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Marine Management, Conservation and Restoration Briefing Note

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1. Introduction

Marine management has a central and fundamental aim: to maintain and enhance the natural system, by ensuring that its physico-chemical structure and functioning lead to a sustainable ecological structure and functioning and the production of ecosystem services, while ensuring that society gains the goods and benefits necessary for its welfare and well-being (Elliott, 2011) (see Briefing Paper 4: *Marine Processes and Functioning and Ecosystem Services; and* Briefing Paper 5: *Societal Drivers, Benefits, Goods and Wellbeing*). The integrated management of marine areas requires the human activities, the resulting pressures, effects and ecological components to be managed, not least within a system of maritime spatial planning (MSP). The management has to be carried out within a system of legislation and by those administrative bodies charged with implementing that legislation (see Briefing Paper 11: *Governance*). Once management has determined that there are likely adverse effects of human activities, then Programmes-of-Measures are required to effect solutions, such as mitigation and/or compensation.

Maintaining and protecting species, habitats and habitat mosaics requires conservation measures. These may include designating particular areas or species as conservation zones and again bringing in management measures to ensure that new or existing activities do not adversely affect those components. Degraded systems, habitats, areas or species as the result of human activities then either need restoring or society should accept or tolerate that degraded state. However, there is a duty on all maritime states to restore degraded habitats either by removing the pressures and allowing recovery (passive restoration) or active restoration, by manipulating the habitats and species such as through geoengineering or ecoengineering (now commonly termed nature-based solutions) (Lepage et al., 2022).

This briefing paper covers each of these aspects – the management, conservation and restoration of marine areas; to add context and support the Simple SES guidance (Gregory et al., 2023).

2. Management of impacts from human activities

The coasts and seas support many activities, each of which has the potential to create pressures, defined as the mechanisms of effects which may be on both the natural and social systems. Hence, those natural and social systems and the activities, pressures and effects all need managing. As a degree of further complexity, the area of one maritime nation state adjoins adjacent maritime states such that transboundary issues of connectivity, coherence and equivalence in the assessment and management of those areas have to be considered (Figure 1) (see Elliott et al., 2023).

Figure 1 A hypothetical multi-user transboundary area showing the area of influence (as a white dashed line) of each activity (From Elliott et al., 2023)

Marine management requires an underlying philosophy and strategy. While marine management requires the same actions and has the same approaches and constraints worldwide, the European Marine Strategy is an example particularly relevant for Marine SABRES and its features have been adopted in countries outside the EU. This Strategy consists of two main pillars - the EU Marine Strategy Framework Directive (MSFD) and the Maritime Spatial Planning Directive (MSPD) which between them aim to create a coherent strategy for managing the features and activities in European marine areas (non-EU countries also have equivalent legislation). In essence, the implementation of such marine strategies aims to determine the status of an area, the effects of activities and their pressures, and the means of controlling and/or removing such pressures and effects (Figure 2). All maritime countries have created a plethora of marine governance (defined as policies, politics, administration and legislation) thereby including both the legal instruments and the bodies charged with carrying out the legislation (Boyes and Elliott, 2014, 2015; see Briefing Paper 11: *Governance*).

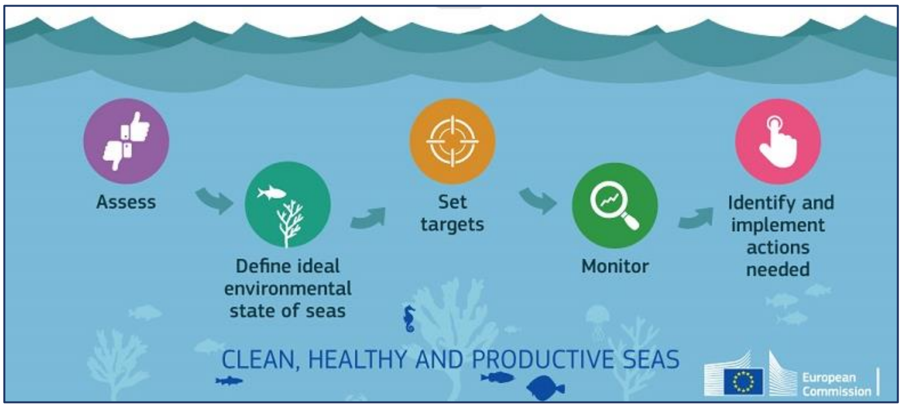

Figure 2. Recommendation of the way to develop a Marine Strategy (note that this sequence is then repeated at 6-year intervals) (https://ec.europa.eu/environment/marine/eu-coast-and-marine-policy/implementation/reports_en.htm)

Marine management and governance have progressed from managing the environment sectorally, i.e. by controlling each sector (fisheries, navigation, sea disposal, conservation, etc.) separately, to adopting a holistic system in which all areas are managed in order to achieve the Ecosystem Approach. The latter is defined as *an integrated approach to the management of human activities that considers the entire ecosystem including humans. The goal is to maintain ecosystems in a healthy, clean, productive and resilient condition, so that they can provide humans with the services and goods upon which we depend. It is a spatial approach that builds around a) acknowledging connections, b) cumulative impacts and c) multiple objectives. In this way, it differs from traditional approaches that address single concerns e.g. species, sectors or activities* (CSWD 2020).

As a pre-eminent example of the Ecosystem Approach, the MSFD had the aim, firstly, to protect and preserve the marine environment, prevent its deterioration or, where practicable, restore marine ecosystems in areas where they have been adversely affected. Secondly, it aimed to prevent and reduce inputs in the marine environment, with a view to phasing out pollution in order to ensure that there are no significant impacts on or risks to marine biodiversity, marine ecosystems, human health or legitimate uses of the sea.

For each country within the European Union, and for those countries outside the EU which still follow the Directive, the MSFD covers from the High Water mark out to the 200 nautical miles (or the mid-line between adjacent countries) limit and so overlaps with the Water Framework Directive operating out to 1 nm. The MSFD requires Member States to achieve Good Environmental Status (GES) while the WFD requires attaining Good Ecological and Chemical Status. Furthermore, with regard to conservation, the Habitats and Species and Wild Birds Directives require an area to be designated for its conservation objectives (names species or habitats) and then maintained in Favourable Conservation Status (see Boyes and Elliott 2014 for details). For each area, the MSFD requires an initial assessment, the development of a GES goal for each of 11 descriptors, the establishment of targets, the development of a monitoring programme and a Programme of Measures to be drawn up to achieve GES (Figure 3) (Borja et al., 2010, 2013). The descriptors are named in Figure 4 and can be regarded as being hierarchical in which D1 (biodiversity) and D4 (foodwebs and functioning) are paramount, i.e. if these are in GES then by definition, there should not be problems with the others Descriptors and vice versa.

