THE UNIVERSITY OF HULL

A Critical Analysis of Marine Environmental Indicators within Regulatory and Policy Texts

being a Thesis submitted for the Degree of PhD

in the University of Hull

by

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Abstract

The use of indicators within marine legislation and policy is a developing phenomenon worldwide. What is less apparent, however, is the effectiveness of such policies in prompting regulatory or remedial responses and achieving particular conservation objectives. Even less well-understood are the relationships that develop between the science, policies, and law in these regulatory frameworks. As such, it is imperative to reach an understanding as to how scientific, economic and social goals are interconnected, and how they in turn influence indicator development.

This gap in understanding provides the rationale for this work, which is to explore and explain the way in which law, policy and science interface in the context of marine regulations. The overall aim of this thesis is to provide a detailed, critical analysis of marine environmental indicators within regulatory and policy texts at the international, European and national levels. Furthermore, it measures the effectiveness of such indicators, as well as their foundation within science, by providing an examination of the operational efficiency of marine environmental indicators, with an emphasis on the techniques and approaches used to accommodate indicators and similar devices. It also analyzes the resultant relationships that have evolved between science, policy and legislation, with a particular focus on the utilization of indicators within national marine industries. The thesis also evaluates the understanding and application of indicators by non-technical personnel by demonstrating through case law review the courts' stance on the utilization of evidence and expert testimony. This research also examines a variety of indicators used in support of the environmental management of the national marine aggregate-extraction industry. The central argument of this thesis is that indicators are relevant within policy and legislative agenda – they create dialogue and bridge communication gaps.

This thesis demonstrates that when founded upon the discussed criteria, indicators allow for effective communication and provide the opportunity to gauge the success of current marine management techniques within international, European and national set agenda. Whether scientifically or politically driven, they are crucial to the successful development and implementation of environmental policies and legislation world-wide. They cross various disciplines (scientific, political, legal) and when properly understood and applied, can assess progress in achieving political and legal goals, ensuring that the needs of humans and the environment are equally balanced.

To Scott Zylich, whose endless patience, support and guidance made this thesis possible. I am here because of you. We did it!

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GLOSSARY

AFDW	Ash Free Dry Weight
BATs	Best Available Techniques
BEPs	Best Environmental Practices
BOD	Biochemical Oxygen Demand
BRTF	Better Regulation Task Force
BWD	Bathing Water Directive
CBD	Convention on Biological Diversity
CEFAS	Centre for Environment, Fisheries, & Aquaculture Science
CEI	Core Environmental Indicators
cfu	Colony forming unit
CO_2	Carbon Dioxide
COM	Communication
COP	Conference of the Parties
CPA	Coast Protection Act
DAPSI(W)R(M)	Drivers-Activities-Pressures-State-Impact-Welfare-Response-Measures
DPSEEAC	Drivers-Pressures-State-Change-Exposure-Effects-Action-Context
Defra	Department for Environment, Food & Rural Affairs
DPSIR	Driving forces-Pressures-State-Impacts-Response
DSR	Driving force-State-Response
EAPs	Environmental Action Programs
EBI	European Benchmark Indicators
EC	European Community
ECJ	European Court of Justice
EQO/EQS	Environmental Quality Objective/Environmental Quality Standard
EcoQOs	Ecological Quality Objectives
EC SDS	EC's Sustainable Development Strategy
EEA	European Environment Agency
EEZ	Exclusive Economic Zones
EFP	Experimental Fishing Program
EIAs	Environmental Impact Assessment
EMODNET	EU Marine Observation and Data Network
EMS	Environmental Management Systems
Env-LR	Environmental Law Review
ES	Environmental Statement
EU	European Union
FAO	Food and Agriculture Organization
FEPA	Food and Environment Protection Act
GDP	Gross Domestic Product
HDI	Human Development Index
HEI	Human Environment Index
HNDAs	High Natural Dispersion Areas
ICES	International Council for the Exploration of the Sea
ICJ	International Court of Justice
ICM	Integrated Coastal Management

ICZM	Integrated Coastal Zone Management
IOC	Intergovernmental Oceanographic Commission
IEEP	Institute for European Environmental Policy
IMF	International Monetary Fund
IMO	International Maritime Organization
IPPC	Integrated Pollution Prevention and Control
JNCC	Joint Nature Conservation Committee
LME	Large Marine Ecosystems
KEI	Key Environmental Indicators
MARBEF	EU Network of Excellence: Marine Biodiversity & Ecosystem Function
MARPOL	International Convention for the Prevention of Pollution from Ships
MBIs	Market-Based Instruments
MCAA	Marine and Coastal Access Act 2009
MCEU	The Marine Consents and Environment Unit
MCZs	Marine Conservation Zones
MDS	Multidimensional Scaling Ordination
mg/L	Milligram per liter
MHWS	Mean High Water Springs
MIPS	Material Intensity per Service unit
MLWS	Mean Low Water Springs
MMO	Marine Management Organization
MNP	Netherlands Environmental Assessment Agency
ml	Milliliter
MPAs	Marine Protected Areas
MSFD	Marine Strategy Framework Directive
MSY	Maximum Sustainable Yield
N	Nitrogen
NEPIs	New Environmental Policy Instruments
NGOs	Non-Governmental Organizations
nms	Nautical miles
NO_x	Nitrogen oxides
NRA	National Rivers Authority
NSI	National Statistical Institutes
OECD	Organization for Economic Co-operation and Development
OSPAR	Oslo and Paris Commission
P	Phosphorus
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
p.e.	Population equivalent
Ppm	Parts per million
PSR	Pressure-State-Response
PTVs	Policy Target Values
QSR	Quality Status Reports
RIVM	National Institute of Public Health and Environment
RSPB	Royal Society for the Protection of Birds
SACs	Special Areas of Conservation

SBSSTA	Subsidiary Body on Scientific, Technical and Technological Advice
SBT	Southern Bluefin Tuna
SCISCW	State Change-Impact-State-Change-Welfare
SD	Sustainable Development
SDI	Sustainable Development Indicator
SDU	Sustainable Development Unit
SEA	Single European Act
SO_x	Sulphur Oxide
SPAs	Special Protection Areas
SRVs	Sustainable Reference Values
TAC	Total Allowable Catch
TEU	Treaty on the European Union
TOA	Treaty of Amsterdam
T/R ratio	Treatment Station/Reference Station Ratio
$\mu g/m^3$	Microgram/meter cubed
UK	United Kingdom
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNCSD	United Nations Commission on Sustainable Development
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
UNFCC	United Nations Framework Convention on Climate Change
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNGA	United Nations General Assembly
UNSD	United Nations Statistics Division
VAs	Voluntary Agreements
WFD	Water Framework Directive
WHO	World Health Organization

Chapter 1: Introduction

1.0 Introduction

The use of indicators within marine policy and legislation is a developing phenomenon worldwide. As governments begin to take a more holistic approach to marine management, it is inevitable that economic and social goals will become enshrined within environmental regulation. As such, it is imperative that an understanding is reached as to how scientific, economic and social goals are interconnected, and how they in turn influence indicator development. Arguably, a more integrated framework is needed to provide policy-makers and legislators with a coherent approach to the use of marine indicators within the context of sustainable development and to ensure that such an approach is based upon a firm scientific foundation.

There are a range of instruments at the international, European and domestic level designed to secure sustainable development of marine spaces, protect environmental resources, and which encourage the utilization of environmental indicators.[1] At the international level, this includes the UNCLOS[2] and regional agreements, such as OSPAR.[3] At the EU level, this includes the Environmental Action Programs, the EC Maritime Policy,[4] the Water Framework Directive[5], the EU Habitats[6] and Birds Directives[7], and the Marine Strategy Framework Directive.[8] Different domestic legal regimes also have such instruments, including the U.S. Oceans Act[9], the U.S. Clean Water Act[10], and the UK Marine and Coastal Access Act.[11] Legislation is supported by policy documents, which facilitate or drive the use

[1] This list is illustrative, not exhaustive. These legal and political instruments, among others, will be discussed in greater detail in Chapters 2-7 of this thesis.
[2] United Nations (1982) United Nations Convention on the Law of the Sea
[3] OSPAR (1992) Convention for the Protection of the Marine Environment of the North-east Atlantic
[4] COM (2007) Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: An Integrated Maritime Policy for the European Union 575 Final
[5] Council Directive Establishing a Framework for Community Action in the Field of Water Policy 2000/60/EC [2000] OJEU L 327/1-327/72
[6] Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora 92/43/EEC [1992] OJ L 206/0007-0050
[7] Council Directive on the Conservation of Wild Birds 79/409/EEC [1979] OJ L 103/0001-0018
[8] Council Directive Establishing a Framework for Community Action in the Field of Marine Environmental Policy (Marine Strategy Framework Directive) 2008/56/EC [2008] OJ L 164/19-164/40
[9] US Congress (1997) The Oceans Act of 1997 S.123
[10] EPA (1972) Federal Water Pollution Control Act 33 U.S.C 1251 et seq
[11] Marine and Coastal Access Act 2009 c. 23

of indicators, such as Safeguarding Our Seas.[12] These instruments seek to attain sustainable development by assessing the current state of the marine environment and the extent of human impacts, and ensuring that certain management goals are achieved. Gubbay notes that there has been an array of reports and information that examine the extent to which these measures and polices have been established.[13] What is less apparent is the effectiveness of such policies in prompting regulatory or remedial responses and achieving particular conservation objectives.[14] Even less well-understood are the relationships that develop between the science, policies, and law in these regulatory frameworks. This gap in understanding provides the rationale for this thesis, which is to explore and explain the way in which law, policy and science interface in the context of marine regulation. This is done by looking at indicators, a tool used at the interface between science and decision-making.

In this chapter, the aims of the thesis and its underlying rationale are presented, before reviewing the core concept of the indicator and its management context. This will then provide a basis for the research and analysis in the subsequent chapters.

1.1 Defra Project ME4118

This thesis and the research supporting it is part of a larger Department for Environment Food and Rural Affairs (Defra) project, ME4118, which is entitled "Environmental Indicators: A Structured Approach to the Evaluation of Impacts Arising from Human Activities at Sea". ME4118 promoted an integrated approach to indicator applications across appropriate spatial scales in order to more effectively regulate human activities at sea.[15] It addressed current trends in policy and regulatory thought and demonstrated an interfacing of science, law and policy disciplines via the employment of environmental indicators. Indicators can be developed and employed for effective communication, which allows a better opportunity to exchange

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[12] Defra, *Safeguarding Our Seas: A Strategy for the Conservation and Sustainable Development of our Marine Environment* (2002) 82pp

[13] S Gubbay "A Review of Marine Environmental Indicators: Reporting on Biodiversity Aspects of Ecosystem Health" [2004] 73pp (p 7)

[14] Ibid, at p 7

[15] H Rees 'ME4118 'Roll-out' meeting: Report of a Workshop on Progress and Plans for the Development of Marine Environmental Indicators' [2006] (CEFAS unpublished report) 11pp (p 3)

information on spatial and temporal patterns in the environment.[16] This, in turn, ensures that human activities remain compatible with environmental needs.[17]

ME4118 revolved around three unique yet interrelated themes. This thesis was designed to deliver the research necessary for Theme 1, entitled “Legislative Aspects”, which focused on the policy and legal aspects of indicator development. It sought to explain how law and policy frameworks influenced indicator design and operation, and investigate how the technical requirements of indicators could be accommodated within legal and policy instruments. This is important due to increasing trends that have arisen towards employing indicators within new policy and regulatory frameworks in order to assess progress towards set goals and objectives.[18] Through this theme, the project sought to generate a regulatory risk assessment framework for effective use of indicators.[19]

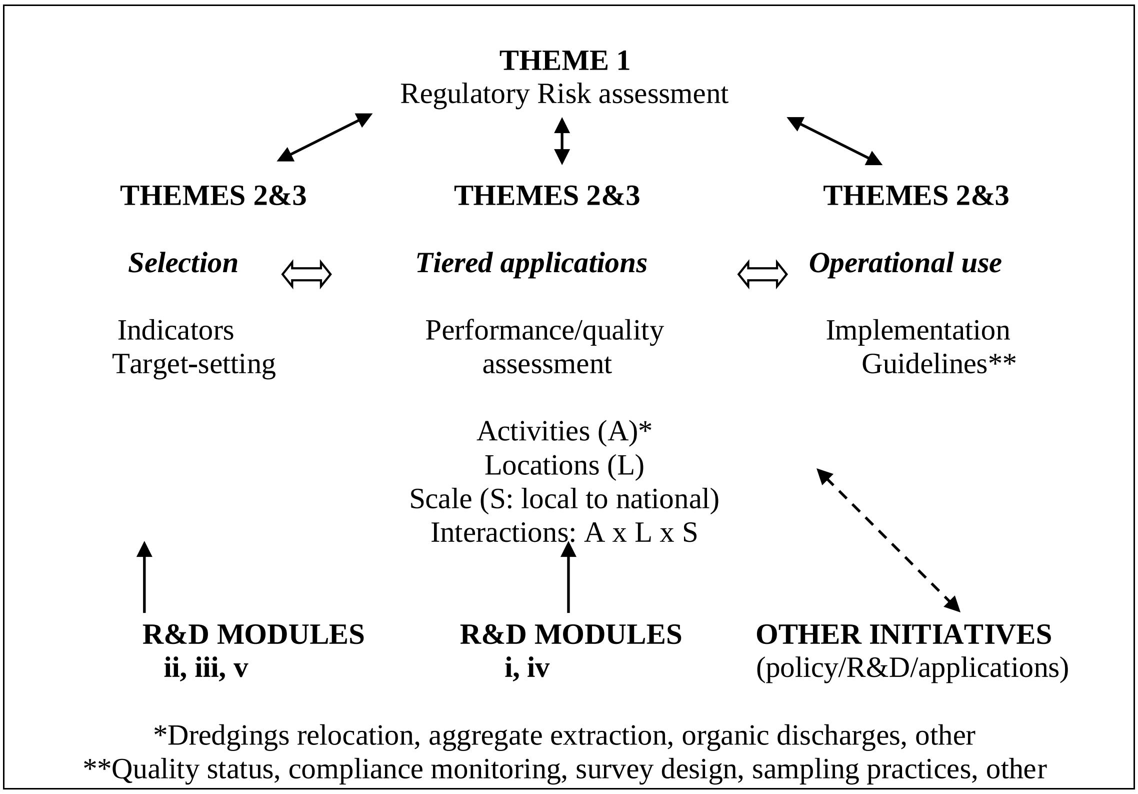

Figure 1.1: *Structure of Defra project ME4118*.[20]

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[16] UNEP, *Monitoring and Indicators: Designing National-level Monitoring Programmes and Indicators* (Note by the Executive Secretary. Subsidiary Body on Scientific, Technical and Technological Advice. Convention on Biological Diversity, UNEP/CBD/SBSSTA/9/10, 2003) 45pp
[17] Ibid
[18] H Rees (2006) *supra* note 15 (p 4)
[19] Ibid at p 3
[20] Ibid, at p 4

Embedded within the pursuit of these objectives was an important organization, the Centre for Environment, Fisheries & Aquaculture Science (Cefas), as well as another project, the EU Network of Excellence: Marine Biodiversity & Ecosystem Function (MARBEF). Connections with external stakeholders such as these are necessary to establish essential links between scientific, legal, political and socio-economic elements, and to relate such links to indicator development. Ultimately, ME4118 sought to sustain a rigorous and meticulous scientific approach to the development and assessment of indicators, as well as promote transparency in indicator formulations.[21] This thesis analyzes how law and policy provide a medium for science and how, in turn, scientists must know the risks and assessments of policy and law in the advice that they give. Hence this thesis indicates that an understanding can be reached as to how science, policy and law are interrelated and the depth to which interfacing occurs between various policy goals (scientific, social, economic and legal). This, in turn, contributes to the advancement of knowledge in this field.

1.2 Overall Aim of the Thesis

This thesis provides a detailed, critical analysis of legal and policy frameworks, at the international, European and national levels, with a focus on how marine environmental indicators are used. Furthermore, it seeks to measure the effectiveness of such indicators, as well as their foundation within science (or lack thereof). It analyzes the resultant relationships that have evolved between science, policy and legislation, with a particular focus on the utilization of indicators within national marine industries. The overall aim of this thesis is to provide a critical analysis of marine environmental indicators within regulatory and policy texts. The central argument of this thesis is that indicators are relevant within legislative and policy agenda – they create dialogue and bridge communication gaps.

As this thesis demonstrates, the use of indicators is developing rapidly, and often within quite flexible statutory regimes. While the thesis aims to provide a broad ranging review of international, regional and domestic regulatory regimes, it cannot exhaustively describe such regimes given the extensive scope of marine law and policy at these levels. Instead the emphasis is on the techniques and approaches used to accommodate indicators and similar devices. In order to assess how scientific and

[21] H Rees (2006) *supra* note 15 (p 4, 11)

technical practice has developed within operative legal regimes, the focus is on regimes operative as of 2011. This includes the principal regulatory and policy frameworks governing marine activities in general and dredging/aggregates in particular.

The dredging/aggregate case study was prioritized by Defra, but also provides an opportunity to test the interface between law and science in a regime influenced by international, regional and national law and policy. This case study was selected because it represents an important industry within the UK. Arguably, it reveals the utility of environmental indicators in a regulatory context and the importance of integrating law and science at the development and application stages of indicators. The marine aggregate industry provides a useful case study since, historically, it has been a complex and fragmented industry with many agencies, policies and legislation overlapping in practice.[22] And although transition is currently underway from the more fragmented system to the new Marine Management Organization (MMO) licensing system, this industry can still be used to analyze the extent to which indicators are operationally efficient.[23]

Indicators must be based on robust and defendable science to assess marine health and underpin marine management.[24] The key research questions that this thesis addresses are as follows:

1. Can indicators used in marine contexts achieve operational utility?
2. What is a successful indicator?
3. How does the use of marine environmental indicators vary in terms of the scale they are used at (e.g. international, European, national)?
4. How does the use of marine environmental indicators vary between law and policy (at different scales)?
5. Are indicators efficiently used in both law and policy at the international, European and national scales?

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[22] S Gubbay "A Review of Marine Aggregate Extraction in England and Wales, 1970-2005" [2005] 36pp

[23] Defra (2002) *supra* note 13. Also see Elliott (2011) "Marine Science and Management Means Tackling Exogenic Unmanaged Pressures and Endogenic Managed Pressures – A Numbered Guide" Marine Pollution Bulletin 62: 651-655

[24] Ibid, at p 651

6. What are the instances of success and failure in marine environmental indicator development and application?
7. Does law influence policy or policy influence law in the development and application of marine environmental indicators (e.g. is there a top-down or bottom-up influence)?
8. What evidence is there that indicators have made a difference in successfully managing resources?

1.3 Thesis Structure

The subsequent six chapters of this thesis explore the communicative roles of indicators in international, European and national legal and policy instruments. Figure 1.2 is a schematic diagram showing the layout of the thesis. Since this thesis argues that legislation is supported by policy, the chapters will be laid out with legislation first, followed by policy starting with the international scale and working down to the national scale. Through this approach, the thesis will answer the key research questions and link the analysis of indicator development and application across pertinent legal and political frameworks at the three levels.

Chapter 2 explains the meaning and use of the concept of an indicator, emphasizing how its use is highly contextual (hence the reviews of different decision support systems and subsequent analysis of regulatory frameworks). Although it is impossible for an indicator to meet every criteria, they should at least meet most, if not all, of the four core functions of an indicator. This chapter answers research question 2 and determines how the effectiveness and efficiency of an indicator can be measured.

Chapter 3 explores International Environmental Law and its influence on indicator development and application. This type of law provides the broad regulatory context within which indicators can be used and applied within the legal scopes. For example, international agreements may generate standards (indicators) that are adopted in national legislation, or which guide decision-makers in areas that have multiple interfaces (such as international trade and the environment).[25] This chapter provides analysis for research questions 1-7.

[25] S Bell and D McGillivray *Environmental Law* (OUP 2006) 910pp (p 144)

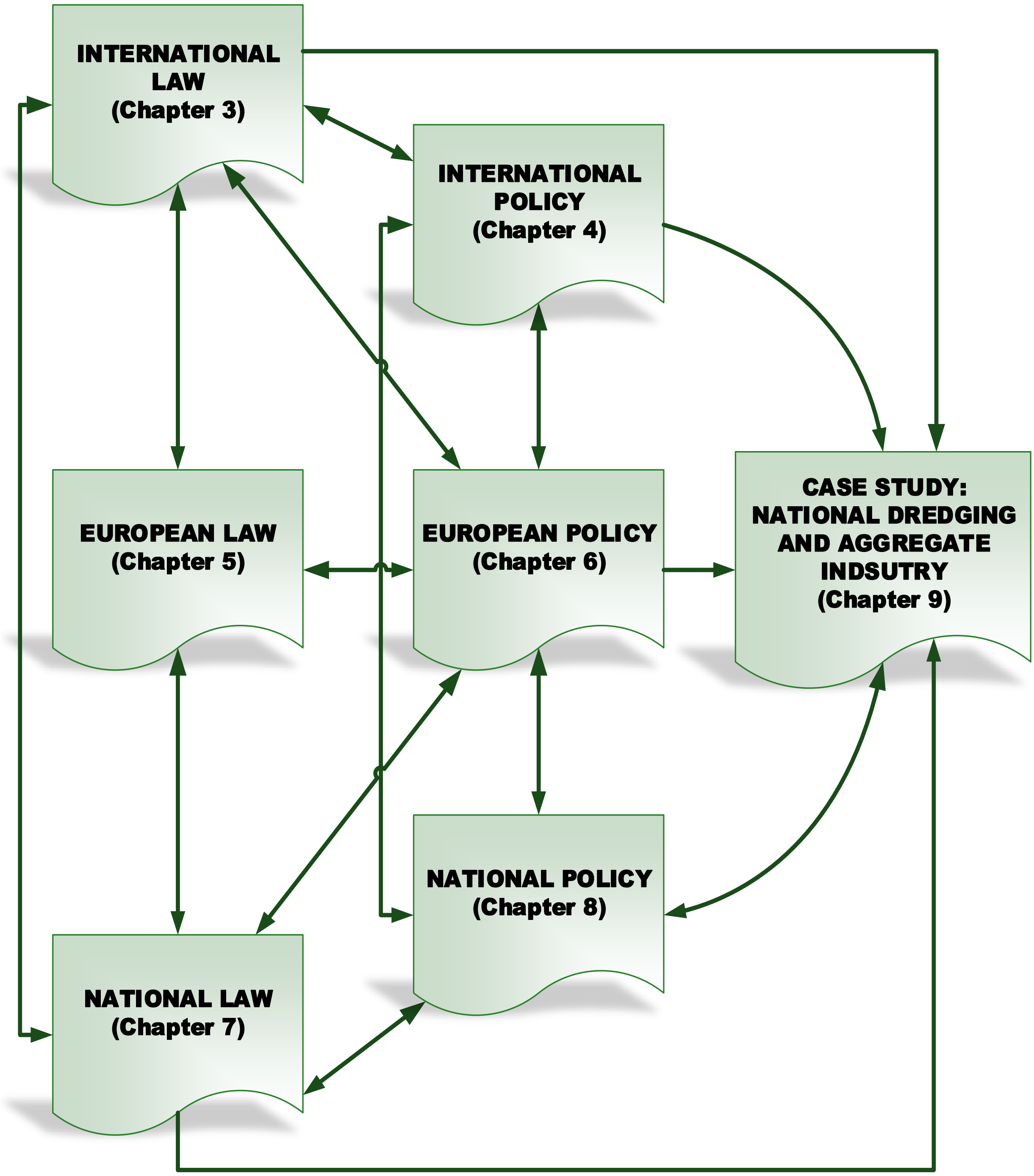

Figure 1.2: Schematic diagram showing the layout of the thesis. The arrows go both ways between each level because although legislation is supported by policy documents and there is clearly a top-down approach (International→European→National), this thesis analysis demonstrates that marine environmental indicators are also influenced from the bottom up. These, in turn, all influence the chosen case study.

Chapter 4 explains the role of indicators in International Environmental Policy. For a number of issues relating to the marine environment, action has been required to be instigated at an international level. This is due to the trans-boundary nature of the ocean, which allows human activities to impact areas beyond national boundaries.

Additionally, environmental problems commonly regarded as local, regional or national may have international or even global ramifications (i.e. global climate change, the use of outer space and the deep sea bed, fishery management, etc.).[26] These issues often arise beyond the jurisdiction of any single national government and are inherently international in scope.[27] Without international policy, a clear understanding of the marine environment and the corresponding data collected from indicators cannot effectively occur. The analysis from this chapter will be used to help answer research questions 1-7.

Chapter 5 explains the role of EU Environmental Law, which has become an important source of environmental legislation, thus creating a profound impact on the direction and trend of global environmental law. The EU requires a purposive approach to environmental law, combined with specific standards (measured via indicators) for environmental quality and emission levels, to provide clarity when drafting the legislation in different languages and for transposition into various national strategies.[28] International and EU reviews are necessary in this thesis to meet the requirements laid out in ME4118. Furthermore, they delimit the scope of indicators within domestic regulatory frameworks, and facilitate interactions in respect of marine systems that transcend national boundaries (hence why Defra sought such reviews in ME4118). Again, the analysis of this chapter will be used to help answer research questions 1-7.

Chapter 6 analyzes the use of indicators within environmental policies of the EU. It demonstrates that the indicator concept has become an important element of all facets of contemporary marine management and regulation within the EU. It also explores various policy documents to demonstrate that the EU has become a powerful advocate for the protection of the marine environment and a strong supporter for the utilization of environmental indicators. Through the literature reviews and subsequent analysis, further insight is gained towards research questions 1-7.

Chapter 7 of this thesis explores national environmental law and the importance of indicators in domestic environmental legislation. It demonstrates that

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[26] Lynton Keith Caldwell *International Environmental Policy: Emergence and Dimensions* (DUP 1990) 460pp (p 12)
[27] Ibid, at p 12
[28] S Bell and D McGillivray (2006) supra note 25 (p 88)

indicators provide communication and allow England to assess how scientific, economic and social goals are interconnected with respect to the marine environment. The UK must have such tools to balance conservation needs with human demands placed on the marine environment, in order to meet social and economic requirements.[29] Arguably, by utilizing indicators, the UK can achieve its sustainable development objectives and its ambitious vision for the marine environment. This analysis further answers research questions 1-7 and demonstrates that although marine environmental indicators are influenced by a top-down approach, they are also shaped from the bottom-up.

Chapter 8 explores the role of indicators within national policy. English policy documents demonstrate that an approach to marine management founded upon confident and scientifically sound environmental indicators has a high degree of political legitimacy and currency.[30] This chapter analyzes the use of environmental indicators in national policies within the UK to show how the indicator concept has become an important element of contemporary marine management, most particularly as it pertains to set policy agenda and augments the analysis that supports research questions 1-7.

Chapter 9 examines a specific case study (national marine aggregate-extraction industry). This case study investigates the indicators employed within the environmental management of this industry, as well as discusses the current national regulatory framework in relation to the requirements of EC Directives, European policies and international regulatory and policy frameworks. In addition to supporting the analysis for research questions 1-7, this chapter provides evidence to help answer research question 8.

Since this is a law thesis, the research is a combination of methodologies. It is mainly doctrinal, library based analysis of texts, with some comparative and case study elements added to test the findings and support the answers to the research questions. Literature was collected to analyze various marine environmental indicators and their application in legislative and policy texts. Common patterns at the three levels of

[29] Defra, *A Sea Change: A Marine Bill White Paper* (2007) (p 2)
[30] Defra, *The Government's Responses to Its Seas of Change Consultation to Help Deliver Our Vision for the Marine Environment* (2004) (p 7)

governance have been interrogated to determine the use of these types of indicators in international, European and national texts, as well as to determine the effectiveness of such indicators between law and policy. A variety of sources were utilized to synthesize the answers for the research questions. Furthermore, summaries of the findings were produced in conceptual diagrams (based on the literature) throughout the thesis. These diagrams were populated with cross-referenced evidence gathered from regulatory and policy-based texts, as well as case studies, judicial findings and a specific marine industry (marine aggregate dredging). Although this approach was largely determined by the Defra research project, this thesis went further and provided a critical analysis and comparative interdisciplinary study to determine the importance of marine environmental indicators in the development and application of regulatory and policy texts.

This thesis probes the relationships that have evolved and now exist between various policy goals (i.e. scientific, social, economic and legal) through the development and application of marine environmental indicators. It demonstrates, through historical and contemporary literature, the effectiveness of such indicators. It also analyzes their foundation within science (i.e. are they scientifically or politically driven?) and ultimately provides a critical assessment of the operational efficiency of marine environmental indicators by answering eight key research questions.

Chapter 2: Indicators

2.0 Indicators Explained

This chapter defines and explains how indicators are used. It demonstrates that indicators are highly contextual. By examining the principle decision support systems within which they are used, as well as reviewing the literature on indicator attributes, this chapter is able to demonstrate their core function of communicating information. This can enhance understanding of natural and social systems, and, in turn, facilitate (marine) environmental decision-making.

The indicator concept is an important element of contemporary marine management and regulation.[1] For the purpose of this research, an indicator is conceived of as a tool utilized for the specific purpose of identifying and communicating change in a system. It is a parameter, or a value derived from parameters, that reveals information about or explains the circumstances of a phenomenon, environment or region.[2] Primary indicators are those which are a direct measurement, e.g. fish stock size. Secondary indicators are those derived from a set of parameters, e.g. a diversity index which is derived from species richness and abundance. Indicators possess meaning that stretches beyond what is directly associated with the parameter value.[3] For example, an indicator on water quality may illustrate the current chemical or biological parameters of the water, but it can also demonstrate the effects of human activities on the environment (i.e. through pollution, dumping, aggregate extraction, etc.).

Furthermore, an indicator quantifies and illustrates change by measuring and charting an operational objective. These can include objectives for both the pressures generated by human activities and the state of components.[4] For example, an indicator can be utilized to chart the quality of bathing waters, to ensure that regulators are meeting the objectives fleshed out in the EC Bathing Waters Directive.[5] Indicators can also have an operational meaning. They can be derived with a management action

[1] S Gubbay "A Review of Marine Environmental Indicators: Reporting on Biodiversity Aspects of Ecosystem Health" [2004] 73pp (at p 7)
[2] M Linster "OECD Work On Environment Indicators 'INECE-OECD Expert Workshop on Environmental Compliance and Enforcement Indicators: Measuring What Matters'" [2003] 8pp (p 2)
[3] Ibid, at p 2
[4] Ibid, at p 8
[5] Council Directive 76/160/EEC of 8 December 1975 Concerning the Quality of Bathing Water [1976] OJ L 31, 5.2.1976 76/160/EEC

in place, such that if the indicator is breached, action can be taken. They provide a bridge between objectives and action.[6] Ultimately, indicators serve four basic functions: communication, simplification, quantification, and standardization.[7] These are ordered according to the hierarchy that this research has found as important, and will be known as the core functions of an indicator moving forward.[8] Although indicators do not have to meet all four core functions, this research has found that the strength and effectiveness of an indicator is determined by its ability to meet most, if not all, of the four functions.

Although not always explicitly identified in a legislative and policy context, indicators are nonetheless widely used in both (as demonstrated by Annex I of the Bathing Waters Directive).[9] Often, they are referred to by such terms as “standards”, “targets”, “trigger-values”, “thresholds”, “bench-mark values”, and “criteria”, against which specific variables or indicators are assessed.[10] Some scientists have even argued that limits and targets are benchmark values of an indicator, as they detail where a specific parameter lies in relation to an overall set objective, management goal, or subsequent management action.[11] The fixed and variable elements of the many terms for indicators are therefore used synonymously in any discussion of indicator utility and operational efficiency in a policy and regulatory context.[12] Table

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[6] FAO *Indicators for Sustainable Development of Marine Capture Fisheries FAO Technical Guidelines for Responsible Fisheries* (1999) 68pp

[7] UNEP, *Monitoring and Indicators: Designing National-level Monitoring Programmes and Indicators* (Note by the Executive Secretary. Subsidiary Body on Scientific, Technical and Technological Advice. Convention on Biological Diversity, UNEP/CBD/SBSSTA/9/10, 2003) 45pp; Also see Elliott “Marine Science and Management Means Tackling Exogenic Unmanaged Pressures and Endogenic Managed Pressures – A Numbered Guide” [2011] Marine Pollution Bulletin 62: 651-655; Also see Aubry and Elliott (2006) “The Use of Environmental Integrative Indicators to Assess Seabed Disturbance in Estuaries and Coasts: Application to the Humber Estuary, UK” [2006] Marine Pollution Bulletin 53: 175-185

[8] The importance of these four core functions in this particular order is seen throughout the subsequent chapters, specifically, Chapter 2 (pg. 14), Chapter 3 (pg. 55, 58, 73 85), Chapter 4 (pg. 98, 99, 104, 111) and Chapter 5 (pg. 146, 151) among others.

[9] Council Directive Concerning the Management of Bathing Water Quality and Repealing Directive 76/160/EEC 2006/7/EC [2006] OJEU L 64/37-64/51 (Annex I)

[10] Royal Commission on Environmental Pollution *Setting Environmental Standards* (21st Report,’ 1998) 232pp

[11] S Rogers and M Tasker “The Manchester Workshop on Marine Objectives: A Workshop to Identify Objectives in Support of the UK Vision for the Marine Environment” [CEFAS unpublished report, 2005] 43pp (p 8)

[12] E Bayer, R A Barnes and H L Rees “The Regulatory Framework for Marine Dredging Indicators and their Operational Efficiency within the UK: A Possible Model for Other Nations?” [2008] ICES Journal of Marine Science 65 pp1402-1406 (p 1402)

2.1 provides the typology of indicators that are discussed and analyzed throughout this chapter and the subsequent chapters.

Table 2.1: Typology of Indicators discussed in this thesis

INDICATOR TYPOLOGY	MEANING	EXAMPLE
Primary	Directly measured	Fish Stock Size
Secondary	Derived from parameters	Diversity Index
Univariate **Individual** **Sector**	Report on one feature of an ecosystem	Level of a particular pollutant
Suite **Summary** **Headline** **Multivariate**	Report on ecosystem function	Effect that pollution has on traditional food webs
Pressure	Reflect anthropogenic pressures	Sewer Discharge
State	Report on the status of the environment	Water Temperature
Response	Reactions to prevent, or change damage	Environmental Statements
Driving Force	Produce pressure indicators	Urban Growth
Impact	Result from state indicators	Declines in fishery population
Type A **Descriptive**	Depict what's happening	Acidification
Type B **Performance**	Reference value	Targets for Nitrogen established by the EU
Type C **Efficiency**	Illustrative of success	Decreases in Emissions
Type D **Welfare**	Illustrative of overall welfare	Economic Success
Redundant	Communicate the same information	Biomass and Ash Free Dry Weight

Environmental indicators illustrate a specific aspect of the environment with the aim of guiding policy makers and informing the public of the effectiveness of both legislation and management in improving the state of the environment.[13] It has been argued that communication is the main function of indicators.[14] They should enable or promote information exchange regarding the issue that they address.[15] This thesis maintains that indicators are intended to relay technical information in a more comprehensible manner, i.e. communication is their main function. Effective communication demands simplicity, clarity, common language and shared understanding (which directly ties to the four core functions of an indicator mentioned above). Thus, indicators should communicate and simplify a complex reality.[16]

Indicators communicate a conceptually simple expression of the need for management action, despite the fact that the underlying science behind the indicator may in fact be quite complex.[17] These simple expressions are advantageous, as they provide transparency and can help to reduce and/or eliminate disagreements between sometimes conflicting interests.[18] Further to this, effective management requires measurement and predefinition of action. Established indicators pre-set the measurements that, once breached, would trigger action from a management level. Indicators offer a common language and approach to the management of the environment within policy and law via their communicative abilities.

Environmental indicators supply information on environmental problems and the seriousness of such issues.[19] They are also employed to support policy development and priority setting by identifying key factors that cause pressures on the environment, as well as monitor the effects of policy responses.[20] Thus, many purposes exist for indicators, with communication being their most important function.[21] They can measure and communicate the performance of environmental/ecological quality status and regulatory effectiveness.[22] These include

[13] S Gubbay (2004) *supra* note 1 (p 11)
[14] E Smeets and R Weterings "Environmental Indicators: Typology and Overview" [1999] 19pp (p 5)
[15] Ibid, at p 5
[16] Ibid, at p 5
[17] Ibid, at p 1402
[18] Ibid, at p 1402
[19] EEA *Environmental Indicators: Typology and Overview* (Technical Report No. 25 to the European Environmental Agency, 1999) 19pp (p 5)
[20] Ibid, at p 5
[21] H L Rees *et al* "Role of Benthic Indicators in Regulating Human Activities at Sea" [2006] Environmental Science & Policy 9 496-508pp (p 497)
[22] Ibid, at p 497

indicators to measure reductions in effluent loads in response to regulatory action.[23] They can also provide a less prescriptive means to meet legal requirements. Furthermore, indicator formulations and the management schemes within which they are embedded must be responsive to new scientific knowledge.[24] Going back to the basic definition of an indicator, they are used to identify and communicate change in a system.

Thus, indicators are of immense significance to policy and law. They measure the bearings that legislative initiatives have had on both the quality of the environment and the socioeconomic circumstances of coastal regions throughout the world, as well as the future of sustainable development.[25] Indicators can communicate this technical information in a more simplified manner, thus bridging the known gap that exists between scientists, policy-makers, legislators and non-specialists. Through such effective communication, indicators can arguably allow for a better opportunity to exchange information on spatial and temporal patterns in the environment.[26] This, in turn, helps to ensure that human activities remain compatible with environmental management needs.[27] A summary of some of the strengths and weaknesses for utilizing indicators is provided in Table 2-2.

Currently, governments recognize that an understanding must be reached as to how scientific, economic and social goals are interconnected and how effective communication can be established between all three.[28] Arguably indicators offer a means to communicate and disseminate technical information in relatively simple means, despite the fact that the underlying science may be complex. Yet, with simplification there exists the possibility of reducing a very complex situation into a too-simple index. Thus, if indicators 'translate' complex information' into easier language, then they must do so without compromising the integrity of the underlying information, or there must be a balancing between the loss of 'quality' and the effectiveness of the decision-making system. Regardless, indicators promote more efficient communication, improved transparency and dissemination of information

[23] H L Rees *et al* (2006) *supra* note 21 at p 497
[24] Ibid, at p 499
[25] C Mageau and J Barbiere "Preface" [2003] Ocean & Coastal Management # 46 pp 221-223 (p 221)
[26] E Bayer, R A Barnes and H L Rees (2008) *supra* note 12 (p 1402)
[27] Ibid, at p 1402
[28] Ibid, at p 1402

among the various agencies. This allows human activities to remain compatible with environmental needs so that progress can be sustained for the entire planet into the distant future. In other words, they contribute towards sustainable development.

