizen science covers.

Table 2: Citizen Science & Thematic Topics, Sets, Sub-sets and Notes for Natural and Management Systems

Thematic Topics - Sets	Topic Subsets	Notes
Natural Systems		
Oceanography	Chemical – nutrient fluxes, salinity, sewage pollution	Porty Water Collective (fb and Instagram) Surfers against sewage (SAS) www.sas.org.uk
	Physical – storms, rainfall	
Plankton	Phytoplankton	Algal species (blooms)
	Zooplankton - Gelatinous	Jellyfish, salps; MCS Jellyfish survey
	Zooplankton	
Seashore	Coastal habitats (terrestrial)	
	Estuarine species	
	Estuarine habitats	Example: saltmarsh, restoration projects e.g. managed realignment
	Marine intertidal species	Shoresearch CWT, Intertidal seagrass (CLP Nature Action, Fife) The Shore Thing; CoCoast (Capturing our Coast)
	Marine intertidal (biotopes)	e.g. under-boulder communities; Edinburgh Shoreline
Seabed	Sublittoral plant – species	

	Sublittoral animal species	e.g. oysters, restoration projects Restoration Forth consortium = various community groups
	Sublittoral biotopes	e.g. kelp, maerl, seagrass. (Restoration Forth consortium = various community groups); https://sussexwildlifetrust.org.uk/helpourkelp
		Moray Ocean Community (MOC); MaCCOLL
Fish	Agnaths	
	Elasmobranchs	Sharks and rays The Shark Trust; Great Eggcase Hunt, Basking shark observations.
	Teleosts – pelagic – water column	
	Teleosts – demersal – seabed, benthic species	Examples: Sturgeon, seahorses
Turtles	Turtle strandings and at sea	http://www.ukturtles.online/
Birds	Estuarine species - waders	BTO WeBS counts
	Coastal breeding species Rock (e.g.kittiwakes, auks) and sediment (e.g.plovers, terns)	Chesil Little Tern project (and others e.g. Langstone Harbour)
	Marine species & Seawatching e.g. Shearwaters & petrels	
Seals & otters	Grey & Harbour Seals, otters	Cornwall Seal Research Trust
Cetaceans	Toothed whales	Dolphins & sperm whales; Hebridean Whale and Dolphin Conservancy; Manx Whale and Dolphin Watch
	Baleen whales	Forth Marine Mammals; South West Marine Ecosystems Hebridean Whale and Dolphin Conservancy; Manx Whale and Dolphin Watch
Multiple marine species	Cornwall Wildlife Trust (CWT) Strandings network CWT Seaquest	Individual animals, cetaceans and seals and wrecks of marine life stranded. Seaquest – Timed observations of mobile species from fixed vantage points
Freshwater		SmartFly river monitoring and Riverfly Monitoring Initiative(supported by Freshwater Biological Association
Management Topics & Human activities		
Thematic Topic Set	**Thematic topic subset**	**Notes**
MPA & Proposed development sites		Baseline recording by Seasearch divers
Water Quality		Catchment Monitoring Cooperative – Rivers Trust
	Chemical contaminants	

	Nutrients – land based sources	
	Organic enrichment: sewage. Inc. storm water overflows	
	Oil pollution	e.g. Beached bird surveys - RSPB
Litter & Plastic Pollution	Plastic pollution	e.g. Beachwatch – MCS, and multiple collection projects

Appendix 4 Marine Climate Change Impact Partnership – Scientific Thematic Topics

MCCIP topics – https://www.mccip.org.uk/all-uk/uk-impacts/hub

Physical Environnent

1. Temperature

UK seas show an overall warming trend, which is projected to continue over the coming century. Most models suggest an increase of over 3°C by the end of the century for high emission (RCP8.5) scenarios.

2. Dissolved Oxygen

Increasing temperatures will continue to reduce the solubility of oxygen and enhance stratification. The ongoing decline in dissolved oxygen concentrations is particularly marked below the thermocline.

3. Stratification

Thermal stratification in UK shelf seas will continue to start earlier and end later in the year due to changes in air temperature. The strength of stratification is also projected to increase.