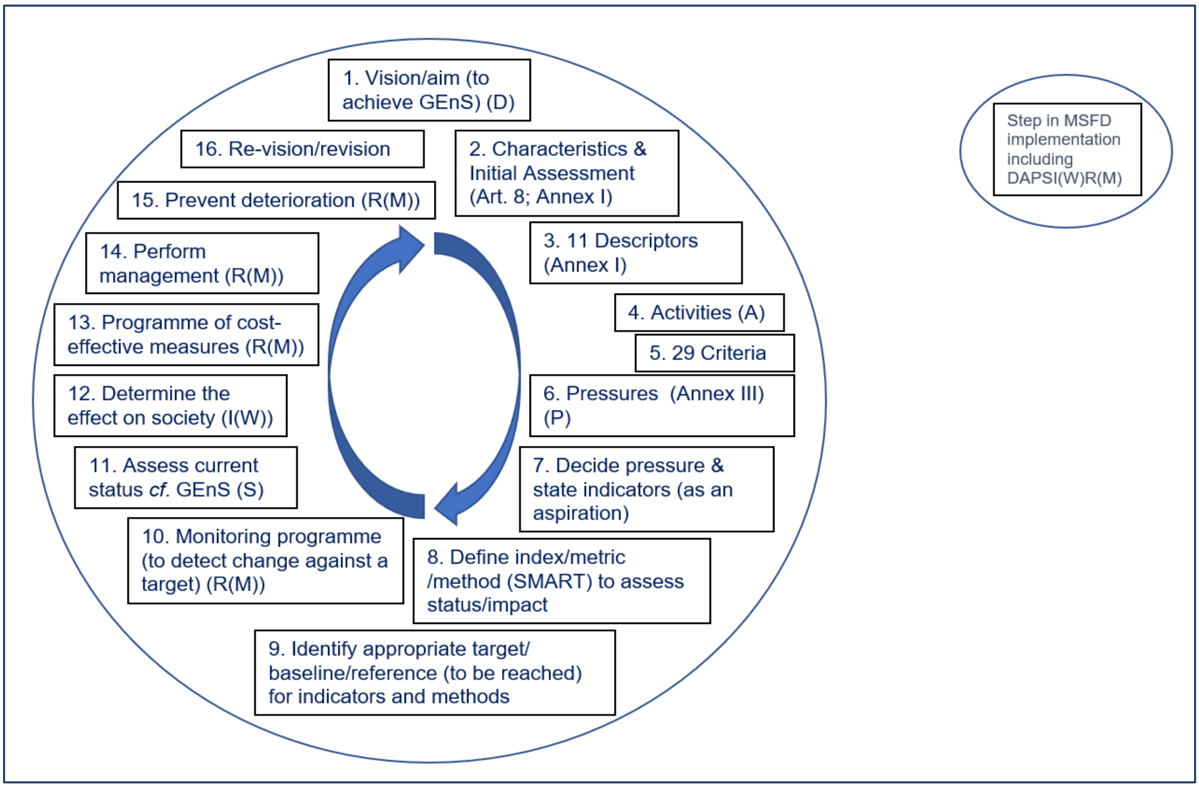

Figure 3. A conceptual model of the implementation of the MSFD, with the cause-consequence-response model DAPSI(W)R(M) superimposed (see Briefing Paper 3: Cause-Consequence-Response Chains – DAPSI(W)R(M)) (from Elliott et al., 2015).

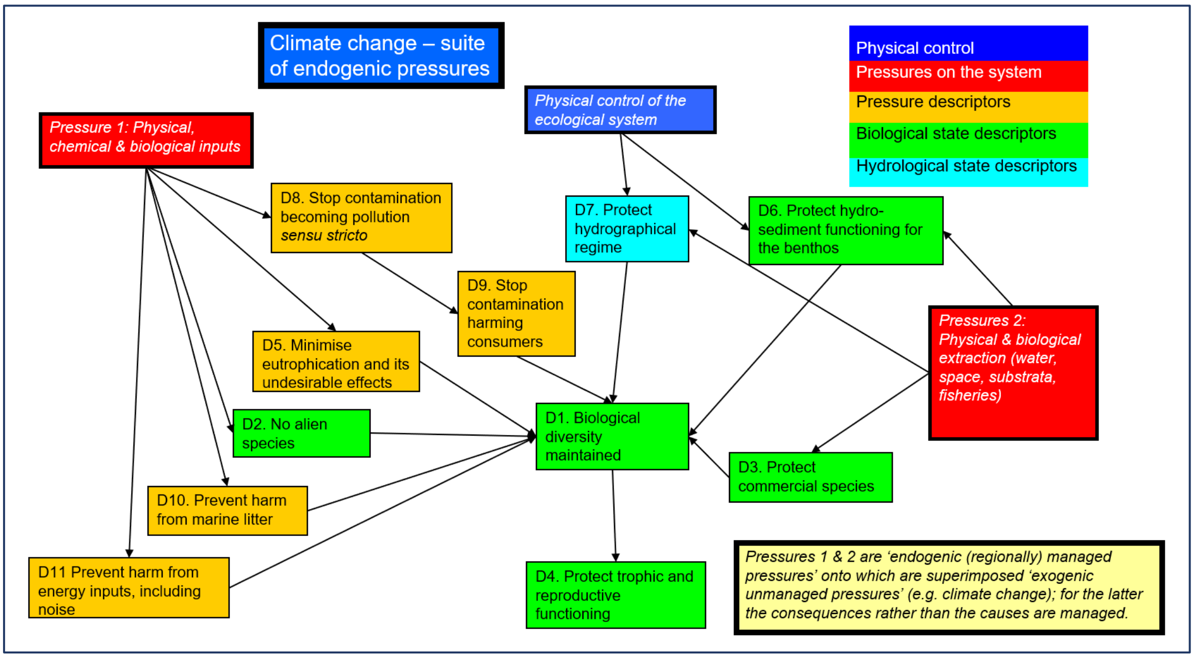

Figure 4. The EU MSFD linkages between the 11 Descriptors, whether they relate to state or pressures and their relationship to endogenic and exogenic pressures, including climate change (modified from Borja et al., 2010).