Table 2.2 Summary of some of the strengths and weaknesses for utilizing indicators[29]

Strengths of Indicators	**Weaknesses of Indicators**
1.) Communication	1.) No clear and concise definition
2.) Identify and quantify change in a system	2.) Inconsistencies in development and application
2.) Bridge objectives with action	3.) Confusing terminology
4.) Guide policy makers and support policy development	4.) Underlying science may be incomplete or uncertain
5.) Inform the public	5.) Need to be constantly revised
6.) Offer simplicity, clarity, common language and shared understanding	6.) Simplification can mislead or reduce a very complex situation into a too-simple index
7.) Simplifies a complex reality	
8.) Measure legislative initiatives	

Furthermore, because sustainable development involves action across science, policy and law at the national, regional and international levels, more complex and comprehensive indicators are required, which are capable of measuring/communicating complex interactions between the environment, society and the economy.[30] Thus, a recent trend has replaced individual and sectoral indicators with suites of indicators that are able to reflect and report on ecosystem structure and function, as opposed to one specific feature.[31] Otherwise referred to as headline or summary indicators, these suites of indicators are used (complimentarily) to communicate the complex issues that arise when pursuing an ecosystem based approach to marine management.[32] They are necessary to adequately report on ecosystem health, structure and function.[33] Additionally, indicators not only report on

[29] See Table 2.3 for details on the literature reviews that support these findings.
[30] J Prescott "Quality of Life Counts: Indicators for a Strategy for Sustainable Development for the United Kingdom: A Baseline Assessment" [1999] 310pp (p 3)
[31] S Gubbay (2004) *supra* note 1 (p 9)
[32] Ibid, at p 21
[33] Ibid, at p 21

ecosystem condition, but also communicate compliance with various legislative initiatives (i.e. for marine licenses).

Indicators depend upon good science, yet the underlying knowledge base may sometimes be incomplete or uncertain. This is seen with the marine environment, as the present level of understanding of marine ecosystems is inadequate.[34] This inhibits the development of robust and meaningful measures on a holistic scale for the marine environment.[35] Until such a feat is accomplished, any management approaches that are developed will be unable to deliver a higher level of environmental protection.[36] Thus, the development and utilization of indicators and associated standards is a process that may have to be repeatedly adjusted as understanding of the environment improves with scientific comprehension.[37] If this is not reflected within regulatory context, then the management approach will ultimately be ineffective.

Such barriers are being overcome through developments in marine management, which recognize the importance and need for robust scientific research.[38] This includes the development of marine indicators. Furthermore, emphasis is placed on the need for the precautionary principle where scientific evidence is not conclusive.[39] This approach assumes that an opportunity will be provided to revisit the indicators as scientific knowledge of the environment increases. Thus, this management utilizes caution in any and all cases where it is believed that action within the marine environment will cause human harm or affect the ecosystem and its resources, even when there is insufficient scientific evidence.[40] Such uncertainties in meaning and knowledge mean that effective, transparent and clear communication will be a key feature of decision-making systems. Consequently, a clear understanding of indicator usage is essential. It must be embraced by regulatory agencies, in order to realize where the gaps in knowledge lie, and how these can be overcome. Furthermore, there is a need to analyze specific case studies (similar to the

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[34] S I Rogers and B Greenaway "A UK Perspective on the Development of Marine Ecosystem Indicators" [2005] Marine Pollution Bulletin #50 p 9-19 (p 11)
[35] Ibid, at p 11
[36] Ibid, at p 11
[37] H L Rees (2006) *supra* note 21 (p 4, 11)
[38] Defra, *The Government's Responses to Its Seas of Change Consultation to Help Deliver Our Vision for the Marine Environment* (2004) (p 7)
[39] Ibid, at p 7
[40] Ibid, at p 7

analysis undertaken within this thesis regarding the marine-aggregate and extraction industry), in order to determine how these gaps in scientific understanding affect policy and law. Such case studies allow comprehension on how the best scientific data is being employed in a regulatory context. Furthermore, it provides policy makers and regulators an opportunity to help shape or answer some of the potential problems that science is facing.

There are various ways that indicators can be applied to meet management objectives. But the function of an indicator is context specific, thus the effectiveness or efficiency of an indicator will depend on the user who develops, applies and interprets the indicator. Consequently, a clear understanding of the various frameworks which employ indicators is essential. These frameworks tend to structure or require indicators to operate in certain generic ways, hence the many different functions for which indicators are used (and which were addressed in this section). The subsequent section will review the most common indicator frameworks and further explore the various functions of indicators (as determined by the context in which they are applied).

2.1 Indicator Frameworks

As stated above, it is necessary to review the main indicator frameworks, as management frameworks may demand certain types of indicators. By understanding the various indicator frameworks, one can better understand the qualities demanded of different indicators (i.e. descriptive, performance, response, etc.). Furthermore, it is important to explore the concepts that influence indicators, as they often include non-scientific values. Costs and benefits exist when utilizing marine indicators within the auspice of environmental management objectives (see Table 2.2). This section will highlight how indicators are linked to management objectives, and consequently, are connected to social/political values, as well as scientific principles.[41]

[41]The field is now moving rapidly because of the Marine Strategy Framework Directive – see Hering, *et al* "The European Water Framework Directive at the age of 10: A critical review of the achievements with recommendations for the future" [2010] Science of the Total Environment 408(19): 4007-4019; See also Borja *et al* "Marine Management – Towards an Integrated Implementation of the European Marine Strategy Framework and the Water Framework Directives' [2010] Marine Pollution Bulletin 60: 2175-2186

Mageau and Barbiere suggest that there are a number of commonly used indicator frameworks.[42] The most significant frameworks are the Pressure-State-Response (PSR) framework developed by the Organisation for Economic Co-operation and Development (OECD); as well as the revised Driving forces-Pressure-State-Impacts-Response (DPSIR) framework adopted by the European Environment Agency (EEA) and other international organizations.[43] Similar frameworks cited by Mageau and Barbiere include the Input-Output-Outcome-Impact framework of the World Bank and the model developed by the Coastal Resources Center to track different orders of subsequent outcomes of the integrated coastal management (ICM).[44] In recent years, the traditional DPSIR framework has evolved to the State Change-Impact-State Change Welfare (SCISCW), as well as the Drivers-Pressures-State Change-Exposure-Effects-Action-Context (DPSEEAC) frameworks. These frameworks themselves continue to evolve.[45] However, despite the increasing sophistication of the indicator frameworks, certain core functions and features of indicators remain constant (e.g. the four core functions). This will be discussed in greater detail in Section 2.2.

2.1.1 PSR Framework

Policy makers and legislators aim to ensure sustainable development of the marine environment by reducing the pressures exerted upon it, via a various network of indicator frameworks. [46] These frameworks act as reporting systems, focusing specifically on three types of indicators: pressure (P), state(S) and response (R).[47]

Pressure indicators reflect the anthropogenic pressures that are placed on the environment as a result of human activities (such as marine-aggregate dredging and commercial fishing).[48] From a policy perspective, they are often considered as the starting point for tackling environmental issues.[49] They describe developments in the

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[42] C Mageau and J Barbiere (2003) *supra* note 25 (p 222)
[43] Ibid, at p 222
[44] Ibid, at p 222
[45] Smith *et al* "Conceptual Models for the Effects of Marine Pressures on Biodiversity: Deliverable 1.1." [2014] 82pp
[46] S I Rogers and B Greenaway (2005) *supra* note 34 (p 9)
[47] J Jones "Development of Indicators on the Quality of the Marine Environment: Proceedings of the Seabed Disturbance Indicators Workshop [Five Lakes Tolleshunt Knights 6&7 February 2002] 72pp (p 5)
[48] OECD, *OECD Environmental Indicators: Development, Measurement and Use* (2003) (p 4)
[49] Ibid

release of substances (emissions), physical and biological agents, the use of resources and the use of land.[50] In other words, they are particular stressors on the environment in the form of direct pressures.[51]

Pressure indicators include such examples as sewage discharges and increased organic inputs,[52] as well as the measurements of nutrient or contaminant flux, or sediment toxicity.[53] Other examples of pressure indicators include the measurement of dredging activities, which can be achieved by estimating quantities of residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation, etc.) resulting from the operation of the dredging project.[54] The dredging activity itself can be measured by assessing the annual extraction of sediments from the marine sea bed (i.e. 872,000 tons of sediments extracted from an extraction site in the Thames estuary in 1971) and comparing the historical dredging intensity levels against macrofauna and sediment samples collected within these areas.[55] An analysis of such indicators will be revisited later in this thesis, when a discussion on indicators and the marine aggregate-extraction industry of the UK is examined in depth.

State indicators represent the resultant condition of the environment, due to the exertive pressures placed upon it.[56] These affect human health and well-being, as well as the socio-economic fabric of society.[57] State indicators are responsible for describing the current status of an area. This is achieved through physical phenomena (i.e. temperature), biological phenomena (i.e. fish stocks) and/or chemical phenomena (i.e. atmospheric CO_2^- concentrations).[58] For example, if the state of the environment changes as a result of an increase level of nutrient run-off or increased pollution, then impacts on human health and the ecosystem will become apparent, such as a decline in shellfish productivity.[59] State indicators depict changes in environmental variables (geo/physical/chemical/biological) that describe the characteristics and conditions of

[50] E Smeets and R Weterings "Environmental Indicators: Typology and Overview" [1999] 19pp (p 9)
[51] A Aubrey, M Elliott and S Boyes "Effective Integration & Operational Use of P, S & I Indicators: Literature Review & Lessons for Thematic R&D under ME4118" [2006] Report to CEFAS 30pp (p 3)
[52] Ibid, at p 3
[53] H L Rees (2006) *supra* note 21 (p 497)
[54] E Bayer, R A Barnes and H L Rees (2008) *supra* note 12 (p 1404)
[55] Ibid, at p 501
[56] OECD (2003) *supra* note 48
[57] Ibid
[58] E Smeets and R Weterings (1999) *supra* note 50 (p 9)
[59] A Aubrey, M Elliott and S Boyes (2006) *supra* note 51 (p 2)

the coastal zone (such as reduced oxygen levels, increased water turbidity, degraded communities, etc.).[60] Not all activities result in impacts that are readily detectable, however. As a consequence, state indicators are often used as indicators of impacts as well.[61]

Examples of state indicators can be found in Annex I of the Bathing Water Quality Directive.[62] These indicators include such measurements as Intestinal enterococci and Excherichia coli, both of which are employed to determine the status of the bathing water (i.e. poor, sufficient, good and excellent quality) for coastal and inland waters.[63] For example, if the indicator Intestinal enterococcus rises above 100 cfu/100 ml of inland water, then according to Annex I, the bathing water drops from excellent quality to good quality in response to the increase in bacteria that is now present in the water. Likewise, coastal bathing waters would be classified as poor quality if the Escherichia coli indicator was worse than the 500 cfu/100 ml of coastal water.[64]

Lastly, response indicators identify the reactions taken by society to either prevent damage to the environment (by acting on the pressures influencing it) or to alter its already observed state (via a modification of the state indicators).[65] These human responses are essentially the employment of policy and legal controls, which are implemented in response to the environmental problem.[66] Thus, the responses feedback on the driving forces, as well as the state or the impacts through adaptive or curative action.[67] There are different societal responses that can be employed. These include negative driving forces, which endeavor to redirect existing trends in consumption and production patterns.[68] Additional responses seek to improve the efficiency of products and procedures by stimulating the development and penetration of clean technologies.[69] Response indicators can also be economic and legislative

[60] A Aubrey, M Elliott and S Boyes (2006) *supra* note 51 (p 3)
[61] Ibid, at p 2
[62] Council Directive Concerning the Management of Bathing Water Quality *supra* note 9
[63] Ibid, at Annex I
[64] Ibid, at Annex I
[65] E Smeets and R Weterings (1999) *supra* note 50 (p 9)
[66] EEA (1999) *supra* note 19 (p 6)
[67] Ibid, at p 6
[68] E Smeets and R Weterings (1999) *supra* note 50 (p 10)
[69] Ibid at p 10

instruments, and are often the actions that follow the employment of the environmental indicators.[70]

A specific example of a response indicator occurs when a regulator placing more stringent conditions when he/she issues a dredging permit in order to protect a specific area of the sea bed, or alternatively, their agreement to issue a permit and allow the dredging activity to proceed as described. According to the 2007 UK Regulations governing the marine aggregate-dredging and extraction industry, the information (indicators) required, along with accompanying scientific metrics, are designed to be employed within an Environmental Statement.[71] Although the Environmental Statement has no legal basis for the license, it is required to get permission for a license. Indicators, therefore, provide the regulator with the necessary information to issue or withhold a dredging permit by weighing the economic benefit from the dredging activity against the environmental impact and sustainability.[72] These types of indicators will be discussed in greater depth in chapter 9 of this thesis, which analyzes the marine aggregate-dredging and extraction industry of the UK.

Thus, the PSR framework is established upon a series of feedback loops, which form a type of environmental policy cycle.[73] This can be seen in Figure 2.1 and is further illustrated in Figure 2.2. These steps form part of an environmental policy cycle that includes problem perception, policy formulation, monitoring, and policy evaluation.[74] Although the PSR framework does establish a series of links between P, S and R indicators, its main folly lies in the fact that sometimes these links suggest linear relationships in the human activity-environment interaction.[75] This neglects the more complex relationships that exist within ecosystems, as well as within environment-economy interactions.[76]

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[70] A Aubrey, M Elliott and S Boyes (2006) *supra* note 51 (p 3)
[71] The Environmental Impact Assessment and Natural Habitats (Extraction of Minerals by Marine Dredging) (England and Northern Ireland) [2007] SI 2007 No 1067 (Para 10)
[72] Ibid, at Para 10
[73] OECD, *OECD Core Set of Indicators for Environmental Performance Reviews: A Synthesis Report by the Group on the State of the Environment* (1993) (p 5)
[74] Ibid, at p 5
[75] Ibid, at p 5
[76] Ibid, at p 5

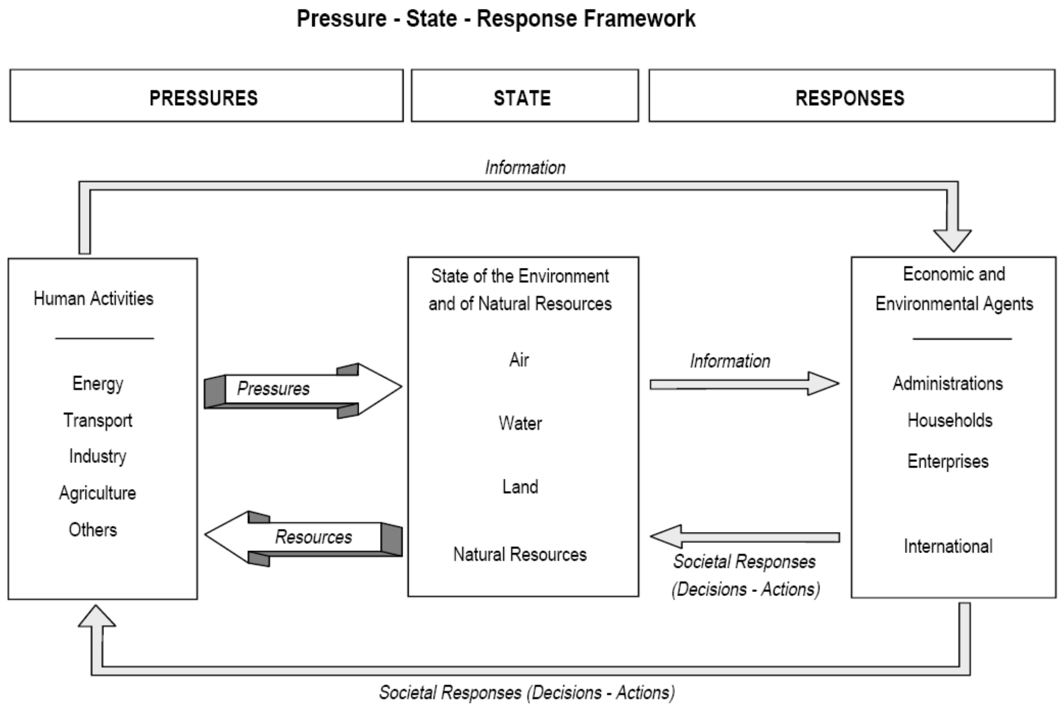

Figure 2.1: PSR Framework [77]

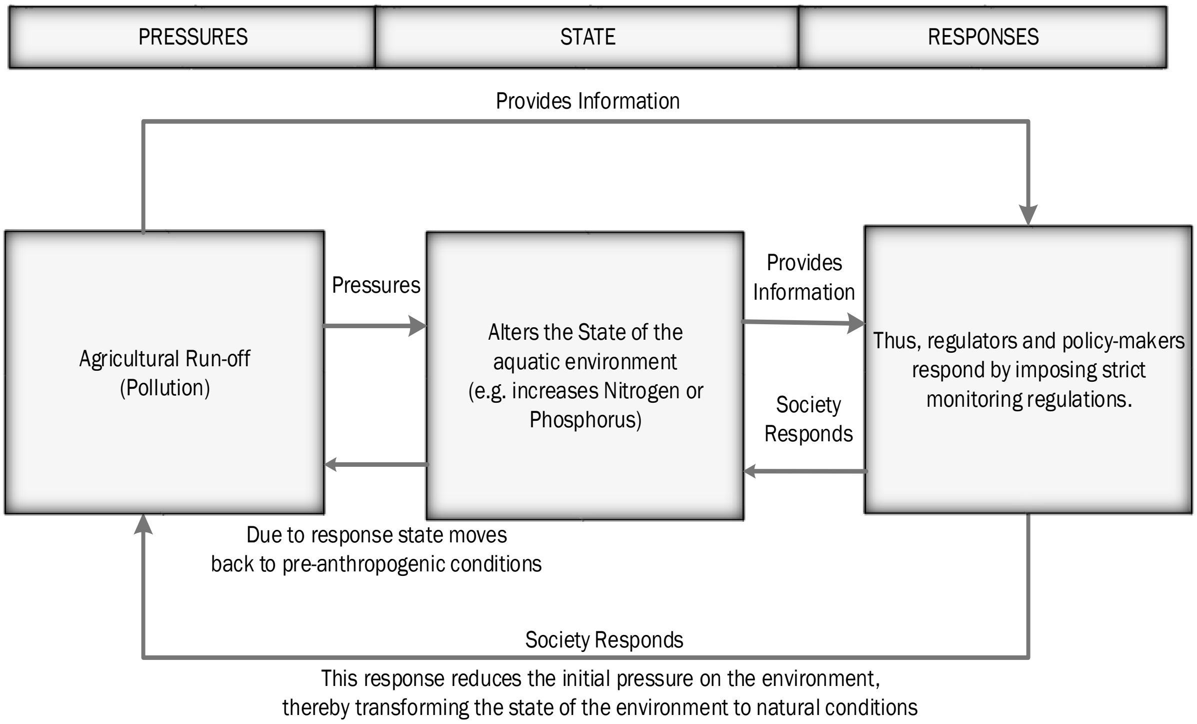

Figure 2.2: An illustrative example of the PSR Framework.
Modified from EEA (1999) supra note 19 (p 10).

[77] EEA (1999) *supra* note 19 (p 10)

2.1.2 DPSIR Framework

Depending on the type of indicator framework utilized, additional indicators (beyond the PSR indicators listed above) can be incorporated into marine management systems. For example, some frameworks call upon the use of indicators that not only identify the pressures placed upon the environment, but also the driving forces that produce such pressures.[78] Indicators that measure driving forces illustrate the social, demographic and economic developments in a society.[79] Further to this, they demonstrate the subsequent changes in the life styles of the population, as well as the inclusive levels of consumption and production patterns.[80] Often it is social and economic developments, such as urban growth or industry that exert pressure on the environment, which, in turn, changes the state of the environment.[81]

Similarly, some frameworks utilize indicators that not only identify the state of the environment, but the resultant impacts that such environmental conditions have upon society.[82] These include impacts that affect human health, ecosystem destruction, the state of the economy, etc.[83] Impact indicators are often associated with state indicators, most particularly in cases where the impacts of human activities are not easily measurable or known (due to lack of scientific knowledge, inadequacies in technology, etc.).[84] For example, the impacts that result from the discharge of heavy metals in waters (pressure indicators) are likely to be closely related to the concentration of heavy metals in waters (state indicators), even if no scientific measurement currently exists to determine the biological disturbance induced in the aquatic organism (impact indicator).[85] Impact indicators often elicit a societal response, which in turns feeds back on the driving forces that created the problem, or which feeds back and influences the initial state and impacts directly.[86] Some examples of impact indicators include the loss of amenity areas, declines in fisheries populations, eutrophication and reduced biodiversity.[87] In the State of the Environment reports, these indicators are usually employed to measure specific issues,

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[78] E Smeets and R Weterings (1999) *supra* note 50 (p 8)
[79] Ibid, at p 8
[80] Ibid, at p 8
[81] EEA (1999) *supra* note 19 (p 6)
[82] E Smeets and R Weterings (1999) *supra* note 50 (p 8)
[83] Ibid, at p 8
[84] A Aubrey, M Elliott and S Boyes (2006) *supra* note 51 (p 2)
[85] Ibid, at p 2
[86] EEA (1999) *supra* note 19 (p 6)
[87] A Aubrey, M Elliott and S Boyes (2006) *supra* note 51 (p 3)

such as changes in human health due to an increase in pollution of inland waters, damage to forests due to emissions and noise disturbance.[88]

Thus, the EEA revised the PSR framework to incorporate a more integrated approach to environmental assessment and policy-making.[89] As a result, the model known as the DPSIR framework was created. This framework differs from the PSR model, in that it separates and distinguishes between the various Driving forces, Pressures, State Changes, Impacts and Responses created via each environmental indicator.[90] It is a systems-based approach that captures key relationships between society and the environment, and is regarded as a philosophy for structuring and communicating policy-relevant research about the environment.[91]

Figure 2.3 illustrates the 'causal link' embodied by the DPSIR framework and Figure 2.4 provides a specific example of indicators in the DPSIR framework. In the context of the marine environment, the *Drivers* of social and economic development refers to the need for food, recreation, space for living and other basic human needs.[92] These are delivered via fisheries, coastal development, recreational sites and other activities related to the marine environment.[93] Each of these drivers creates *Pressures* on the system, such as exploitation of fisheries, extraction of the seabed, or discharges of contaminated waters.[94] As a direct result, a *State Change* of the system occurs, i.e. a change in the concentration of nutrients in the water column or the benthos.[95] This, in turn, produces *Impacts* on society, such as degraded habitats, removal of fish species, or loss of biodiversity, which through its links to human welfare can have positive and/or negative implications.[96] Lastly, there is a need to identify the societal *Response* to these changes in the marine system, which includes tools for managing the marine environment.[97]

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88 EEA (1999) *supra* note 19 (p 14-15)
89 Ibid, at p 4
90 Ibid, at p 6
91 J Atkins, D Burdon, M Elliott and A Gregory "Management of the Marine Environment: Integrating Ecosystem Services and Societal Benefits with the DPSIR Framework in a Systems Approach" [2011] Marine Pollution Bulletin 62(2) pp215-226 (p 215)
92 J.S. Gray and M. Elliott *Ecology of Marine Sediments – From Science to Management* (2nd Ed, OUP, 2009) 215pp (p 175)
93 J Atkins, D Burdon, M Elliott, and A Gregory (2011) *supra* note 91 (p 217)
94 Ibid, at p 217
95 Ibid, at p 217
96 Ibid, at p 217
97 Ibid, at p 217

Thus, the DPSIR framework provides a more detailed and comprehensive understanding of the complex relationships that shape the development of environmental indicators. It is a framework that assesses the causes, consequences and responses to various changes in a more holistic way.[98] Fundamental to the DPSIR framework is the definition of the boundary of the system it describes, the demarcation of which depends on the particular issues of interest and its conceptualization.[99] Also important to note is that pressures on the system can be separated into endogenic managed pressures and exogenic unmanaged pressures. Furthermore, there are natural pressures (based on ecology, climate, geomorphology and other dynamic conditions) that occur on the ecosystem and which can lead to a change in state.[100] Nevertheless, the DPSIR framework is both useful in describing the relationships between the origins and consequences of environmental problems, as well as lending to the understanding of the dynamics that occur between such links.[101]

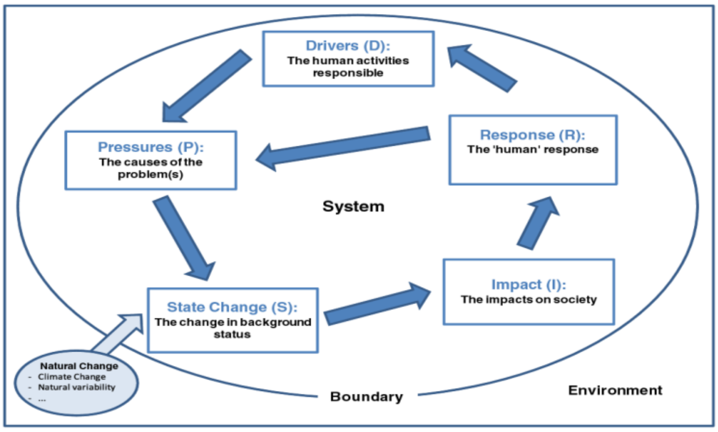

Figure 2.3: The DPSIR framework as a cycle and system in the environment[102]

[98] J Atkins, D Burdon, M Elliott, and A Gregory (2011) *supra* note 91 (p 217)
[99] Ibid at p 215
[100] Ibid, at p 217
[101] P Kristensen "The DPSIR Framework: Workshop on a Comprehensive/Detailed Assessment of the Vulnerability of Water Resources to Environmental Change in Africa Using River Basin Approach" [2004] 10pp (p 1)
[102] J Atkins, D Burdon, M Elliott, and A Gregory (2011) *supra* note 91 (p 216)

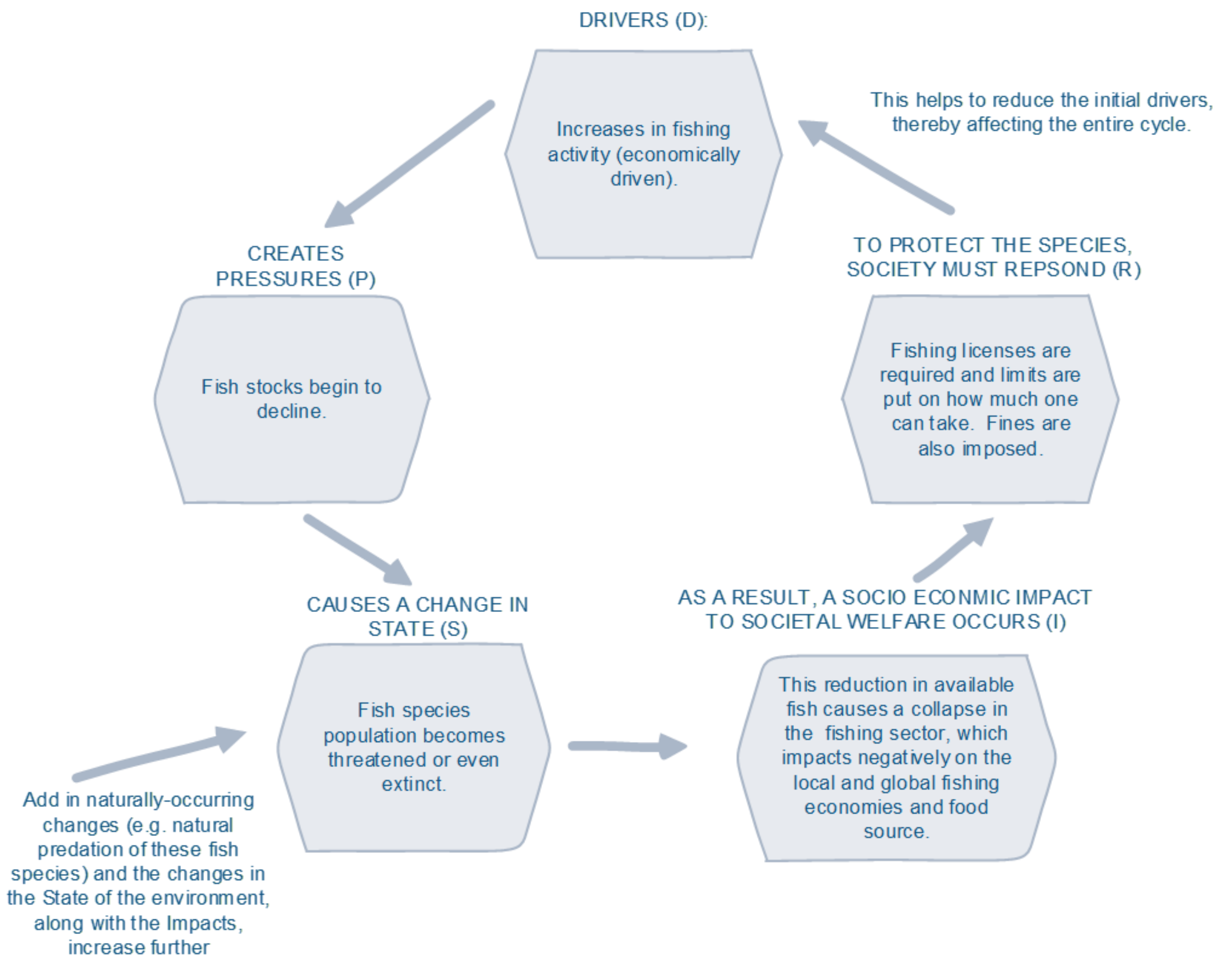

Figure 2.4: An illustrative example of the DPSIR Framework. Amended from J Atkins, D Burdon, M Elliott, and A Gregory (2011) supra note 89 (p 216).

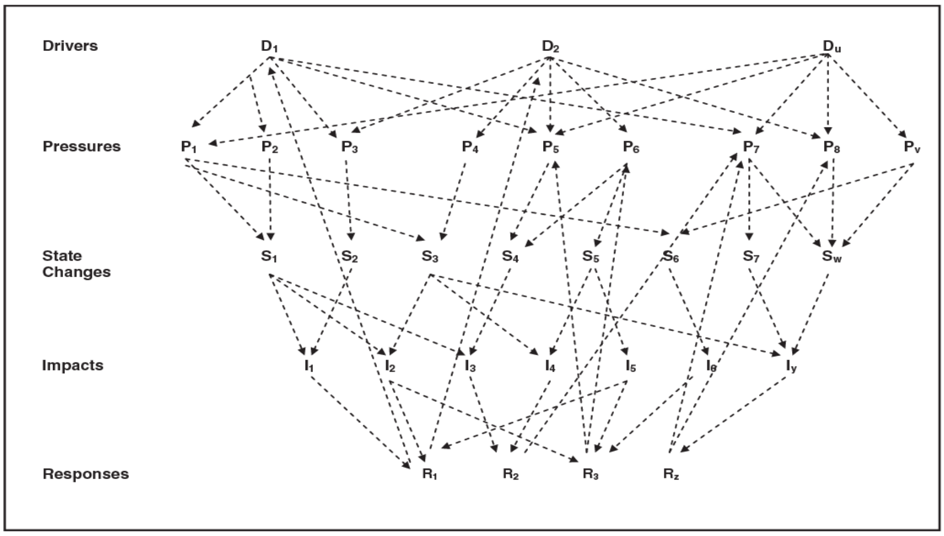

Figure 2.5: An illustration of the multiple interactions within the DPSIR framework[103]

[103] J Atkins, D Burdon, M Elliott, and A Gregory (2011) *supra* note 91 (p 216)

However, although the DPSIR framework more adequately addresses complex relationships that exist in the environment, it still represents a systematic analysis of the many relationships that can and do occur between humans and the environment.[104] The real world is far more complex than can be expressed in simple causal relations in systems analysis.[105] There is arbitrariness in the distinction between the environmental system and the human system.[106] Moreover, many of the relationships between the human system and the environmental system are not sufficiently understood, or are otherwise difficult to capture in a simple framework.[107]

Consequently, individual elements of the DPSIR approach must be considered to have multiple interactions.[108] In other words, the DPSIR approach must illustrate that one activity will impact on others,[109] and that the marine environment is composed of many sectors each interacting and demanding a share of the available resources.[110] For example, although one may attempt to model the management of a fishery utilizing a single DPSIR cycle (which is narrowly or discretely bounded for that particular sector), it must be understood that such a 'marine fishery's DPSIR cycle' is nested within a set of DPSIR cycles that encompass many sectors (i.e. marine aggregates, energy generation, and aquaculture), each of which has complex and non-linear linkages, as well as feedback loops between the various parts of the whole.[111] In other words, the DPSIR cycle is sectoral and hence, requires a set of DPSIR cycles linked for each sector. Figure 2.5, taken from Atkins *et al*, provides a visual illustration of

[104] E Smeets and R Weterings (1999) *supra* note 50 (p 6)
[105] Ibid, at p 6
[106] Ibid, at p 6
[107] Ibid, at p 6
[108] J Atkins, D Burdon, M Elliott, and A Gregory (2011) *supra* note 91 (p 218)
[109] For example, a reduction in wild fisheries could have a knock-on effect to aquaculture.
[110] Ibid, at p 218
[111] J Atkins, D Burdon, M Elliott, and A Gregory (2011) *supra* note 91 (p 218)

these types of multiple interactions that occur within the DPSIR framework. Figure 2.6 provides an illustrative example of the complexities of the DPSIR Framework.

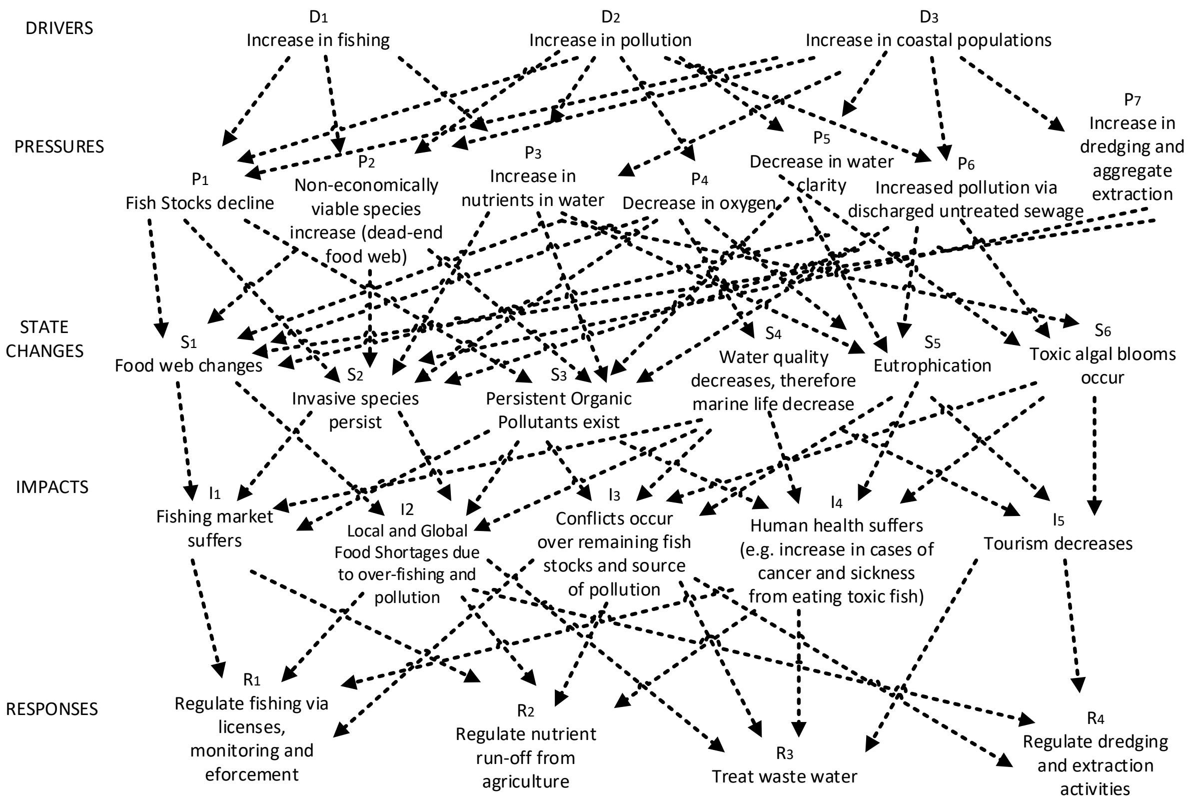

Figure 2.6: Illustrative example of the complexities of the DPSIR Framework. Amended from J Atkins, D Burdon, M Elliott, and A Gregory (2011) supra note 89 (p 216).

More recently, the DPSIR framework has been superseded by the DAPSI(W)R(M) Framework (Drivers-Activities-Pressures-State-Impact-Welfare-Response-Measures).[112] An extension of the DPSIR, it illustrates how societal *Drivers* necessitate *Activities* (i.e. fishing, aggregate extraction) which then produce *Pressures*.[113] These *Pressures* then create changes in the natural *State*, which generate *Impacts* on societal *Welfare* (i.e. declines in fish stocks).[114] Thus a set of *Responses (Measures*) are generated to try and stop/reverse the adverse consequences of human demands, drivers, activities and pressures.[115] These *Measures* may take the form of legislation, economic instruments, policy documents, etc.[116] As a greater understanding of the effects of human activities on the environment has become

[112] E Wolanski and M Elliott *Estuarine Ecohydrology – An Introduction* (2nd Edition Kidlington, OES, 2016) 322pp (p 219)
[113] Ibid, at p 219
[114] Ibid, at p 219
[115] Ibid, at p 219
[116] Ibid, at p 219

known, the DAPSI(W)R(M) Framework has emerged as a tool that is more reflective of the true links and processes that effect ecosystems and their functions. A more complex model then DPSIR, the DAPSI(W)R(M) Framework does impact indicator attributes. Thus, indicators must retain their core attributes, but they must be flexible enough to potentially accommodate more complex and uncertain relationships (such as those seen in Figure 2.6).

2.1.3 Descriptive-Performance-Efficiency-Total Welfare Indicators

The EEA has taken the DPSIR model and has categorized these environmental indicators into four main types. [117] Type A are *descriptive indicators* that depict what is happening to the environment or human health.[118] Type B are *performance indicators* that are linked to a reference value or policy target.[119] Type C are *efficiency indicators* which illustrate the success of the production and consumption processes.[120] Lastly, Type D are *total welfare indicators* which aggregate together economic, social and environmental dimensions to illustrate whether, overall, welfare is increasing.[121] These various types of indicators (PSR, DPSIR, Type A, B, C and D, etc.) are most effective if they meet the four core functions of an indicator mentioned in Section 2.0.

Descriptive indicators are the most commonly used indicators, and include such frameworks as the DPSIR model and the Drivers-Pressures-State-Change-Exposure-Effects-Action-Context (DPSEEAC) framework.[122] They describe the current environmental situation between various geographical regions.[123] Essentially these indicators answer the question 'What is happening to the environment and to humans?'[124] They describe the actual situation with regard to the main environmental issues, such as declines in fishery populations, acidification, toxic contamination and wastes in relation to the geographical levels at which these issues manifest themselves.[125] From a list of more than 100 environmental indicators listed by the

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[117] EEA, *Towards Environmental Pressure Indicators for the European Union THEME 8 Environment and Energy* (1998) (p 5)
[118] EEA (1999) *supra* note 19 (p 8-13)
[119] Ibid, at p 8-13
[120] Ibid, at p 8-13
[121] Ibid, at p 8-13
[122] Ibid, at p 8
[123] E Smeets and R Weterings (1999) *supra* note 50 (p 8)
[124] EEA (1999) *supra* note 19 (p 8)
[125] Ibid, at p 8

EEA, the majority of indicators fall into this category.[126] Although these indicators reflect the situation as it is, they do not reference how the situation should be.