4. Salinity

Most projections suggest that UK shelf seas, and the adjacent Atlantic Ocean, will be less saline than present, driven by ocean-circulation changes in response to climate change.

5. Sea-level

Mean sea level around the UK has risen by about 12–16 cm since 1900. Over the 21st Century, sea level is expected to continue to rise, with higher rates in the south compared to the north.

6. Storms and Waves

Climate change could affect storms and waves in the North Atlantic, but natural variability will continue to dominate in the near future.

7. Coastal Geomorphology

Coastal erosion rate and extent in the UK is expected to increase in the future due to a combination of relative sea-level rise, reduced nearshore sediment supply, and impacts resulting from human activities and management.

8. Ocean Acidification

A decline in pH (increasing acidity) is evident through the global ocean, and rates could increase in the second half of the century. For UK shelf seas, the rate of pH decline is higher in some coastal areas than others.

9. Ocean Circulation

The Atlantic Meridional Overturning Circulation is projected to weaken this century due to climate change, but an abrupt shutdown is unlikely. Changes in shelf sea circulation are more uncertain.

10. Arctic Sea Ice

The extent and thickness of Arctic sea ice continues to decrease, especially in summer months (May to September) and the area of thick, multiyear ice is in significant

Ecosystem Change

11. Coastal Habitats

Sea-level rise and erosion rates are the greatest risk to coastal habitats. Sea-level rise results in deeper waters and bigger waves reaching dunes, shingle and maritime cliffs, causing erosion at the seaward edge.

12. Intertidal Habitats

Warm-favouring species of rocky intertidal habitats have continued to move north along the west coast and east along the south coast of the UK. Further declines in some cold-water species are expected as sea temperature increases.

13. Shallow and shelf Habitats

Modelling suggests that there will be significant shifts in range, distribution and abundance of kelp and cold-water corals across the UK, as well as seabed species in the North Sea. Ocean acidification may cause corrosion of cold-water corals and maerl beds.

14. Deep Sea Habitats

Under a high-emissions scenario, models predict a substantial decrease in seafloor habitat suitability. For cold-water corals in the North Atlantic, around 85% of existing features are predicted to be exposed to increasingly acidic waters by 2060.

15. Plankton

Future warming is likely to continue to shift primary and secondary plankton production northwards. This may negatively affect ecosystem services such as oxygen production and ocean carbon storage in the coming decades.

16. Fish

There have been substantial changes in fish communities in UK waters, with more warm-water species and local declines of some cold-water species. Warming and associated oxygen solubility appears to be affecting growth rates, and the maximum size of fish.

17. Seabirds and Waterbirds

UK and Ireland seabird and waterbird indices show declines since the 1990s, partly due to climate change effects across species' annual cycles and ranges. Many populations are near their range limit or are sensitive to changes in prey availability.

18. Marine Mammals

The main effects of climate change on marine mammals are range shifts, loss of habitat, food-web changes, and increased exposure to disease.

Societal Impact

19. Fisheries

Climate change impacts, coupled with historical overexploitation, has led to declines in fish stocks of some commercial species, including cod, herring, whiting and sprat. Ocean acidification may result in declines in shellfish.

20. Aquaculture

There have been no major changes or geographical shifts in species farmed in the UK, but climate change may increase problems with invasive species, fish gill diseases, and pathogens and more heatwaves may increase mortality.

21. Harmful Species

Climate change could affect the distribution of harmful algae, increase the risk of human infection from Vibrio species and lead to increased Norovirus loading of bathing and shellfish waters.

22. Coastal Flooding

Preliminary results suggest that risk of compound flooding is significantly underestimated. Without appropriate action, projected increases in extreme sea levels will lead to a greater coastal flood risk.

By the 2080s, annual damages from coastal flooding could more than double under high estimates of sea-level rise.

23. Transport and Infrastructure

Sea level rise is increasing flood and erosion risk to critical coastal assets (e.g. energy, transport and water) and marine infrastructure and operations may be increasingly affected by severe weather in the future

24. Cultural Heritage

Historic assets located in the coastal zone will be subjected to enhanced rates of erosion, increased flooding and changes in weathering patterns as a direct result of climate change. Submerged sites will be adversely affected by changes in ocean pH, temperature and circulation patterns.