Under the subsidiarity principle, the MSFD is implemented by national agencies and in tandem with the European Regional Seas Conventions, thereby showing vertical integration from the local to the global. Marine management also requires horizontal integration across all sectors (fishing, aquaculture, navigation, etc.). The European Regional Seas Conventions (RSC) are for the Baltic (HELCOM), Mediterranean Sea (Barcelona Convention), the North-East Atlantic (OSPAR) and the Black Sea (Bucharest Convention). The aim for the MSFD was to work closely, and be implemented, with the RSC and so the RSCs have produced guidance and data relevant to the MSFD implementation. The RSC also produce Quality Status Reports showing the overall characteristics of their areas. As a further complication and area of overlap, the International Council for the Exploration of the Sea (ICES) also performs ecosystem reviews and a marine environmental characterisation.

The descriptors are linked and cover the adverse effects of activities as pressures and state changes to the system (as defined under the cause-consequence-response chain DAPSI(W)R(M)) (see Briefing Paper 3: *Cause-Consequence-Response Chains – DAPSI(W)R(M)*). Good Environmental Status requires to be determined by the monitoring and assessment programme and any remediation required is in actions under the Programme of Measures (PoM). Whereas the MSFD is regarded as the quality assessment directive, its counterpoint the EU Maritime Spatial Planning Directive (MSPD) is regarded as the means of achieving an integrated planning for the seas and so is linked to the European Blue Economy strategy; the MSPD is regarded as an integral part of the PoM. The MSPD aim is to achieve: '*the sustainable growth of maritime and coastal economies and the sustainable use of marine and coastal resources*'. Maritime Spatial Planning (MSP) focuses on planning when and where human activities take place at sea – to ensure these are as efficient and sustainable as possible. The MSP Directive then ensures a coordinated approach to MSP throughout Europe; it enables the efficient and smooth application of MSP in cross-border marine areas; it favours the development of maritime activities, and leads to the protection of the marine environment based on a common framework.

A sea area can be regarded as having a capacity to support and assimilate human activities, what may be termed the carrying capacity and the assimilative capacity (Elliott et al., 2018) (Figure 5). In essence, a sea will have a high environmental quality until activities are permitted, after which that quality will degrade with each activity; quality may be recovered with mitigation but eventually the capacity of the sea to assimilate those human uses will be exceeded, thereby exceeding the threshold for Good Environmental Status as required under the MSFD, i.e. a failure to attain GES (Elliott et al., 2018). Hence, marine management will be required to ensure that the seas can still support those activities for societal benefit while at the same time not being degraded regarding their natural habitats and species.

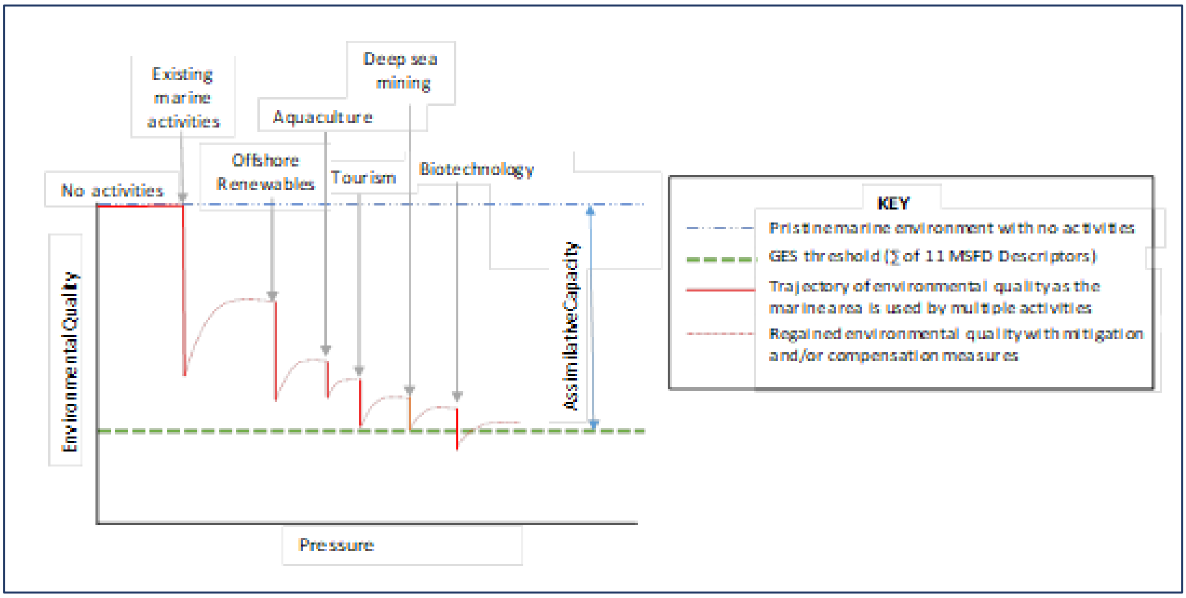

Figure 5. A marine assimilative capacity conceptual model (see text for explanation) (Elliott et al., 2018).

3. Activity-, Pressures-, Effects- and Management Response-Footprints

The plethora of marine human activities and their pressures and effects on natural and societal features require managing at local, national, regional and international scales. This requires management responses to determine (a) the time and area in which the human activities take place; (b) the time and area covered by the pressures generated by the activities on the prevailing habitats and species (in which pressures are defined as the mechanisms of change), and (c) the time and area over which any adverse effects (and even benefits) occur to both the natural and human systems.

These durations and extents of influence can be regarded as footprints and hence the spatial and temporal scales of these leads to the concepts of *activity-, pressures-, effects- and management responses-footprints* (Elliott et al, 2020a; Cormier et al., 2022) (Table 1). These footprints cover areas from tens of m^2 to millions of km^2, and, in the case of management responses, from a large number of local instruments to a few global instruments thereby giving rise to what is termed the management response-footprint pyramids (Figures 6a and b). This pyramid may operate from either bottom-up or top-down directions, whether as the result of local societal demands for clean, healthy, productive and diverse seas or by diktat from national, supranational and global bodies such as the United Nations (see Cormier et al., 2022, for further details). The developer of an activity, via an Environmental Impact Assessment, will be required to determine and control the activity footprint and its pressures and effects leading from that footprint (see Elliott and Wither, 2023). In turn, the regulators permitting that activity should understand the wide range of environmental control regulations, i.e. their footprint, both spatially and temporally. Figure 7 indicates the types of marine management authority likely to be created in each country as well as some of the instruments used by those bodies; it is emphasised that horizontal integration is required across these bodies.

Table 1. Definitions for activity-, pressures-, effects- and management response-footprints (adapted from Elliott, et al. 2020; Cormier et al, 2022).