Performance indicators, on the other hand, describe the situation as it ought to be. They compare actual conditions with a specific set of reference conditions (targets).[127] These types of indicators are relevant for holding specific groups or institutions accountable for changes in environmental pressures or states.[128] Often they are used by countries and international bodies to monitor their progress towards environmental targets by comparing these values to various reference conditions or policy targets.[129] An example of a performance indicator is one that compares the pollution removal rate for nitrogen (N) and phosphorus (P) with national targets established by the European Union in the year 2000.[130]

Efficiency indicators are those indicators which are most important in policy-making.[131] They draw a direct causal link between environmental pressures and human activities.[132] They query whether environmental efficiency is improving, by describing such aspects as the level of emissions and waste generated per unit of GDP, or the volume of fuel used per person per mile travelled.[133] Efficiency indicators can express a single variable or they can be aggregated. An example of an aggregated indicator is the Material Intensity per Service unit (MIPS) indicator, which is utilized to compare the efficiency of the various ways of performing a similar function.[134] An example of a MIPS indicator would be one that compares the amounts of energy and resources utilized for transporting one person one hundred miles by means of the present day car, by airplane or by light rail.[135] Ultimately these indicators are relevant in that they reflect the improvements in the quality of products and processes produced by society, in terms of resources, emissions and waste per unit output.[136]

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126 S Gubbay (2004) *supra* note 1 (p 13)
127 E Smeets and R Weterings (1999) *supra* note 50 (p 11)
128 Ibid, at p 11
129 Ibid, at p 11
130 EEA (1999) *supra* note 19 (p 11)
131 E Smeets and R Weterings (1999) *supra* note 50 (p 12)
132 Ibid, at p 12
133 EEA (1999) *supra* note 19 (p 12)
134 Ibid, at p 12
135 Ibid, at p 13
136 Ibid, at p 13

Lastly, total welfare indicators provide a summary of whether human beings are on a whole better off.[137] They provide a glimpse into the sustainability factors of current human activities and the likelihood that economic and environmental situations will improve with time and awareness.[138] No indicators of this type have been developed for the environment, as of yet.[139] Welfare indicators are currently outside of the EEA's work program and, as such, are not developed or employed by the EEA.[140]

2.1.4 Concluding Thoughts

In conclusion, the aforementioned frameworks represent similar yet different indicator applications selected from varieties that are available to policy makers and regulators. Each framework is unique and is developed and tailored to fit specific needs and criteria defined within environmental management approaches. Yet, no framework exists which can generate sets of indicators for every purpose.[141] And because indicators are linked to management objectives, they are connected to social/political values, as well as scientific principles. Thus, the utilization of a specific indicator framework will be as much dependent on the social and political influences, as the scientific ones.

Furthermore, indicators are a tool and a means to an end, rather than an end in themselves – i.e. they are usually applied as an endpoint. Arguably these frameworks must be elastic to develop over time, as new technology/data emerges and as societal understanding evolves. This will allow the indicators to promote more effective communication, as well as dissemination of information that is accurate and relevant to the issues at hand. This is of vast importance when dealing with marine ecosystems, which differ from other environmental habitats. The availability of historical data, the monitoring capacity, as well as the ecological properties of marine environments make it obvious that no single suites of indicators are universally the best.[142] Consequently, scientists will need to consider the whole marine system when developing their

[137] EEA (1999) *supra* note 19 (p 13)
[138] E Smeets and R Weterings (1999) *supra* note 50 (p13)
[139] S Gubbay (2004) *supra* note 1 (p 13)
[140] EEA (1999) *supra* note 19 (p 13)
[141] OECD (1993) *supra* note 73 (p 5)
[142] J Rice and M J Rochet "A Framework for Selecting a Suite of Indicators for Fisheries Management" [2005] ICES Journal of Marine Science 62 516-527pp (p 517)

indicators. Furthermore, they will have to educate managers and politicians to the view that the marine system is extremely complex, so it is unlikely that any one framework will ever be able to fully and quantitatively predict all natural and anthropogenic changes. This requires that best (expert) judgment, as well as scientific data, is relied upon in decision-making.[143]

2.2 Criteria for Effective Indicators

Environmental indicators are utilized for three important and distinct reasons, which directly correlate with the four core functions of an indicator.[144] First, they provide information about environmental problems (i.e. they communicate).[145] Second, they maintain policy development and priority setting, by distinguishing pressures that are exerted upon the environment and identifying the key features that create them (i.e. they simplify and quantify environmental problems, set standards for returning the environment to natural conditions and communicate these problems to the appropriate authorities).[146] Lastly, they offer a means to monitor the effects of the policy responses.[147]

In addition to these functions, environmental indicators can communicate the current issues to the public, thus making them a powerful tool in raising awareness.[148] They provide a conceptually simple expression of an otherwise complex environment, and ultimately communicate the success of current measures in meeting wider policy agenda, the need for management action (if any), and the ability to ensure that human activities remain compatible with environmental needs.

Due to the growing demand for development and utilization of indicators within policy and marine management, many discussions have ensued regarding the attributes of a sufficient environmental indicator.[149] These discussions are often user driven and therefore, the derived indicators are often representative of a particular

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[143] M Elliott "The Role of the DPSIR Approach and Conceptual Models in Marine Environmental Management: An Example of Offshore Wind Power" [2002] Marine Pollution Bulletin 44(6): iii-vii (p vii)
[144] E Smeets and R Weterings (1999) *supra* note 50 (p 5)
[145] Ibid, at p 5
[146] Ibid, at p 5
[147] Ibid, at p 5
[148] Ibid, at p 5
[149] EEA, *Testing of Indicators for the Marine and Coastal Environment in Europe, Part 1: Eutrophication and Integrated Coastal Zone Management* (2002) (p 5)

stressor or type of activity. This is demonstrated by Rice and Rochet, who focused on suites of indicators for fisheries management.[150] They cautioned that even with modest numbers of indicators, 'current values' of different indicators are likely to support arguments for incompatible management actions.[151] This, in turn, could potentially cause indicators to become a new battleground for partisan arguments, with adversaries selecting indicators whose values happen to support the decision they desire.[152] Examples of indicators used in litigation/application of the law will be discussed in greater detail in the legal chapters of this thesis.

Such thought has led to discussions regarding the criteria for successful indicator development.[153] These have, in turn, produced generally similar lists of criteria.[154] Results of some comparative experiments undertaken by Rice and Rochet suggested that criteria should be ranked according to three classifications, i.e. high = essential, moderate = useful, and minor = inconsequential.[155] This would help to select the most appropriate criteria to meet the needs of the client/user groups involved and can ensure that the criteria employed and indicators selected fit both regulatory and scientific purposes, and are therefore applied in an effective manner.[156]

By researching various sources for indicator criteria,[157] it is possible to synthesize an array of properties/criteria necessary for effective indicators for use in marine management. This list expands on the four basic functions of an indicator mentioned in Section 2.0; they are secondary to the four core functions. This list of criteria, found in Table 2.3, is modified and expanded from various sources (see below). Although not an exhaustive list, this research has determined that these are commonly the most important properties for marine environmental indicators applicable at a legal and policy level. As will be seen in subsequent chapters, these criteria are used most often by scientists and regulators alike and seem to underpin the

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[150] J Rice and M J Rochet (2005) *supra* note 142 (p 516)
[151] Ibid, at p 516
[152] Ibid, at p 516
[153] Ibid, at p 518
[154] Ibid, at p 518
[155] Ibid, at p 518-519
[156] Ibid, at p 1405
[157] EEA, *EEA Core Set of Indicators Guide* (EEA Technical Report, 2005) (p 10); OECD (1993) *supra* note 73 (p 7); ICES, *Guidance on the Application of the Ecosystem Approach to Management of Human Activities in the European Marine Environment* (Cooperative Research Report No 273, 2003) (p 6); S Gubbay (2004) *supra* note 1 (p 16-17); and S I Rogers and B Greenway (2005) *supra* note 34 (p 16)

different indicators analyzed in this thesis. Arguably, environmental indicators should be developed based on these criteria, although no single indicator will successfully meet them all, just as not every indicator will meet all four of the core functions. By utilizing these criteria and the four core functions as a foundation, the indicators will be more effective, but an indicator can still be good/efficient even if it fails to meet some criteria or core functions.

Since no single indicator will meet every characteristic mentioned in this table, it is necessary to incorporate multiple indicators to achieve successful policy approaches.[158] Arguably, several indicators with complementary properties can provide strong and effective support for management decision-making.[159]

Table 2.3: Required properties of indicators for successful marine management, modified and expanded from various sources

▪ Communicative - able to facilitate communication on environmental issues with stakeholders and policy makers by promoting information exchange and comparison of spatial and temporal patterns)[160]
▪ Policy relevant - able to determine the link between the indicator and the environmental problem;[161] able to fulfill management objectives;[162] grounded in theory / relevant and appropriate to management initiatives and understood by management[163]
▪ Scientifically valid - the data and methodology are reliable; results can be validated utilizing sensitivity analysis, confirmation through other data or approaches,[164] by available or routinely collected data[165] or by comparison with other evidence[166]
▪ Simple and robust - be simple, easy to interpret, able to show trends over time, and where possible, able to permit distinction between human-induced and natural changes[167]
▪ Easily measurable - by using existing instruments, monitoring programs and analytical tools available in the relevant areas to achieve accuracy and precision within the timescales needed to support management;[168] have minimum or known bias (error), and the desired signal should be distinguishable from noise or, if present, the noise should be quantified and explained; capable of being updated regularly, being operationally defined and measured, have defined detection limits[169]

[158] ICES (2003) *supra* note 157 (p 7)
[159] Ibid, at p 7
[160] A Aubrey, M Elliott and S Boyes (2006) *supra* note 51 (p 5)
[161] EEA (2005) *supra* note 157 (p 10); OECD (1993) *supra* note 73 (p 7); S Gubbay (2004) *supra* note 1 (p 16-17)
[162] ICES (2003) *supra* note 157 (p7)
[163] Elliott "Marine science and management means tackling exogenic unmanaged pressures and endogenic managed pressures – a numbered guide" [2011] Marine Pollution Bulletin 62: 651-655
[164] ICES (2003) *supra* note 157 (p7); S Gubbay (2004) *supra* note 1 (p 17)
[165] EEA (2005) *supra* note 157 (p 10)
[166] H L Rees (2006) *supra* note 21 (p 500, 502)
[167] P Cochrane "Sustainable Indicators Conference – Towards a Core Set of National Environmental Indicators" <http://www.maf.govt.nz/mafnet/rural-nz/sustainable-resource-use/land-management/sustainable-agriculture-conference/susconf4.htm> (accessed 2 August 2006); S Gubbay (2004) *supra* note 1 (p 17)
[168] ICES (2003) *supra* note 157 (p 6); A Aubrey, M Elliott and S Boyes (2006) *supra* note 51 (p 6)
[169] Elliott (2011) *supra* note 163

▪ Cost efficient - Indicators and measurements should be cost-effective (financially non-prohibitive) given limited monitoring resources, i.e. with an ease/economy of monitoring[170]
▪ Concrete and specific - be directly observable and measureable, rather than reflecting abstract properties that can only be measured indirectly; Indicators should respond to the properties they are intended to measure rather than to other factors, and/or it should be possible to disentangle the effects of other factors from the observed response[171]
▪ Interpretable and unambiguous – the meaning of the indicator is understood by a wide-range of stakeholders; public understanding of the indicator is consistent with its technical meaning; the indicator is relatively easy to understand by non-technical specialists; have a general applicability and be capable of distinguishing acceptable from unacceptable conditions in a scientifically and legally defensive way[172]
▪ Sensitive and responsive - trends in the indicators should be sensitive to changes in ecosystem properties or human impacts and be responsive to effective management action; provide rapid and reliable feedback on the consequences of the management action; Sensitive to a known stressor or stressors and based on an underlying conceptual model, without an all-or-none response to extreme or natural variability[173]
▪ Tightly linked to human activity - relevant to management objectives, part of the management process and not an end to themselves; provide real time information for feedback into management[174]
▪ Able to survive a process of legal interrogation[175]
▪ Anticipatory - sufficient to allow the defense of the precautionary principle; capable of indicating deviation from that expected before irreversible damage occurs[176]
▪ Biologically important - focuses on species, biotopes, communities, etc. important in maintaining a fully functioning ecological community[177]
▪ Broadly applicable and integrative over space and time - usable at many sites and over different time periods; gives a holistic assessment; summarizes information from many environmental and biotic aspects; allows comparisons with previous data to estimate variability and to define trends and breaches with guidelines or standards[178]
▪ Continuity over time and space – Capable of being measured over appropriate ecological and human time and space scales to show recovery and restoration[179]
▪ Low redundancy – provides unique information compared to other measures[180]
▪ Non-destructive – cause minimal and acceptable damage to the ecosystem; be legally permissible[181]
▪ Realistic / attainable – provide information on a 'need-to-know' basis rather than the 'nice-to-know' basis; attainable within the management framework[182]
▪ Responsive feedback to management – responsive to effective management action and regulation; provide rapid and reliable feedback on the findings[183]

[170] C Ehler (2003) "Indicators to Measure Governance Performance in Integrated Coastal Management" [2003] Ocean & Coastal Management #46 335-345pp (p 337); Elliott (2011) *supra* note 163
[171] ICES (2003) *supra* note 157 (p 6); A Aubrey, M Elliott and S Boyes (2006) *supra* note 51 (p 6); Elliott (2011) *supra* note 163
[172] ICES (2003) *supra* note 157 (p 6); A Aubrey, M Elliott and S Boyes (2006) *supra* note 51 (p 6); Elliott (2011) *supra* note 163
[173] ICES (2003) *supra* note 157 (p 7); A Aubrey, M Elliott and S Boyes (2006) *supra* note 51 (p 6); H Rees (2006) *supra* note 21 (p 499); Elliott (2011) *supra* note 163
[174] J Jones (2002) *supra* note 47 (p 54); H L Rees (2006) *supra* note 21 (p 499); C Ehler (2003) *supra* note 170 (p 337); Elliott (2011) *supra* note 163
[175] H L Rees (2006) *supra* note 21 (p 499)
[176] Elliott (2011) *supra* note 163
[177] Ibid
[178] Ibid
[179] Ibid
[180] Ibid
[181] Ibid
[182] Ibid
[183] Ibid

Furthermore, ecosystems are extremely complex and unpredictable, requiring suites of indicators to give an adequate picture of their corresponding state.[184] And the type of indicators selected will be dependent on the user applying them. Thus, management agencies need to agree to a set of indicators and provide guidance to aid their interpretation.[185] Yet, to be cost effective and to provide clear management guidance, suites of indicators should be kept as small as possible, while still fulfilling the needs of all users.[186]

Challenges exist, however, in identifying the suite that best meets the needs for each particular application. Such factors as availability of historical data, understanding impacts created by human uses, and governance systems, make it apparent that no single suite of indicator is universally the best.[187] Consequently, various methods, such as scoring,[188] are often employed to determine the indicators that would be most effective to meet the objectives of the user groups and/or management requirements.[189] This can also include developing a method for integrating heterogeneous indicators into single value 'integrative' indicators, in order to more effectively implement such regulations as the EU Water Framework Directive.[190]

Whether employing suites of indicators or single univariate measures, it is important to secure compatibility among indicators. This ensures that the indicators do not provide conflicting information to managers.[191] Moreover, it prevents the same information from being communicated in several different ways, which could obscure overall patterns.[192] Redundant indicators should be avoided, as both the capacity for meaningful dialogue and the processing ability of rule-based decision-making systems

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[184] OECD *Towards Sustainable Development: Environmental Indicators* (1998) 152pp; FAO *Indicators for Sustainable Development of Fisheries FAO Technical Guidelines for Responsible Fisheries* (2002) 76pp; EEA (2005) *supra* note 157 (p 12)
[185] A Aubry and M Elliott "The Use of Environmental Integrative Indicators to Assess Seabed Disturbance in Estuaries and Coasts: Application to the Huber Estuary, UK" [2006] Marine Pollution Bulletin 53: 175-185pp (p 176)
[186] J Rice and M J Rochet (2005) *supra* note 142 (p 517)
[187] Ibid, at p 517
[188] Scoring indicators is the use of quantitative evaluations to rank candidate indicators and create evaluation matrices according to the needs of the users and the corresponding management objectives.
[189] Ibid, at p 517
[190] A Aubry and M Elliott (2006) *supra* note 185 (p 176, 184)
[191] ICES (2003) *supra* note 157 (p 7)
[192] Ibid, at p 7

becomes saturated when overloaded with information from too many indicators.[193] Indicators must be understood via clear definitions, as well as appropriate assessments and presentations.[194] This will help to prevent contradictory messages, or at least provide an explanation should such contradictions occur.[195] These indicators should also be realistic in their structure and measurement, and should provide information on a need to know basis rather than a nice to know basis.[196] Also, they should be continuously reviewed and refined when necessary, and as scientific understanding of the environment improves.[197] This will ensure that the indicators remain adaptive in their pursuit of management of objectives.[198]

Stated simply, successful implementation of environmental indicators is achieved via the development and application of indicators based on the criteria listed in Table 2.3 and founded on the core functions. Such types of indicators should be simple, able to quantify their measurements, create a standard and communicate the findings. Additional considerations for environmental indicators should also be to establish a relationship between an indicator and its corresponding framework component, as well as consideration of the entire life cycle of an indicator (i.e. beyond its initial application) with a feedback loop to assess its effectiveness in prompting a management decision or application of another indicator.[199]

In conclusion, since the development and application of indicators is user-dependent, there is arguably no real way to categorize the essential criteria for an indicator, apart from the four core functions. The users themselves can evaluate specific indicators against specific criteria, to determine if the criteria have been met. But this will be done on a case by case basis and will change as scientific knowledge improves. But the research has found that by applying the above criteria in some form, and using the four core functions as a baseline , environmental indicators can arguably contribute to successful implementation of marine management objectives, policy and regulations.

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[193] FAO (2002) *supra* note 184 (p 20)
[194] EEA (2005) *supra* note 157 (p 10)
[195] Ibid, at p 10
[196] A Aubrey, M Elliott and S Boyes (2006) *supra* note 51 (p 6)
[197] C Ehler (2003) *supra* note 170 (p 337)
[198] Ibid, at p 337
[199] H L Rees (2006) *supra* note 21 (p 500)

2.3 Concluding Remarks

Indicators have become an important and powerful form of communication within environmental policies and laws world-wide. They are of vital importance, as they provide a conceptually simple expression of an otherwise complex reality. This allows scientists and regulators to readily exchange information and ensure that human activities remain compatible with management needs, policy agenda, and established regulations. Due to improvements in technology and evolving ideologies, governments are beginning to take a more comprehensive approach to marine management. Thus, they are incorporating economic and social objectives within environmental regulations. This places a great demand on indicators to be elastic in their application, as well as pertinent at all tiers of government (i.e. nationally, regionally and internationally).

Indicators quantify and illustrate changes by simplifying and communicating progress towards an operational objective (whether political or legislative). Although not always explicitly identified in policy and legislative texts, they are nonetheless implied in both. Indicators are able to measure the impact that legislative initiatives have had on the quality of the environment and the social and economic circumstances surrounding political and legal initiatives. Whether it is the PSR or DPSIR frameworks (or any similar framework that utilizes indicators to report on changes in a system) these indicator applications present unique frameworks that are as much influenced by policy and social outcome, as they are by science.

This chapter has shown that indicators which are more successful in their ability to communicate meet most, if not all, of the four core functions. However, an indicator can still be successful and effective (e.g. achieve the objectives for which it was designed) if it does not meet all of these functions. And the criteria listed in this chapter, although found to be vital to environmental indicators, are secondary to the four core functions and subjective based on the user, the indicator application and the reasons for it utilization. The very fact that indicators adapt and change with increased scientific knowledge makes them effective (as the subsequent chapters will show). Thus, there are many ways to access the effectiveness of an indicator. The following chapters further explore and answer this research question.

Chapter 3: International Law

3.1 Introductory Comments

International environmental law provides the broad regulatory context within which indicators can be developed and applied. Specific rules guiding the various types of international environmental law can also shape the utilization of indicators to meet the broad and general objectives which underlie the legislation. For example, international agreements may generate standards (indicators) that are adopted in national legislation, or which guide decision-makers in areas that have multiple interfaces (such as international trade and the environment).[1] More specifically, international law can deal with transboundary issues, such as marine spaces, as well as shape the content of regional and domestic law. As such, it is necessary to consider how international law may control or influence the use of indicators.

Traditionally, international law governed relationships between states.[2] Yet it is now widely accepted that states are not the only entities governed by international law.[3] The rules of international law can also impose obligations on other members of the international community, including, international organizations, non-state actors, individuals and organizations.[4] International environmental law endeavors to engage in environmental concerns that are applicable across different states or which have a global influence.[5] Such transboundary problems require international solutions and an ability to communicate the data in a non-technical manner (which indicators offer).

The objective of this chapter is to analyze international environmental law and its influence on both the development and application of marine environmental indicators. It assesses marine indicators and their ability to successfully communicate complex environmental problems, in a simplistic manner at the international level, thereby providing some of the answers to research questions 1 and 2. This chapter also assesses the extent to which international law supports/requires the development of indicators capable of meeting the four core functions. Furthermore, it evaluates the requirements for indicators in international environmental law, and compares these with the criteria for successful indicators mentioned in chapter 2 in order to contribute

[1] S Bell and D McGillivray *Environmental Law* (OUP 2006) 910pp (p 144)
[2] Ibid, at p 86
[3] Ibid, at p 124
[4] Philippe Sands *Principles of International Environmental Law* (Cambridge, 2003) 1116pp (p 124)
[5] S Bell & D McGillivray (2006) *supra* note 1 (p 86)

to the answers for research questions 5 and 6. Finally this chapter analyzes the extent to which indicators are developed and applied within all forms of international law (from treaties, to principles, to judicial decisions), to support the answers for research questions 3, 4 and 7. Are indicators explicitly mandated in International law? Does the research demonstrate a top-down or bottom-up approach for indicator development and application in International law?

Section 3.2 discusses sources of international law and their importance in the development and deployment of environmental indicators. To analyze the utilization of indicators in both the formation and application of the law, one must first understand the structure of international environmental law itself. Thus, Section 3.2 is crucial to lay the foundation for the analysis in the remainder of the chapter. Section 3.3 analyzes international treaties and their influence on indicators. It focuses specifically on the United Nations Law of the Seas Convention (UNCLOS),[6] the Convention on Biological Diversity,[7] the OSPAR Convention,[8] the United Nations Convention on Climate Change,[9] and the MARPOL Convention.[10] Lastly, section 3.4 discusses the deployment of indicators within the application of the law. This section utilizes case law to examine the role of indicators within the system of dispute settlement. It analyzes the extent to which indicators are employed within the application of law, as well as the interpretation of indicators by both experts and non-specialists (i.e. scientists and judges). These sections and subsequent analysis allow the thesis to determine the success and efficiency of marine environmental indicators in International law and sets the stage for deeper discussions regarding the influence of this law on European and national legislation, as well as its influence on policy across the three scales. Figure 3.1 illustrates the development of indicators and key

[6] United Nations Convention on the Law of the Sea 1982
[7] Convention on Biological Diversity 1992
[8] Convention for the Protection of the Marine Environment of the North-east Atlantic 1992
[9] United Nations Framework Convention on Climate Change 1992
[10] International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL) 1978

legal frameworks. It provides a visual assessment of the major discussion points of this chapter.

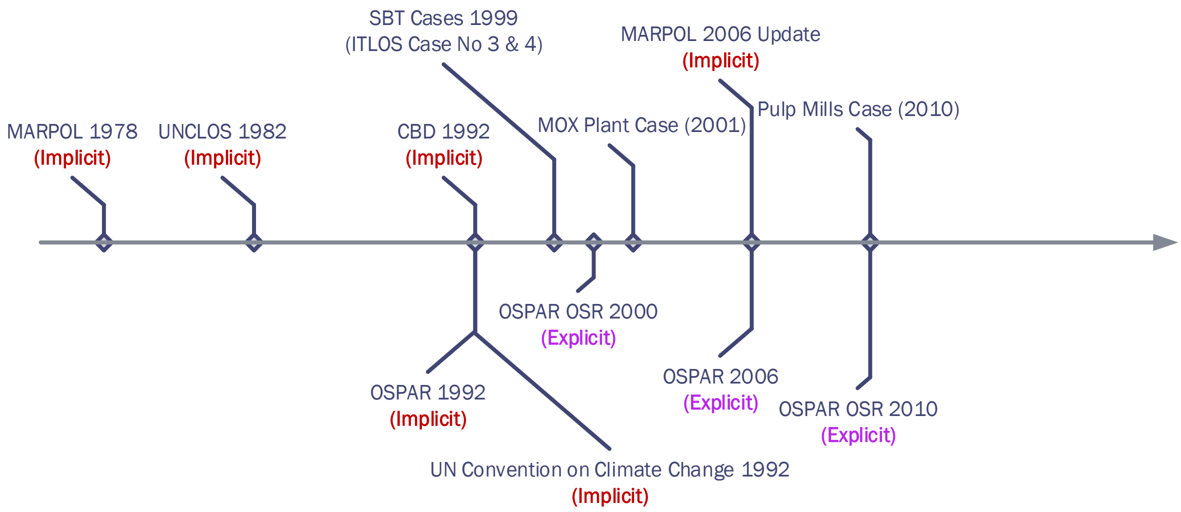

Figure 3.1: Timeline of International legal documents and cases analyzed in this chapter. These are discussed in chronological order within the appropriate subsection. For the regulations (and corresponding policy instruments), the timeline identifies whether indicators are implicit or explicit within the text of the document. The subsequent analysis provided in this chapter explores the progressive development and application of indicators over time in the international legal forum to answer research questions 1-7 in regards to International law.

3.2 Types of International Law and Indicators

Public international environmental law is law between states and may be categorized into 'hard law' and 'soft law'.[11] Hard law consists of treaties/conventions/agreements, customs, generally recognized principles of law, and judicial decisions and writings of publicists. Soft law consists of declarations, principles, recommendations, and standards. Hard law generally comprises those sources of law listed in Article 38 of the Statue of the ICJ.[12] These sources are generally understood to comprise binding rules of law upon States.[13] It is these sources of law that the ICJ would refer to when determining whether a particular legally binding principle or rule of international law existed.[14] This chapter and its analysis focuses on hard law, as arguably these influence law at the European and National levels. Soft law will be discussed in more detail within Chapter 4, International Policy.

[11] S Bell and D McGillivray (2006) *supra* note 1 (p 143, 150-154)
[12] Statute of the International Court of Justice 1945
[13] S Bell and D McGillivray (2006) *supra* note 1 (p 150)
[14] Philippe Sands (2003) *supra* note 4 (p 123)

Treaties are the basic foundation of international law; they are agreements or covenants that are entered into by various international members, including sovereign states, organizations and other pertinent international players.[15] States are only legally bound to treaties when they ratify them.[16] Indicators and their comparative standards are often influenced by the provisions of treaties and agreements, as will be demonstrated by the discussions on the UNCLOS, the CBD, the OSPAR Convention, the Convention on Climate Change and the MARPOL Convention in the subsequent section. They can be the prescribed mechanisms for attaining the objectives fleshed out in the treaties.[17]

Customary international law, on the other hand, is law that is based on state practice and *opinio juris*, where states follow a particular practice out of a sense of legal duty and, in the case of *opinio juris*, obligation (i.e. they do not believe they have a choice to deviate from the law).[18] Customary international law is capable of generating general standards of conduct, which can indirectly shape the operation of indicators. This is seen with such environmental principles as the precautionary and preventive principles, the polluter pays principle, or requiring best available scientific techniques. These have the ability to influence indicators, as they often rely on indicators to determine if the requirements of these principles have been met. However, custom does not appear to be capable of generating specific standards or modes of conduct. As such, indicators are not directly established by custom.

General international principles of law are rudimentary rules necessary to ensure the international forum functions efficiently.[19] They are often intangible and general in nature, but are used to fill legal gaps not covered by regulations. These are often found within treaties and customary international law and transcend down to regional and domestic legal systems.[20]

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[15] S Bell and D McGillivray (2006) *supra* note 1 (p 150)
[16] Ibid, at p 150
[17] Ibid, at p 150
[18] Martin Dixon Textbook on International Law (7th edn, OUP, 2013) 393pp (p 54)
[19] Kohen, Marcelo, and Bérénice Schramm. "General Principles of Law". In *Oxford Bibliographies* in International Law. http://www.oxfordbibliographies.com/view/document/obo-9780199796953/obo-9780199796953-0063.xml accessed 18 September 2016
[20] Ibid

Judicial decisions apply only to the cases (and parties) for which they were designed.[21] Indicators play an important role in this type of law. They can be heavily influenced by judicial decisions and are sometimes assessed in the case laws themselves. Furthermore, they can be employed by academics as a means to explain phenomenon in any particular case. Thus, the manner in which the judicial system interprets indicators is highly important. It is here that one can observe exactly how indicators communicate complex information in a less complex manner, how this is interpreted by the ICJ, and the importance of these indicators in meeting the set objectives of the international laws. Judicial decisions are addressed in more detail within Section 3.4.

Writings of publicists represent expert opinions on international law. They are used as a means to identify and further clarify the law. Although not directly used to create indicators, these writings can help explain indicators in more depth. This type of law will be touched on by my review of international literature throughout the chapter.

In general, this chapter will only focus on treaties and judicial cases, and will not include a further discussion of custom international law or general principles. This is because, as discussed above, indicators are often directly associated with treaties and judicial cases and are only indirectly tied to customary international law via general principles (which are often applied and referred to within judicial cases).

International environmental law can help to mitigate deleterious effects and irreversible damage to ecosystems that lie beyond the control of individual States.[22] Global issues have now emerged that require common solutions. Indicators provide the means to understand such complex environmental issues as global warming, fishery stock declines and the melting of the ice caps. Indicators can also illustrate the links between the global economy and environmental degradation, thus supporting the theories of sustainable development. Consequently, to assess the effectiveness of indicators in international law, the manner in which they are employed and the extent

[21] Statute of the International Court of Justice (1945) *supra* note 12 (Art 59)
[22] S Bell and D McGillivray (2006) *supra* note 1 (p 149)

to which they are both influenced by and understood within the said law must be analyzed. The next section analyzes the influence that treaties have on indicators.

3.3 International Treaties and Indicators

International agreements (treaties) have the potential to both influence and develop indicators/standards, which can then be adopted on national or regional levels.[23] The standards/indicators that they influence are often of varying degrees of severity and have a variety of mechanisms that can be utilized to obtain the desired results.[24] Although not explicit within every treaty, arguably they are implied as a means to obtain global environmental objectives. This section reviews a selection of treaties that govern the environment and assesses the extent to which these treaties accommodate or shape the use of indicators. It fleshes out the instances of success and failure in marine environmental indicators implied in treaties and the influences that these treaties have on regional and national legislation.

3.3.1 UNCLOS

The United Nations Convention on the Law of the Sea (UNCLOS) provides the basic legal framework for the regulation of ocean activities and has been regarded as a 'constitution for the oceans.'[25] The UNCLOS recognizes that the problems of ocean space are closely interrelated and need to be considered as a whole.[26] Furthermore, it draws light to the fact that the regulation of ocean activities is often beyond the limits of national jurisdiction.[27] UNCLOS provides the legal basis for the future development of oceans law and policy. For example, Article 311 precludes incompatible agreements from being adopted by States Parties and requires that these agreements be compatible with the UNCLOS and ultimately not affect the rights of other States.[28] Thus, other measures should be consistent with the UNCLOS. This implies a top-down approach, where UNCLOS influences other laws and policies at the European and national levels, without infringing on States sovereign rights.

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[23] S Bell & D McGillivray (2006) *supra* note 1 (p 144)
[24] Ibid, at p 151
[25] Koh "A Constitution for the Oceans' Remarks by Tommy T.B. Koh, of Singapore, President of the Third United Nations Conference on the Law of the Sea" [1982] 5pp (p 5)
[26] United Nations Convention on the Law of the Sea (1982) *supra* note 6 (Preamble)
[27] Ibid, at Preamble
[28] Ibid, at Art 311(1), (2) and (3)

Although no explicit reference to indicators exists within UNCLOS, arguably they are implicitly required as operational tools which can be employed to measure progress towards achieving its objectives. Establishing a legal order for the seas and oceans requires the equitable and efficient utilization of resources, as well as the conservation of living resources, and the study, protection and preservation of the marine environment.[29] Indicators offer a means for such communication. For example, they have the capacity to assist regulators and States in measuring these objectives laid out in UNCLOS. Combined with other regulatory tools, indicators can ensure that the ocean resource exploration and exploitation is being carried out for the benefit of mankind as a whole. Thus, indicators can be utilized to show the link between resources and social goals, as they operate at the nexus between science and social objectives.

The analysis of the UNCLOS provisions can be divided into two parts: provisions which imply the use of indicators (i.e. general provisions on pollution and the use of science) and provisions that explicitly use 'indicators.' Examples of provisions that imply the use of indicators include Article 19 of UNCLOS, which implies the use of indicators to measure prejudicial passage by ships which can cause willful and serious pollution.30 Indicators can be employed to convey whether such pollution activities occurred. Furthermore, they offer a means to communicate such impacts to the ICJ and others seeking to enforce the rules of innocent passage. Once pollution activities have been identified (via indicators), regulators can work to reverse the harmful effects of the pollution and prevent further damage to the oceans. Thus, indicators have the capacity to measure such objectives, as the conservation of living resources, the preservation of the environment, infringement on fisheries laws, and pollution.31 Indicators can offer a coastal State the means to exchange important information, which can allow for the proper utilization and enforcement of the UNCLOS. But it's important to note that where indicators are implicit, considerable latitude exits in how they will be developed and used at the State level.

The potential for indicators is best illustrated in the context of rules on fishing levels. These are provisions which explicitly use indicators, and include Article 61 of

[29] United Nations Convention on the Law of the Sea (1982) *supra* note 6 (Preamble)
[30] Ibid, at Art 19(2)(h)
[31] Ibid, at Art 21(1)

the Treaty, which addresses the conservation of the living resources of the oceans and implies the utilization of environmental indicators. Indicators can be a means to measure such objectives as the allowable catch of the living resources in the EEZ, or the effects that harvested species have upon the environment.[32] An example of such an indicator is the maximum sustainable yield, which is the maximum allowable limit that any particular fish can be caught before impact occurs to the fish population.

Furthermore, Article 61(2) requires that coastal States take into account the best scientific evidence available to ensure proper conservation and management of the living resources in the EEZ.[33] This could include indicators, as they are scientific tools capable of communicating such complex information. This requirement mandates one of the main criteria for indicators mentioned in chapter 1 (i.e. scientifically valid). Thus, indicators are not only employed to measure the status of the living resources, but can also be utilized to evaluate the effectiveness of the conservation measures in obtaining the set objectives.

Additionally, Article 61(5) requires that this scientific information (which includes catch and fishing effort statistics) must be updated and exchanged on a routine basis by competent international authorities.[34] In other words, the UNCLOS promotes the exchange of this scientific information, which is obtained through indicators. Thus, UNCLOS promotes the constant communication and refinement of these indicators, to ensure proper enforcement of the regulations.

Article 62 addresses the employment of scientific data (which implies indicators) to promote optimum utilization of the living resources in the EEZ.[35] Coastal States must determine the capacity of living resources that can be harvested, so as not to deplete the standing stocks. They must employ a means to measure such objectives. Arguably, this can be achieved via indicators that measure the current and changing status of the specific species. The indicators must do more than communicate the status of the species, however. They must also convey the significance of the living resources of the area to the economy of the coastal State

[32] United Nations Convention on the Law of the Sea (1982) *supra* note 6 (Art 61(1))
[33] Ibid, at Art 61(2)
[34] Ibid, at Art 61(5)
[35] Ibid, at Art 62(1)

concerned.[36] Thus, Articles 61 and 62 call upon coastal States to demonstrate (implicitly via indicators) both the scientific and economic significance of the living resources in their environment.

As mentioned previously, this illustrates the divergent nature of indicators. They are instruments to measure various types of information, regardless if this information is environmental or economical. Thus, UNCLOS implies the use of indicators as a means to determine which species may be caught, the catch quotas, the regulations and other pertinent information applicable to the EEZ.[37] And States who fish in another's EEZ must utilize their own money and technology to help develop indicators to communicate the required information. But they must do so under the guidance of the coastal State in question.

Article 200 of UNCLOS implies the utilization of indicators via the promotion of scientific studies, research programs and information exchange.[38] This data (which arguably can include indicators) can be used to communicate various sources of pollution to the marine environment.[39] States must exchange such information as the source and extent of pollution, risks associated with exposure, the pathways of the pollution, and ways to remedy it.[40] Indicators can offer a means to meet the requirements of this Article. Scientific data is arguably another term for indicators (as mentioned previously in this thesis). States can employ indicators to measure for and determine the extent/effects of pollution. Indicators can, in turn, communicate this information to the relevant regulators.

Similarly, Article 201 mandates that States "establish appropriate scientific criteria for the formulation and elaboration of rules, standards and recommended practices and procedures for the prevention, reduction and control of pollution of the marine environment."[41] This implies the use of indicators, as scientific criteria is synonymous with the term indicator (as argued throughout this thesis). Thus, States can employ indicators to measure for the established criteria. They can help prevent,

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[36] United Nations Convention on the Law of the Sea (1982) *supra* note 6 (Art 62(3))
[37] Ibid, at Art 62(4)(b)
[38] Ibid, at Art 200
[39] Ibid, at Art 200
[40] Ibid, at Art 200
[41] Ibid, at Art 201

reduce, and (where possible) control pollution to the marine ecosystems. This directly correlates with Article 204, which requires that States utilize scientific methods to observe, measure and analyze marine pollution. Arguably, this surveillance can be achieved via the deployment of indicators. They can communicate the risks, effects, and extent of the marine pollution. Furthermore, they can determine the potential polluting impacts that pre-approved activities have upon the marine environment. This allows the State to remain in compliance with the mandates of Articles 201 and 204.

Themes related to the utilization of scientific research and information, and the deployment of measures to illustrate the status of natural resources is repeatedly found throughout the UNCLOS. These themes influence the development and application of indicators as a means to ensure the proper enforcement of the Treaty among the signatory members. Indicators provide an effective means for communicating a variety of complex information (mandated by the Treaty). This includes environmental, scientific and economic information related to the oceans and seas. Indicators are more than capable of communicating the requirements of UNCLOS, so long as they are founded on the four core functions and maintain some of the indicator criteria. Thus, UNCLOS provides a framework for indicator use, although this is mostly implicit. This can be seen through UNCLOS' use of rules of reference, which is a rule that requires the development of specific standards in pursuit of UNCLOS general obligations – usually through other multilateral agreements, such as OSPAR.[42] There is no explicit mandate for indicators in the Convention, most likely due to the broad framework of the agreement itself and the need to be applicable beyond international borders. Thus, UNCLOS takes a top-down approach in that it influences the development and application of marine environmental indicators, but leaves the specific deployment of indicators to the individual signatory members. Thus, the success of the indictors is solely dependent on the signatory member developing and applying the indicators. These indicators can be operationally efficient if the signatory member ensures they are founded on the four core functions and the appropriate indicator criteria.

[42] Redgwell "Mind the Gap in the gairs: The Role of Other Instruments in LOSC Regime Implementation in the Offshore Energy Sector" [2014] The International Journal of Marine Coastal Law 29 pp 600-621

This broader approach taken by UNCLOS in regards to marine environmental indicators is not without failure and issues. Because the specifics of indicator development and application are left to the signatory members, differences in approaches can occur. These differences can result in conflicting or incompatible indicators, which ultimately becomes a problem at the case law level. This is explored in greater detail in Section 3.4.