Footprint	Definition
Activity-footprint	The area and/or time, based on the duration, intensity and frequency of an activity which ideally has been legally sanctioned by a regulator in an authorisation, licence, permit or consent, and which should be clearly

	defined and mapped in order to be legally-defendable; it should be both easily observed and monitored and attributable to the proponent of the activity.
Pressures-footprint	The area and time covered by the mechanism(s) of change resulting from a given activity, or all the activities in an area, once avoidance and mitigation measures have been employed (the endogenic managed pressures). It does not necessarily coincide with the activity-footprint and may usually be larger but could be smaller. It also needs to include the influence and consequences of pressures emanating from outside the management area (the exogenic unmanaged pressures); given that these are caused by wide-scale events (and even global developments) then these are likely to have larger scale (spatial and temporal) consequences.
Effects-footprint	The spatial (extent), temporal (duration), intensity, persistence and frequency characteristics resulting from (a) a single pressure from a marine activity, (b) all the pressures from that activity, (c) all the pressures from all activities in an area, or (d) all pressures from all activities in an area or emanating from outside the management area. They include both the adverse and positive consequences on the natural ecosystem components and on the ecosystem services and societal goods and benefits. They need to include the near-field and far-field effects and near- and far-time effects because of the dynamics and characteristics of marine areas and the uses and users of the area. They may be larger in extent and more persistent than the causing activity-footprint and the resulting pressures-footprints. They also need to encompass the effects of both endogenic and exogenic pressures operating in that area.
Response-footprints	The area and time covered by the governance methods and approaches of monitoring, assessing and controlling the causes and consequences involved in the use of the marine environment through public policy-making, marine planning and regulatory processes. The policies, marine plans and technical measures produced by these processes indicate the means of determining if legal controls are satisfied, and of providing information and data to national and supra-national bodies. They focus on the area and/or time covered by the marine management actions and measures (e.g., programme of measures), including the distribution and range of a species.

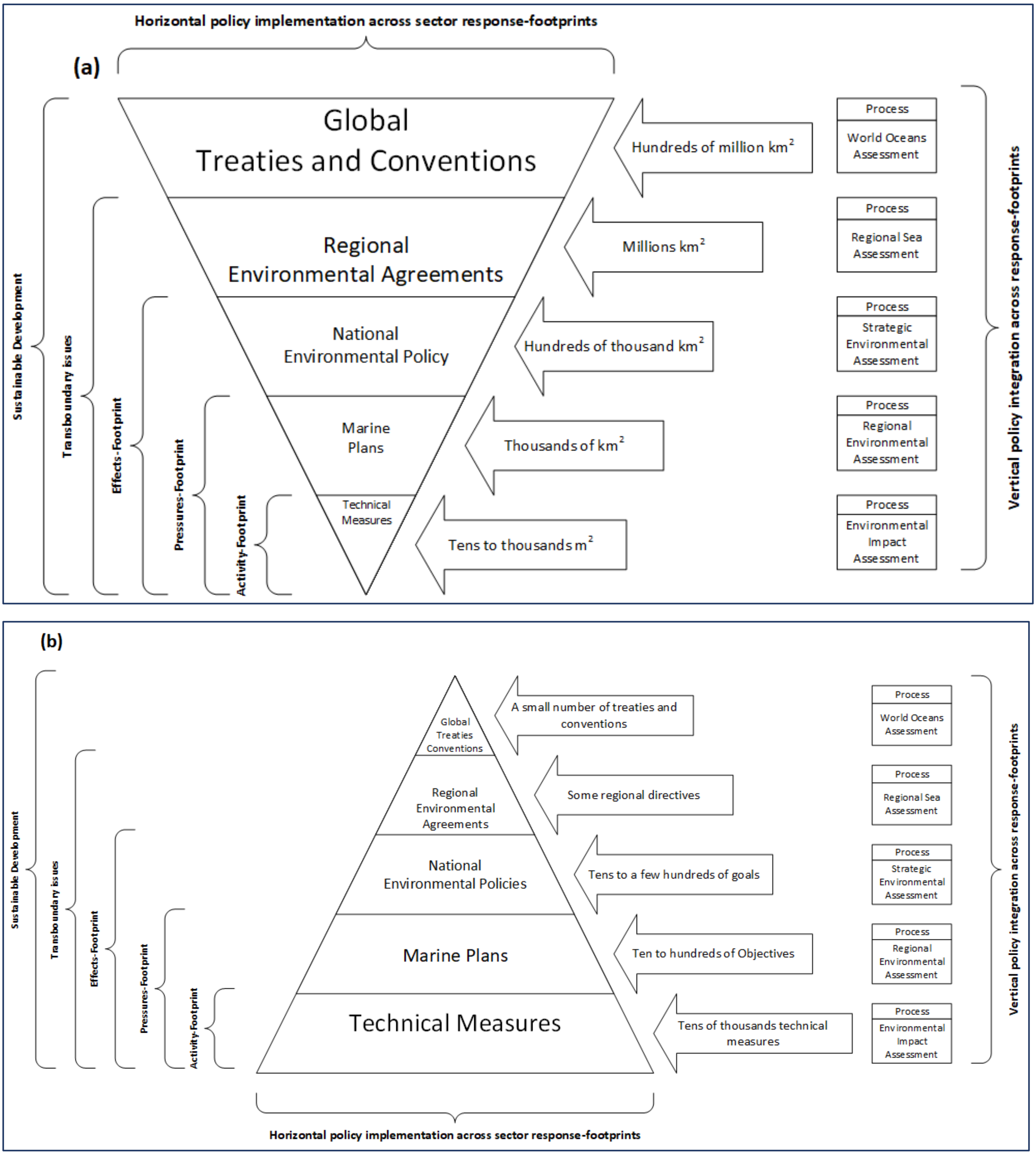

Figure 6. The management response-footprint pyramids showing (a) the area covered by the management measures, and (b) the number of measures of each type; the height of the pyramids indicates vertical integration whereas each horizontal slice of the pyramid will include all sectors (fisheries, navigation etc.) which must be horizontally integrated (after Cormier et al., 2022).