Ultimately, indicators can evaluate the ability of the State to meet and enforce the objectives and regulations laid out in UNCLOS. In conclusions, UNCLOS is a framework agreement, so its provisions are to be developed through compatible agreements. As such, indicators are more likely to be explicitly found in such implementing agreements as the Convention on Biological Diversity, the OPSAR Convention, the United Nations Framework Convention on Climate Change and the MARPOL Convention. These are now reviewed.

3.3.2 The Convention on Biological Diversity

The Convention on Biological Diversity (CBD) was designed to recognize and protect the intrinsic value of biological diversity.[43] Although indicators are not explicitly mandated within the context of the Convention, their use is implicit as tools to facilitate information exchange, which can, in turn, contribute to meeting the underlying objectives of the Convention. Whilst indicators are a form of information, the way in which such information is required and used within the CBD means that indicators are required as a structured form of information.

Indicators can be used to measure diversity within species, between species and of ecosystems, as required under Article 2. They can be employed to provide information and knowledge on biological resources, including genetic resources, organisms, populations, or other biotic components of ecosystems. Article 7 (and Annex I) of the Convention requires that ecosystems and habitats that contain high diversity, as well as large numbers of endemic, threatened species, wilderness and migratory species be identified and monitored, which implies the development and application of indicators able to perform such monitoring.[44] These indicators can

[43] Convention on Biological Diversity (1992) *supra* note 7

[44] Furthermore, indicators allow for information exchange regarding genomes and genes of social, scientific or economic importance. Annex I, para 3

communicate technical information regarding important species in a simplistic manner that allows policy-makers, legislators and non-specialists to better understand the marine environment.[45] Such data is publically available.[46] This provides transparency, thereby ensuring that human activities remain compatible with the objectives of the Convention (i.e. to protect biological diversity).

The Convention calls upon Contracting Parties to develop or adapt existing plans and programs, as well as national strategies, for the conservation and sustainable use of biological diversity.[47] Such implementing measure invariably entail the use of indicators. An example of this is found in the Seventh Meeting of the Conference of the Parties (COP).[48] The COP is tasked with reviewing scientific, technical and technological advice on biological diversity [49] The COP may establish subsidiary bodies to provide scientific and technical advice, as deemed necessary, for the implementation of the Convention.[50] The Convention also established a Subsidiary Body on Scientific Technical and Technological Advice (SBSTTA).[51] The COP works with these subsidiary bodies to help interpret, provide advice to States, and to develop indicators to measure the objectives fleshed out in the Convention. For example, the COP established an Ad Hoc Study Group on Indicators of Coral Bleaching.[52] It is designed to develop indicators (pertaining to molecular, cellular, physiological, and community) to measure coral bleaching and the long term responses of reefs to such environmental stresses.[53] The COP also mandated that work programs be adopted by States to monitor for marine and coastal biodiversity.[54] These programs must include indicators to measure progress, as well as evaluate and assess ecosystems.[55] This directly correlates with the duty to integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programs and policies.[56] Thus, one can see

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[45] Convention on Biological Diversity (1992) *supra* note 7 (Annex I)
[46] See https://www.cbd.int/gbo1/annex.shtml
[47] Convention on Biological Diversity (1992) *supra* note 7 (Art 6)
[48] COP *Decisions Adopted by the Conference of the Parties to the Convention on Biological Diversity at its Seventh Meeting* (2004) 49pp
[49] Convention on Biological Diversity (1992) *supra* note 7 (Art 23(3)(b))
[50] Ibid, at Art 23(3)(g)
[51] Ibid, Art 25.
[52] COP (2004) *supra* note 48 (p 25)
[53] Ibid, at p 25
[54] Ibid, at p 4, 12, 25
[55] Ibid, at p 4, 12
[56] Convention on Biological Diversity (1992) *supra* note 7 (Art 6)

how binding law begins to blend with policy, as plans and programs become a means of achieving general legal goals.

The function of the SBSTTA is outlined in Article 25, and here the implied function of indicators is most prominent. Indicators can communicate the necessary information regarding biological diversity to scientists, regulators and policy-makers. Indicators of biological diversity can be developed through research undertaken by the subsidiary bodies. Potential indicators include the number of individuals, the different numbers of species, the decline in genetic diversity, and other scientific measures related to biological diversity.

Article 7 of the Convention mandates that each Contracting Party should identify components of biological diversity, having regard to the indicative list of categories set out in Annex I.[57] This implies that the list of categories fleshed out in Annex I are themselves indicators that can be measured and monitored to determine the important elements of biological diversity. Additionally, Contracting Parties must identify activities that have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity.[58] These effects can be monitored through sampling and the use of indicators.

In regards to protected areas, States must establish systems where special measures are to be taken to conserve biological diversity.[59] States must also rehabilitate and restore degraded ecosystems and promote the recovery of threatened species.[60] Again, indicators can be developed and deployed to help meet these objectives. They can aid in the determination of protected areas, and can measures impacts on ecosystems, natural habitats, and populations of species. The application of indicators within plans and management strategies can ensure that degraded ecosystems are restored and protected. Essentially, indicators have the potential to help protect and conserve biological diversity by providing the necessary knowledge and information (i.e. a basic understanding) of ecosystems and their various components.

[57] Convention on Biological Diversity (1992) *supra* note 7 (Art 7(a))
[58] Ibid, at Art 7(c)
[59] Ibid, at Art 8(a)
[60] Ibid, at Art 8(f)

Contracting Parties must also adopt measures for the recovery and rehabilitation of threatened species.[61] Such measures can include indicators, which can encourage cooperation and provide transparency on the importance of biological diversity. Indicators can be used to measure species numbers, to determine if populations are growing or declining as a result of human activities. Other indicators can be employed to measure species richness, genetic variability and available habitat in relation to the recovery and rehabilitation of threatened species.

Article 14 of the Convention requires that Contracting Parties undertake environmental impact assessments for all proposed projects that are likely to have significant adverse effects on biological diversity.[62] Indicators can monitor changes in the environmental composition, i.e. water pollution, decline in species numbers, population drops, increase in water turbidity, etc. Indicators can also communicate and exchange this information with appropriate parties, which is a direct mandate of the Convention.[63] Indicators can help facilitate co-operation and can be included within the environmental assessments to relay existing damage to the environment, as well as prevent further devastation.

Thus, indicators are an important facet to the Convention on Biological Diversity. Although not explicitly mandated within the text, they are implicit as a means to conserve biological diversity and the sustainable use of its components. They appear explicitly in the national reports (required under Article 26, e.g. such as those for the UK[64]) and are the focus of specific questions in the pro-formas for reports. The CBD is a binding agreement that has direct influence on domestic policy through the role and practices of subsidiary bodies and their direct involvement in the creation of national reports (at the International level, but also down to national level – due to the top-down approach of the Convention). Thus, international law affects the development and use of indicators down to the domestic level. Furthermore, law does influence policy, particularly at the international level, in that it influences reports

[61] Convention on Biological Diversity (1992) *supra* note 7 (Art 9(c) and (d))
[62] Ibid, at Art 14(a)
[63] Ibid, at Art 14(c)
[64] UK "United Kingdom and its Overseas Territories and Crown Dependencies: Third National Report to the Convention on Biological Diversity" (2005) 160pp
<< http://www.cbd.int/doc/world/gb/gb-nr-03-p1-en.pdf>> accessed 7 September 2005

and findings that are communicated by States to meet the obligations of the international regulations (thereby contributing to the answer for research question 7).

Indicators can provide transparency regarding ecosystems and the impacts that human activities have upon biological diversity. This helps to ensure that human activities remain compatible with the management objectives of the Convention. Similarly, indicators can be utilized to ensure that activities within the jurisdiction or control of one State do not cause damage to the biological diversity of other States, or of areas beyond the limits of national jurisdiction. However, the CBD has little to say about the qualities of an indicator (i.e. robust, transparent, etc.). However, if indicators are used to measure the performance of obligations, then this implies the deployment of more complex suites of indicators capable of dealing with intricate systems. Thus, indicators and the criteria underlying them are implied within the Convention, but no specifically mandated. They are another way to meet the obligations of the regulations.

Through the research it is apparent that indicators are one of the most important tools to achieve the objectives of the Treaty (hence why they are implied throughout the Convention). Despite this, they are not written into law. Following the review of UNCLOS, a pattern is beginning to emerge within international legal instruments favoring an open-ended approach to science and indicators. The CBD, as a framework agreement, establishes a particular mandate for States to protect biodiversity, but is flexible in its approach to meet this objective due to the fact that the States parties are sovereign States with varying national priorities and capacities to transpose the general commitments into domestic law. International law must be applicable across multiple borders and ecosystems, and therefore, must be flexible in its approach. Thus, the CBD depends upon the national transposition of measures and the way in which local conditions and contexts are determined, since these will drive the specific indicators. Indicators can and are deployed to integrate the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programs and policies within a given State. Perhaps all that can be concluded from the CBD is that indicators must be policy responsive. Also, that the effectiveness of any indicators will be context and user dependent, as this context will determine which indicators are developed and the criteria upon which they are founded. Policy and context responsivity are enhanced if the indicators are able to meet the four core functions (communication, simplification, quantification, and standardization.).

3.3.3 The OSPAR Convention

The OSPAR Convention merged and modernized the Oslo and Paris Conventions and provided a more inclusive and simplified approach to managing pollution of the maritime area.[65] Although the term indicator is not explicit within the text, the Contracting Members recognized (from current data – indicators), that the ecological equilibrium and legitimate uses of the sea were being threatened by pollution.[66] The implication of indicators within the OSPAR Convention represents an important element towards contemporary marine management of the North-east Atlantic. For example, the Convention references the precautionary principle and notes that even when science (i.e. indicators) is unable to provide conclusive evidence of a causal relationship between inputs to the marine environment and resultant effects, measures must be taken to minimize hazards to human health, living resources, and marine ecosystems.[67]

The Convention also requests States to employ the best available techniques and the best environmental practices, as well as the latest technological developments, to reduce and prevent environmental pollution.[68] This includes the development and deployment of indicators that can provide a more holistic understanding of the marine environment, and which can effectively communicate and exchange information on patterns in the environment. Since these tools are based upon technological advances, changes in scientific knowledge may result in the associated indicators and standards being revised. Similarly, best environmental practices include the application of the most appropriate combination of environmental control measures and strategies.[69] Arguably, this includes indicators. They are a means to determine the environmental hazard of any given product (including its production), the potential environmental benefit or penalty of substituting materials or activities, and the social and economic implications.[70] Similar to best available techniques, these practices (and their

[65] Convention for the Protection of the Marine Environment of the North-east Atlantic (1992) *supra* note 8
[66] Ibid, at Preamble, p 5
[67] Ibid, at Article 2, p 8
[68] Ibid, at Article 2, p 8
[69] Ibid, at Appendix 1, p 29
[70] Ibid, at Appendix 1, p 30

corresponding indicators) will change as scientific knowledge and understanding increases.[71]

Beyond the Convention, OSPAR has also utilized indicators within their environmental policy frameworks that have emerged during the North Sea Conference.[72] For example, the 6th North Sea Conference expressed a commitment to develop and employ indicators for fisheries and marine litter.[73] These indicators can monitor for ecological quality objectives (EcoQOs) of fisheries and general marine litter. EcoQOs can take the form of targets (values where there is a commitment to attain them), limits (values where there is a commitment to avoid breaching them) or indicators (values which simply show what is happening).[74] Thus, an EcoQO is another idiom for an indicator. Similar to indicators, a complete system of ecological quality objectives has the ability to provide a practical, scientifically based and consistent method to implement the ecosystem approach to which OSPAR has committed itself.[75]

Additionally, the OSPAR Convention requires that all Contracting Parties publish joint assessments on the quality status of the marine environment at regular intervals.[76] These assessments specifically call upon the use of indicators to evaluate the effectiveness of various measures for the protection of the marine environment, as well as identify priorities for action.[77] Arguably, regular marine assessments based on environmental indicators can increase knowledge and understanding of the marine environment, thereby minimizing gaps and resulting in more comprehensive environmental laws.[78] OSPAR Quality Status Report 2010 ('QSR 2010') stresses the need for "appropriate indicators" to evaluate "the quality status of the ecosystem in response to pressures from human activities," specifically in the areas of climate

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[71] Convention for the Protection of the Marine Environment of the North-east Atlantic (1992) *supra* note 8 (Appendix 1, p 30)
[72] Gubbay "Review of Marine Indicators: Reporting on Biodiversity Aspects of Ecosystem Health" [2004] (p 25)
[73] OSPAR, *North Sea Ministerial Meeting on Environmental Impact of Shipping & Fisheries* (2006) (p 6, 16)
[74] Ibid, at p 11
[75] OSPAR Commission, *Report on North Sea Pilot Project on Ecological Quality Objectives* (2006) (p 11)
[76] Convention for the Protection of the Marine Environment of the North-east Atlantic (1992) *supra* note 8 (p 9)
[77] OSPAR Commission, *Quality Status Report 2010* (2010) 177pp (p 9)
[78] Ibid, at Preface

change, eutrophication, hazardous and radioactive substances, among other areas.[79] The indicators employed in the QSR 2010 are developed and applied to communicate a condensed and simplified overview of trends in pressures and impacts affecting the North-East Atlantic and its regions.[80] Since this is a policy-based document, specific types of indicators are referenced, but none are mandated. Instead, States are given the freedom to use indicators either based in their national strategies or those better able to measure the objectives for which they are monitoring. The majority of indicators selected in the QSR 2010 are operationally efficient because they are founded on the core functions and successfully communicate the trends occurring in the North-East Atlantic Regions.[81]

The OSPAR Convention also provides the grounds for the adoption of legally binding 'Decisions' within five areas of focus.[82] Known as the five strategies, they have established objectives and requirements for action relating to hazardous substances, radioactive substances, eutrophication, the protection and conservation of ecosystems, and biological diversity of the maritime area.[83] The strategies contain provisions for the development of dynamic selection and prioritization mechanisms (i.e. indicators) to identify these hazardous substances and assist the Commission in selecting those indicators for which priority action will be taken.[84] They include the application of indicators to measure the targeted substances (i.e. mercury, hexachloroethane, short chained chlorinated paraffin, PAHs and PCBs).[85]

Indicators are also implicit within other areas of the OSPAR Convention. For example, Appendix 2 provides a list of criteria recommended when setting priorities and assessing the nature and extent of programs and measures.[86] Arguably, these criteria represent indicators and include persistency, toxicity, tendency to

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[79] OSPAR Commission (2010) *supra* note 77 (p 6-7, 9)
[80] Ibid, at p 8
[81] Ibid, at p 150-161; Heslenfeld and Enserink "OSPAR Ecological Quality Objectives: the utility of health indicators for the North Sea" [2008] ICES Journal of Marine Science 65 (8): pp 1392-1397 (p 1395-1396)
[82] Convention for the Protection of the Marine Environment of the North-east Atlantic (1992) *supra* note 8 (Article 13, p 11)
[83] OSPAR Commission, *Quality Status Report 2000* (2000) 107pp (p 36)
[84] Ibid, at p 37
[85] Ibid, at p 37
[86] Convention for the Protection of the Marine Environment of the North-east Atlantic (1992) *supra* note 8 (Appendix 2, p 31)

bioaccumulate, and radioactivity (among others).[87] These criteria reveal a list of 'benchmark values' against which indicators can assess the negative impacts of human activities. Appendix 2 also contains a list of substances for which the Convention recommends routine monitoring (via the deployment of indicators), and against which the criteria should be applied. These include heavy metals and their compounds, organohalogen compounds, organic compounds of phosphorus and silicon, biocides, pesticides, oils, hydrocarbons and other persistent compounds/synthetic materials.[88] Indicators can be utilized to measure the concentration of these substances within the marine environment. They can communicate the findings to scientists and regulators, so that a determination can be made regarding the hazards and negative impacts of these substances. Additionally, the indicators can exchange information on which substances are naturally occurring (as well as background concentrations) and those substances that are man-made and extremely detrimental to the environment.

Appendix 3 of the Convention provides a list of criteria that identify the effects of human activities to conserve the ecosystem and biological diversity of the maritime area.[89] These criteria can be measured via indicators and include such quantifications as the extent, intensity and duration of the human activity under consideration, the actual and potential adverse effects of the human activity on specific species, communities and habitats, the actual and potential adverse effects of the human activity on specific ecological processes, and the irreversibility or durability of these effects.[90] These criteria are not necessarily exhaustive or of equal importance for the consideration of a specific activity.[91] Furthermore, due to the lack of prescriptive guidance on indicator selection, States Parties are given freedom of choice and flexibility when selecting such indicators.

Indicators are tools that can gauge the present status of the OSPAR maritime area, as well as measure changes to marine ecosystems.[92] They gather information and allow regulators and policy-makers to assess the current status of the maritime areas and make the necessary decisions to protect it. This research has found that

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[87] Convention for the Protection of the Marine Environment of the North-east Atlantic (1992) *supra* note 8 (Appendix 2, p 31)
[88] Ibid, at Appendix 2, p 31
[89] Ibid, at Appendix 3, p 32
[90] Ibid, at Appendix 3, p 32
[91] Ibid, at Appendix 3, p 32
[92] OSPAR Commission (2000) *supra* note 83 (p 15)

indicators establish crucial links between OSPAR and various other policy and legislative systems geared at setting goals for the marine environment.[93] Indicators help integrate the many different approaches to protect and conserve the marine environment from various sources of marine pollution.[94] Thus, within the OSPAR Convention, both a top-down and bottom-up approach are evident. The Convention guides States Parties, but it also influenced by many EU instruments.[95] The objectives of the EU instruments complement OSPAR's objectives and because the indicators are operationally efficient (i.e. founded on the four core functions), there is successful communication occurring between international law and policy, as well as between international law and European law (i.e. law is influencing policy and policy is influencing law between various scales).[96] However, it is important to note this success is slowed by many difficulties, including lack of commitment by States Parties, many organizations and their involvement, and occasional scientific struggles, such as a lack of harmonized monitoring data, which hampers efforts.[97]

Consequently, although not explicit within the legislative text, indicators are implicit within the Convention as a means to help prevent and eliminate pollution, as well as protect marine ecosystems against the adverse effects of human activities.[98] Similar to the previous discussed Conventions, the OSPAR Convention has little to say about the qualities of an indicator (i.e. easily measurable, robust, communicative, etc.). It does, however, reference that data used to meet the objectives of the OSPAR Convention be scientifically valid (i.e. best available techniques, and best environmental practices), which is an important quality of an indicator (as discussed in chapter 1).

Since there is no explicit requirement to use particular indicators, or indicators with particular attributes, the States Parties enjoy the freedom to choose indicators that meet their national strategies, as well as the objectives of the Convention. Thus, the

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[93] See footnotes 72-81 and the accompanying text.
[94] OSPAR Commission (2006) *supra* note 75 (p 16)
[95] See footnotes 72-81 and the accompanying text, as well as Chapter 5 on EU law. The following directives (the Birds and Habitats Directives, the Water Framework Directive and the Marine Strategy Directive) all have direct influence on the OSPAR Convention and various objectives set by this Treaty at the international level. See also Heslenfeld and Enserink (2008) *supra* note 81 (p 1396)
[96] Heslenfeld and Enserink (2008) *supra* note 81 (p 1395)
[97] Ibid, at p 1396
[98] Convention for the Protection of the Marine Environment of the North-east Atlantic (1992) *supra* note 8 (p 8)

success and efficiency of the indicator is dependent on the user developing them. But, unlike the other Conventions, OSPAR is influenced by the bottom-up as much as it demonstrates a top-down control. Because multiple instruments are affecting the indicators, they are almost guaranteed to be successful and operationally efficient (because multiple instruments are ensuring they are based on the four core functions). Arguably, the indicators deployed to meet the objectives of the Convention help to safeguard human health, conserve marine ecosystems and, when practicable, restore devastated marine areas.[99] They provide transparency, communicate technical information in a simplified manner, and allow scientists and regulators to work together to ensure that management efforts, are successful in meeting the wider legal agenda.

3.3.4 The United Nations Framework Convention on Climate Change

The United Nations Framework Convention on Climate Change (UNFCCC) was created to address the growing issues and concerns with climate change and greenhouses gases on the global environment, as well as the impacts to economic and social structures of the States Parties.[100] Within the Convention, no explicit mandate for indicators is given. Instead, the framework broadly refers to the use of scientific knowledge, the exchange of technical information and the communication of socio-economic and legal information related to climate change and the consequences of current practices (including their contribution to increased greenhouse gas emissions and global climate change).[101] Although not directly aimed at the marine environment, it is important to discuss this Convention within this work because of the recognized direct and indirect impacts of climate change on marine ecosystems.[102]

Arguably, the UNFCCC is broad in its approach to indicator development and application because it must be applicable across a wide-variety of States, each of which has "differentiated responsibilities, and respective capabilities [as well as varied] social and economic conditions."[103] Indeed, the Convention notes that States have the sovereign right to exploit their own resources and pursue their national

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[99] Convention for the Protection of the Marine Environment of the North-east Atlantic (1992) *supra* note 8 (p 8)
[100] United Nations Framework Convention on Climate Change (1992) *supra* note 9 (Preamble)
[101] Ibid, at Art 4(1)(g)
[102] Ibid, at Preamble
[103] Ibid, at Preamble

environmental and development policies, so long as their activities do not cause damage to environments beyond their national control.[104] Thus, the Convention routinely implies the development and application of indicators to monitor and communicate climate change, but it does not mandate specific indicators, nor does it explicitly reference the criteria that should underline indicators. Instead, it notes that approaches developed by States must be flexible, and be included in social, economic and environmental policies and actions at the regional and national levels.[105] Thus, the Convention demonstrates a two-way approach to indicator development – it has a general mandate to address climate change and use science (top-down) – combined with a scope for States to use a general individual approach (bottom up). The Convention mandates that national policies and corresponding measures to mitigate climate change (including the development and application of indicators to communicate such measures) must be developed and must communicate the "anthropogenic emissions of greenhouse gases" with the objective of protecting and enhancing greenhouse gas sinks and reservoirs.[106]

As mentioned above, no specific reference to indicators is made in the Convention. Instead, the Convention routinely implies the development and application of indicators in its references to the development of analytical work and exchange/communication of scientific research, which directly ties to the four core functions of an indicator (most notably communication).[107] It notes that this work must be re-evaluated as new scientific findings become available and that where full scientific certainty cannot be achieved, States must utilize precautionary measures to help minimize the causes and adverse effects of climate change.[108] Furthermore, while no mandate of specific indicators is made, the Convention does require the use of best available scientific knowledge as appropriate (which links these indicators to robust qualities, which will ensure success and operationally efficiency), to mitigate the effects of climate change.[109]

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[104] United Nations Framework Convention on Climate Change (1992) *supra* note 9 (Preamble)
[105] Ibid, at Preamble, Art 4(1)(f) and (2)(a)
[106] Ibid, at Art 4(2)(a)
[107] Ibid, at Preamble
[108] Ibid, at Preamble, Article 3(3)
[109] Ibid, at Art 4(2)(c)

Yet, although specific indicators and corresponding criteria are not mandated within the UNFCCC, it does mandate that the methodologies employed to measure for climate change and create national inventories of anthropogenic emissions must be agreed upon by the Conference of the Party.[110] Thus, the Convention is promoting an approach to indicator development and application that has certain minimum requirements, but again, these are in broad terms. Instead of mandating the specific methodologies to develop these tools, it merely mandates that a uniformed approach be taken and agreed by all. Once again, there is a top-down approach to indicator development, with law influencing policy, and a recognition of the variabilities that exist globally between States Parties. Consequently, States are to "take climate change considerations into account, to the extent feasible, in their relevant social, economic and environmental policies and actions."[111] Furthermore, developed countries are to aid developing countries, via financial resources, in their objectives to develop indicators capable of measuring the effects of climate change and which aid developing countries in their obligations under the Convention.[112] This may provide a degree of horizontal integration of practice involving indicators. Thus, the UNFCCC implicitly calls upon the development and application of marine environment indicators and which influences policy and law from a top-down approach (as well as horizontally across other international instruments).[113]

Despite this approach, the UNFCCC demonstrates a bottom-up approach to indicator development (similar to the OSPAR Convention), where regional and national bodies and agencies are able to influence the direction and application of this Convention, via their involvement with the Conference of the Parties.[114] These bodies and agencies are allowed to participate by guiding the direction of the Convention, including the development of scientific and technical approaches (i.e. indicators) utilized to communicate information and advice through the establishment of subsidiary bodies for scientific and technical advice.[115] It is within this Article that the implicit call for the application and development of indicators is most prominent.

[110] United Nations Framework Convention on Climate Change (1992) *supra* note 9 (Art 4(1)(a) and 7(2)(d))
[111] Ibid, at Art 4(1)(f))
[112] Ibid, at Art 4(3)
[113] Ibid, at Art 5(a)
[114] Ibid, at Art 7(6)
[115] Ibid, at Art 9(1)

These subsidiary bodies are to provide assessments regarding the state of the environment (i.e. state indicators), as well as prepare scientific assessments on the causes of climate change (i.e. driver and pressure indicators) and the effects of the measures taken to mitigate climate change (i.e. response indicators).[116] Thus, States are influencing the development and application of appropriate indicators in a position where national and regional strategies are directly impacting and influencing international law and global approach to climate change.

Consequently, from the analysis of the UNFCCC, it is apparent that the success of indicators deployed to meet the objectives of the Convention is solely dependent on the user developing and applying them. These indicators should, in theory, be operationally efficient, as there is a call in the Convention for the scientific evidence (i.e. indicators) to be able to successfully communicate complex situations in a more simplified manner, such that it can be understood by scientific, technical and managerial personnel, as well as the general public.[117] This is a direct mandate that the indicators developed and applied must be founded on the four core functions. But no mention is afforded to the criteria underlying the indicators, which means that the success or failure of the indicator will be directly dependent on the user that develops them and what they are developed on. Successful indicators can and most likely are developed by States,[118] but, as seen in later case studies, due to a lack of strict direction, misunderstandings in the science behind the indicators can sometimes occur. This is evaluated in greater detail in Section 3.4.

3.3.5 The MARPOL Convention

The International Convention for the Prevention of Pollution from Ships (the MARPOL Convention) aims to prevent and minimize both accidental and operational pollution from routine ships.[119] Developed by the International Maritime Organization (IMO), MARPOL is regarded as a generally accepted international rule

[116] United Nations Framework Convention on Climate Change (1992) *supra* note 9 (Art 9(2)(a)-(e) and 12(1)(a) and (b))
[117] Ibid, at Art 6(a)(i)-(iv)
[118] For example, Hohne and Harnisch (2002) "Evaluating indicators for the relative responsibility for climate change – alternatives to the Brazilian proposal and global warming potentials" [2002] Third International Symposium on Non-CO2 Greenhouse Gases (NCGG-3) 6pp; Fussel, H.M. "How inequitable is the global distribution of responsibility, capability, and vulnerability to climate change: A comprehensive indicator-based assessment" [2010] Global Environmental Change 20(4): 597-611pp
[119] MARPOL Consolidated Edition 2006 (p 3)

or standards for the purpose of meeting UNCLOS general obligations.[120] Although not explicitly mandated, the Convention implies the use of environmental indicators to monitor the marine environment. They can measure pollution, as well as the corresponding activities responsible. This, in turn, allows regulators to take steps to remediate harm, or prevent harm, to the environment, as well as control the release of the harmful substances.

The Convention broadly defines such terms as harmful substances, discharge, and incident.[121] For example, a harmful substance is defined as one “which can create hazard, harm, damage, or interference if introduced into the marine environment.”[122] This entails the use of more specific descriptors or measures of harm, or in other words indicators. Environmental indicators can define these types of substances and their effects on the marine environment, including hazards to human health, marine life and the ecosystem. Furthermore, indicators can communicate these effects to the relevant authorities who can respond with clean-up efforts, regulations and enforcements. The discussion below will provide examples of such indicators and analyze if these marine environmental indicators are successful and operational efficient within the auspice of the MARPOL text.

The Convention requires that sufficient evidence be available to enable proceedings for alleged violations.[123] Also, Article 6 states that “Parties to the Convention shall co-operate in the detection of violations and the enforcement of the provisions of the present Convention, using all appropriate and practicable measures of detection and environmental monitoring, adequate procedures for reporting and accumulation of evidence.”[124] This implies the use of indicators to provide the information and evidence necessary to determine that a violation has occurred. For example, if hazardous materials are illegally dumped from a ship, changes in water quality can detect the pollution and provide the necessary evidence that harm has been caused to the environment. Indicators, such as water quality, changes in population

[120] James Harrison *Making the Law of the Sea: A Study in the Development of International Law* (CUP, 2013) 316pp (p 154-199)
[121] International Convention for the Prevention of Pollution from Ships, 1973 (1978) *supra* note 10 (Art 2)
[122] Ibid, at Art 2(2)
[123] Ibid, at Art 4(1)
[124] Ibid, at Art 6

densities, Biochemical oxygen demand (BOD) parameters, phytoplankton and algae blooms offer a means to detect environmental impacts due to pollution from ships. Yet, MARPOL does not mandate the use of specific indicators, nor does it designate what sufficient evidence means: presumably this will depend upon domestic law standards and burdens of proof. Although the Convention does mandate specific measurements be taken within the Annexes, States can select the indicators that they deem relevant to measure these attributes, but they must share this data with the IMO, as well as other parties to the Convention.[125] This creates transparency and allows for a global approach to pollution prevention from ships. Arguably, it can even contribute to uniformity, if states can follow others' practices.

The six Annexes of the Convention address prevention of various forms of pollution.[126] It is within these Annexes that the implicit use of indicators is more apparent. Monitoring protocols are fleshed out and details are provided as to how States can meet the mandates of these Annexes and ultimately prevent pollution. The following discussion of the Annexes demonstrate this case in point.

Annex I applies to the prevention of oil contamination from operational measures, as well as accidental discharges.[127] Indicators are implicit as a means to measure these contaminants, including asphalt solutions, gasoline blending stocks, oils, gasoline, jet fuels, distillates, naphtha and gas oil.[128] Regulation 1 defines the instantaneous rate of oil discharge as "the rate of discharge of oil in liters per hour at any instant divided by the speed of the ship in knots at the same instant."[129] Measured in parts per million (ppm), this indicator can determine when the discharge of the oil substance exceeds 15ppm (the maximum level granted by the mandates of Annex I).[130] Furthermore, Regulation 14 refers to oil filtering equipment as a means to measure oily mixtures discharged into the sea.[131] This equipment must contain an alarm to indicate when the level of discharge cannot be maintained.[132] The system must also

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[125] International Convention for the Prevention of Pollution from Ships, 1973 (1978) *supra* note 10 (Art 12(1))
[126] Ibid, at Annexes I-V
[127] Ibid, at Annex I
[128] Ibid, at Annex I, Appendix I
[129] Ibid, at Annex I, Regulation 1(12)
[130] Ibid, at Annex I, Regulation 14(6)
[131] Ibid, at Annex I, Regulation 14(6)
[132] Ibid, at Annex I, Regulation 14(7)

have arrangements to automatically stop any oil discharges that exceed 15ppm.[133] Additionally, when visible traces of oil are observed near a ship or its wake, governments can utilize indicators to determine if the regulations have been violated.[134] These investigations should include such indicators as the wind and sea conditions, the track and speed of the ship, other possible sources of the oil, and any relevant oil discharge records.[135] Thus, Annex I implies the utilization of indicators, and provides a means to measure for them.

Annex II applies to the control of pollution by noxious liquid substances.[136] Indicators are implicit within this Annex as a means to measure for pollution by various chemicals transported via ships. These are defined via four categories.[137] These 4 classifications are indicators which communicate the severity of the pollution. Annex II provides a detailed explanation for how these indicators have been devised and, consequently, how the categories are assigned to various liquid substances. See Tables 3.2 and 3.3 for explanations regarding these guidelines. Indicators are also implicit in Annex II via the definitions supplied in Regulation 1. For example, the term noxious liquid substance is defined as "any substance indicated in the Pollution Category column of the International Bulk Chemical Code or provisionally assessed under the provisions of regulation 6.3 as falling into category X, Y or Z."[138] Arguably, this term is an indicator. If a substance meets the criteria of this definition, then it is a noxious liquid substance and the provisions of this Annex apply. This and other terms are defined within Annex II to allow the contracting parties to properly identify noxious liquid substances and apply the Convention as appropriate. Some examples of indicators provided for in Annex II include liquid substances, solidifying substances, high-viscosity substances, low-viscosity substances, residues, and residue/water mixtures.[139]

[133] International Convention for the Prevention of Pollution from Ships, 1973 (1978) *supra* note 10 (Annex I, Regulation 14(7))
[134] Ibid, at Annex I, Regulation 15(7)
[135] Ibid, at Annex I, Regulation 15(7)
[136] MARPOL (2006) *supra* note 119 (p 5)
[137] International Convention for the Prevention of Pollution from Ships, 1973 (1978) *supra* note 10 (Annex II, Regulation 6(1))
[138] Ibid, at Annex II, Regulation 1(10)
[139] Ibid, at Annex II, Regulation 1

Indicators are implicit within Annexes III-IV as a means to measure the different types of pollution for which the Annexes were created and the effects that these substances have on the marine environment. For example, indicators can determine if sewage is improperly discharged from a ship.[140] Similarly, indicators can identify harmful substances and ensure that these substances are packaged properly, as well as determine the Hazard Rating of the substance.[141]

Table 3.2: Guidelines of the categorization of noxious liquid substances. Products are assigned to pollution categories based on an evaluation of their properties as reflected in the resultant GESAMP Hazard Profile as shown in the table below:[142]

<table>
<tr><th>Rule</th><th>A1
Bioaccumulation</th><th>A2
Biodegradation</th><th>B1
Acute Toxicity</th><th>B2
Chronic Toxicity</th><th>D3
Long-Term Health Effects</th><th>E2
Effects On Marine Wildlife And on Benthic Habitats</th><th>Cat</th></tr>
<tr><td>1</td><td></td><td></td><td>≥5</td><td></td><td></td><td></td><td rowspan="4">X</td></tr>
<tr><td>2</td><td>≥4</td><td></td><td>4</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td></td><td>NR</td><td>4</td><td></td><td></td><td></td></tr>
<tr><td>4</td><td>≥4</td><td>NR</td><td></td><td></td><td>CMRTNI</td><td></td></tr>
<tr><td>5</td><td></td><td></td><td>4</td><td></td><td></td><td></td><td rowspan="7">Y</td></tr>
<tr><td>6</td><td></td><td></td><td>3</td><td></td><td></td><td></td></tr>
<tr><td>7</td><td></td><td></td><td>2</td><td></td><td></td><td></td></tr>
<tr><td>8</td><td>≥4</td><td>NR</td><td></td><td>Not 0</td><td></td><td></td></tr>
<tr><td>9</td><td></td><td></td><td></td><td>≥1</td><td></td><td></td></tr>
<tr><td>10</td><td></td><td></td><td></td><td></td><td></td><td>F_P, F or S If not Inorganic</td></tr>
<tr><td>11</td><td></td><td></td><td></td><td></td><td>CMRTNI</td><td></td></tr>
<tr><td>12</td><td colspan="6">Any product not meeting the criteria of rules 1 to 11 and 13</td><td>Z</td></tr>
<tr><td>13</td><td colspan="6">All products identified as: ≤2 in column A1; R in column A2; blank in column D3; not F_P, F or S (if not organic) in column E2; and 0 (zero) in all other columns of the GESAMP Hazard Profile</td><td>OS</td></tr>
</table>

140 International Convention for the Prevention of Pollution from Ships, 1973 (1978) *supra* note 10 Annex IV
141 Ibid, at Annex III
142 Taken from International Convention for the Prevention of Pollution from Ships, 1973 (1978) *supra* note 10 (Annex II, Appendix 1)

Table 3.3: Further guidelines for the categorization of noxious liquid substances. Note, column E2 is used to define pollution categories. Abbreviated legend to the revised GESAMP Hazard Evaluation Procedure (continued)[143]

Column E Interfaces with other uses of the sea			
E1 Tainting	E2* Physical effects on wildlife & benthic habitats	E3 Interference with coastal amenities	
		Numerical rating	Description & action
NT: not tainting (tested) T: tainting test positive	F_P: Persistent floater F: Floater S: Sinking substances	0	No interference No warning
		1	Slightly objectionable Warning, no closure of amenity
		2	Moderately objectionable Possible closure of amenity
		3	Highly objectionable Closure of amenity

Annex VI applies to the prevention of air pollution from ships.[144] Indicators are implicit within Annex VI as a means to measure for emissions from ships and determine the amount of pollution that such emissions may cause. Arguably, the elements mentioned in the Annex, such as ozone-depleting substances, including Halon 1211 (Bromochlorodifluoromethane), Halon 1301 (Bromotrifluoromethane), Halon 2402 (1,2-Dibromo-1, 1, 2, 2-tetrafluoroethane (also known as Halon 114B2)), CFC-11 (Trichlorofluoromethane), CFC-12 (Dichlorodifluoromethane), and CFC-115 (Chloropentafluoroethane), are themselves indicators (which, although examples, are more precise than other previously discussed international conventions, such as UNCLOS and OSPAR).[145] These substances are indicators of pollution. The deployment of these indicators can determine when emissions are above the legal limit expressed in the Annexes. Annex VI requires that assessments are undertaken to measure air pollution from ships. They must include such indicators as the description of the impacts that emissions cause on terrestrial and aquatic ecosystems, areas of natural productivity, critical habitats, water quality, human health, prevailing wind patterns, meteorological conditions, and areas of cultural and scientific significance (among others).[146] The sources of this relevant data (i.e. indicators), as well as

[143] International Convention for the Prevention of Pollution from Ships, 1973 (1978) *supra* note 10 (Annex II, Appendix 1)
[144] Ibid, at Annex VI
[145] Ibid, at Annex VI, Regulation 2(6)
[146] Ibid, at Annex VI, Appendix III(2.2)(.3)

methodologies, must be identified within this assessment.[147] Once such emissions have been measured, indicators can then be utilized to ensure ships remain within compliance of the Annex.

Indicators can ensure that the objectives of the MARPOL Convention are met by monitoring the levels of pollution from ships. They are implicit throughout the Convention and its corresponding Annexes as a means to ensure compliance, communicate findings and ultimately prevent and minimize pollution from routine operations. Further to this, flag States must ensure that domestic regulations are adopted consistent with MARPOL. To the extent that MARPOL establishes precise technical requirements, then indicators must be suited to these. However, similar to the CBD, MARPOL has little to say about the qualities of an indicator (i.e. robust, transparent, etc.). Much depends upon domestic implementation, since some flexibility is afforded to States in terms of monitoring and compliance.

Thus, similar to the other conventions at the international level, indicators are not explicitly mandated, but instead, implied throughout the framework of the regulation. Arguably, this creates a top-down approach, but one that allows the States Parties the ability to develop and deploy the indicators that best fit their national strategies (so long as they are consistent with MARPOL). Similar to other conventions, the success and efficiency of the chosen indicators is dependent on the user developing them. Since no direction or indicator criteria is afforded States through MARPOL, the States themselves should ensure the indicators are based on the four core functions and founded on criteria most prevalent to meet their objectives.