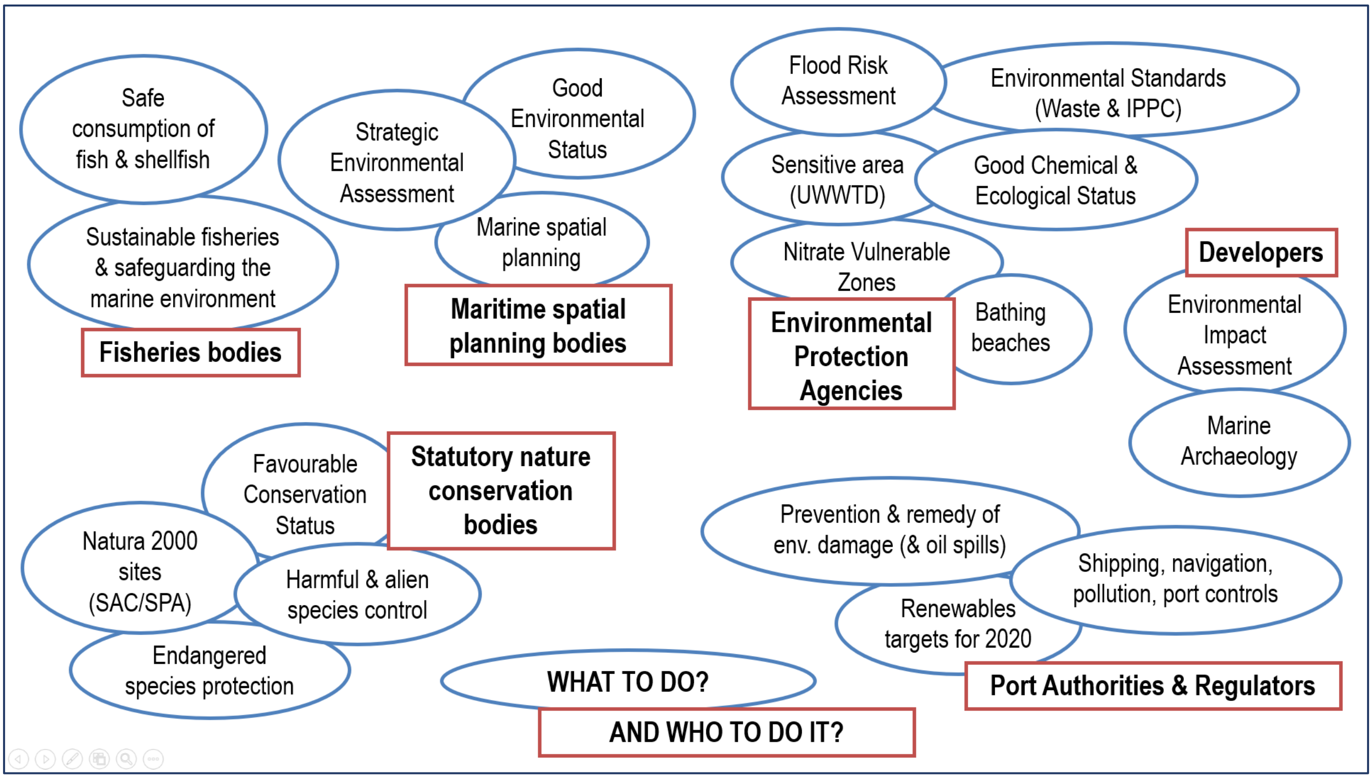

Figure 7. The types of management bodies and examples of their instruments

As exemplified by the Marine SABRES project, the complexity of the marine environment and the complexity of its assessment and management and governance system requires a systems approach (Elliott et al., 2020b; Gregory et al., 2023). At its most simple, this can be regarded as having three parts – setting the priorities and determining the issues in an area as well as the vision for the area (Part A), obtaining the relevant natural and social data (Part B) and using those data amongst stakeholders, the administrators enacting the legislation (Part C) (Figure 8). The analysis of these features shows that there are many tools and approaches in managing areas, that management covers from the small to the large scale, and that the management measures can be presented as an ordered list (Table 2).

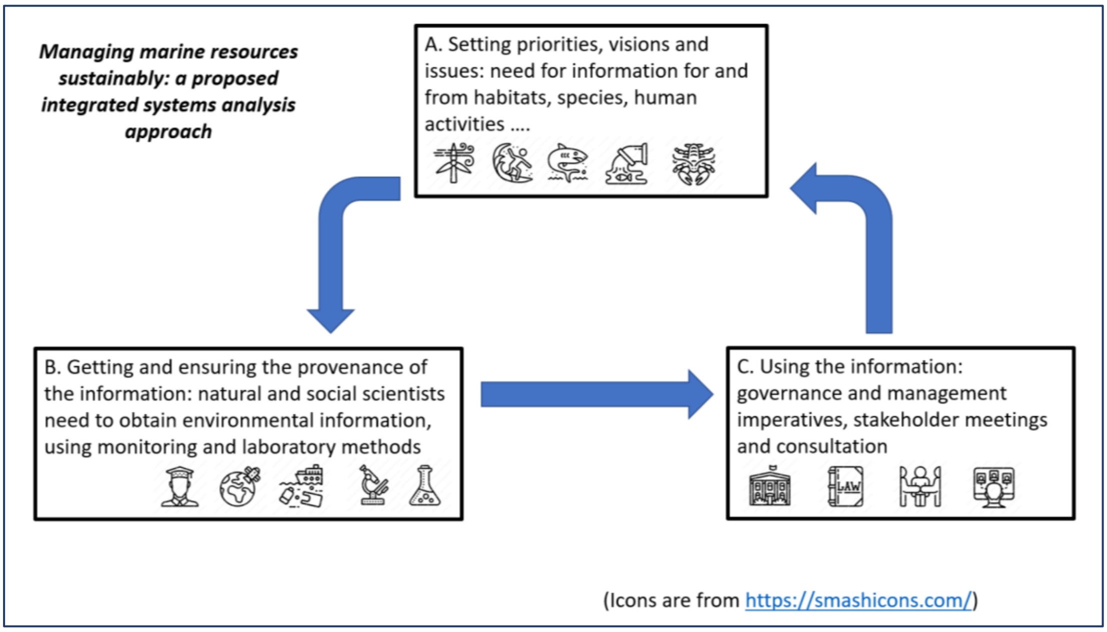

Figure 8. An underpinning systems analysis approach (from Elliott et al., 2020b)

Table 2. How and where are we managing activities and what is the recipe for integrated marine management? (modified from Elliott and Wither, 2023, and references cited within this briefing paper)

How are we managing activities?	Where are we managing?	Recipe Leading to Integrated Marine Management:
By management action; By developing programmes of measures; By developing monitoring schemes; By linking monitoring to SMART indicators (indicators which are Specific, Measurable, Achievable, Realistic, and Timebound); By feedback to check if management is working; By implementing laws; By having many management bodies; By making industry get their house in order; By realizing the management footprint; By having visions, objectives, policies; By using good and fit for purpose science.	A small area (the activity footprint); A middle-sized area (pressures footprints); Middle to large areas (effects footprints); Whole estuaries; Whole catchments/ river basins; Catchment-estuary-coastal areas; Seas and sea regions; Regional seas; Areas Beyond National Jurisdictions; The globe.	Need to understand how our activities lead to which pressures; Need to understand which pressures are within and outside our control; Need to understand ecological structure and functioning; Need to understand what state changes on the natural system occur from those pressures; Lead to describing the impact on human welfare as effects on Ecosystem Services and Societal Goods and Benefits; Lead to defining the appropriate responses as management measures; Require implementation of governance (policies, politics, administration and legislation); Within a multiuser system requiring resolution of conflicts amongst users; Communicate by working with stakeholders.