Thus, this approach can promote success in indicator development. But, as will be seen in the case study analysis discussed in the next section, due to a lack of strict direction, misunderstandings can occur among the States Parties. This can create mixed messages and even prevent a successful implementation of the Convention. This is not a fault of the indicators, per se, but a lack of clarity in the regulation itself (which is necessary, since international law cannot strictly dictate national strategies, but instead, seeks to influence them to meet the greater objectives of the International

[147] International Convention for the Prevention of Pollution from Ships, 1973 (1978) *supra* note 10 (Annex VI, Appendix III(2.2)(.3))

Convention while simultaneously recognizing States differences in capabilities, finances and national structures).

Nevertheless, despite a lack of strict guidance on indicator development and application, MARPOL has precise technical demands to prevent pollution to the marine environment. Indicators provide a means to set standards and measure compliance, to ensure progress towards meeting the objectives fleshed out within the MARPOL Convention in a manner that does not infringe on the States Parties' sovereign rights.

Table 3.3 presents a summary of the findings discussed throughout Section 3.3 and further explains the interactions of these legal documents with marine environmental indicators.

Table 3.3: A summary of legal documents discussed in Section 3.3 and their interaction with marine environmental indicators.

Treaty	Explicit indicators	Implicit indicators	Top-Down Approach	Bottom-Up Approach	Operationally efficient indicators? (i.e. meet core functions and criteria)
UNCLOS	No	Yes	Yes	No	Yes – but dependent on user.
CBD	No	Yes	Yes	No	Yes – but dependent on user. Here we begin to see the influences of law on policy
OSPAR	No	Yes	Yes	Yes	Yes – but dependent on user. Here we begin to see the influences of law on policy, as well as the effects of a bottom-up approach
UNFCCC	No	Yes	Yes	Yes	Yes – but dependent on user. Here law is influencing policy from the top-down, but also from the bottom-up.
MARPOL	No	Yes	Yes	No	Yes – but dependent on user (yet still must be consistent with the terms of the Convention)

3.4 International Case Law

The role of evidence in international litigation is interesting, since litigation provides an opportunity for two States to bring before a third party adjudicator evidence which can be adduced to assess whether or not each State has complied with its international obligations.[148] Historically, the role of procedures and evidence in litigation before the ICJ has been characterized as flexible or lacking in transparency.[149] More recently, however, the ICJ has heard a number of cases that contained many challenging evidentiary issues, including "factual, scientific and technical evidence of extreme complexities."[150] Such cases have required the ICJ to confront the status and treatment of evidence more directly. For example, they must exercise their power to obtain their own evidence to supplement the case, limit the volume of unnecessary and superfluous evidentiary items, and even hold preliminary proceedings to inform the parties on what they require in the way of facts and proof.[151] Furthermore, when dealing with scientific and technical advisers, the ICJ has found it more useful to have these persons as experts or witnesses, as opposed to members of counsel.[152] Regardless of these obstacles, the ICJ is confronting the use of evidence and scientific data head on, bringing an interesting perception and interpretation on one facet of international litigation.

Following the analysis of indicators within a selection of marine environmental agreements, it is useful to examine how indicators are considered in case law, since such may provide more general guidance on the use of evidence/indicators. This section explores the application of indicators within international cases, to determine the extent to which indicators are employed and understood. The analysis of the cases focuses solely on the application of indicators to meet the objectives of the over-arching regulations. Thus, this section analyzes the application and interpretation of indicators by the courts (regardless if the use of indicators is implicit or explicit within the regulations). Within each case study, the role of the indicator deployed is accessed to determine the level of success and operational efficiency of the indicator. Has the function and intended purpose of the indicator been met? Does the indicator meet the four core functions and what criteria is it founded on? Table 3.4 provides a summary of the indicators deployed in each case, and compares the role of the indicator, while analyzing the level of success.

[148] Rudiger Wolfrum "International Courts and Tribunals, Evidence" [2012] (Paragraph 1 and 4)
[149] Chester Brown "Book Review of Evidence before the International Court of Justice" [2011] International Courts and Tribunals 10: pp 205-210 (p 205)
[150] Ibid, at p 205
[151] Ibid, at p 206
[152] Ibid, at p 208-209

Table 3.4: A summary of indicators deployed in each case study, as well as a comparison on the roles of each indicator and an analysis on the level of success of the indicators.

CASE STUDY	INDICATORS USED	CONTEXT	ROLE OF INDICATOR	LEVEL OF SUCCESS?
1.) New Zealand v Japan (ITLOS Case No 3) 2.) Australia v Japan (ITLOS Case No 4)	MSY TAC	Status of SBT stock	To determine the status of the SBT stock, effects of Japan's activities on stock levels, and their success and failure to restore SBT stocks to sustainable levels	The indicators demonstrated historical low levels. But they could not determine if Japan's EFP affected SBT status. They also could not determine the measures needed to conserve SBT. Thus, the indicators were not successful because they could not answer or communicate the information they were intended to relay.
3.) Ireland v United Kingdom (MOX Plant Case) (ITLOS Case No 10)	Liquid radioactive discharge to the Irish Sea, which can off-gas to the atmosphere	Air Quality Water Quality	Effects to human health (contamination to beaches, atmospheric contamination) Impacts on fisheries (lobsters, seaweeds)	Yes, the indicators were successful. They were founded on the four core functions, as well as pertinent criteria. The UK used both historical and current indicators to prove no harm would occur to the marine environment.
4.) Argentina v Uruguay (Pulp Mills) (ICJ Rep. 14)	*Dissolved Oxygen *Total Phosphorus *Phytoplankton (Algal Blooms) *Dioxins and foran concentration *Biological Diversity Zooplankton Biomarkers of pollution in fish Species Diversity Concentration of resin acids/chlorinated phenols and plant sterols in fish Mercury and Lead levels	Water Quality	To determine pollution levels To determine the effects on biodiversity and fisheries To determine changes to the ecosystem as a direct result of the Mills operations.	Dissolved Oxygen: Successful for Uruguay. Argentina misunderstood the meaning of the indicator (which isn't the fault of the indicator – it is the fault of the user applying it). Phosphorus: Successful for Uruguay. Argentina didn't supply the adequate data to support their claims. Algal Blooms: Successful for Uruguay. Again, Argentina didn't provide indicators that were successful, thus, the indicators did not support their claims. Dioxin and furan concentrations: Successful for Uruguay. Argentina's claims were not supported by the findings of these indicators. Biological Diversity: Successful for Uruguay. Argentina's claims were not supported by the findings of these indicators.

***These were the indicators analyzed in this case study analysis**

3.4.1 Southern Bluefin Tuna (ITLOS Case No 3 and 4)

The first and second cases to be analyzed in regards to the use of indicators to meet regulatory requirements are the *International Tribunal for the Law of the Sea 27 August 1999 Southern Bluefin Tuna Cases (New Zealand v Japan; Australia v Japan) (Case Nos. 3 and 4)*.[153] These cases demonstrate the importance of environmental indicators in determining compliance with the law. They also illustrate the effects of varying interpretations of the indicators by the Court. Furthermore, they draw upon standards set by various international conventions and bring to light the importance of scientific research and political pressure.

These cases concern a dispute over catches of southern Bluefin tuna (SBT).[154] New Zealand and Australia alleged that Japan had failed to comply with its obligation to cooperate in the conservation of the SBT stock by, *inter alia*, undertaking unilateral experimental fishing for SBT in 1998 and 1999.[155] They maintained that the scientific evidence available (i.e. indicators) showed that the amount of Bluefin tuna taken under the experimental fishing program (EFP) could endanger the existence of the stock.[156] Furthermore, both countries argued that Japan failed to co-operate with them to ensure the conservation of SBT, including having regard to the requirements of the precautionary principle.[157] Australia and New Zealand sought provisional measures requiring Japan to cease experimental fishing and to reduce its catch levels of SBT.

In response, Japan denied these claims.[158] It contended that scientific evidence demonstrated that implementation of its EFP would not cause further threat to the SBT stock.[159] Furthermore, Japan stated that the EFP was necessary to reach a more reliable assessment of the potential for the stock to recover.[160] It offered to negotiate protocols for the development of such indicators as EFP and Total Allowable Catch (TAC) to determine if their actions were in fact impacting SBT. Japan argued that both States rashly resorted to proceedings under UNCLOS, despite the absence of any

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[153] *Southern Bluefin Tuna Cases (New Zealand v Japan; Australia v Japan)* [1999] ITLOS Case Nos. 3 and 4
[154] Ibid, at Intro
[155] Ibid, at Para 28 and 29
[156] Ibid, at Para 73
[157] Ibid, at Para 28(1)(d)-(e) and 29(1)(d)-(e)
[158] Ibid, at Para 47
[159] Ibid, at Para 73
[160] Ibid, at Para 73

scientific proof, making this a scientific dispute (not a legal one).[161] ITLOS disagreed. They noted that the list of highly migratory species contained within Annex I of UNCLOS included SBT, and therefore, made this argument a matter of law as much as it was a matter of science.[162] The Tribunal also noted that it was within its jurisdictional rights to prescribe provisional measures to prevent serious harm to the marine environment.[163]

There was no disagreement between the parties that the stock of SBT was severely depleted and at its historically lowest levels, as the indicators demonstrated this.[164] The Tribunal found that scientific uncertainty did exist, however, regarding the measures that should be taken to conserve the stock of SBT.[165] Additionally, there was no agreement on whether the conservation measures previously taken had led to the improvement in the stock of SBT.[166] Nevertheless, they argued that catches taken within the framework of any EFP should not result in total catches that exceed agreed upon levels.[167]

Indicators are implicit within these cases. They are presented as scientific evidence to support the claims of each party. Furthermore, experts were called by each State to provide the data/indicators and interpret the meanings as they understood them.[168] These main indicators included the Maximum Sustainable Yield (MSY) and the TAC, two scientific measurements used to determine the level of the fish stocks. These indicators were deployed to communicate the status of the SBT, the effects of Japan's activities on the stock levels, and the success/failure of Japan to help restore these fish stocks to sustainable levels.[169] The Tribunal was tasked with evaluating this evidence (i.e. indicators). Although it could not conclusively rule on the evidence presented (as each State maintained that their evidence was accurate), they did rule as a matter of urgency on provisional measures to protect the stock.[170]

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[161] *Southern Bluefin Tuna Cases (New Zealand v Japan; Australia v Japan)* [1999] *supra* note 153 (Para 33)
[162] Ibid, at Para 49
[163] Ibid, at Para 67
[164] Ibid, at Para 71
[165] Ibid, at Para 79
[166] Ibid, at Para 79
[167] Ibid, at Para 81
[168] Ibid, at Para 25
[169] Ibid, at Para 28(1)(a), 28(2)(b), 29(1)(a), and 29(2)(b)
[170] Ibid, at Para 80

Japan requested that the Tribunal refer to a panel of independent scientists to interpret the indicators.[171] It asserted that this matter was a scientific dispute over interpretation of the indicators, not a dispute on law-breaking.[172] Japan asserted that a panel of independent scientists could resolve the issues that existed between the three States.[173] The Court did not follow this approach, however. They treated these disputes as legal, rather than technical. This raises the question on whether judges can really deal with technical matters. When it came down to it, the Tribunal referred back to the law, and not the science, which arguably marginalized the use of indicators.

These cases demonstrate that agreed upon processes and evidence can persuade the Court more than unilateral approaches. Even when the indicators are inconclusive, the Court is likely to favor a precautionary approach.[174] Thus, the Tribunal utilized caution with the inconclusive data, as this is an agreed upon conservation measure in international law that helps to ensure conservation and proper management of SBT. The Tribunal stressed that all members to the Convention should act with precaution and prudence to ensure effective conservation and prevent serious harm to SBT stock.[175]

In conclusion, the judgments of these two cases rested on the interpretations of the indicators. Through their interpretation, the Tribunal concluded that the stock of SBT was severely depleted.[176] Since this was not disputed by the parties, it shows a degree of consensus on the point that indicators are important. According to the indicators, stocks were at their historically lowest levels, which was a cause for serious biological concern, thereby requiring legislative measures, which all three parties agreed.[177] This confirms that it is easier to demonstrate historical and current matters, but much more difficult to model or predict future activities and action. But were the stocks being depleted further by the Japanese EFP? Or was Japan's fishing a scientific endeavor to discover the real threats to SBT stocks? The Tribunal found that the indicators were inconclusive – i.e. there was scientific uncertainty regarding the

[171] *Southern Bluefin Tuna Cases (New Zealand v Japan; Australia v Japan)* [1999] *supra* note 153 (Para 33)
[172] Ibid, at Para 33, 42
[173] Ibid, at Para 35
[174] Ibid, at Para 80
[175] Ibid, at Para 77
[176] Ibid, at Para 71
[177] Ibid, at Para 71

effects of Japan's EFP, or the measures that should be taken to conserve the SBT stocks.[178] They felt that parties to the Convention should intensify efforts and ensure conservation and optimum utilization of SBT stock. The Tribunal also noted that there was no agreement or shared data between the parties in this case that could be employed to determine whether previous conservation measures had in fact led to the improvement of the stock of SBT.[179]

Thus, for these two cases, the indicators deployed by the Parties were not successful because they could not answer or communicate the information they were intended for. Arguably, this is because the indicators were not properly founded on the four core functions and were not based on the appropriate criteria. Because the indicators were inconclusive, they could not communicate the necessary information (one of the four core functions) and were not clearly proven to be scientifically valid, simple to interpret, tightly linked to human activity or founded upon any other relevant criteria. This is not necessarily the fault of the indicator, but instead, could be blamed on the parties who developed and applied the indicators. Rather than base the indicator on scientific criteria, they manipulated them for their own political purposes. And unlike the historical data, which showed depletion of SBT stocks over time, the MSY and TAC could not communicate the effects of Japan's activities on stock levels, nor could it communicate Japan's work to restore stock's to sustainable levels. Consequently, since the indicators did not conclusively prove either argument, the Tribunal used precaution with SBT stocks and ruled in favor of Australia and New Zealand.[180]

3.4.2 The MOX Plant Case (ITLOS Case No 10) – Ireland vs. UK

The third case to be analyzed in regards to the utilization of environmental indicators in international litigation is the *MOX Plant Case (Ireland v United Kingdom) (ITLOS Case No. 10)*.[181] Although this case focused on jurisdictional issues, it also addressed the application of indicators to measure the polluting effects of the MOX Plant. This case illustrates the importance of indicators founded on the four core functions and pertinent criteria (specifically communication, scientifically valid, policy relevant,

[178] *Southern Bluefin Tuna Cases (New Zealand v Japan; Australia v Japan)* [1999] *supra* note 153 (Para 79)
[179] Ibid, at Para 79
[180] Ibid, at Para 80, 90
[181] *The MOX Plant Case (Ireland v. United Kingdom)* [2001] ITLOS Case No 10

tightly linked to human activity) when allegations of potential environmental pollution are made and the arguments that can result from disagreements on indicator interpretations.

This case rested on a dispute concerning the environmental impacts of the MOX plant and the protection of the Irish Sea.[182] Ireland accused the UK of failing to take the necessary measures to prevent, reduce, and control pollution to the Irish Sea from discharges and/or accidental releases of radioactive materials/wastes from the MOX plant to the marine environment, as well as the atmosphere.[183] Ireland argued that once plutonium was introduced into the MOX plant, some discharges to the marine environment and emissions to the atmosphere would occur with irreversible consequences.[184] Ireland did not have specific indicators or concrete data to support its concerns.[185] Thus, it called for the use of the precautionary principle to prevent potential harm to flora and fauna, as well as to human health.[186]

The UK responded to Ireland's claims by providing concrete evidence (indicators) which proved that the risk of pollution, if any, from the operation of the MOX plant would be infinitesimally small and negligible.[187] The UK maintained that commissioning the plant would not cause serious harm to the marine environment.[188] The data derived from the indicators showed that gaseous discharges from the MOX Plant to the UK were 0.002µSv per year (two thousandths of a millionth of a Sievert) and that the dose of liquid discharges was 0.000003µSv per year (three millionths of a millionth of a Sievert).[189] Furthermore, exposure of gaseous discharges from the MOX Plant to Ireland were 0.00004µSv per year (four hundred thousandths of a millionth of a Sievert).[190] And exposures of liquid discharges to Ireland would be 0.000003µSv per year (three millionths of a millionth of a Sievert) – considerably less

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182 *The MOX Plant Case (Ireland v. United Kingdom)* [2001] *supra* note 181 (Para 2)
183 Ibid, at Para 26(1)
184 Ibid, at Para 68
185 *Request for Provisional Measures and Statement of Case Submitted on Behalf of Ireland* [2001] ITLOS (Para 11)
186 *The MOX Plant Case (Ireland v. United Kingdom)* [2001] *supra* note 181 (Para 71); *Request for Provisional Measures and Statement of Case Submitted on Behalf of Ireland* [2001] *supra* note 185 (Para 11)
187 *Written Response of the United Kingdom* [2001] ITLOS (Para 97)
188 *The MOX Plant Case (Ireland v. United Kingdom)* [2001] *supra* note 181 (Para 73)
189 *Request for Provisional Measures and Statement of Case Submitted on Behalf of Ireland* [2001] *supra* note 185 (Para 56)
190 Ibid, at Para 59

than the exposure to the UK[191]. Since the UK regulations of exposure for radioactive discharges from a single new source is 0.3mSv (three tenths of a thousandth of a Sievert), the MOX Plant is at least three times more stringent than the requirements of EU and UK law.[192] The UK argued that Ireland had failed to supply "cogent evidence" that serious harm to the marine environment would result from the operation of the MOX plant.[193]

Indicators play an interesting role in this case. The UK used indicators to communicate the pollution that can result from activities associated with the MOX plant, as well as potential responses to this change. As mentioned above, the indicators utilized by the UK were discharges of radioactive materials and/or wastes to both the marine environment and the atmosphere.[194] The Tribunal decided the situation was not urgent enough to justify provisional measures, as there was no evidence of imminent harm. In fact, it can be reasonably inferred that the Tribunal was influenced by the UK's arguments, as it had a clearer and stronger evidence base. Arguably, the UK's indicators were founded on the four core functions, as well as pertinent criteria (including policy relevant, scientifically valid, concrete and specific and able to survive legal interrogation). It could be argued that Ireland failed because their indicators were abstract and generic, making assumptions on what could occur without any data specific to the site to back up their claims. In other words, they were not scientifically valid, or concrete and specific.

Thus, indicators maintain an important role in this case study. They depict current pollutant discharges from the plant (or lack thereof), and thus, communicate true effects of the MOX Plant on the marine environment. To provide some concrete perspective on their indicators, the UK interpreted their data to demonstrate that "the combined annual doses to the most exposed members of the public (for gaseous and liquid discharges from the MOX Plant) would be less than one millionth of the annual

[191] *Request for Provisional Measures and Statement of Case Submitted on Behalf of Ireland* [2001] *supra* note 185 (Para 59)
[192] Ibid, at Para 97
[193] *The MOX Plant Case (Ireland v. United Kingdom)* [2001] *supra* note 181 (Para 75); *Request for Provisional Measures and Statement of Case Submitted on Behalf of Ireland* [2001] *supra* note 185 *supra* note 185 (Para 1)
[194] *The MOX Plant Case (Ireland v. United Kingdom)* [2001] *supra* note 181 (Para 26(1)-(2)); *Request for Provisional Measures and Statement of Case Submitted on Behalf of Ireland* [2001] *supra* note 185 (Para 14, 32, 55, 56, 59, 97-99)

dose that the average person receives from background radiation occurring naturally in the environment."[195] Furthermore, the dose to a heavy consumer of fish and shellfish from the Irish Sea is "less than 1% of the average dose of 3,000 micro-Sieverts received in a year from all sources of radiation."[196] Thus, the UK's indicators disproved Ireland's claims and showed that exposure to radiative discharges from the MOX Plant is negligent and that it is safe to eat fish and shellfish from the Irish Sea and enjoy its amenities.[197]

Thus, the UK utilized indicators to support its claim that operations from the MOX plant would not harm the marine environment. The UK argued that their evidence refuted Ireland's claims regarding the risk of pollution from the operation of the MOX Plant.[198] Arguably this was due to the fact that their indicators were founded on the core functions and based on appropriate indicator criteria. The UK asserted that Ireland had failed to supply indicators to support their claim of irreparable damage or serious harm to the marine environment as a result of the operation of the MOX plant.[199] Arguably, Ireland's indicators were not based on the core functions, nor were they founded on appropriate criteria.

Yet, an interesting point can be raised on the interpretation of indicators by non-technical personnel. Despite the concrete foundation of the UK's indicators, the Court was divided on their understanding of the evidence. Judge Szekely disagreed with the UK's indicators. He felt that they were surprisingly empty, superficial and totally inadequate by any standard.[200] He asserted that their assessments were not even backed by the most elementary appropriate scientific or technical support.[201] Furthermore, none of these indicators had been independently validated.[202] In his interpretation, the evidence was partial and incomplete in all respects.[203]

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[195] *Request for Provisional Measures and Statement of Case Submitted on Behalf of Ireland* [2001] *supra* note 185 (Para 98)
[196] Ibid, at Para 99
[197] *The MOX Plant Case (Ireland v. United Kingdom)* [2001] *supra* note 181 (Para 97 and 99)
[198] Ibid, at Para 72
[199] Ibid, at Para 75
[200] Ibid, at Para 13 of the Separate Opinion of Judge *Ad Hoc* Szekely
[201] Ibid, at Para 15 of the Separate Opinion of Judge *Ad Hoc* Szekely
[202] Ibid, at Para 15 of the Separate Opinion of Judge *Ad Hoc* Szekely
[203] Ibid, at Para 15 of the Separate Opinion of Judge *Ad Hoc* Szekely

Judge Anderson, on the other hand, cited an independent study that noted several anthropogenic inputs of concern into the Irish Sea.[204] These concerns included sewage, heavy metals, organic compounds, and radionuclides, none of which had widespread severe impact; in fact, most were being reduced.[205] Thus, from his interpretation of the indicators, small scales of introduction from the MOX Plant, as well as its distance from Ireland (over 100 miles) did not make it clear to him that there would be serious harm to the marine environment.[206]

Judge Mensah noted that there was a clear and palpable difference in opinion between the parties regarding harm to the marine environment, which was further exacerbated by a lack of evidence on Ireland's part.[207] With no clear and distinctive indicators to demonstrate serious harm to the marine environment, he agreed with the ruling of the Tribunal. These sentiments were shared by Judges Caminos, Yamamoto, Park, Akl, Marsit, Eiriksson and Jesus, who all agreed that the dispute was characterized by a lack of agreement on the scientific evidence (indicators). Ireland argued that the Tribunal should have followed the path it took in the *Southern Bluefin Tuna Cases* and prescribed measures to preserve the existing situation.[208] But the judges disagreed. They stated that the SBT cases were quite different, as those parties had come to a mutual agreement that the tuna stock was at its historically lowest levels.[209] In the current case, the Tribunal was being asked to qualify Ireland's claims of the possible introduction of radioactivity as 'deleterious' without being able to assess the evidence about the current situation in the Irish Sea.[210] Once again, this demonstrates the importance of sound science underlying the indicators (a criteria that the UK based their indicators on), as well as agreed upon vs. contested evidence, and the problems which arise in determining contested evidence's provenance. Without such a foundation, the law cannot be applied in the manner for which it was intended (i.e. to protect the marine environment).

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[204] *The MOX Plant Case (Ireland v. United Kingdom)* [2001] *supra* note 181 (Para 21 of the Separate Opinion of Judge Anderson)
[205] Ibid, at Para 21 of the Separate Opinion of Judge Anderson
[206] Ibid, at Para 18 of the Separate Opinion of Judge Anderson
[207] Ibid, at Para 8 of the Separate Opinion of Judge Mensah
[208]Ibid, at Para 2 of the Joint Declaration of Judges Caminos, Yamamoto, Park, Akl, Marsit, Eiriksson and Jesus
[209] Ibid, at Para 14 of the Separate Opinion of Judge Wolfrum
[210] Ibid, at Para 14 of the Separate Opinion of Judge Wolfrum

In conclusion, this case demonstrates the importance of indicators being founded on the core functions and appropriate criteria. This ensures effective communication of the potential impacts of pollution (or lack thereof). The UK provided this through their indicators, thus their arguments may have been validated and the Court ruled in their favor. Ireland disagreed with these indicators, but offered no concrete evidence to support their assertions. And although varied interpretations of the indicators occurred among the Tribunal, the UK's indicators stood firm because of their foundation. Ireland's claims that commissioning the MOX plant would introduce risks to the marine environment was not founded on scientific evidence, and therefore, was not substantial and focused.[211] Without conclusive indicators to determine the casual relationship between the activities at the plant and the potential risks, Ireland could not uphold its argument. Indicators must be linked to outcomes and be conclusive in scientific findings, to have significant impacts on the application of the law. Without such a solid foundation on the core functions and corresponding criteria, the indicators cannot be successful and operational efficient.

Interpretation of the data presented during the hearing was quite varied between the Judges. Yet, the Tribunal did recognize the importance of the UK's indicators in communicating no harm to the marine environment or the atmosphere.[212] This answers research questions 1 and 2. If indicators cannot communicate their intended measures (i.e. are not founded on the core functions), and if they are not scientifically valid, policy relevant, concrete and specific and able to survive legal interrogation, then they will fail to be operationally efficient (which occurred with Ireland's assertions). Thus it appears that through this case, the ITLOS Tribunal has implicitly acknowledged the value of successful and operationally efficient indicators.

3.4.3 Argentina v. Uruguay [2010] ICJ Rep. 14[213]

The fourth case to be analyzed in regards to the utilization of environmental indicators in international litigation is (2010)) ICJ Rep. 14: *Pulp Mills on the River Uruguay (Argentina v. Uruguay) Judgment*.[214] This dispute arose over the planned construction

[211] *The MOX Plant Case (Ireland v. United Kingdom)* [2001] *supra* note 181 (Para 8 of the Separate Opinion of Judge Treves)
[212] Ibid, at Para 4(b), 23 of the Separate Opinion of Judge *Ad Hoc* Szekely
[213] *Pulp Mills on the River Uruguay (Argentina v. Uruguay) Judgment*, [2010] ICJ Rep. 14
[214] Ibid

and future commissioning of two pulp mills on the River Uruguay.[215] Argentina claimed that these mills would cause pollution, thereby affecting the water quality of the river, which, in turn, would affect biodiversity and fisheries.[216] Argentina asserted that Uruguay had not prepared an environmental impact study, as required under the law. Uruguay responded that Argentina had failed to validate any claims of harm, or risk of harm, to the aquatic ecosystem as a result of their actions and alleged violations.[217] Uruguay asserted that removing the pulp mills would be detrimental to their economy and disproportionately burdensome.[218] Uruguay requested that if they were not in complete compliance with their obligations to protect the river and its ecosystems, they would take whatever additional protective measures would be necessary to ensure compliance.[219]

Both Parties had collected a substantial amount of scientific data (indicators) on the baseline levels of contaminants that were present in the river both prior to and after the mill was commissioned and began production activities.[220] These indicators included water and air quality, phytoplankton and zooplankton numbers, health indicators, biomarkers of pollution in fish, monitoring data of the fish fauna in the immediate vicinity of the mill, fish community and species diversity, concentrations of resin acids, chlorinated phenols and plant sterols in fish, surveys of species of Tillandsia, the mill pre-start-up audit, and mercury and lead levels in fish muscle.[221] Both argued that the other's data was inadequate and often incomplete.[222] Each State utilized its own testing programs, sampling parameters, sampling locations and sampling dates to measure for these indicators.[223]

The water quality indicators measured from effluent discharges from the mill raised the most controversy. These included dissolved oxygen, total phosphorus (and the resultant eutrophication from phosphate), phenolic substances, nonylphenols and

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[215] *Pulp Mills on the River Uruguay (Argentina v. Uruguay) Judgment*, [2010] *supra* note 213 (Paragraph 1 and 25)
[216] Ibid, at Paragraph 1 and 22(1)
[217] Ibid, at Paragraph 23(2)
[218] Ibid, at Paragraph 23(2)
[219] Ibid, at Paragraph 23(2)
[220] Ibid, at Paragraph 229
[221] Ibid, at Paragraph 230
[222] Ibid, at Paragraph 231
[223] Ibid, at Paragraph 232-235

nonylphenolethoxylates, and dioxins and furans.[224] Through the Court's meticulous examination of each of these indicators, Argentina's claims regarding increased levels for each substance was found to be based on insufficient evidence. Three of these substances, as well as algal blooms and biological diversity, are discussed in greater detail below, to illustrate how the Court reached its interpretation of the evidence (indicators) and the impacts that their assessments had on the case.

Dissolved oxygen is environmentally beneficial and is regulated by an international standard minimum of 5.6 mg/L for river waters.[225] Argentina alleged that Uruguay's mill had a negative effect on dissolved oxygen in the river, causing it fall below this standard.[226] Uruguay countered that Argentina's measures were for 'demand for oxygen' and not 'dissolved oxygen.' Thus, to solve this dispute, the Court analyzed this indicator for the River Uruguay and, based on their interpretation of the science, found that Argentina's allegations were unproven.[227] Their figures were in fact, incorrect – they did not correlate with other subsidiary bodies that had gathered this indicator post mill operation.[228] Other monitoring groups showed that dissolved oxygen was well above the international minimum standard.[229] It appears that Argentina completely misunderstood the meaning of this indicator, which cost them their argument. This is not the fault of the indicator, but the fault of the user using it. The Court employed various sets of data taken over time to demonstrate that no significant difference had occurred in the level of dissolved oxygen in the river.[230] Through this specific indicator analysis, the importance of sufficient evidence is apparent. Had Argentina correctly understood the indicator, and provided adequate data to support their claims, then possibly, they could have won their argument.

Phosphorus was an interesting indicator for this case. Both Parties agreed that phosphorus levels in the river were high (a direct result of natural and anthropogenic sources).[231] Yet, the Parties disagreed on the correlation between the higher

[224] *Pulp Mills on the River Uruguay (Argentina v. Uruguay) Judgment*, [2010] *supra* note 213 (Paragraph 237)
[225] Ibid, at Paragraph 238
[226] Ibid, at Paragraph 238
[227] Ibid, at Paragraph 239
[228] Ibid, at Paragraph 239
[229] Ibid, at Paragraph 239
[230] Ibid, at Paragraph 239
[231] Ibid, at Paragraph 240

concentrations of phosphorus in the river waters and the algal bloom that occurred in February 2009 (after the mill began production).[232] Argentina maintained that the mill was directly responsible for eutrophication of the river waters (from increased inputs of phosphorus), which they argued created the algal bloom.[233] Uruguay denied that any such correlation existed within the data.[234] The Court settled this dispute by drawing, once again, upon the existent indicators. They observed that no international standard existed for levels of phosphorus, nor did Argentina have a national standard for this substance.[235] Thus, they used the limit for total phosphorus found in Uruguay's national legislation, which was 0.025 mg/L (for drinking water, irrigation of crops for human consumption, and water for recreational purposes where direct human contact existed) and 5 mg/L for all other water usage.[236] Based on this standard, the indicators demonstrated that the mill complied with and was below total phosphorus concentrations in effluent discharges.[237] Thus, based on their interpretation of the indicators, the Court ruled that the amount of total phosphorus discharged from the mill was insignificant in comparison with the overall total phosphorus that already existed in the river from other sources.[238]

The argument on the algal bloom was a bit more complex. Argentina claimed that the algal bloom was a direct result of nutrient loadings (emissions) from Uruguay's mill, including phosphate and other compounds present in detergents and fertilizers.[239] Argentina cited indicators that demonstrated effluent products in blue-green algal blooms, as well as satellite images depicting chlorophyll concentrations in the water.[240] Uruguay contested these findings, stating that the bloom was a result of upstream pollution due to sewage run-off from the increased visitors to the town's yearly carnival.[241] Both Parties agreed that the concentrations of nutrients were high in the river (both before and after the bloom).[242] They also agreed that a direct

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[232] *Pulp Mills on the River Uruguay (Argentina v. Uruguay) Judgment*, [2010] *supra* note 213 (Paragraph 241)
[233] Ibid, at Paragraph 241
[234] Ibid, at Paragraph 241
[235] Ibid, at Paragraph 242
[236] Ibid, at Paragraph 242
[237] Ibid, at Paragraph 242
[238] Ibid, at Paragraph 247
[239] Ibid, at Paragraph 248
[240] Ibid, at Paragraph 248
[241] Ibid, at Paragraph 249
[242] Ibid, at Paragraph 250

correlation existed between algae growth, higher temperatures, low and reverse flows, and the presence of high levels of nutrients (such as nitrogen or phosphorus).[243] Yet, the Court ruled that there was not enough evidence to support a correlation that the algal bloom was a result of the nutrient discharges from the mill.[244] Once again, strong, sufficient evidence is directly tied to the potency of an indicator. If the foundation for the indicator (i.e. the evidentiary base) cannot be established, then the indicator loses its meaning. Thus, successful and operationally efficient indicators must be founded on the core functions and be based on relevant criteria. Such was the case for Uruguay's argument. Argentina could not prove that the increased levels of phosphorus and the algal bloom were directly tied with Uruguay's mill. Thus, they lost their argument.

The next indicator that Argentina relied upon in its argument was dioxin and furan concentrations. Although they were low in surface sediments, Argentina contended that they had steadily increased after the mill commenced operations.[245] Argentina did not claim that an international standard had been violated, but instead, alleged that a sample of *sábalo* fish was found to contain elevated levels of dioxins and furans.[246] Argentina correlated these elevated levels to the commissioning of the mill.[247] Uruguay refuted these claims, citing that these elevated levels could not be linked to the operation of the mill.[248] Uruguay argued that many other industries were in operation along the river and in the neighboring bay, making it impossible to attribute the elevated concentrations to one mill.[249] Furthermore, Uruguay argued that the *sábalo* fish was a highly migratory species – thus, its elevated levels could not necessarily be pinned to one particular portion of the river or the mill.[250] Lastly, Uruguay's indicators demonstrated that the measures of dioxins and furans detected in the effluent were not measurably higher than the baseline levels that had been established in the river.[251] Based on this lack of evidentiary support linking the

[243] *Pulp Mills on the River Uruguay (Argentina v. Uruguay) Judgment*, [2010] *supra* note 213 (Paragraph 250)
[244] Ibid, at Paragraph 250
[245] Ibid, at Paragraph 258
[246] Ibid, at Paragraph 258
[247] Ibid, at Paragraph 258
[248] Ibid, at Paragraph 258
[249] Ibid, at Paragraph 258
[250] Ibid, at Paragraph 258
[251] Ibid, at Paragraph 258

increase in dioxins and furans to the mill's operations, the Court interpreted the indicators as showing no clear evidence to support Argentina's allegations.[252] Yet again, a lack of evidence to support the indicators resulted in the Court's rejection of Argentina's argument. Argentina's indicators were not successful because they were not founded on the basic core functions (communication, simplification, quantification, and standardization) and the criteria could not withstand legal scrutiny.

Lastly, Argentina argued that Uruguay had failed to take the necessary measures and precautions to protect and preserve biological diversity and habitats from the pollution of the mill.[253] Argentina asserted that it was Uruguay's responsibility to protect species habitats, as well as the flora and fauna of the aquatic environment where the mill was located.[254] Argentina insisted that the indicators deployed showed that abnormal mutations were detected in aquatic organisms.[255] These included malformations of rotifers and loss of fat by clams, as well as the bioaccumulation of pollutants within detritus feeding fish.[256] Uruguay contested these allegations, citing that Argentina had no evidentiary support for their claims of pollution, or harmful effects to fish.[257] Although a possibility existed that effluence from the mill could move downstream, Uruguay argued that it would be diluted to 1:1000 of its concentration.[258] This would render it harmless and below concentrations capable of causing pollution or effecting biodiversity and ecological habitats.[259] The Court analyzed the data presented and found no sufficient evidence to support Argentina's claim that Uruguay had breached its obligations to protect and preserve biodiversity.[260] No clear relationship had been established between the indicators (i.e. between the discharges from the mill and the malformation of rotifers, or the dioxins found in the *sábalo* fish, or the loss of fat in clams).[261] Yet again, the

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[252] *Pulp Mills on the River Uruguay (Argentina v. Uruguay) Judgment*, [2010] *supra* note 213 (Paragraph 258)
[253] Ibid, at Paragraph 260
[254] Ibid, at Paragraph 260
[255] Ibid, at Paragraph 260
[256] Ibid, at Paragraph 260
[257] Ibid, at Paragraph 261
[258] Ibid, at Paragraph 261
[259] Ibid, at Paragraph 261
[260] Ibid, at Paragraph 262
[261] Ibid, at Paragraph 262

Court ruled Argentina's claims unfounded, as no proof or evidence was presented which could support their claims.

This case is especially important regarding indicators and international litigation, as it is a prime example of the use of operationally efficient indicators to monitor for pollution, as well as the Court's interpretation of such data. The burden of proof and expert evidence (which includes indicators) was presented and challenged in this case.[262] Argentina claimed that Uruguay's mills were polluting the aquatic environment. However, Uruguay claimed that the indicators presented by Argentina were weak and did not support their claims.[263] The Court responded that both States had presented a tremendous amount of factual and scientific data (including detailed indicators).[264] Yet, they found that Uruguay's indicators were successful and operationally efficient. Argentina's indicators did not support their claims or demonstrate any patterns that could conclusively be linked to the mill's operations. Through their findings, the court illustrates the need for indicators to be subject to scrutiny (cross examination, i.e. to withstand legal scrutiny), demonstrating that the Court found these criteria to be extremely important when dealing with technical evidence in case law.[265] Indicators must be developed on the core functions and be founded on the appropriate criteria to be successful and operationally efficient. Furthermore, the Court noted that it is their responsibility to evaluate the evidence in its entirety and draw conclusions appropriately and in accordance with the rules of international law.[266] Thus, the ICJ established its role in the interpretation and application of the evidence (indicators). Consequently, indicators hold a significant place within international litigation. They are the means upon which decisions are based. The Court's interpretation of the data (including its relevance) has significant impacts upon the outcome of the case.

The Court's rulings demonstrate the importance of correctly interpreting environmental indicators. Understanding an indicator's meaning is essential to effectively using that indicator to measure for or argue a specific point. Furthermore,

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[262] *Pulp Mills on the River Uruguay (Argentina v. Uruguay) Judgment*, [2010] *supra* note 213 (Paragraph 160-168)
[263] Ibid, at Paragraph 161
[264] Ibid, at Paragraph 165
[265] Ibid, at Paragraph 167 and 168
[266] Ibid, at Paragraph 166

ensuring the indicators are founded on the core functions and appropriate criteria will ensure their success and operational efficiency. In all five indicators analyzed above, Argentina did not properly develop, apply or understand the meaning behind the scientific data. Furthermore, Argentina did not provide a strong evidentiary base to support their claims. As the Applicant, it was their duty to provide a sound burden of proof. But Argentina's data was not founded on the core functions and, thus, did not corroborate their claims.

The Pulp Mills case is extremely important in an analysis on the use of indicators within international litigation. Arguably, it is the only international case to directly deal with indicators and this level of technical evidence. Furthermore, it demonstrates the significance in understanding and supporting the indicators that are employed to measure progress or demonstrate regression from mandated obligations. If not developed on the core functions, and without a strong evidentiary base to support them, the indicators will not be successful. Furthermore, the case demonstrates that other factors (i.e. criteria) are important to solidify the true meaning of an indicator. As demonstrated in the analysis, the appropriate criteria will be user dependent. For this case, the indicators needed to be communicative, scientifically valid, concrete and specific, interpretable and unambiguous and tightly linked to human activity. For this case, since Argentina's indicators did not meet these criteria, they were unsuccessful and could not adequately communicate Argentina's claims. This had detrimental effects on the outcome of a case for Argentina, demonstrating the significance of successful indicators in case law.

3.5 Concluding Remarks

In conclusion, international law presents an important forum in which to analyze the deployment of environmental indicators. Since international environmental law stems from the application of general rules and principles derived from classic international law, indicators are most often employed as a means to measure environmental problems (i.e. pollution). Environmental problems are often transboundary in nature and thus, require indicators that are globally applicable. Yet no explicit mandate for indicators is found in most international regulations. Arguably, this is because with international law most agreements establish only general obligations of conduct and leave technical details to be developed at regional or national levels. Thus, indicators are implied within international agreements, but in general terms due to the broad framework of the agreement. Different agreements often vary in their scope and allow for context specific indicators and monitoring at the regional and national levels.[267] Yet, if the developed indicators are not successful and operationally efficient, then issues arise similar to those found in the MOX Plant and Pulp Mills cases – contesting views of the state of the environment are advanced. Arguably, indicators utilized at the international level must founded on the four core functions (or some portion of them, most notably communication), in order to successfully communicate across multiple regions.[268] Without this foundation, the indicators will not be based on the appropriate criteria, lose their value and are no longer effective tools.[269]

As noted, environmental indicators are implicit within many international Treaties. Yet, tension arises between the precise and flexible indicator frameworks utilized within the international treaties. For example, UNCLOS is general in its approach to indicator development and application and provides little direct relevance to indicators other than promoting best available science.[270] Some direction on indicators is provided when discussing fishing levels, but it is in no means as defined as those that are seen in OSPAR.[271] OSPAR has developed precise rules and techniques regarding indicators, including developing and employing EcoQOs to determine the structure and function of the marine ecosystem.[272] Thus, international treaties create a means to influence the development of environmental indicators. These indicators are then adopted at the national level, when the Treaty is incorporated within domestic legislation. The indicators are applied to various situations and their outcomes are interpreted by an array of regulating authorities. If a dispute occurs involving the indicators, then they are interpreted within the judicial system through case law. These cases vary in nature, but demonstrate that indicators are pertinent when interpreting environmental laws that affect the global community.

Yet, in reviewing the timeline at the beginning of this chapter, an interesting pattern begins to emerge. Although all of the international treaties are implicit in their

[267] Such as those seen in the CBD, OSPAR, etc.
[268] As evidenced by the OSPAR Convention, the CBD and the Pulp Mills case.
[269] Such as was seen in the Southern Blue Fin Tuna cases or the MOX plant case.
[270] See pp 45-50.
[271] See pp 55-60.
[272] See pp 55-60.

use of indicators, a shift in the approach of international environmental agreements in regards to indicators becomes apparent. Initially, the regulations utilize a top-down approach, influencing marine environmental indicators in legislation and policy at the regional and national levels (as seen in the UNCLOS and the CBD). But, as time evolves, the regulations begin to have a top-down and bottom-up approach to indicator development and application. As seen with OSPAR, the UNFCCC and MARPOL, the law is influencing policy (in terms of indicators), and regional and national instruments are now influencing international law and statutory approaches as well. The indicators are efficient in these treaties, so long as the user develops and applies them based on the core functions and the appropriate criteria. Additionally, in case law, one begins to see the emergence of cases that are based solely on the interpretation of indicators. Thus, indicators hold a prominent space in international environmental law and are pertinent in affecting treaties from the top-down, as well as the bottom-up.

This chapter has demonstrated that indicators play a crucial role in the international legal forum. When developed and applied founded on the core functions, they are a means to measure the effectiveness of various legal mechanisms. If not successful and operationally efficient, however, indicators can obscure an already complex situation by providing approximations and imprecise data on international environmental concerns. Thus, regulating authorities must work to ensure that indicators are founded on the core functions and relevant criteria to make them successful and operationally efficient in International environmental law. This will allow indicators to meet the objectives for which they were designed and ultimately strengthen environmental legislation and enhance international cooperation.

Chapter 4: International Policy

4.1 Introductory Comments

In recent years, ecological issues and the environmental arena have risen to become one of the fastest growing sectors of international law.[1] International organizations have also been quite instrumental in contributing to environmental amelioration, emergent environmental policies and subsequent environmental regulations.[2] For a number of issues relating to the environment (and specifically the marine environment), action has been required to be instigated at an international level. This is due to the trans-boundary nature of the ocean, which allows human activities to impact areas beyond national boundaries. Additionally, environmental problems commonly regarded as local, regional or national may have international or even global ramifications (i.e. global climate change, the use of outer space and the deep sea bed, fishery management, *inter alia*).[3] These issues often arise beyond the jurisdiction of any single national government and are inherently international in scope.[4] Without international cooperation and influence, a clear understanding of the marine environment and the corresponding data collected from indicators cannot effectively occur.

This chapter analyzes the development and application of marine environmental indicators within international environmental policies. It demonstrates that the indicator concept has become an important element of all facets of contemporary marine management and regulation at an international level. It assesses indicators in the international policy arena against the four core functions and appropriate criteria to determine if the indicators are successful and operationally efficient, thereby answering research questions 1-2 and 5-6. Can international policy documents successfully communicate complex environmental problems through the application of indicators? This chapter also analyzes the evolution of international environmental policies and their implicit and explicit use of marine environmental indicators to achieve policy objectives. Lastly, this chapter analyzes marine environmental indicators within international environmental policy documents to

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[1] Radoslav Dimitrov *Science and International Environmental Policy: Regimes and Non-regimes in Global Governance* (Oxford, Rowman and Littlefield Publishers, Inc., 2005) 209pp (p 1)
[2] Ibid, at p 6
[3] Lynton Keith Caldwell *International Environmental Policy: Emergence and Dimensions* (Durham & London, DUP, 1990) 460pp (p 12)
[4] Ibid, at p 12

determine if international policy influences law to what scale and the role of indicators in this arena (research questions 3, 4 and 7). Is there a top-down or bottom-up approach for indicator development in international policy?

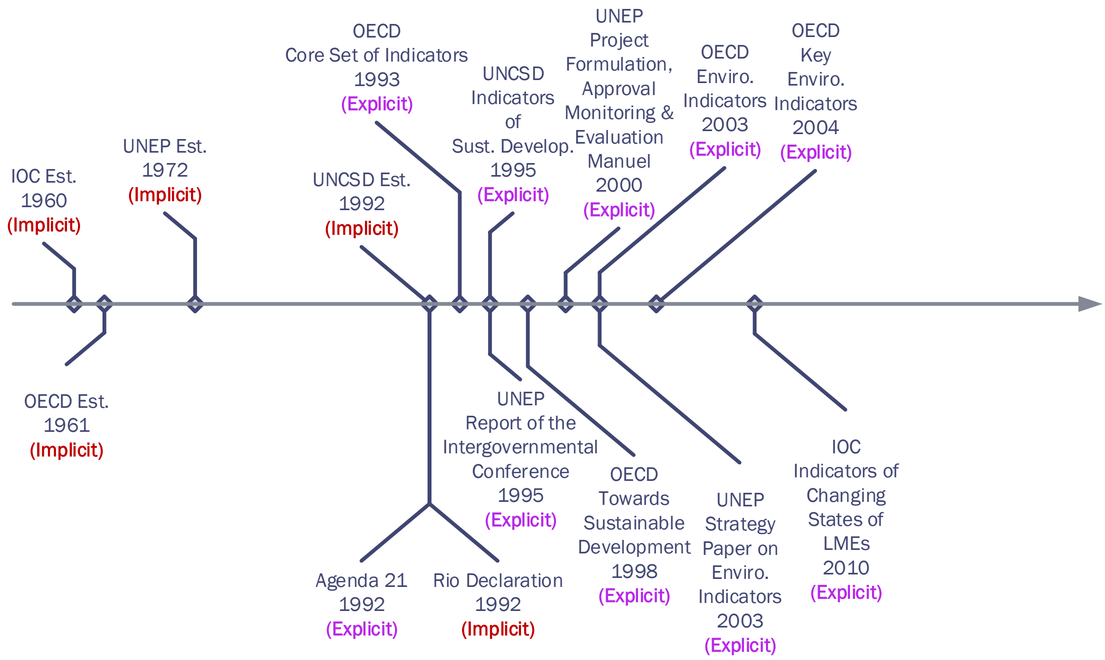

Figure 4.1: Timeline of International environmental organizations and policy documents analyzed in this chapter. These are discussed in chronological order within the appropriate subsection. Each organization and document is listed as explicit or implicit with regards to the use of indicators within the text of the document. The subsequent analysis provided in this chapter explores the progressive development and application of indicators over time in the international environmental policy forum to answer research questions 1-7 with regards to International policy.

Section 4.2 defines the scope of international policy, and the relevance of science to the policy process (including indicators). It begins by explaining the parameters of international environmental policy and the role of indicators to lay the foundation for the analysis of the rest of the chapter. Section 4.3 outlines the history of international organizations, to determine how these institutions came to play an important role in the formation of international environmental policy, as well as indicator usage. It explores International Organizations, Conferences and Policy Initiatives and their linkage to environmental policies and indicators, with specific sections focusing on some key agencies: the United Nations Commission on Sustainable Development (UNCSD), the Organization for Economic Co-operation and Development (OECD), the United Nations Environment Program (UNEP), and the Intergovernmental Oceanographic Commission (IOC). Specifically, it analyzes the role of international environmental organizations in the development and application of environmental indicators and compares the indicators most readily used at the international policy level against the four functions (communication, simplification, quantification, and standardization) and criteria for successful indicators, setting the stage for an analysis on the influence of international environmental policy on international law, as well as European and National law and policy. Figure 4.1 illustrates the development of indicators and key international policy documents. It provides a visual assessment of the major discussion points of this chapter.

4.2 International Environmental Policy and Indicators

International environmental policy is comprised of measures designed to protect the environment from pollution and human impacts on a global scale. Due to the transboundary nature of pollution and the global characteristic of the environment, it is important to obtain international cooperation in order to have effective international environmental policy.[5] Essentially, international policy, similar to international law, is a product of inter-state meetings and/or positions taken by international organizations (thus making international organizations indispensable to international policy).

Furthermore, international environmental policy is not one policy. It is a comprehensive and vaguely bounded area of concern within which many issues, problems and policies have emerged.[6] It represents the bona fide positions taken by governments and international organizations in relation to environmental issues and problems.[7] A major difficulty of international environmental policy lies in the fact that the dangers these policies address may not threaten all people, or all in the same way (i.e. a change in climate may benefit Saharan countries but might ruin agriculture in Europe).[8] Furthermore, international environmental policy is often general in its rules and/or principles, can lack agreement or consensus from States, has no enforcement, and usually is costly to implement.

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[5] Marsiliani, Rauscher and Withagen "Environmental Policy in an International Perspective" [2003] Economy & Environment Volume 26 336pp (xiii)
[6] Ibid, at p 6
[7] Ibid, at p 10
[8] Ibid, at p 13

International environmental policy is partially driven by the international environmental movement.[9] This movement exemplifies learning from experience and is made explicit and understandable through science.[10] Science plays a role in the formation and implementation of international policy because it provides the evidence basis for decisions (measured via indicators). These indicators simplify and more effectively communicate otherwise complex situations, such as the global environment. They demonstrate the effectiveness of the management actions themselves.[11]

Consequently, advancing science has revealed a great deal as to the structure and process of nature and its relationship to the economy and society. This has necessitated the formation of linkages and relationships between otherwise conflicting agencies, organizations and ideologies.[12] For example, coastal water quality issues interlink with health, fisheries, and economic problems.[13] Similarly, endangered species issues entail questions of habitat, land use, recreation, commerce and ethics.[14] Thus, environmental policy making may arguably be understood as an effort to reconcile behavior with knowledge. In essence, science is politically neutral and offers a means (through indicators) to link environmental, economic and social objectives (albeit it can be susceptible to misuse).

Yet, environmental protection and conservation was not the original aims of international policy. As this chapter shows, initially economic preservation was the main driving force, followed by an emphasis on social justice. Considered a profit – people – planet mentality this formed the initial foundation of sustainable development.[15] This consequently impacted the type of indicators developed and applied in early international environmental policy. Yet, issues such as global climate change, disintegration of stratospheric ozone, decline of fisheries and other environmental problems appear to be prompting governments to cooperate for their

[9] Caldwell (1990) *supra* note 3 (p 3)
[10] Ibid, at p 3
[11] Ibid, at p ix
[12] Ibid, at p 9, 10
[13] Ibid, at p 11
[14] Ibid, at p 11
[15] S Shastri (2015) *Viva* (personal communication to E Bayer from S Shastri (Hull)) Hull: verbal communication (25 September 2015)

mutual protection and to focus beyond economic and social concerns.[16] This has allowed nations who have never previously worked together to perceive the common interests between the environment, society and the economy and, therefore, approach environmental issues through cooperative efforts.[17] These efforts include developing and applying operationally efficient environmental indicators aimed at protecting and preserving the environment (including marine ecosystems) for more than economic and social purposes. See Figure 4.2 for an illustrative comparison of historic vs. contemporary thought on environmental indicator development.

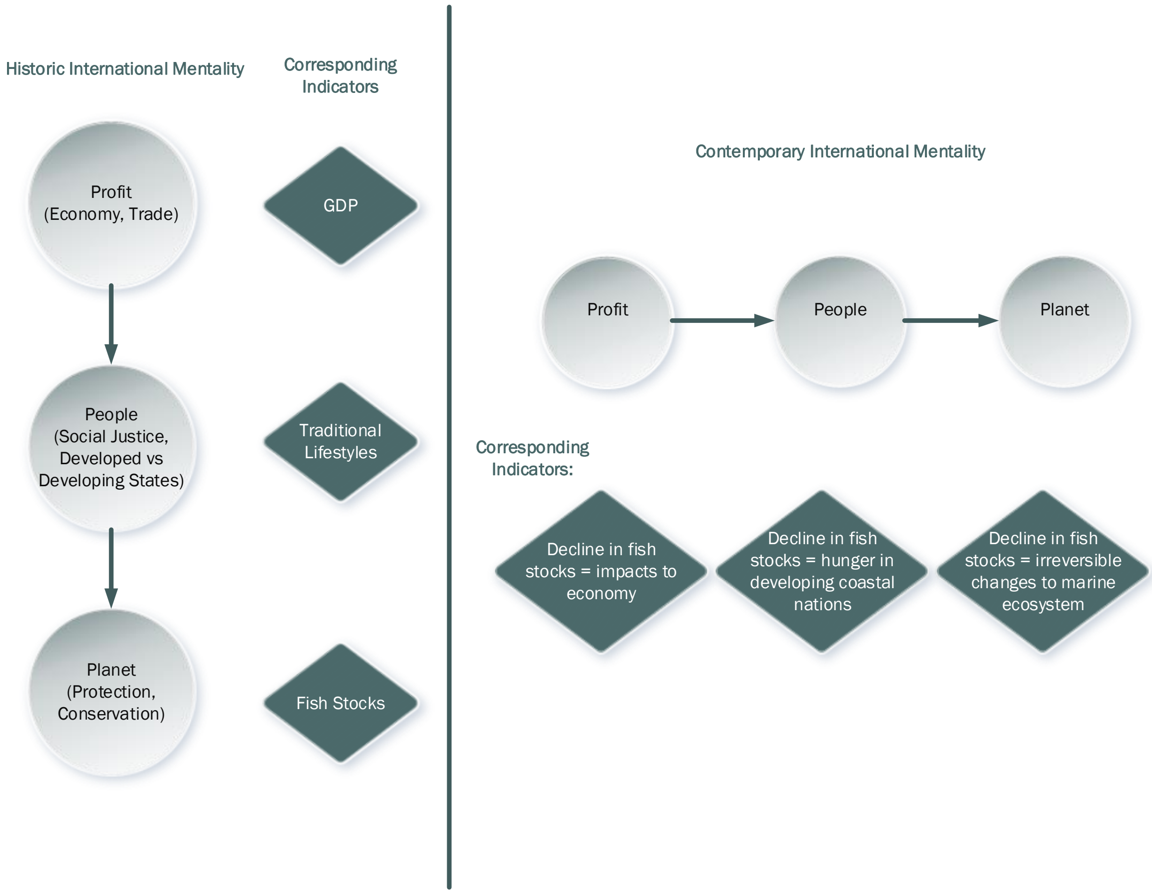

Figure 4.2: Historic views on indicator development vs. contemporary mentality. Current view recognizes the connections between the three distinct areas of sustainable development and the need for indicators that are successful in communicating and connecting all three. Arguably, this has also paved the way for an approach to indicator development (and policy/law formation) that is influenced as much from the bottom-up as it is from the top-down.

Similarly, international marine policy is the study of international marine affairs by various private and governmental bodies, in order to understand the

[16] Caldwell (1990) *supra* note 3 (p 4)
[17] This can be seen in the UNEP Oceans and Coastal Areas Program, Agenda 21, the UNCLOS, and other international environmental organizations. Ibid, at p 4

processes, functions and resources of the oceans.[18] Ocean usage has grown exponentially, which in turn has necessitated a growing need for the provision of global marine science services.[19] Furthermore, there are important tasks pertaining to marine science which require international action to be achieved (such as the study of ocean processes, the regulation for rational use of the oceans and facilitation of ocean research activities).[20] These require international mechanisms (such as indicators to measure and interpret the global ocean's processes and ultimately achieve political objectives).[21]

It is understood that the goals of international environmental policy cannot be achieved by responding to apparent and immediate environmental problems.[22] Often these problems are manifestations of deeper environmental disorders that require systematic analysis and explication from science.[23] Additionally, one common effect of science and policy analysis is to reveal environmental issues as more complex and comprehensive than as first perceived.[24] Furthermore, to understand the significance of environmental policy today, it is necessary to know the circumstances that led to the present situation,[25] i.e. scientists studying fishery declines need to know the historical progression of the fishery industry, the lifecycle of specific species, *inter alia* in order to more accurately explain what is current happening and why. Thus, marine environmental indicators play an integral part in international environmental policy, as they can help to explain current environmental trends and the connections to the economy and society.

4.3 International Organizations, Conference and Policy Initiatives

International organizations have played a key role in marine management, as well as in the development and application of environmental indicators to meet set objectives, such as sustainable development, marine biodiversity and Ecological Quality

[18] National Academy of Sciences (1972) *International Marine Science Affairs: A Report by the International Marine Science Affairs Panel of the Committee on Oceanography* 92pp (at p 1)
[19] Ibid, at p 3
[20] Ibid, at p 1, 3
[21] Ibid, at p 1, 4 and 5
[22] Ibid, at p 6
[23] Ibid, at p 6
[24] Caldwell (1990) *supra* note 3 (p 12)
[25] Ibid, at p 4

Objectives (EcoQOs).[26] These formal institutions are sites of interaction between science and politics and between ideas and behaviors.[27] Thus, their history and the influence on environmental policy and indicator development must be addressed here.

A number of international organizations emerged post World War II and have played a key role in developing policy and/or facilitating States capacity to make policy in respect of global issues. They are responsible for the production of multinational frameworks, as well as the setting of minimal environmental standards. Yet, there are four international organizations that have been central to the development of marine indicators, and which have influenced the development of policy initiatives in the EU and nationally.[28] These are UNCSD, OECD, the UNEP and the IOC, which are discussed here. Table 4.l provides a comparison of the international organizations/policy documents and the indicators used. It explores if indicators are explicit or implicit within the organization and policy documents, analyzes the objectives for which the indicators were designed, and assesses if these instruments are top-down or bottom-up in their influence. This information is used to determine the operational efficiency and success of the indicators.

[26] S Gubbay "A Review of Marine Indicators: Reporting on Biodiversity Aspects of Ecosystem Health" [2004] 73pp (p 25)
[27] Dimitrov (2005) *supra* note 1 (p 6)
[28] S Gubbay (2004) *supra* note 26 (at p 25)

Table 4.1: Comparison of the international organizations/policy documents and the indicators used to achieve their specific objectives. This information is used to determine the operational efficiency and success of indicators applied through international environmental policies.

ORG./ POLICY	EXPLICIT? IMPLICIT? PRESCRIPTIVE?	INDICATOR TYPE	EXAMPLES	OBJECTIVES OF INDICATOR	TOP-DOWN? BOTTOM-UP?	EFFICIENT?
UNCSD	-Initially implicit, but became explicit over time. -Development and use of indicators is not prescriptive.	*DSR Framework *Indicators of sustainable development *Use of marine environmental indicators has been historically slim	-Algae concentration -Faecal coliforms -% of total pop. living in coastal areas -annual catch by major species	*To determine impact of human activities on marine and coastal environments *Sustainable development.	Top-Down	-Yes – but user dependent. -No specific indicator criteria stated, but implies they should be relevant to sustainable development: -Tightly linked to human activity -Communication of human effects on the environment -Scientifically valid -Simple & robust
AGENDA 21	-Explicit -Development and use of indicators is not prescriptive.	*Socio-economic indicators *Environmental indicators	-pollution -marine erosion -loss of resources -habitat destruction -water quality -surveys of marine biodiversity -inventories of endangered species and critical habitats -effects of UV rays -sea level changes	*To determine human impacts on marine and coastal environments. *To determine the importance of biodiversity and ecosystem function. *To protect the ocean and its resources.	Top-Down (and horizontal across other int'l orgs)	-Yes, but user dependent. -Should be based on: -Communication -Scientifically valid -Policy relevant -Cost efficient -Easily measurable -Tightly linked to human activity

RIO DEC.	-Implicit -Not prescriptive	*Socio-economic indicators *Environmental protection indicators	No specific examples are provided.	*To measure impacts to the environment. *To improve scientific understanding. *To communicate information.	Top-Down	-Yes – but user dependent. -No specific indicator criteria stated, but implies they should be: -Simple -Robust -Cost efficient -Communicative -Scientifically valid -Policy relevant -Interpretable -Tightly linked to human activity
OECD	-Explicit throughout the various policy documents. -More prescriptive (sets of indicators have been published and specific criteria are recommended).	*PSR Framework *40-50 specific indicators are listed. *Only a few are designed to measure the marine environment.	-Atmospheric concentration of greenhouse gas -Ground level UV B radiation -Emissions of N & P in water and soil -Fish catches	*To measure sustainable development (specifically impacts to the economy, society and the environment in that order).	Top-Down and Bottom-Up (States can influence the CEI and the KEI indicator selection and can influence OECD policy).	-Yes – specific criteria are supported by the OECD: -policy relevance -utility for users -analytical soundness -measurability
UNEP	-Initially implicit (no mention of indicators in documents forming the UNEP in 1972), but became explicit over time (by 2000). -Prescriptive for indicator criteria	*Qualitative and quantitative indicators *PSR Framework *Descriptive indicators	-HEI -Area under forest cover -CO_2 emission per capita -Access to improved water sources and sanitation	*To evaluate outcomes of programs and projects that have an impact on the environment. *Do these programs and policies cause changes in the environment?	Top-Down	-Yes –specific criteria are supported by the UNEP: -Appropriateness -Relevance -Effectiveness -Efficiency -Sustainability & impact

IOC	-Initially implicit (no mention of indicators in documents forming the IOC in 1960), but became explicit over time (by 21st century). -Prescriptive with regards to the 5-modules of their indicator approach, but not as to which indicators to use.	*DPSIR Framework	-5-module indicator approach: i.) productivity ii.) fish/fisheries iii.) pollution & ecosystem iv.) socioeconomic v.) governance	*To measure the changing states of LMEs. *Marine ecosystem assessment and management. *To understand climate variability. *To improve long-term sustainability & recovery of marine goods and services.	Top-Down and Bottom-Up	-Yes – but user dependent. -No specific indicator criteria stated, but implies they should be: -communicative -scientifically valid -simple & robust -broadly applicable

4.3.1 The UNCSD

Within the network of the United Nations there exist two organizations of predominantly high importance to environmental and marine affairs, and most particularly, the development of marine and environmental indicators. These are The United Nations Commission on Sustainable Development (UNCSD) and The United Nations Environment Program (UNEP).

The UNCSD interprets and implements key policy instruments, such as Agenda 21, and the Rio Declaration on Environment and Development[29] It has been tasked with monitoring progress towards meeting the set agenda of each of these policy documents by analyzing and evaluating reports (which contain indicators) regarding the environment and development.[30]

Although the term indicator is not specifically mentioned when discussing the role of the UNCSD, its use is implied. Indicators provide the UNCSD with a means to enhance dialogue between the UN and entities outside the United Nations system, as well as provide information regarding the implementation of environmental conventions.[31] Through the use of indicators, progress can be monitored on meeting the objectives of Agenda 21, the Rio Declaration and other policy documents. Furthermore, scientific input can help to ensure that the indicators used are

[29] *Report of the United Nations Conference on Environment and Development* (A/RES/47/190, 1992) (Paragraph 3 and 4)
[30] Ibid, at Paragraph 3 and 4
[31] Ibid, at Paragraph 3 and 4

operationally efficient (based on the core functions and appropriate indicators), which ensures that the indicators communicate the necessary information and are understood by all parties (both technical and nontechnical alike). For example, algae concentrations in coastal waters and concentrations of faecal coliforms in freshwater are indicators used by the UNCSD to determine the impact of human activities and pollution on the environment.[32] These indicators meet the four core functions and appropriate criteria (i.e. tightly linked to human activities, communicate the effects of these activities on the environment, scientifically valid, simple and robust). Similarly, the percentages of total population living in coastal areas and the annual catch by major species are two indicators which are operationally efficient because they are founded on the four core functions and the appropriate criteria listed above. They are used by the UNCSD to communicate human influences on marine and coastal environments.[33] The UNCSD is charged with the responsibility of deploying indicators to communicate and bridge gaps between nations in an effort to achieve sustainable development for all members of its international community.

Consequently, the UNCSD plays a key role with regards to the development and application of environmental indicators. In response to the call of Agenda 21, the UNCSD set out to create a work program on indicators of sustainable development.[34] They believed that well developed indicators could aid in the understanding of sustainable development and lend to the achievement of pre-set policy goals.[35] According to the UNCSD, indicators can provide crucial guidance for decision-making.[36] They can translate physical and social science knowledge into manageable units of information that can facilitate the decision-making process.[37] Indicators can also help to measure and calibrate progress towards sustainable goals.[38] They can provide an early warning, sounding the alarm in time to prevent economic, social and

[32] UNCSD (1995) *Indicators of Sustainable Development: Guidelines and Methodologies* <http://www.un.org/esa/sustdev/natlinfo/indicators/isdms2001/isd-ms2001isd.htm> accessed 19 November 2009 (p 2)
[33] Ibid, at p 11
[34] This diverse group of stakeholders includes governments, international organizations, academic institutions and other expert working groups. Ibid, at p 1 and 4
[35] Ibid, at p 4
[36] Ibid, at p 4
[37] Ibid, at p 4
[38] Ibid, at p 4

environmental damage.[39] They are important tools to communicate ideas, thoughts and values.[40]

The UNCSD recognized, however, that developing, testing and deploying indicators of sustainable development may vary from country to country.[41] This will depend on a variety of factors, including, national priorities and objectives, availability of data, economic stability, technological accessibility, competitiveness, and frameworks used.[42] Accordingly, the use of environmental indicators should not be considered prescriptive at the international level. No sets of indicators can be final and definitive, but must be developed and adjusted over time to fit country-specific conditions, priorities and capabilities.[43] This supports the discussion in Chapter 2 that although marine environmental indicators should be developed based on the four core functions and criteria to be successful and operationally efficient, no single indicator will ever successfully meet them all. By using that the indicators developed are founded on the four core functions and the most appropriate criteria (not all crite3ria, just those appropriate for the intended purpose), the indicators are more likely to be successful and operationally efficient, thereby achieving their intended purpose.

It was also noted that when high-level policymakers were involved, the work on indicators progressed more rapidly.[44] This is interesting, as it demonstrates that indicator development can be policy (not scientifically) driven, which begs the question as to whether indicators founded on political objectives can be scientifically sound. Arguably, they can be, if scientists are given the opportunity to be involved in the development and application stages for indicators. This was in fact the case with the UNCSD. Their report, *Indicators of Sustainable Development: Guidelines and Methodologies*, demonstrates that when policy-makers work together with scientists to develop and implement indicators, real progress can be achieved.

The UNCSD initially used the DSR framework (driving force-state-response – a derivative of the OECD's PSR framework), but eventually they felt that there was

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[39] UNCSD (1995) *supra* note 32 (p 4)
[40] Ibid, at p 4
[41] Ibid at p 6
[42] Ibid, at p 6
[43] Ibid, at p 1
[44] Ibid, at p 6

a need to refocus the indicator framework to emphasize their policy objectives.[45] They felt that this would make the value of the indicator more obvious.[46] Thus their framework evolved from a DSR approach to one focusing on sustainable development.[47]

Within this new framework, indicator methodology sheets were drafted to determine the successfulness and relevance of the developed indicators in comparison with the criteria underlying them. They were designed to assist countries in developing priority indicators considered most relevant in the context of their sustainable development policies and programs.[48] This process of designing indicators is similar to the approach that was taken in ME4118. The methodology sheets contain basic information on the indicator, including its definition and unit of measure, the purpose for the indicator in sustainable development decision-making (i.e., policy relevance), the criteria upon which it was based, international targets and relevant international conventions.[49] They also contain methodologies associated with the indicator, data availability, and a listing of the agencies involved in the preparation of the methodology sheets.[50]

Environmental indicators clearly have the potential to assist in national decision-making.[51] Yet, the UNCSD's coverage of marine environmental indicators is relatively slim. This is because, in general, suitable candidate indicators for oceans and the coastal zone are not readily available or supported by commonly accepted goals on the international level (arguably EU marine indicators are better developed).[52] These indicators are heavily dependent on the application of precautionary and anticipatory principles to maintain biodiversity and ecosystem productivity while improving the quality of life of coastal communities.[53]

Past work on international environmental indicators has arguably adopted a more sectoral approach, especially in respect of marine policy and law. Marine

[45] UNCSD (1995) *supra* note 32 (p 7)
[46] Ibid, at p 7
[47] Ibid, at p 11
[48] Ibid, at p 5
[49] Ibid, at p 5
[50] Ibid, at p 5
[51] Ibid, at p 6
[52] Ibid, at p 18
[53] Ibid, at p 18

indicators (such as percentage of fish species captured or nitrate concentration within coastal waters) have often been developed and applied sectorally and not in combination with other indicators. In other words, they do not always meet the criteria of broadly applicable and integrative over space and time (to give a holistic assessment), a basic criteria discussed in Chapter 2. This can and has prevented regulators from determining the true causes of fish declines, or the source of the pollution. This sectoral approach to indicators occurred because the main driving force behind the development of indicators varied greatly within the international organization, as well as from country to country. Large gaps occurred within the policy approaches, which were themselves driven by the social and economic standings of each member state. The UNCSD recognized this to be problematic. They acknowledged that a more holistic and cooperative approach to environmental marine management would be more effective. Consequently, much work and cooperation is still needed to achieve indicators and frameworks that can express the complexities and interrelationships of the global environment.[54]

In conclusion, the UNCSD has recognized the need for indicators developed on the four core functions and based on appropriate criteria. Such indicators advocate an integrated ecosystem approach to protect oceans and coastal areas.[55] Activities such as unsustainable exploitation of fish and other living resources, marine pollution from shipping, offshore oil and gas projects, and the protection of biodiversity and fragile ecosystems must be addressed.[56] Through the development and application of such indicators as algae concentration in coastal water, annual catch by major fish species, percent of total population living in coastal areas and the abundance of selected key species (all of which are UNCSD indicators of sustainability), better management of the marine environment can occur (both globally and on a national scale).

4.3.1.1 Agenda 21 and Rio Declaration

This section analyzes Agenda 21 and the Rio Declaration noting the influences that these programs have had on the development and application of environmental and marine indicators world-wide. It evaluates such areas as development, the

[54] UNCSD (1995) *supra* note 32 (p 10)
[55] Ibid, at p 18
[56] Ibid, at p 18

environment and the marine sector to ascertain the recommendations of Agenda 21 and the Rio Declaration, and analyze the true impact that these programs have had on global sustainable economic growth, environmental management and indicator development. It investigates Agenda 21 and the Rio Declaration's stance on indicators to determine if these indicators are successful and operationally efficient and their role in the management of the global environment.

Agenda 21 is one of the most comprehensive and effective program of action ever sanctioned by the international community.[57] Its successful implementation is the responsibility of Governments through the use of national strategies, plans, policies, processes and indicators.[58] Indicators offer a means to measure and exchange information regarding biodiversity,[59] the oceans and coastal zones,[60] toxic and hazardous substances,[61] and other important environmental concerns discussed within Agenda 21.

Indicators play a significant role in the Agenda 21 Program. They are explicit within the policy document as a means to measure progress towards the set objectives. Yet, Agenda 21 is not prescriptive as to which indicators a state should use. The program cites the inequalities in economic conditions among developing countries as a reason for their lack of prescription on indicators.[62] Environmental standards can pose severe economic and social costs if they are uniformly applied across developed and developing countries.[63] It does, however, provide monitoring examples, citing that States must achieve a qualitative improvement of waste streams through activities aimed at reducing their hazardous characteristics.[64] Agenda 21 also calls States to prepare coastal profiles identifying critical areas, eroded zones, physical processes, development patterns, user conflicts and specific priorities for management (all of which can be monitored by indicators).[65] Additionally, States must undertake long-

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[57] Maurice Strong "Statement by Maurice F. Strong, Secretary-General United Nations Conference on Environment & Development at Plenary Meeting Closing the United Nations Conference on Environment & Development, Rio De Janeiro, Brazil 14 June 1992" [1992] (p 4)
[58] UNDESA *Agenda 21. A Program of Action for Sustainable Development* (1992) (paragraph 1.3)
[59] Ibid, at paragraph 15.6
[60] Ibid, at paragraph 17.6
[61] Ibid, at paragraph 19.5 and 20.9
[62] Ibid, at paragraph 8.2
[63] Ibid, at paragraph 8.2
[64] Ibid, at paragraph 20.12(e)
[65] Ibid, at paragraph 17.6(c)

term research on the importance of biodiversity for ecosystem functions and the role of ecosystems in producing goods, environmental services and other values supporting sustainable development.[66]

Although these examples do not detail which indicators to use, they do allocate how this monitoring should take place. Furthermore, Agenda 21 implicitly warrants that successful and operationally efficient indicators are based on the four core functions and appropriate criteria for which they were developed. When based upon the criteria communicative, scientifically valid, policy relevant, cost efficient and easily measurable, the indicators are more applicable across multiple countries, can meet the needs of regulators, and are fit both regulatory and scientific purposes. This is the criteria that Agenda 21 implies as necessary for successful and operationally efficient indicators.

In addressing the protection of the oceans (as well as its living resources), Agenda 21 calls upon the development and deployment of socio-economic and environmental indicators.[67] These indicators help to achieve integrated management of marine and coastal resources, to halt the global degradation and erosion of coastal resources and the coastal environment.[68] Although still not prescriptive in its call for the use of specific indicators,[69] Agenda 21 gives more guidance on the development and application of indicators for monitoring marine objectives and the criteria upon which these indicators should be founded then it does for other policy areas addressed within the document.[70] For example, it urges Coastal States to integrate their management of coastal areas and the marine environment by promoting indicators that can communicate harm to the environment, are tightly linked to human activity and scientifically founded.[71] These include indicators of pollution, marine erosion, loss of resources, habitat destruction and water quality.[72] Such indicators can be used to prepare coastal profiles, identify critical areas, physical processes and development

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[66] UNDESA (1992) *supra* note 58 (paragraph 15.5 (f))
[67] Ibid, at paragraph 17.8(b) and 17.4
[68] Ibid, at paragraph 17.8(b) and 17.4
[69] Agenda 21 cites that the implementation of indicators by developing countries should commensurate with their individual technological and financial capacities. Ibid, at paragraph 17.2
[70] Ibid, at paragraph 17.8(b)
[71] Ibid, at paragraph 17.5(e), 17.6(c) and 17.8(b)
[72] Ibid, at paragraph 17.5(e), 17.6(c) and 17.8(b)

patterns, and thereby, more accurately assess environmental impacts due to human activities.[73]

Through the use of such indicators, Agenda 21 is able to determine that the contaminants which pose the greatest threat to the marine environment include sewage, nutrients, synthetic organic compounds, sediments, litter and plastics, metals, radionuclides, oil/hydrocarbons and polycyclic aromatic hydrocarbons (PAHs).[74] It urges States to measure marine environmental quality by deploying indicators that monitor emissions and discharges of compounds likely to accumulate in the marine environment.[75]

Examples of other indicators implied within Agenda 21 include surveys of marine biodiversity and inventories of endangered species and critical coastal and marine habitats.[76] States are recommended to assess the potential of marine living resources, in order to maintain or restore populations of marine species at levels that can produce the maximum sustainable yield.[77] They should also clearly define the limits for the indicator (i.e. if above x, the fish population is at a healthy level; conversely, if below y, the fish population is at risk of suffering decline). Yet, the details of the specific indicators are left to the State's discretion; they need only be founded upon the four core functions and recommended criteria to ensure their success and operational efficiency.

Although this is more specific guidance than provided for in other policy areas within Agenda 21, these are by no means mandated or prescriptive indicators. Instead, they are general measurement tools from which States should select specific objectives to monitor for within their own national strategies. Agenda 21 only implies that indicators are founded on the core functions and appropriate criteria. This allows them to meet the needs of the users, which ensures that the indicators selected fit both regulatory and scientific purposes, and are therefore successful and applied in an effective manner. With successful and operationally efficient indicators, States can share their data and establish global profiles and indicator databases that provide

[73] UNDESA (1992) *supra* note 58 (paragraph 17.5(e) and 17.6(c))
[74] Ibid, at paragraph 17.18 ad 17.35(a)
[75] Ibid, at paragraph 17.18 and 17.35(a)
[76] Ibid, at paragraph 17.7
[77] Ibid, at paragraph 17.8

information on the sources, types, amounts and results of pollutants effecting the global marine environment.[78]

Agenda 21 also calls upon international organizations to aid States in the assessments of marine pollution.[79] This is noteworthy. It goes beyond the routine stance that policy and indicators should be developed within States and their own national strategies, to assert that international organizations should (when appropriate) take the lead and develop successful and operationally efficient indicators to monitor for marine pollution. Furthermore, States and international organizations should work to coordinate their approaches, so that useful and compatible data are obtained that monitor and chart global progress towards marine environmental protection.

The importance of indicators is continually reinforced throughout the Agenda 21 document. Similar to the UNCSD, these indicators tend to be more sectoral in nature (i.e. identifying sources of pollution) and are often of socio-economic importance. Yet, Agenda 21 goes beyond the UNCSD in that it not only takes a top-down approach to environmental management and indicator development, but a horizontal approach as well (across other International organizations). It urges States to develop globally accepted methodologies for coastal vulnerability assessments, which includes a global consensus on the development of indicators and the criteria that supports them.[80] It provides examples of these indicators, including the marine biological effects of increased levels of ultraviolet rays, the role of oceans as a carbon sink, systematic observations of coastal habitats and sea level changes, inventories of marine pollution sources, and reviews of fisheries statistics.[81] It notes that these indicators should be assessed for all oceans and seas and linked to existing data, in order to exchange and communicate global changes to the environment.[82]

As implied within Agenda 21, the development and application of indicators allows for comparable analysis and soundness of data (when founded upon the four core functions and appropriate criteria). Successful and operationally efficient indicators aid in effective marine and environmental management, which results in

[78] UNDESA (1992) *supra* note 58 (paragraph 17.35(e))
[79] Ibid, at paragraph 17.31
[80] Ibid, at paragraph 17.101(c)
[81] Ibid, at paragraph 17.101(e), 17.102 and 17.106(c)
[82] Ibid, at paragraph 17.103(b), (d), and (e)

greater knowledge of the marine environment and promotes integrated management and progress towards various political objectives, including sustainable development.