4. Marine Nature Conservation and Protection

Marine activity managers will be charged with ensuring that their activities do not affect designated nature conservation sites irrespective of whether the industry is in, adjacent to or further away from the site. Therefore, they will be required to consult with and get permission from the local environmental protection agency, the marine licensing agency and the local statutory nature conservation body (Figure 7). Many marine areas are designated for their conservation value (e.g., Table 3 gives the plethora of nature conservation designations), each emanating from a particular piece of legislation (a regulation or Directive in the case of a country or European designation) or an agreement (in the case of local, regional and global designations). The sites will be designated to protect specific and designated features (named species and habitats, these may be termed the conservation objectives) from plans or projects (the industrial and urban activities).

The regulatory body will then require an assessment of the potential effects of the activity; this may be an Appropriate Assessment in the case of the EU Natura 2000 Directives (the Habitats & Species and Wild Birds Directives), a Habitats Regulations Assessment (HRA) or an Environmental Impact Assessment (EIA) (Lonsdale et al., 2017; Elliott & Wither, 2023) and including a cumulative effects assessment (Lonsdale et al., 2020). It is emphasised that while the statutory body is not required to demonstrate that there will be an adverse environmental effect by the activity, the developer will be asked to demonstrate that there will not be an adverse environmental effect. However, demonstrating a negative effect is challenging and may not always be possible. An adverse environmental effect although demonstrated may still be allowed if it is decided by the competent authority that there are good reasons for this and the effects cannot be mitigated, the designation of so-called IROPI – Imperative Reasons of Overriding Public Interest.

Some nature designated sites will allow activities as long as they are shown not to adversely affect the designated features; more usually these require either prevention or mitigation measures, or, where these are not possible, then by creating new habitats, the practice of ecoengineering (now often termed nature-based solutions) or geoengineering (e.g., Wolanski and Elliott, 2015). Under some designations, activities are not allowed, for example no-take zones or no-trawl zones in which fishing will be prohibited. Some of the designations allow recreational activities but not commercial ones.

The prevailing laws or adopted procedures will ensure that the nature designated areas or species are maintained or restored to a given status and hence activities will be controlled to restrict the pressures and effects. Any causes of actual or potential degradation will then have to be removed, reduced or mitigated or, failing that, compensated. The latter is of three types to compensate: the users of an area (e.g., economic compensation for fishermen affected), the resource affected (e.g., by restocking with fish or replanting seagrasses), or the habitat affected (e.g., by re-creating habitats elsewhere, such as by wetland creation) (Wolanski & Elliott, 2015).

The 2022 Convention on Biological Diversity agreed that countries would aim for 30% of their areas to be protected for nature and biodiversity by 2030 with a third of that being strictly protected, i.e. where activities are greatly (strictly or strongly) controlled; this is described as the '30x30 +10' approach. Hence it is expected that in the coming years the designated areas will increase in size.

It is also emphasised that some areas will have more than one designation. For example, many European Marine Sites (EMS) will be designated both for their bird populations and other species and habitats; hence they may be an EMS, SAC, SPA and Ramsar Site (Table 3). As such, the protected areas may range in size from very localise areas to large areas as in the case of EBSAs (Ecologically and/or Biologically Sensitive Areas) covering large ocean areas. In addition, each country will have its own nature protection designations, many of which may be for terrestrial areas which could include terrestrial coastal areas, possibly up to high water tide mark or even including intertidal areas.

Table 3. Examples of Marine Nature Conservation designations (modified from Elliott and Wither, 2023)

Acronym	Title	Originator
PSSA	Particularly Sensitive Sea Areas	global, International Maritime Organisation
SAC	Special Areas of Conservation	EU Habitats & Species Directive
SPA	Special Protected Areas	EU Wild Birds Directive
MPA	Marine Protected Areas	EU Maritime Spatial Planning Directive, etc. global
SSSI	Sites of Special Scientific Interest	UK
OECM	Other Effective Conservation Measures	global
EBSA	Ecologically and/or Biologically Sensitive Areas	global
HPMA	Highly Protected Marine Areas	UK
MCZ	Marine Conservation Zones	UK
NTZ	No-Take Zones	global

EFH	Essential Fish Habitat	US, UK, etc
BSH	Broad Scale Habitats	UK etc.
HSCI	Habitats and Species of Conservation Importance	UK etc.
EMS	European Marine Sites	EU Natura 2000 Directives
FOCI	Feature of Conservation Importance	UK etc.
VMEs	Vulnerable Marine Ecosystems	FAO
Ramsar	Sites under the Ramsar Wetlands Convention	global

5. Habitat and Species Restoration

Once a marine area has been degraded through human activities, then restoration measures will need to be implemented in order to return the site to an acceptable nature conservation status. Such a restoration may be passive, i.e. by removing the pressures and allowing the system and its species and habitats to recover, or active, by supporting/enhancing the habitats and species (Lepage et al., 2022). The conceptual model (Figure 9) indicates that an ecosystem (or one of its habitats or species) will degrade through human activities but that degradation may be reduced through prevention and mitigation of pressures. The system may recover once the pressures are removed (the red arrow) or if that is not successful then habitat rehabilitation or restoration will be required. Failing that, habitat recreation, creation, replacement or compensation will be required (for definitions of these terms see Elliott et al., 2007). Restoration may include geoengineering, i.e. changing the physical shape and structure of the area, and ecoengineering, now often termed nature-based solutions.

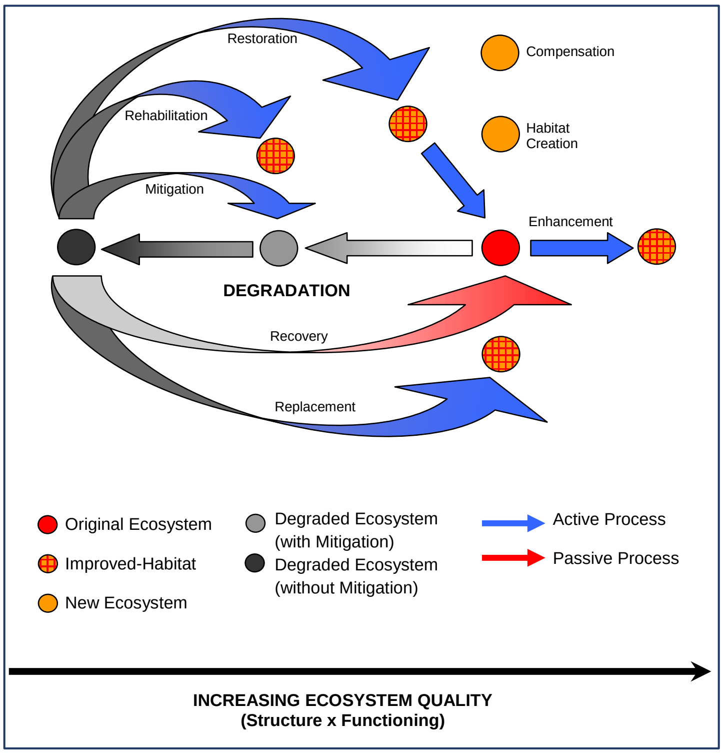

Figure 9. A conceptual model showing the options for habitats degraded by human activities (from Elliott et al., 2007)

The Programmes of Measures (see above) required by the MSFD and other Directives and legislation requires the prevention of degrading activities and the reversal of the adverse effects. Central to this is the use of ecoengineering to restore, recreate or replace habitats and to help species to recover.

Ecoengineering (also termed Nature-based Solutions), which is to be used after the after pressures have been removed or controlled, or even if the pressures cannot be removed, is of two types (Elliott et al., 2016; Lepage et al., 2022). Ecoengineering Type A in which management changes the physics of the area, including changing the physiography and manipulating, where relevant, the freshwater flows from the catchment, to produce the ecological niches which in turn lets the ecology and habitats develop, especially if the colonising species are ecological engineers; this is on the basis that organisms will then recolonise the area with natural recruitment patterns.

If Type A ecoengineering is not successful, and habitat-forming and other species are not returning, then Type B Ecoengineering will aim to enhance and restore the ecology, by restocking, reseeding or replanting, in turn creating habitats or letting the ecological engineer species modify habitats, thus enhancing the physical-biological links. Ecoengineering initiatives often aim to accelerate natural rehabilitation and sometimes harness dynamic variability. However, they often only achieve establishing a static system (the desired state) even if this does not include all natural successional processes and stages. The success of ecoengineering requires an understanding of ecohydrology, the links between the biota, especially the habitat-forming species, and the hydrophysical environment (Wolanski & Elliott, 2015).

Table 4 indicates why systems degrade and how this can be reversed. It is emphasised that whereas active restoration and ecoengineering are potentially more successful in coastal and estuarine/lagoonal areas, they are less so (or even not possible) in offshore areas where often the only alternative is to remove the pressures and let the area recover naturally. For example, while a degraded beach or estuarine wetland can be recreated or restored in the same place or even elsewhere, a subtidal, offshore sandbank changed by siting a wind farm cannot be recreated elsewhere as it would require changing the hydrodynamic and sedimentary regime.

Finally, it is of note that in 2023, the European Commission proposed a Nature Restoration Law as a key element of the EU Biodiversity Strategy. Although greater details are not yet available, the Law proposes 'binding targets to restore degraded ecosystems, in particular those with the most potential to capture and store carbon and to prevent and reduce the impact of natural disasters'. The law will need to integrate the Marine Strategy and the implementation of the Natura Directives for Habitats and Species and Wild Birds.

Table 4. Management for what needs restoring, why and how? (from Wolanski and Elliott, 2015; Elliott et al., 2016).

What?	Cause?	Reverse?
Land-claim	Wetland removal/dyke construction	Restocking with vegetation, reconnection, resculpting
DO sag	Waste discharges	Reduction/treatment of inputs, reoxygenation, bubbling
Bivalve biogenic reef loss	Siltation, overharvesting,	Adaptation, flushing, regulation, restocking
Eutrophication	Poor flushing, excess nutrients	Reconnection, regulation
Biota kills	Toxin input, WQ problems	Regulation, industry removal
Coral reef loss	Siltation, direct damage, bleaching	Run-off controls, re-creation, global rethinking,

Loss of fish	Overharvesting, climate change, hydrodynamic barriers	Restocking, rethinking, adaptation, regulation
Salinity change	Upstream abstraction, impediments to flow	Removal, reconnection
Loss of seagrass	Smothering, nutrient excess, disease, hydrographic change	Reduction, removal, reconnection, replanting
Loss of flow	Diversion, abstraction, structures	Reconnection, reallocation
Seabed extraction	Aggregate removal, loss of sediment fraction	Reseeding, regulation, reallocation
Taxonomic changes	Non-indigenous species influx	Removal, eradication, prevention

References and Further reading

Andersen, J. H., Berzaghi, F., Christensen, T., Geertz-Hansen, O., Mosbech, A., Stock, A., Zinglersen, K. B., Wisz, M. S., 2017. Potential for cumulative effects of human stressors on fish, sea birds and marine mammals in Arctic waters. Estuarine, Coastal and Shelf Science, 184: 202-206.

Borgwardt, F., Robinson, L.A., Trauner, D., Teixeira, H., Nogueira, A.J.A., Lillebø, A.I., Piet, G.J., Kuemmerlen, M., O'Higgins, T., McDonald, H., Arevalo-Torres, J., Barbosa, A.L., Iglesias-Campos, A., Hein, T., Culhane, F., 2019. Exploring variability in environmental impact risk from human activities across aquatic ecosystems. Sci. Total Environ. 652. https://doi.org/10.1016/J.SCITOTENV.2018.10.339

Borja, A., Elliott, M., Andersen, J.H., Cardoso, A.C., Carstensen, J., Ferreira, J.G., Heiskanen, A.-S., Marques, J.C., Neto., J., Teixeira., H., Uusitalo., L., Uyarra., M.C., Zampoukas, N., 2013. Good Environmental Status of marine ecosystems: What is it and how do we know when we have attained it? *Marine Pollution Bulletin*, 76: 16-27.

Borja, Á., Elliott, M., Carstensen, J., Heiskanen, A.-S., van de Bund W., 2010. Marine management – towards an integrated implementation of the European Marine Strategy Framework and the Water Framework Directives. Marine Pollution Bulletin 60: 2175-2186.