Similarly, the Rio Declaration consists of a series of principles whose primary aim is to create a mutual understanding of development that supports socio-economic growth, while simultaneously preventing the continued deterioration of the environment.[83] Although the term indicator is not explicitly mentioned within the text, they are implicit as a means to measure the objectives fleshed out within the policy document. The UNGA acknowledges that States have the sovereign right to exploit their own natural resources pursuant to their own environmental and development policies.[84] Yet, it also notes that it is each State's responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment.[85] States need to monitor their activities (through the application of indicators) to ensure that they are not negatively impacting the environment. Thus, Principle 2 implies the deployment of indicators to measure a State's impact on the environment.

Additionally, States are urged to enact effective environmental legislation, including environmental standards (indicators), management objectives (against which the indicators are assessed) and priorities that reflect the environmental and development context to which they apply.[86] Similar to Agenda 21, Principle 11 of the Rio Declaration acknowledges that standards applied by some states may be inappropriate and of unwarranted economic and social cost to other states, in particular, developing nations.[87] Nevertheless, all signatory members are encouraged to develop and apply standards within their national strategies.[88] When founded upon the four core functions and appropriate indicators, the indicator will be successful and operationally efficient.

Based on the implications within the Rio Declaration the criteria deemed most appropriate are simple, robust, cost efficient, communicative and scientifically valid. If founded on these criteria, the indicators will relay technical information in a

[83] UNDESA (1992) *supra* note 58 (Background)
[84] UNGA *Report of the United Nations Conference on Environment and Development* (A/CONF.151/26 (Vol I), 1992) (Principle 2)
[85] Ibid, at Principle 2
[86] Ibid, at Principle 11
[87] Ibid, at Principle 11
[88] Ibid, at Principle 9, 10 and 11

simplified manner, thereby improving a state's knowledge of the environment and effectively communicating essential features. These indicators allow states to exchange information on spatial and temporal patterns in the environment, which directly meets the requirements of Principle 9.[89] Thus, Principles 9, 10 and 11 imply the use of indicators to improve scientific understanding, exchange information and create environmental standards.[90]

Environmental protection must constitute an integral part of indicator development and cannot be considered in isolation from it.[91] States are encouraged to reduce and eliminate unsustainable patterns of production and consumption and improve scientific understanding through an exchange of knowledge.[92] This is achieved via successful indicators, including sharing the technology behind the development of the indicator. Developing indicators that are based on the four core functions and appropriate criteria provides a deeper understanding of the impacts that human activities create on the environment, as well as the linkages that exist between the environment and the economy. Thus, Principles 4, 7, 8 and 9 imply the use of indicators in order to improve scientific understanding and promote environmental protection.

The Rio Declaration calls upon States to be transparent with their environmental information, and to disseminate this information to the best of their ability.[93] Environmental issues are best handled with the participation of all users. Thus, the indicators implicit in the Rio Declaration must be communicative, policy relevant, simple, interpretable, and tightly linked to human activities. If founded upon the core functions and these criteria (as well as those mentioned previously in the section), the indicators can efficiently communicate with the public, policy-makers, legislators, as well as technical, and non-technical specialists. They will illustrate how scientific, economic and social goals are interconnected, and will demonstrate the depths to which interfacing occurs between the various policy goals (i.e. scientific, social, economic and legal). The indicators will also determine the impacts that activities may have on the environment (i.e. changes in water quality, increases in

[89] UNGA (1992) A/CONF.151/26 (Vol I) *supra* note 84 (Principle 9)
[90] Ibid, at Principle 9, 10 and 11
[91] Ibid, at Principle 4
[92] Ibid, at Principles 8 and 9
[93] Ibid, at Principle 10

bacterial populations, declines in fish stocks, *inter alia*). Thus, successful and operationally efficient indicators possess the ability to meet the objectives underlying the Rio Declaration.

In conclusion, Agenda 21 and the Rio Declaration represent two policy documents that demonstrate the importance of the indicator concept as an element of environmental/marine management. Although not always explicitly identified in the texts, indicators and their corresponding criteria are widely implicit in both. Often, their use may be masked by other words. Indicators offer a means of tracking progress towards achieving the set objectives of each document. If developed and implemented based on the four functions and appropriate criteria, the indicators will be successful and operational efficient to meet the overall objectives of sustainable development. Agenda 21 and the Rio Declaration are not prescriptive as to which indicators should be developed and applied. They grant freedom to states in their indicator selections, which allows States to retain their sovereignty and rule by their individual national strategies, while still creating a more holistic approach to environmental management.

4.3.2 The OECD

Although the present purpose of the OCED is the promotion of economic growth and the advancement of international trade, it provides an important forum for the study and exchange of information relating to environmental problems and the coordination of policies relating to the environment.[94] In recent decades the OECD has recognized that environmental and economic analysis cannot be examined in isolation.[95] Environmental issues have a direct causal link with many economic and social issues that occur internationally.[96] The OECD recognizes that a healthy environment is a prerequisite for a strong, healthy economy and for sustainable development.[97] This made it imperative that they bring together environmental, economic and social concerns across national frontiers for a better understanding of the problems and the best way to tackle them.[98] Thus, the OECD began to use indicators as tools to track progress, support policy evaluation and inform the public,[99] especially in regards to

[94] Caldwell (1990) *supra* note 3 (p 98)
[95] OECD *Towards Sustainable Development: Environmental Performance Reviews* (1998) (p 8)
[96] OECD *OECD Environmental Indicators: Development, Measurement and Use* (2003) (p 4)
[97] OECD (1998) *supra* note 95 (p 3)
[98] Ibid, at p 6, 103 and 109
[99] OECD *OECD Key Environmental* Indicators (2004) 36pp (p 3)

the environment. Indicators compile data, communicate current trends and provide a glimpse of future patterns.

The OECD pioneered the use of environmental indicators by developing and publishing the first international sets of indicators.[100] These were subsequently used and supported in various environmental legislation, budget proposals, and other political vehicles.[101] They designed indicators to be used in the state of the environment reporting, as well as to measure environmental performance and progress towards sustainable development.[102] These indicators were also designed to be used at the national level for planning, clarifying policy objectives and setting priorities.[103] The OECD has been attributed with defining the very essence and concept of an indicator, as well as establishing a specific set of criteria to be used in the development of indicators.[104] These three criteria include policy relevance/utility for users, analytical soundness and measurability. When used in conjunction with the four core functions, they form the basis for successful indicators. More importantly, the OECD have become experts in the application of such indicators in pursuit of their policy goals, making them a leader in indicator applications.

The OECD's work on indicators led to an agreement on a conceptual framework.[105] Known as the pressure-state-response (PSR) model, this framework structures and classifies indicators into broad categories (discussed in chapter 2).[106] Within this framework, the OECD recognize 4 major categories for indicator usage: measurement of environmental performance; integration of environmental concerns in sector policies; integration of environmental and economic decision-making; and reporting on the state of the environment.[107] They acknowledged that the development and application of environmental indicators could be combined with economic and social policies.[108] Such action would further strengthen a country's capacity to

[100] OECD (2004) *supra* note 99 (p 8)
[101] Ibid, at p 8
[102] M Linster "OECD Work On Environment Indicators INECE-OECD Expert Workshop on Environmental Compliance and Enforcement Indicators: Measuring What Matters" [2003] (at p 1)
[103] Ibid, at p 1
[104] OECD (2003) *supra* note 96 (p 4-5)
[105] Ibid at p 4
[106] OECD *OECD Core Set of Indicators for Environmental Performance Reviews: A Synthesis Report by the Group on the State of the Environment* (1993) (p 11)
[107] Ibid, at p 8
[108] OECD (2003) *supra* note 96 (p 4)

monitor and assess environmental conditions and trends.[109] This would increase accountability and allow states to evaluate their work towards achieving domestic objectives and international commitments.[110] And when based upon the four core functions and OECD's required criteria, the indicators can be successful and operationally efficient. Thus, the OECD merges environmental issues with economic and social ones through the deployment of indicators via environmental performance reviews that measure "population growth, demographic patterns and economic growth, selected sectoral trends and patterns of environmental significance, as well as economy-wide environmental expenditure."[111] Environmental performance reviews reduce the overall pollution burden, manage natural resources in a sustainable way, and strengthen international co-operation.[112]

The OECD characterizes indicators as cost-effective and valuable tools that perform two major functions.[113] First, indicators reduce the number of measurements and parameters that normally would be required to give an exact presentation of a situation.[114] Second, indicators simplify the communication process and the manner in which information, results, or measurements are provided to the user.[115] Thus, the OECD supports the four core functions as the very essence and foundation of an indicator. The OECD regards indicators as an expression of the best knowledge available.[116]

Yet, the OECD's bivalent rationale for the development and application of indicators that focus on both economic and environmental concerns has prompted some criticisms. For example, Susan Gubbay argued that the OECD's emphasis has been too focused on sustainable development indicators.[117] These include some environmental indicators, but with poor coverage of marine aspects that are often limited to fisheries.[118] She believes that too much emphasis is placed on sustainable development and not on producing more effective indicators for environmental, and

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[109] OECD (2003) *supra* note 96 (p 4)
[110] Ibid, at p 4
[111] OECD (1993) *supra* note 106 (p 9)
[112] OECD (2003) *supra* note 96 (p 16)
[113] Ibid, at p 4
[114] OECD (1993) *supra* note 106 (p 5)
[115] Ibid, at p 5
[116] Ibid, at p 5
[117] S Gubbay (2004) *supra* note 26 (p 25)
[118] Ibid, at p 25

specifically marine, management. This is not a flaw, but an observation that the OECD's indicators are more sectoral in nature and primarily focus on the economy first, society second ad the environment third (the profit-people-planet model discussed in Section 4.2).

Yet, the OECD asserts that several indicator sets exist that serve many purposes and audiences.[119] Moreover, the objective of the OECD's is to focus on a broader purpose (beyond marine issues). None of their indicator sets are necessarily final or exhaustive in character.[120] They are regularly refined and may change as scientific knowledge, policy concerns and data availability progress.[121] The OECD further stresses that not all indicators can be directly associated with a specific environmental issue.[122] Indicators are not designed to encompass all aspects of environmental, economic or social concerns, either individually or simultaneously. They are devised to reflect single trends and draw the needed political and social attention to such tendencies. Thus, according to the OECD, indicators are only one tool for evaluation and when founded on the four core functions and the criteria they have deemed pertinent, they have the ability to be successful and operationally efficient.[123]

The OECD uses several types of indicators for various purposes. These include the Core Environmental Indicators (CEI), which are designed to help track environmental progress and the factors involved in it.[124] This set contains approximately 50 indicators, all of which are selected on a regular basis by Member States and which are reflective of the major environmental concerns.[125] The CEI provides a baseline assessment, or a minimal set of standards, needed to achieve international policy goals. They are designed to be flexible in application, so as to fit in state's national political agenda. Table 4.2 provides an overview of the OECD's core set (CEI) by environmental issues, the measurability of each indicator and similarities within the UNCSD.

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[119] OECD (2003) *supra* note 96 (p 4-5)
[120] Ibid, at p 4-5
[121] Ibid, at p 4-5
[122] OECD (1993) *supra* note 106 (p 11)
[123] OECD (2003) *supra* note 96 (p 14)
[124] Ibid, at p 6
[125] Ibid, at p 6

Another set of indicators used by the OECD are the Key Environmental Indicators (KEI), which are a reduced set of core indicators (approximately 10-13 indicators).[126] These are selected from the more extensive core set. They are used to inform the general public and provide key signals to policy makers of vital trends occurring in the existing indicator data.[127] Table 4.3 lists the OECD's KEIs and figure 4.3 presents the key categories of environmental indicator sets used by the OECD. The CEI and the KEI indicators are founded on the core functions and based on the OECD's recommended criteria for successful indicators, which have allowed them to be applicable across many countries and for many purposes (i.e. to be operationally efficient).

[126] M Linster (2003) *supra* note 102 (p 4)
[127] Ibid, at p 6

Table 4.2 OECD CEI: Overview of the OECD's core set by environmental issues. S = short term measurability (basic data is currently available for a majority of OECD countries). M = medium term measurability (basic data is partially available, but further efforts needed to improve their quality/efficiency and geographic coverage). L = long term measurability (basic data not available for a majority of OECD countries; further data collection is needed). Main core indicators are presented in bold with complimentary indicators (to accompany the messages of the main indicators) and proxy indicators when the main indicator is currently not measureable (M/L or L rating). Indicators that are similar to the UNCSD are marked with a ✓.[128]

Issue		Core indicators[7]	([8])
Climate change	Pressures	**Index of greenhouse gas emissions✓**	M
		– CO2 emissions	S
		– CH4 emissions	S/M
		– N2O emissions	S/M
		– CFC emissions	S/M
	Conditions	♦ **Atmospheric concentrations of greenhouse gases; Global mean temperature**	S
	Responses	**Energy efficiency**	M/L
		– Energy intensity✓ (total primary energy supply per unit of GDP or per capita)	S
		– Economic and fiscal instruments (e.g prices and taxes, expenditures)	S/M
Ozone layer depletion	Pressures	♦ **Index of apparent consumption of ozone depleting substances (ODP)** ✓	M
		– Apparent consumption of CFCs/ and halons	
	Conditions	**Atmospheric concentrations of ODP**	S/M
		Ground level UV-B radiation	
		– Stratospheric ozone levels	S/M
	Responses	**CFC recovery rate**	M
Eutrophication	Pressures	Emissions of N and P in water and soil ➔ **Nutrient balance**	L
		– N and P from fertilizer use✓ and from livestock	S
	Conditions	**BOD/DO in inland waters, in marine waters✓**	S/M
		Concentration of N & P in inland waters , in marine waters	
	Responses	**Population connected to biological and/or chemical sewage treatment plants**	M/L
		– Population connected to sewage treatment plants	S
		– User charges for waste water treatment	M
		– Market share of phosphate-free detergents	S/M
Acidification	Pressures	**Index of acidifying substances**	M/L
		– Emissions of NOx and SOx	S
	Conditions	**Exceedance of critical loads of pH in water & soil**	M/L
		– Concentrations in acid precipitation	S
	Responses	**% of car fleet equipped with catalytic converters**	S/M
		Capacity of SOx and NOx abatement equipment of stationary sources	M/L
Toxic contamination	Pressures	**Emissions of heavy metals**	M/L
		Emissions of organic compounds	L
		– Consumption of pesticides✓	S/M
	Conditions	**Concentration of heavy metals & organic compounds in env. media & in living species**	L
		– Concentration of heavy metals in rivers	S/M
	Responses	**Changes of toxic contents in products and production processes**	L
		– Market share of unleaded petrol	S
Urban environmental quality	Pressures	**Urban air emissions (SOx, NOx, VOC)**	M/L
		– Urban traffic density	M/S
		– Urban car ownership	S
		– Degree of urbanisation (urban population growth rates, urban land) ✓	S/M
	Conditions	**Population exposure to air pollution, to noise**	L/M
		– Concentrations of air pollutants✓	S
		Ambient water conditions in urban areas	M/L
	Responses	**Green space** (Areas protected from urban development)	M/L
		Economic, fiscal and regulatory instruments	M
		– Water treatment and noise abatement expenditure	S/M

[128] Taken from OECD (2003) *supra* note 96 (Annex III)

Issue		Core indicators[7]	([8])
Biodiversity	Pressures	**Habitat alteration and land conversion from natural state** to be further developed (e.g.. road network density, change in land cover, etc.)	L
	Conditions	**Threatened or extinct species as a share of total species known✓**	S
		Area of key ecosystems✓	M
	Responses	**Protected areas as % of national territory✓ and by type of ecosystem**	S/L
		– Protected species	S
Cultural landscapes		Indicators to be further developed e.g. Presence of artificial elements, Sites protected for historical, cultural or aesthetic reasons	
Waste	Pressures	**Generation of waste (municipal, industrial, hazardous, nuclear) ✓**	S
		– Movements of hazardous waste	S
	Responses	**Waste minimisation** (to be further developed)	L
		– Recycling rates✓	S/M
		– Economic and fiscal instruments, expenditures	M
Water resources	Pressures	**Intensity of use of water resources ✓** (abstractions/available resources)	S
	Conditions	**Frequency, duration and extent of water shortages**	M/L
	Responses	**Water prices and user charges for sewage treatment**	S/M
Forest resources	Pressures	**Intensity of forest resource use ✓** (actual harvest/productive capacity)	M
	Conditions	**Area✓, volume and structure of forests**	S/M
	Responses	**Forest area management and protection** (e.g. % of protected forest area in total forest area; % of harvest area successfully regenerated of afforested)	M/L
Fish resources	Pressures	**Fish catches✓**	S
	Conditions	**Size of spawning stocks**	M
	Responses	**Fishing quotas**	S/M
Soil degradation (desertification & erosion)	Pressures	**Erosion risks: potential and actual use of land for agriculture**	L
		– Change in land use	S
	Conditions	**Degree of top soil losses**	M/L
	Responses	**Rehabilitated areas**	M/L
Material resources (new issue)		**Intensity of use of material resources✓** (Indicators to be developed, link to Material Flow Accounting)	
Socio-economic, sectoral and general indicators *(not attributable to specific environmental issues)*	Pressures	**Population growth & density✓**	S
		Growth and structure of GDP✓	S
		Private & government final consumption expenditure	S
		Industrial production	S
		Structure of energy supply✓	S
		Road traffic volumes;	S
		Stock of road vehicles	S
		Agricultural production	S
	Responses	**Environmental expenditure**	M/L
		– Pollution abatement and control expenditure	S/M
		– Official Development Assistance✓ (indicator added on the basis of experience with environmental performance reviews)	S
		Public opinion	S

The results of the OECD work, and in particular its PSR framework for environmental indicators and the criteria upon which they must be based, has influenced similar activities within a number of countries and international organizations.[129] Such models as the DPSIR, the Input-Output-Outcome-Impact, the State Change-Impact-State Change Welfare, and the DPSCEEAC frameworks were all directly influenced by and a result of the OECD's PSR Framework. Indicators are used similarly in these frameworks, although a larger variety of indicators are applied through these frameworks to meet the additional objectives (i.e. driving forces, impacts, exposure, *inter alia*). As such, the criteria upon which these indicators are based may differ from the OECD's recommended criteria, although the indicators

[129] M Linster (2003) *supra* note 102 (p 5)

should still be founded on the four core functions. Despite these differences in indicator frameworks, the OECD stresses that coherence among countries and international harmonization is essential to ensure that the data and the corresponding indicators are meaningful to both decision making and performance evaluation.[130] This will allow policy makers to make effective international comparisons.[131] The OECD works to ensure that the indicator process is harmonized, even if the context for indicator usage differs.

Table 4.3: OECD Key Environmental Indicators (KEI). This list is neither final, nor exhaustive and should be used in conjunction with indicators from the other OECD Core Set.

POLLUTION ISSUES		**Available indicators***	**Medium term indicators****
Climate change	**1.**	CO2 emission intensities	Index of greenhouse gas emissions
Ozone layer	**2.**	Indices of apparent consumption of ozone depleting substances (ODS)	Same, plus aggregation into one index of apparent consumption of ODS
Air quality	**3.**	SOx and NOx emission intensities	Population exposure to air pollution
Waste generation	**4.**	Municipal waste generation intensities	Total waste generation intensities, Indicators derived from material flow accounting
Freshwater quality	**5.**	Waste water treatment connection rates	Pollution loads to water bodies
NATURAL RESOURCES & ASSETS			
Freshwater resources	**6.**	Intensity of use of water resources	Same plus sub-national breakdown
Forest resources	**7.**	Intensity of use of forest resources	Same
Fish resources	**8.**	Intensity of use of fish resources	Same plus closer link to available resources
Energy resources	**9.**	Intensity of energy use	Energy efficiency index
Biodiversity	**10.**	Threatened species	Species and habitat or ecosystem diversity Area of key ecosystems

** indicators for which data are available for a majority of OECD countries and that are presented in this report*

*** indicators that require further specification and development (availability of basic data sets, underlying concepts and definitions).*

In conclusion, the OECD seeks to use their existing indicator sets in order to have a more significant impact on environmental management. These indicators are founded on the four core functions and the specific criteria recommended by the OECD. Despite their focus on the three main criteria, the OECD is responsible for developing the majority of criteria discussed in Chapter 2, as they found that these criteria resulted in the most successful and operationally efficient indicators. The PSR framework also became the basis for other frameworks, such as the DPSIR – devised by the EU. The OECD notes, however, that it is necessary to continue to improve the quality and comparability of existing indicators, as well as continuously refine indicator definitions and measurements, and develop indicators in response to new and

[130] OECD (2003) *supra* note 96 (p 15)
[131] Ibid, at p 15

emerging policy concerns.[132] This necessitates greater policy relevance and increased quality and timeliness of basic data sets.[133] It also requires a closer link between environmental data and existing economic and social information systems.[134] The progress of the OECD on environmental policies and indicators exemplifies a growth in the understanding of the connections between economic and environmental issues.[135] Their developments are indicative of the need for inter-agency and international cooperation.[136] This is arguably achieved through effective communicative channels, brought about by well-defined indicators.

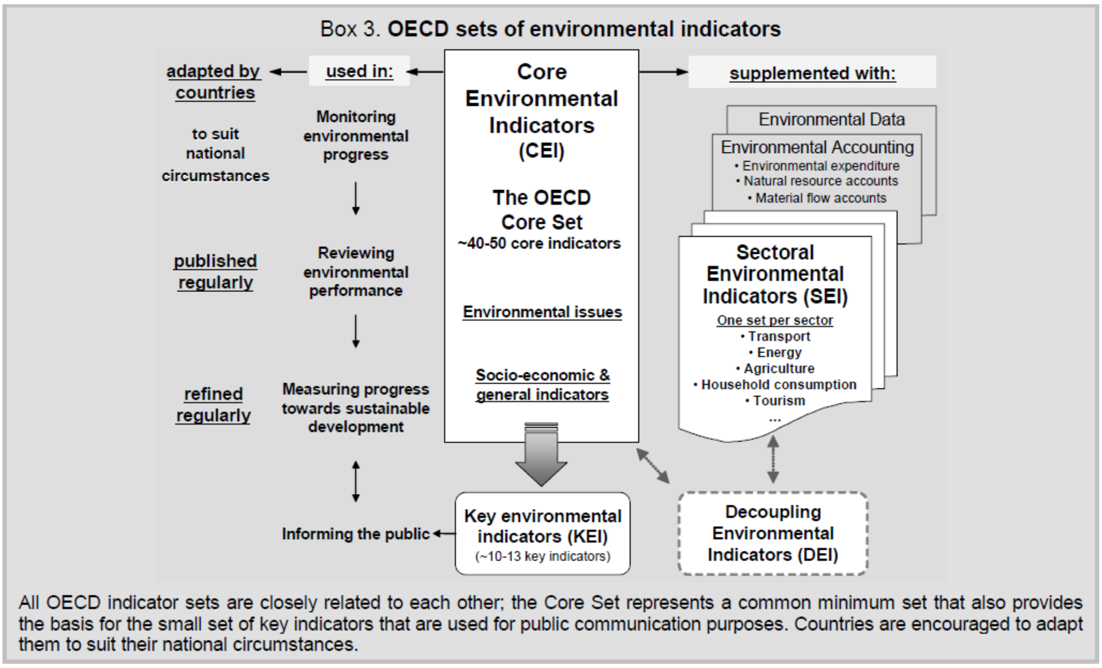

Figure 4.3: OECD Sets of Environmental Indicators[137]

4.3.3 The UNEP

The UNEP represents the environmental concerns of the United Nations. Its mission is to review the state of the world environment, enhance understanding of the critical links between the environment and human activities, identify priorities for international action, flag emerging issues, and strengthen national, regional, and global information handling capacities.[138] Arguably, each of these goals can be

[132] OECD (2003) *supra* note 96 (p 17)
[133] Ibid at p 17
[134] Ibid, at p 17
[135] Caldwell (1990) *supra* note 3 (p 100)
[136] Ibid, at p 100
[137] Taken from OECD (2003) *supra* note 96 (p 6)
[138] *Resolution Institutional & Financial Arrangements* RES 2997 (XXVII, 1972) (p 1)

achieved through the development and implementation of indicators that communicate the connections between human development and the environment. Indicators can identify the need for international action, flag emerging issues by relaying otherwise complex data in a simplified manner, and ultimately strengthen management by reporting on the current state of the environment.

When developed and applied upon the four core functions and appropriate criteria, indicators are successful and operationally efficient Successful indicators can assess progress towards meeting agreed environmental protection, such as those found in the CBD.[139] For example, in 2000, the UNEP undertook initiatives to develop the Human Environment Index (HEI).[140] HEI uses indicators to track progress towards environmental protection goals for Land, Air and Water components of the environment respectively.[141] Such indicators include the area under forests cover, CO_2 emission per capita, and access to improved water sources and sanitation.[142] This indicator framework has been used by the UNEP to communicate trends in environmental performance, as well as provide basic information on the environment and geographic contexts.[143]

Initially, however, environmental indicators were not explicitly called for in UNEP documents. Founded in 1972, indicators did not become explicit for the UNEP until closer to 2000. By this time, the UNEP had come to recognize that indicators represent a major tool in a result oriented type of environmental management program.[144] Consequently, they called for the development and use of performance indicators associated with the following evaluation criteria: appropriateness, relevance, effectiveness, efficiency, sustainability and impact.[145] Indicators founded on the four core functions and these criteria are required for all environmental programs and projects sponsored by the UNEP, to evaluate outcomes of the specific

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139 S Gubbay (2004) *supra* note 26 (p 25)
140 UNEP "Strategy Paper on Environmental Indicators" [2003] (p 4). HEI is borrowed from the Human Development Index (HDI), which was established by the United Nations Development Program (UNDP).
141 Ibid, at p 8
142 Ibid, at p 8
143 Ibid, at p 8
144 UNEP "UNEP Project Formulation, Approval, Monitoring, and Evaluation Manuel" (2000) <http://www.unep.org/eou/Evaluation/Guidelines/index.asp> accessed 3 March 2006 (p 13.89)
145 Ibid, at p 13.89

program or project.[146] The UNEP realizes the need for precise indicators for evaluation purposes, and recognizes the difficulties involved in choosing and setting indicator measurements associated with environmental programs or projects in general.[147] Therefore, the UNEP uses both quantitative and qualitative indicators (based on the criteria mentioned above). The type of indicators used depends on the nature of the program/projects under evaluation and the corresponding evaluation criterion.[148]

Through the indicator development, application and evaluation process, the UNEP can effectively determine the outputs of each of their environmental programs and projects, as well as the success in meeting set environmental goals. Furthermore, they can determine if the resources allocated for a project were effectively utilized to achieve the intended results, as well as the future sustainability of the project.[149] Ultimately, indicators are applied by the UNEP to measure changes to the environment from divisional programs and projects.[150]

The effectiveness of the UNEP's catalytic role depends on their ability to raise global/regional/national/ environmental awareness, as well as develop a consensus in policy response, and influence international and inter-governmental organizations for environmental action.[151] Through the application of environmental indicators, the UNEP can inform the global community of current environmental trends and future directions of policy agenda. The UNEP is influential due to their data sets and observations, which are achieved via the application of indicators. This data allows the UNEP to develop more accurate environmental policy within the global community.

The UNEP has adopted the OECD's PSR framework for environmental indicators.[152] The PSR framework has generally been accepted, but questions have been raised about its limitations in terms of cause/effect relationships, responding to

[146] UNEP (2000) *supra* note 144 (p 13.89)
[147] Ibid, at p 13.89
[148] Ibid, at p 13.89
[149] Ibid, at p 13.90 and 13.91
[150] Ibid, at p 13.95
[151] Ibid, at p 13.91
[152] S W Bie, A Baldascini and J B Tschrley "The Context of Indicators in FAO" (p 2) Taken from: *Land Quality Indicators and Their Use in Sustainable Agriculture and Rural Development: Proceedings of FAO Workshop* (1996)

changing state conditions, and its ability to address biophysical, social and economic issues in a holistic manner.[153] The importance of the PSR framework in being issue- or objective-driven and not indicator-driven has also been addressed as an important limitation.[154] Nonetheless, the PSR framework is used to develop indicators that link available data with the appropriate user, to generate adequate decision making.

The type of indicator developed and used will vary depending on the user, the purpose of the indicator, and the desired outcomes. For example, when identifying a specific problem, the UNEP feels that general descriptive indicators should be developed and used, to raise public awareness.[155] On the other hand, indicators that are more detailed are necessary to address strategy, policy, and project formulation, i.e. they focus on the cause of a problem and projected impacts.[156] The UNEP also emphasizes the need for goals and targets.[157] These are known as quantitative indicators, i.e. quantities set at the national and local levels to help implement various policies.[158] Despite the differences between these indicators, they are founded upon the four core functions and the appropriate criteria mentioned above. Figure 4.4 is adapted from the UNEP decision-making cycle. It illustrates the relationship that results between indicators and each step of the decision-making process.

The UNEP's focus on sustainable development and corresponding indicators has drawn attention to the links between the environment, the economy and social stability as a whole.[159] As argued with the OECD, adequate government responses are more likely when the activity in question can be linked to human influences and impact negatively on the economy. To qualify and quantify pressures, states and responses, indicators must be developed to represent extremely complex situations.[160] The PSR framework (Figure 4.5) has been adopted by many institutions for such indicator development (even though it cannot properly reflect the real world because

[153] J R Benites and J B Tschirley "Summary Report and Conclusions" (p 3) Taken from: *Land Quality Indicators and Their Use in Sustainable Agriculture and Rural Development: Proceedings of FAO Workshop* (1996)
[154] Ibid, at p 3
[155] M Schomaker "Development of Environmental Indicators in UNEP" (p 3) Taken from *Land Quality Indicators and Their Use in Sustainable Agriculture and Rural Development Proceedings of FAO Workshop* (1996)
[156] Ibid, at p 3
[157] Ibid, at p 3
[158] Ibid, at p 3
[159] Ibid, at p 4
[160] Ibid, at p 4

linkages are not necessarily linear).[161] Through such undertakings, the UNEP has significantly influenced the development of environmental indicators and the creation of policies geared at the attainment of sustainable development.

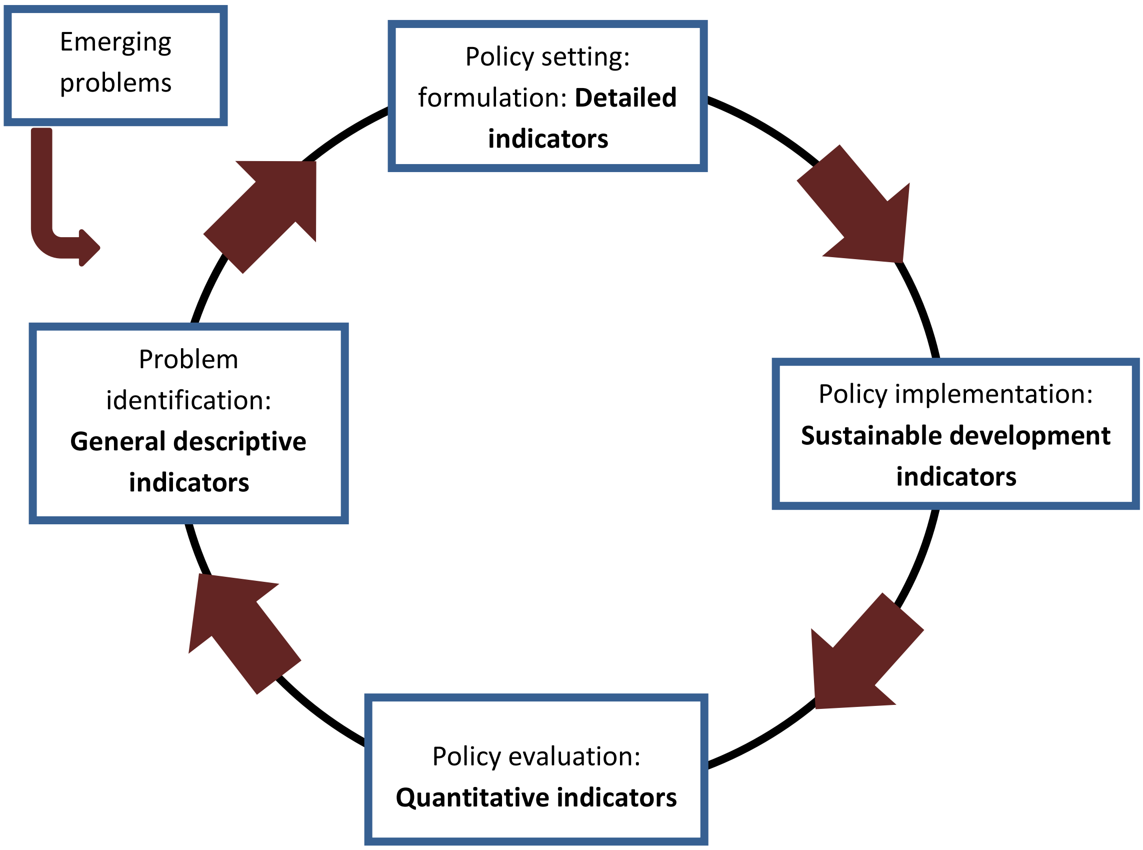

Figure 4.4: UNEP Decision-making cycle and indicators [162]

With regards to the marine environment, the most considerable contribution of the UNEP has been the establishment of the Global Program of Action.[163] This Program aims to prevent degradation to the marine environment from land-based activities by urging states that it is their duty to preserve and protect the marine environment.[164] It is exhortatory and guiding, rather than prescriptive, emphasizing the ideology of Agenda 21, i.e. that States should promote sustainable development and integrated marine management via the development and application of environmental indicators.[165]

[161] M Schomaker (1996) *supra* note 155 (p 4)
[162] adapted from: M Schomaker (1996) *supra* note 155 (p 3)
[163] UNEP *Report of the Intergovernmental Conference to Adopt a Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities* (UNEP(OCA)/LBA/IG.2/7, 1995)
[164] Ibid, at Paragraph 3
[165] Ibid, at Paragraph 11

Collaboration is of particular significance when dealing with marine and coastal areas, which span the jurisdiction of multiple countries. Cooperation (in regards to sharing data from indicators, or developing appropriate indicators) allows for more accurate identification and assessment of problems and can help establish action priorities.[166] Such cooperation also leads to developing measures that fit the particular environmental and socio-economic circumstances.[167] Known as policy relevant, this is one of the criterion mentioned previously that UNEP suggests indicators are founded on. Thus, a strong impetus exists towards both integrated management of the marine environment, as well as the development of environmental indicators that communicate complexities of marine ecosystem functions. The UNEP believes that to attain sustainable development, successful and operationally efficient indicators must be developed and applied.[168] This will aid in the protection of various ecosystem components (i.e. genes, species, *inter alia*) and, therefore, promote ecosystem health and provide economic and social benefits (through maritime culture and traditional lifestyles).[169]

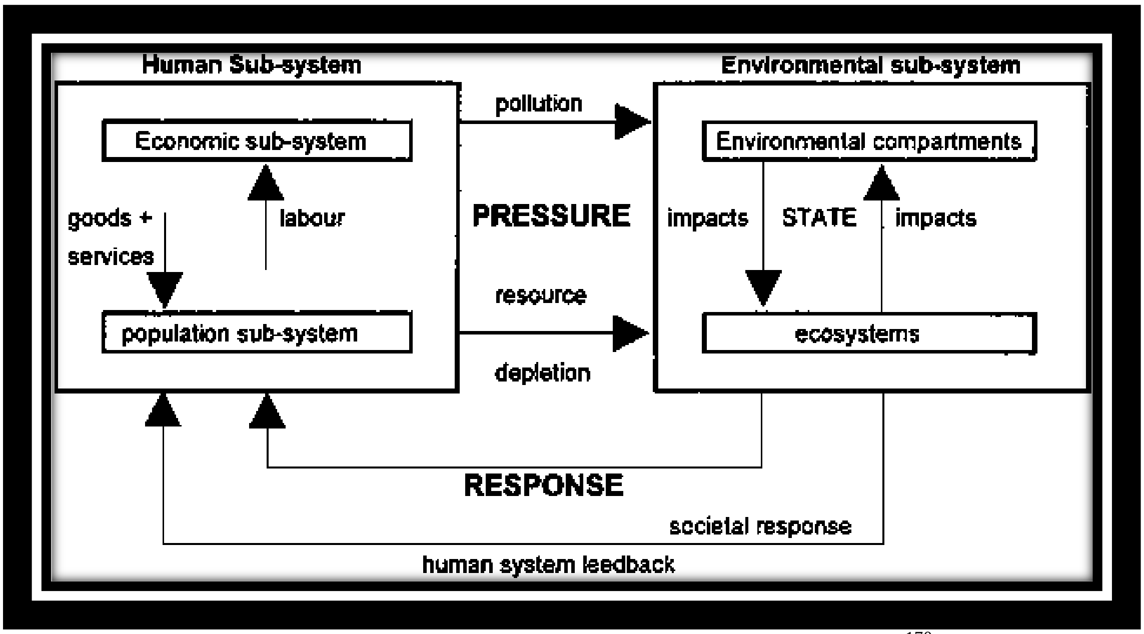

Figure 4.5: Pressure-state-response framework as used by the UNEP [170]

The UNEP appreciates that indicators are ever evolving and dynamic; they are not by all means exhaustive. They strive to promote the development and application of effective indicators that can provide a solid and firm foundation for policy and

[166] UNEP (1995) *supra* note 163 (Paragraph 29)
[167] Ibid, at Paragraph 29
[168] Ibid, at Paragraph 16
[169] Ibid, at Paragraph 16
[170] M Schomaker (1996) *supra* note 155 (p 5)

legislative measures, and which are founded upon the four core functions and their suggested criteria. Such indicators will have the ability to evolve and develop as more scientific information becomes known. This will allow the UNEP to continue to assess global, regional and national environmental conditions, facilitate the transfer of knowledge (through indicators), encourage new partnerships world-wide and ultimately promote the wise-use and sustainable development of the global environment.