Boyes, S.J. & Elliott, M (2015). The excessive complexity of national marine governance systems - has this decreased in England since the introduction of the Marine and Coastal Access Act 2009? Marine Policy, 51: 57-65 *doi:* https://doi.org/10.1016/j.marpol.2014.07.019.

Boyes, S.J. & Elliott, M. (2014). Marine Legislation – the ultimate 'horrendogram': International Law, European Directives & National Implementation. *Marine Pollution Bulletin*, 86(1-2): 39-47. doi: https://doi.org/10.1016/j.marpolbul.2014.06.055

Cavallo, M., Borja, A., Elliott, M., Quintino, V., Touza, J., 2019. Impediments to achieving integrated marine management across borders: the case of the EU Marine Strategy Framework Directive. *Marine Policy* 103: 68-73. https://doi.org/10.1016/j.marpol.2019.02.033

Cavallo, M., Elliott, M., Touza-Montero, J., Quintino, V., 2016. The ability of regional coordination and policy integration to produce coherent marine management: implementing the Marine Strategy Framework Directive in the North-East Atlantic. Marine Policy, 68: 108-116. https://doi.org/10.1016/j.marpol.2016.02.013

Cormier, R., Elliott, M., Borja, Á., 2022. Managing Marine Resources Sustainably – The 'Management Response-Footprint Pyramid' Covering Policy, Plans and Technical Measures. Front. Mar. Sci. 9:869992. https://doi.org/10.3389/fmars.2022.869992

CSWD, 2020. Commission Staff Working Document: Background document for the Marine Strategy Framework Directive on the determination of good environmental status and its links to assessments and the setting of environmental targets. Accompanying the Report from the Commission to the European Parliament and the Council on the implementation of the Marine Strategy Framework Directive (Directive 2008/56/EC). European Commission SWD(2020) 62 final.

Dunstan, P., Calumpong, H., Celliers, L., Cummins, V., Elliott, M., Evans, K., Firth, A., Guichard, F., Hanich, Q., de Jesus, A.C., Hildago, M., Mohammed, E., Lozano-Montes, H-M., Meek, C.L., Polette, M., Purandare, J., Smith, A., Strati, A., Vu, C.T. (2021). Chapter 27: Developments in management approaches. World Oceans Assessment II, United Nations, New York, Vol. II, 441-469. Downloaded from https://www.un.org/regularprocess/woa2launch

Elliott, M. (2011). Marine science and management means tackling exogenic unmanaged pressures and endogenic managed pressures – a numbered guide. Marine Pollution Bulletin, 62: 651-655. http://dx.doi/10.1016/j.marpolbul.2010.11.033

Elliott, M., Borja, A., Cormier, R. (2020a). Activity-footprints, pressures-footprints and effects-footprints – walking the pathway to determining and managing human impacts in the sea. Marine Pollution Bulletin, 155: 111201; https://doi.org/10.1016/j.marpolbul.2020.111201.

Elliott, M., Borja, A., Cormier, R. (2020b). Managing marine resources sustainably: a proposed integrated systems analysis approach. Ocean & Coastal Management, 197, 105315, https://doi.org/10.1016/j.ocecoaman.2020.105315

Elliott, M., Borja, Á., Cormier, R., (2023). Managing marine resources sustainably – ecological, societal and governance connectivity, coherence and equivalence in complex marine transboundary regions. Ocean & Coastal Management, 245: 106875; https://doi.org/10.1016/j.ocecoaman.2023.106875

Elliott, M., Boyes, S.J., Barnard, S., Borja, Á. (2018). Using best expert judgement to harmonise marine environmental status assessment and maritime spatial planning. *Marine Pollution Bulletin*, 133: 367-377; https://doi.org/10.1016/j.marpolbul.2018.05.029.

Elliott, M., Mander, L., Mazik, K., Simenstad, C., Valesini, F., Whitfield, A., Wolanski, E., (2016). Ecoengineering with Ecohydrology: successes and failures in estuarine restoration. *Estuarine, Coastal and Shelf Science* 176: 12-35, doi: https://doi.org/10.1016/j.ecss.2016.04.003.

Elliott, M., Wither, A., (Eds.) (2023). Environmental Consequences and Management of Coastal Industries: Terms and Concepts. Elsevier, Amsterdam, Paperback ISBN: 9780443137525, eBook ISBN: 9780443137532

Gregory, A.J., Atkins, J.P., Smith, G., Elliott, M. (2023). *Simple Social-Ecological Systems Guidance, Deliverable 3.2.* Marine SABRES, European Union's Horizon Europe research and innovation programme under grant agreement no. 101058956. and the UKRI Project Number 10050525

Korpinen, S., Klančnik, K., Peterlin, M., Nurmi, M., Laamanen, L., Zupančič, G., Murray, C., Harvey, T., Andersen, J. H., Zenetos, A., Stein, U., Tunesi, L., Abhold, K., Piet, G., Kallenbach, E., Agnesi, S., Bolman, B., Vaughan, D., Reker, J., Royo Gelabert, E., 2019. Multiple pressures and their combined effects in Europe's seas. ETC/ICM Technical Report 4/2019: European Topic Centre on Inland, Coastal and Marine waters: 164 pp., Brussels.

Lepage, M., Capderrey, C., Meire, P., Elliott, M. (2022). Chapter 8 Estuarine Degradation and Rehabilitation. In: Fish and Fisheries in Estuaries – A Global Perspective (ed., Whitfield, A.K., Able, K.W., Blaber, S.J.M. & Elliott, M.), pp. 458-552. John Wiley & Sons, Oxford, UK; ISBN 9781444336672.

Lonsdale, J., Weston, K., Elliott, M., Blake, S., Edwards, R. (2017). The Amended European Environmental Impact Assessment Directive: UK Marine Experience and Recommendations. *Ocean and Coastal Management,* 148: 131-142.

Lonsdale, J-A, Nicholson, R, Judd, A, Elliott, M, Clarke, C (2020). A novel approach for cumulative impacts assessment for marine spatial planning. Environmental Science & Policy, 106: 125-135; https://doi.org/10.1016/j.envsci.2020.01.011

Ramsar Convention – see https://rsis.ramsar.org/

Verones, F., Moran, D., Stadler, K., Kanemoto, K., Wood, R., 2017. Resource footprints and their ecosystem consequences Scientific Reports, 7, 40743.

Wolanski, E., Elliott, M. (2015). *Estuarine Ecohydrology: an introduction*. Elsevier, Amsterdam; ISBN 978-0-444-63398-9, p322.