4.3.4 The IOC

The Intergovernmental Oceanographic Commission (IOC) was founded by the United Nations Educational, Scientific and Cultural Organization (UNESCO) in 1960.[171] It was created to understand and effectively manage ocean and coastal resources through international cooperation and the establishment of global programs in marine research, hazard mitigation and capacity development.[172] Initially, indicators were not explicitly mentioned in IOC documents, although they were inferred as a means to provide information and data exchange on the physical, chemical and biological aspects of the ocean, thereby contributing to a global knowledge base of ocean observations and human impacts.[173] But by the early 21st century, indicators had become an explicit and prominent tool in the ecosystem based management of the IOC.[174]

In 2010, the IOC, in collaboration with its partners, produced a report on indicators to measure the changing states of large marine ecosystems (LMEs).[175] This report took a broad approach to marine ecosystem assessment and management, using a five-module indicator structure.[176] This five-module approach used indicators of ecosystem (i.) productivity, (ii.) fish and fisheries, (iii.) pollution and ecosystem health, (iv.) socioeconomics, and (v.) governance.[177] These suites of indicators were based on the DPSIR framework and measured the changing states of LMEs to support

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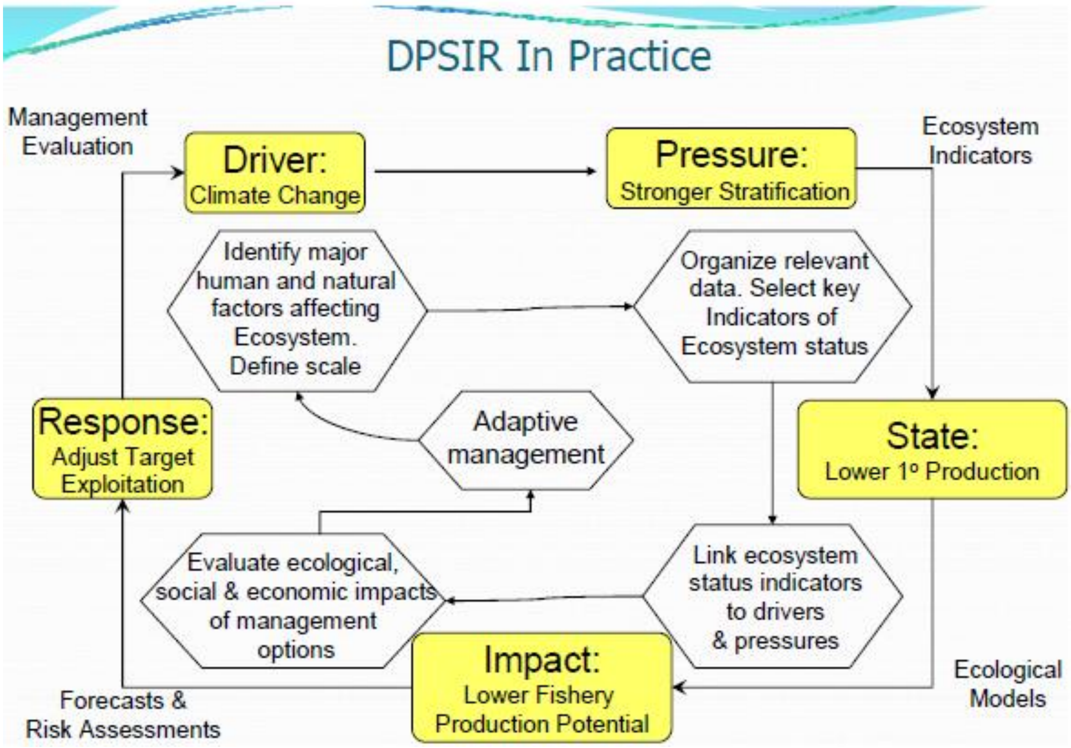
[171] UNESCO "About the Intergovernmental Oceanographic Commission (IOC)" (2005) http://www.unesco.org/new/en/natural-sciences/ioc-oceans/about-us/ accessed 22 November 2015
[172] Ibid
[173] Ibid
[174] K Sherman *et al* "Indicators of Changing States of Large Marine Ecosystems" [2010] pp13-50
[175] Ibid
[176] Ibid, at p 13, 15
[177] Ibid, at p 15

evolving management actions.[178] Figure 4.6 is an illustrative example of DPSIR indicators for climate warming of the North Sea LME. Figure 4.7 is a graphic depiction of the LME modules as suites of ecosystem indicators.

Figure 4.6: DPSIR model illustrating indicators of climate warming of the North Sea LME. Courtesy of Michael Fogarty, NMFS.[179]

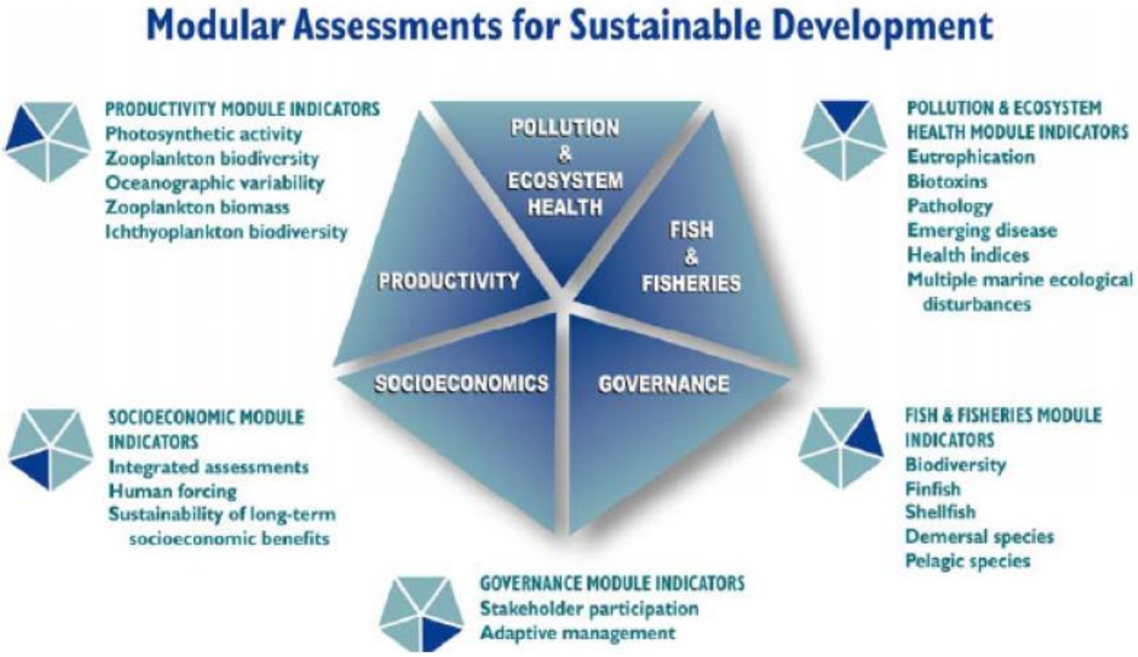


The first three sets of indicators (productivity, fish and fisheries and pollution and ecosystem health) focus on the driving forces, pressure and state aspects of the DPSIR Framework. These include such indicators as zooplankton biodiversity, species composition, chlorophyll *a*, stock identification, coastal pollution, water quality and multiple marine ecological disturbances.[180] These are used to determine the extent of coastal eutrophication, as well as the exploitation of economically important marine resources. These indicators are by no means exhaustive, nor is the IOC prescriptive in the application of these specific indicators. On the contrary, it is only prescriptive with regards to the five-module approach; it is guiding as to which indicators a State should use within each module. Similar to the OECD, the IOC is in fact as much influenced by the bottom-up as it is the top-down. It is an international

[178] K Sherman *et al* (2010) *supra* note 174 (p 15)
[179] Ibid, at p 16
[180] Ibid, at p 17, 22 and 27

organization that seeks to influence regional and national regulatory approaches to the management of ocean and coastal resources. But it is also influenced by the participating members and the indicators that they develop and apply within their national strategies. These, in fact, form the baseline of the indicator modules.[181]

Figure 4.7: 5-Module indicator approach used by the IOC (Sherman et al 2005).[182]



The fourth and fifth sets of indicators (socioeconomics, and governance) focus on the impact and response aspects of the DPSIR framework. Unlike the first three sets of indicators (which are quantitative in nature), these indicator modules are more qualitative. They do not always show unit measures, but instead, summarize the current global situation from an economic and regulatory standpoint. These include such indicators as fishing and aquaculture, tourism, marine industries and local jurisdictional frameworks.[183] Once again, these are in no means exhaustive or prescriptive. Instead, they are ambiguous with regards to specific indicators, relying on the development and application of indicators from participating States and members to guide these modules (the bottom-up approach mentioned above).

To determine if these marine environmental indicators are successful and operationally efficient, an evaluation of the criteria which underlies the indicators must be undertaken. Unlike the OECD and the UNEP, which specified explicit indicator

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[181] K Sherman *et al* (2010) *supra* note 174 (p 16-35)
[182] Ibid at p 16
[183] Ibid, at p 36, 40

criteria, the IOC does not. Their report implies that the indicators developed and applied will be user specific, and that this will influence the success and operational efficiency of the indicators. From an analysis of this report, it appears that the most important criteria are communicative, scientifically valid, simple and robust, broadly applicable, integrative over space and time, tightly linked to human activity and policy relevant. These criteria relate directly to the main objectives behind each indicator module. And arguably, if based on the four core functions, and these criteria, the indicators will be successful and operationally efficient. This was demonstrated throughout the report, in that the indicators selected were able to communicate an otherwise complex situation into a simplified depiction of human impacts and state changes affecting global coastal and ocean ecosystems.

In conclusion, the IOC stresses that to achieve a global ecosystem-based approach to the management of coastal and ocean resources, it must explore the links between management activities and sustainable socio-economic ecosystem benefits.[184] This is achieved through the development and application of successful and operationally efficient indicators capable of communicating human impacts to global marine ecosystems. Through the communication that these indicators provide, the IOC can help to recovery depleted fisheries, restore degraded habitats, control nutrient over-enrichment, reduce coastal pollution, conserve biodiversity and halt climate change.[185] Indicators based on the four core functions and the criteria explored above will be successful and operationally efficient. They can help the IOC determine the current state of the global marine environment and regulatory reform that must be undertaken to halt and reverse these negative impacts.

4.4 Concluding Remarks

Many international environmental policies and organizations exist which have had tremendous impacts on the pursuit of environmental objectives through the formation and application of indicators. Global awareness of the impact of human activities on the marine environment has resulted in ameliorated efforts towards conservation and protection. Arguably, this can be achieved through the use of successful and operationally efficient indicators capable of promoting integration between science,

[184] K Sherman *et al* (2010) *supra* note 174 (p 44)
[185] Ibid, at p 45

policy and law in order to apply a more coherent and holistic approach to marine management. Science plays a role in the formation and implementation of international policy because it provides the evidence basis for decisions (measured via indicators), while remaining politically neutral.

Upon analyzing various international organizations and their approaches to indicator development, a pattern emerges. Although these organizations believe that the application of indicators at the international level should in no means be prescriptive, they do feel that it is imperative to provide guidance on the development and deployment of these tools. Thus, the UNCSD developed indicator methodology sheets to determine the successful and relevance of indicators in comparison with the criteria upon which they are founded. These sheets were designed to assist countries in developing priority indicators that would be most relevant to meet the underlying objectives of their environmental policies. Responsible for Agenda 21 and the Rio Declaration, neither the UNCSD nor these policy documents are prescriptive in indicator selection or the criteria upon which these indicators should be founded. They imply similar criteria (tightly linked to human activities, scientifically valid), but leave the choice of indicator selection to the participating states.

Similarly, the OECD pioneered the use of indicators by developing and publishing the first international set, including the criteria for successful indicators. They have been attributed with defining the very essence of an indicator and they founded the PSR model. The OECD also exhibits a top-down and bottom-up approach to indicator development. States can influence CEI and KEI development and selection, as well as influence OECD policies. Furthermore, unlike the UNCSD, the OECD does support specific criteria for successful and operationally efficient indicators, as well as more specific sets of indicators.

The UNEP, on the other hand, recommends that both quantitative and qualitative indicators be used, to help ensure that the criteria they have defined are met. Similar to the OECD, specific indicator criteria are supported by the UNEP, however, they are not prescriptive as to which indicators should be developed and applied. Additionally, the UNEP takes a strictly top-down approach to indicator development.

Lastly, the IOC explicitly uses indicators to measure the changing state of the global marine environment and to undertake effective marine ecosystem assessment, and management, as well as the sustainable use of marine goods and services. Unlike the UNEP and OECD, no specific indicator criteria are recommended. But the IOC is prescriptive with regards to the five-modules of their indicator approach, although the selection of which indicators to use within these modules is left to the user.

Thus, it becomes apparent that environmental policies, in collaboration with international organizations, help to shape and guide the development and application of successful and operationally efficient marine environmental indicators, to ensure effective communication and good relations between States, as well as protection of global marine ecosystems.

Through the analysis of this chapter, a second pattern emerges with regards to environmental indicators within international environmental policies. In referring back to Figure 4.1, indicators were not explicit in the earlier days of international environmental organizations and their corresponding policies. It wasn't until the mid-late 90's that environmental indicators burst on the scene. And even then, these were often sectoral in nature and more focused on the "profit" or economic benefits of the environment, with little focus on the marine sector. More sustainable development centric in nature, these indicators focused on major environmental resources of economic importance, as this was reflective of the current thought of international policies of that time-frame. Eventually, indicators progressed to a "people" or society-focus, again in line with the objectives of sustainable development. And it has only been recently that a "planet" or more environmental view has been reflected in international environmental organizations, their policies and the corresponding indicators (refer to Figure 4.2 and Section 4.2).

As discussed throughout this chapter, international organizations have supported similar types of indicators based on the four core functions and founded upon an array of criteria. These indicators are successful and operationally efficient, but are most often user dependent. Although some organizations use different indicator frameworks (like the DPSIR or the PSR), they are nevertheless propagating harmonious indicator systems founded on the four functions and corresponding criteria for successful indicators. Furthermore, as analyzed through this chapter, these frameworks are successful in linking indicators to the corresponding policies for which they were designed.

Consequently, within international environment policies, different indicator applications are evident. Many reasons underline these disparities, but the most significant of these are the inequalities in economic conditions among developing countries. Environmental indicators may pose severe economic and social costs if they are uniformly applied across various nations. As such, international policy will often remain non-prescriptive in its guidance on the matter. Yet, due to the trans-boundary nature of the marine environment, action instigated at the international level is still responsible for further action pursued at the national and regional levels. This Chapter demonstrated that indicators applied at an international policy level are successful and affected by both a top-down and bottom-up approach. Environmental and marine indicators can provide crucial guidance for decision-makers by translating physical and social science knowledge into manageable units of information that help to facilitate the decision-making process. Thus, indicators can be used as a starting point to aid countries in measuring their own national progress towards environmental and marine sustainable development, which then feeds back on the development of international policy, creating a cyclical approach to environmental protection and marine management at the international level.

Chapter 5: European Union Law[1]

5.1 Introductory Comments

The European Union has become an important source of environmental legislation which, despite its economic foundations, has had a profound impact on the management of marine environments in the EU. The EU requires a purposive approach to environmental law, combined with specific standards (measured via indicators) for environmental quality and emission levels, to provide clarity when drafting the legislation in different languages and for transposition into various national strategies.[2]

EU environmental law is contained within Treaties, legislation passed by the institution (i.e. regulations, directives), international treaties to which the EU is a party and the judgments of the European Court of Justice (ECJ). It has resulted in great impacts and changes in the environmental law of the States and has even confronted environmental issues in an organized manner at a centralized government level.[3] The EU forms a supranational organization, in which the Member States have agreed to take a more unified approach to environmental management, which often includes the use of environmental indicators. Consequently, to assess the effectiveness of these indicators in European legislation and court cases, the manner in which these indicators are deployed and the extent to which they are understood within the legislation must first be assessed.

The objective of this chapter is to analyze European law and its influence on both the development and application of marine environmental indicators. It analyzes the influence that European law has on marine indicators and the ability of these indicators to successfully and efficiently communicate complex environmental problems, thereby answering research question 1 and 2. Are marine environmental indicators operationally efficient in European law and, if so, what makes them successful? This chapter also assesses the extent to which European law requires indicators and evaluates these indicators against the criteria for successful indicators to answer research questions 5 and 6. Lastly, this chapter analyzes the extent to which indicators are developed and applied within all forms of European law (from

[1] EU and EC will be used interchangeably throughout this thesis when describing the EU.
[2] S Bell and D McGillivray *Environmental Law* (OUP, 2006) 910pp (p 88)
[3] Ibid, at p 30

legislation to case law) to answer research questions 3, 4 and 7. How does EU law compare with international law? Are indicators explicitly mandated? Is EU law influenced by international law, national law, or both (i.e. is there a top-down or bottom-up influence for indicator development) and does law influence policy in European law?

Section 5.2 examines the EC Treaty and the role of indicators within the main pieces of legislation. Are they implicit within the Treaty? Does the Treaty promote operationally efficient indicators? Section 5.3 reviews some important EU Directives and the indicators that are used to meet the legal obligations (including the Discharged Pollution Directive, the Environmental Impact Assessment Directive, the Water Framework Directive, the Bathing Water Directive, and the Marine Strategy Framework Directive). Sections 5.2 and 5.3 examine the influence that indicators have had on EU legislation creation. Lastly, Section 5.4 analyzes the use of indicators within EU case law. It analyzes the role that indicators play in the application of the law at the ECJ, as well as the interpretation of the law by non-specialists. What is the role of the indicators used and are they successful and operationally efficient? These sections and subsequent analyses are used to determine the success and efficiency of marine environmental indicators within European law, as well as discuss the influence this law has on International and national legislation, and its influence on policy across the three scales. Figure 5.1 illustrates the development of indicators and key European legal frameworks. It provides a visual assessment of the major discussion points of this chapter.

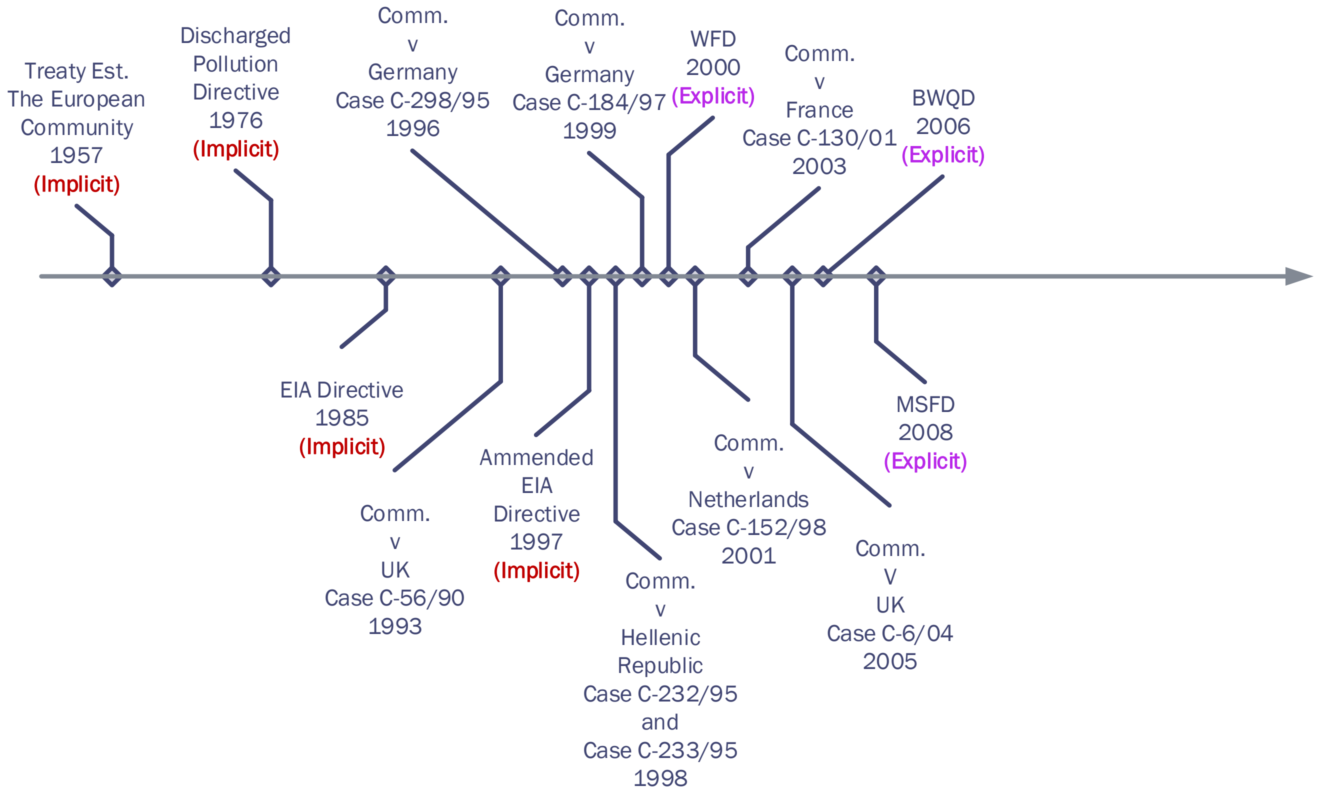

Figure 5.1: Timeline of European legal documents and cases analyzed in this chapter. These are discussed in chronological order within the appropriate subsection. For the Directives, the timeline identifies whether indicators are implicit or explicit within the text of the document. The subsequent analysis provided in this chapter explores the progressive development and application of indicators over time in the EU legal forum to answer research questions 1-7 with regards to EU law.

5.2 The EC Treaty and Indicators

Indicators form a tangible means to identify, summarize and communicate significant trends of the environment and relevant information relating to the impacts of regulated activities. As discussed throughout this thesis, often the term "indicator" is not explicit in the legislative text, nor are they mandated in legal documents (as was seen in the international law chapter). Yet their use is often implied and justified by the fact that they provide a means to determine whether a standard, criterion or objective has been met. They can ensure that Member States implement EC Directives, as well as meet their own national targets. This chapter further proves that indicators guide environmental policy and law.

The EC Treaty contains the main sources of EU environmental law.[4] Although there is no mention of indicators within these environmental Articles, the Treaty nevertheless provides the broad regulatory context within which indicators can be used. Furthermore, specific rules within the EC Treaty shape the use of indicators. Consequently, these rules must be accessed, to determine how these can influence the role of indicators within EU Directives and case law.

Article 174 specifically fleshes out the EU's objectives on the environment.[5] This includes preserving, protecting and improving the quality of the environment, protecting human health, utilizing natural resources prudently and rationally, and promoting measures at the international level to deal with world-wide environmental problems.[6] Although no mention of environmental indicators is made, the Treaty allows for indicators to be applied within the scope of the legislation. Arguably, indicators are necessary to measure the Community's objectives towards a high level of environmental protection, as well as a Member State's ability to achieve such objectives. Article 174(3) further confirms this. It states that when preparing the Commission's policy on the environment, the Council must take account of available scientific and technical data.[7] This is a mandatory obligation of the Treaty, although it is open -ended as to precisely what data is used.

Thus, the Treaty promotes the use of indicators as a means to measure various political and legal objectives. These indicators can be used in a variety of legislation (Regulations, Directives, Decisions, Opinions, and Court Decisions).[8] They can also be used to determine progress towards meeting the set agenda of the environmental action programs.[9] Environmental indicators can measure the desired targets and objectives that the programs have defined, as well as communicate those findings back to the Council. This science-based approach is typified in a range of legislative instruments, which can best be described as technocratic.[10] The EC Treaty also grants

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[4] Treaty Establishing the European Community [1957] OJ C326/01 (Art 1-4)
[5] Ibid, at Art 174(1)
[6] Ibid, at Art 174(1)
[7] Ibid, at Art 174(3)
[8] Ibid, at Art 175(3)
[9] Ibid, at Art 175(3)
[10] See A. E. Toeller and H. C. H. Hofmann "Democracy and the Reform of Comitology" [2000] In Andenas, M. and A. Türk (eds.), *Delegated Legislation and the Role of Committees in the EC* (Hague, London, and Boston, 2000) pp. 25-50.

Member States the ability to pursue measures, including indicators, which are more stringent than those laid out in the Treaty or subsequent environmental programs.[11] The Member States must ensure, however, that these measures remain compatible with the EC Treaty.

Thus, the EC Treaty is more generic in its approach to develop and apply environmental indicators. It implies the use of indicators to gather scientific and technical data aimed at improving environmental quality, protecting human health and using national resources rationally. But it leaves the choice of which indicators to deploy to the user. Thus, the success and operational efficiency of the indicators is user dependent. The chosen indicators should be founded on the four core functions (communication, simplification, quantification, and standardization – See chapter 2), but even the criteria upon which they should be developed is left to the user's discretion. No specific indicators are provided and the Treaty takes a strict top-down approach to the use of environmental indicators and the formation of pertinent environmental legislation and corresponding policies.

5.3 EU Directives and Indicators

EU environmental Directives contain some of the most influential environmental legislation.[12] They are often vague in their commitments, lack specific details, and may contain wider-ranging derogations to soften the potential impact of the directive.[13] Directives lay down practical compliance targets, which are measured via indicators. Thus, indicators are implicit as a means to meet regulatory controls. Directives also provide the regulatory context within which indicators can be used. Furthermore, the rules fleshed out within directives can shape the development and use of indicators.

Member States have a duty to implement EU environmental directives, including the indicators, criteria, targets, and standards that are bound within the directive. They are valuable legislation that flesh out the objectives of the EU, but leave the choice and form of compliance to the discretion of the Member State, so that it fits within their own national strategies (so long as the Directive is implemented

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[11] Treaty Establishing the European Community supra note 4 (Art 176)
[12] Ibid, at Art 249
[13] S Bell and D McGillivray (2006) *supra* note 2 (p 189)

fully within the time limit allotted).[14] Yet Member States must proceed with caution. Indicators must be defined on science so that the indicators do not lose their meaning. Member States may also face the obligation to apply specific scientific techniques that have been fleshed out within the Directive. Thus, Directives provide another legislative means by which environmental indicators can be used. The following subsections provide examples to illustrate these points.

5.3.1 The Discharged Pollution Directive

Within Section 5.4, there are five cases evaluated regarding the application of indicators based upon Council Directive 76/464/EEC on Pollution Caused by Certain Dangerous Substances Discharged into the aquatic environment of the Community.[15] This Directive protects the aquatic environment from pollution caused by persistent, toxic and bioaccumulable substances.[16] Member States must take the appropriate steps to eliminate water pollution caused by the dangerous substances in List I and II of the Annex.[17] List I includes organohalogens, organophosphorus, mercury, cadmium, persistent mineral oils and hydrocarbons.[18] These have limit values that discharge standards cannot exceed.[19] Indicators can be used to measure the toxicity, persistence and accumulation of these substances in living organisms and sediment.[20] List II, on the other hand, includes substances belonging to the groups in List I which do not have set limit value, as well as metalloids and metals, biocides and other substances that have a deleterious effect on the aquatic environment.[21] For these substances, Member States must establish programs, which include discharge standards (measured via indicators) based on the quality objectives of the Council.[22]

Although not explicit in the legislative text, indicators are nonetheless important within this Directive. The emission standards mandated in Article 5 and the limit values mandated in Article 6 can be measured via indicators. Indicators can be

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[14] Treaty on the Functioning of the European Union [2010] OJ C 83/47-C 83/199 (Art 288) and Case 41-74 (1974) Yvonne van Duyn v Home Office. [1974] ECR 01337.
[15] Council Directive of 4May 1976 on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community 76/464/EEC [1976] EC OJ 1976 L 129 (p 23)
[16] Ibid, at Preamble
[17] Ibid, at Art 2
[18] Ibid, at Annex I
[19] Ibid, at Art 6(1)
[20] Ibid, at Art 6(2)
[21] Ibid, at Annex II
[22] Ibid, at Art 7

used to determine the levels of pollution for each item in List I and II, as well as when the emission standards have been breached and when the quality standards are not being met.

As mentioned above, no specific indicators are mandated in the text and no corresponding criteria is recommended. The only mandates given to Member States are that the items in List I and II are measured for and concentration levels/quantities are kept below permissible discharge limits. The Directive does imply criteria, however. Based on an analysis of the text, the indicators must be founded on the four basic functions and be communicative, scientifically valid, tightly linked to human activity, sensitive and responsive.[23] The success and operational efficiency of each indicator, however, will be dependent on the user developing and applying them (as seen in Section 5.4). Thus, discretion is left to the Member States, but they must ensure to implement the Directive according to the requirements or a breach of the Directive will occur (this includes the development and application of indicators to measure for substances in Lis I and II).

It is important to note that this Directive has a top-down and bottom-up approach to implementation and indicator development. Member States must strictly implement the minimum requirements of the Directive in their national strategies, but they have the flexibility to adopt more stringent measures.[24] Additionally, this Directive must be implement3ed in accordance with other pertinent regulations and coordinated across Member States, so that data is shared and meaningful on a regional level.[25] Thus, Member States can influence the corresponding application of the Directive, so long as the minimum mandates are met. Thus, to understand the importance of these indicators within the Directive, it is necessary to analyze specific case law and evaluate the interpretation of such indicators by non-specialists (hence why these specific cases are discussed in the next section). The analysis of Section 5.4 is used to determine how the structure of the Directive inhibits or prohibits successful and operationally efficient indicators.

[23] Discharged Pollution Directive *supra* note 15 (Preamble, Art 1(e), 6(1), 6(4) and Annex I)
[24] Ibid, at Preamble
[25] Ibid, at Preamble, Art 7

5.3.2 The Environmental Impact Assessment Directive

The Environmental Impact Assessment (EIA) Directive assesses the environmental impacts of planned projects to determine whether the stated activities pose a potential significant effect.[26] Similar to the Discharged Pollution Directive, the EIA Directive makes no explicit reference to indicators. Instead, they are implied as a means to assess the potential significant environmental effects of projects, by communicating information such as the effects of the project on human beings, fauna and flora, as well as the effects on soil, water, air, climate and the landscape.[27] Examples of these projects are detailed in Annexes I and II of the Directive and include such activities as agriculture, extraction and the construction of motorways.

This Directive allows decision-makers and regulators to make appropriate decisions regarding a proposed project via their interpretation and understanding of the data supplied by the applicant.[28] This data includes a description of the project (the size, the location, the design), a description of the measures taken to minimize the environmental effects, as well as the information detailed in Annex III (i.e. pollution from the project, the use of natural resources, the absorption capacity of the natural environment and the extent of the impact of the project).[29]

Thus, the Directive leaves the interpretation of the data to the regulator and requires that the data be presented in a "non-technical summary."[30] This raises the question about the extent to which decision makers have the time and resources to investigate and evaluate large amounts of technical data in EIAs. Can the regulator dedicate the necessary time to become an expert on the subject, and if not, will their perception of the project be incorrect? To prevent misinterpretations, scientists and regulators must work together when developing and applying indicators to meet the objectives of the Directive. Indicators have the ability to simplify an otherwise complex reality and can convey the potential impacts of a project in a manner that is understood across multiple disciplines (policy, science, law). They can determine if

[26] Council Directive on the Assessment of the Effects of Certain Public and Private Projects on the Environment 85/337/EEC [1985] OJEU L 175/40-175/48 (Art 1)
[27] Ibid, at Art 3
[28] Council Directive 97/11/EC Amending Directive 85/337/EEC on the Assessment of the Effects of Certain Public and Private Projects on the Environment 97/11/EC [1997] OJEU L 073 (Introduction)
[29] Ibid, at Art 5 and Annex III
[30] Ibid, at Art 5

the project falls below the stated threshold or outside the defined criteria, which would exempt the project from the EIA process.[31]

As mentioned above, the Directive does not explicitly mandate the use of specific indicators, nor that the indicators be developed on specific criteria. Instead, the choice of which indicators to use is left to the resolve of the developer.[32] The only guidance provided is in Article 5.[33] It requires the description of the project, the size, measures to avoid adverse effects, and the main effects the project may have on the environment.[34] Although the Directive is clear that indicator criteria is user dependent and the success and operational efficiency of the indicators will depend on the Member State developing and applying it, it implies that the indicators should be based on the four core functions and be communicative, policy relevant, tightly linked to human activity and broadly applicable and integrative over space and time.[35] Furthermore, Member States are granted the authority to impose stricter regulations to protect the environment and set thresholds and criteria beyond that required in the Directives, so long as a true assessment of the proposed project is made.[36] Thus, the Directive influences the Member States from the top-down, but also allows for bottom-up influence as well. This is important, as the EIA Directive is adhering to the spirit of the EU by recognizing that differences occur between Member States (financially, environment-wise) and that without the freedom to choose which indicators they can and will use, a Member State may not be able to successfully meet the requirements of the Directive.

Consequently, although not explicitly mandated within the Directive, indicators remain a fundamental component of EIAs, ensuring that the necessary information of a planned project is communicated to the proper authorities. Moreover, the EIA Directive further demonstrates that the EU recognizes the importance of the four core functions of an indicator. When the indicators are based on the core functions and appropriate criteria, they bridge science and policy/law by communicating changes to a system in a relatively simple and straightforward manner.

[31] Council Directive 97/11/EC Amending Directive 85/337/EEC on the Assessment of the Effects of Certain Public and Private Projects on the Environment 97/11/EC *supra* note 28 (Art 5-10)
[32] Ibid, at Introduction
[33] Ibid, at Art 5
[34] Ibid, at Art 5
[35] Ibid, at Annex III
[36] Ibid, at Introduction and Art 4

Indicators provide an analysis of essential features and characteristics of a project and the potential impacts that the stated project will have on the environment. To be successful and operationally efficient, they must communicate the effects of a project across Member States and be founded on the four core functions and appropriate criteria. If the indicators cannot simplify, quantify and communicate the potential outcomes, and cannot be linked to the proposed project, then they fail and the regulator cannot approve the project. Thus, indicators help regulators to determine if a proposed project will pose a significant threat or risk to the environment, as well as link the potential outcomes of a project with the initial proposal, making them an essential implicit component of the EIA Directive.

5.3.3 The Water Framework Directive

The Water Framework Directive (WFD) seeks to protect and enhance aquatic ecosystems, promote sustainable water use, ensure the progressive reduction of pollution, and mitigate the effects of floods and droughts.[37] This is achieved by measuring quality elements, which are used to classify the ecological status of various bodies of water.[38] These include the biological elements of the water body, as well as the hydromorphological, chemical and physio-chemical elements supporting the biological elements.[39] These measurements are indicators that the Member States must identify for each body of water within their jurisdiction. They help to determine reference points/conditions (i.e. the natural state of the environment without human influence or disturbance) and assist in gauging fluctuations from such points.

Various types of indicators can be used to measure the bodies of water. They can include descriptive indicators (i.e. pollution impacts), performance indicators (i.e. policy target values), efficiency indicators (i.e. the level of waste generated per unit of GDP) and welfare indicators.

The WFD states that the Community must take into account all available scientific and technical data, including environmental conditions, when preparing policy on the environment.[40] Member States must implement measures to achieve

[37] Council Directive Establishing a Framework for Community Action in the Field of Water Policy [2000/60/EC] OJEU L 327/1-327/72 (Art 1)
[38] Ibid, at Annex V
[39] Ibid, at Annex V
[40] Ibid, at Intro(12)

good water status and ecological potential, as well as limit the input of pollutants into water.[41] They must also protect, enhance and restore all bodies of water within their jurisdiction. This can be achieved via indicators, which monitor water quality and provide a coherent and comprehensive overview of the environment.[42]

The WFD mandates the use of 'appropriate indicators', although it does not explicitly define the term within the legislative text.[43] It does, however, provide guidance on the quality of indicators by defining 'ecological status', 'good ecological status', 'good groundwater chemical status', 'environmental objective', and 'environmental quality approach' (all measured via environmental indicators).[44] For example, an environmental quality standard is defined as the concentration of a particular pollutant(s) in the water, sediment or biota which should not be exceeded to protect human health and the environment.[45] An indicator is a measurement of an environmental quality standard; it can depict pollution levels in a body of water and communicate deviations from good/excellent water quality.

The problem is that the Directive does not provide a clear determination as to when these indicators have crossed threshold values for the ecological status classifications. For example, Annex V discusses a 'general definition of ecological quality' for each type of water body. But it does not set a threshold value to determine when water quality has crossed from 'moderate' status to 'poor' status or from 'high' status to 'good' status.[46] The only distinction given between the various definitions of ecological status is a slight change in the verbiage of an already ambiguous description. For example, the only differentiation between 'poor' status and 'bad' status is the use of the words major vs. severe, respectively.[47]

This links to the potential problems with indicators in that their function is not purely technical, but linked to political or legal objectives, which in turn, are value driven, or drafted in open textured terms. Therefore, although these indicators may

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[41] Council Directive Est. a Framework for Community Action in the Field of Water Policy *supra* note 37 (Art 4(1))
[42] Ibid, at Art 8 (1)
[43] Ibid, at Art 4(6))
[44] Ibid, at Art 2
[45] Ibid, at Art 2(34)
[46] Ibid, at Annex V(1.2)
[47] Ibid, at Annex V(1.2)

communicate general information about a body of water, they will not necessarily demonstrate when the environment has crossed from 'high' status to 'good' or 'poor' status. This prevents environmental managers from accurately labeling water quality because the requirements fleshed out within the text of the legislation are too vague. Thus, one Member State may define a shared body of water as 'good' status based on their interpretation of the data, whereas another Member State may define the same body of water as 'moderate' or 'poor'. This creates confusion and defeats the purpose of the indicator, which can be detrimental to both the effectiveness of the Directive and the application of appropriate indicators. This is not the fault of the indicators, but a fault in the design of the legislation and how indicators should be developed and used. No clear direction is given on the appropriate indicator criteria. And since this thesis argues that successful and operationally efficient indicators must be founded on the four core functions and relevant criteria, the indicators developed and applied for the WFD are highly susceptible to failure.

Debates have ensued regarding the ambiguity of this Directive. This thesis argues that, according to the indicator timeline (Figure 5.1), this is the first directive that has explicitly mandated indicators within the text of the regulation. Being one of the first directives to require indicators, it had no precedent on indicator definitions, indicator qualities, criteria, etc. Plus, recognizing the sovereignty of Member States, the Directive must be strictly implemented, but must be broad enough to be applicable across various Member States (creating a top-down and bottom-up approach to the Directive and the development and application of indicators). Perhaps, because this Directive has a direct impact on human health, the regulators wanted indicators mandated within the text of the legislation (setting it appart from previous directives). But perhaps, the use of imprecise qualitative statements is a form of compromise. It is a way of mediating the economic/political consequences of the Directive.

Table 5.1 illustrates the ambiguous definitions of ecological quality that are mandated by the Directive. The phrases of the text that distinguishes one status from another have been underlined, to further demonstrate the oversimplification and elusiveness of the legislation and its definitions. No explanation is given within the text to define the difference between such words as 'major' or 'severe', 'deviate only slightly' and 'deviate moderately', etc. This further exacerbates the confusion that these definitions, and corresponding indicators, cause regulators. Consequently, it can be unclear what the indicator is saying in relation to the objectives of the Directive.

Table 5.1: General Definition of Ecological Quality for Rivers, Lakes, Transitional and Coastal Waters.Adapted from EC (2000).[48]

Element	High status	Good status	Moderate status
General	There are no, or only very minor anthropogenic alterations to the values of the physico-chemical and hydromorphological quality elements for the surface water body type from those normally associated with that type under undisturbed conditions. The values of the biological quality elements for the surface water body reflect those normally associated with that type under undisturbed conditions and show no, or only very minor, evidence of distortion. These are the type-specific conditions and communities.	The values of the biological quality elements for the surface water body type show low levels of distortion resulting from human activity, but deviate only slightly from those normally associated with the surface water body type under undisturbed conditions.	The values of the biological elements for the surface water body type deviate moderately from those normally associated with the surface water body type under undisturbed conditions. The values show moderate signs of distortion resulting from human activity and are significantly more disturbed than under conditions of good status.

Waters achieving a status below moderate shall be classified as poor or bad.

Waters showing evidence of major alterations to the values of the biological quality elements for the surface water body type and in which the relevant biological communities deviate substantially from those normally associated with the surface water body type under undisturbed conditions, shall be classified as poor.

Waters showing evidence of severe alterations to the values of the biological quality elements for the surface water body type and in which large portions of the relevant biological communities normally associated with the surface water body type under undisturbed conditions are absent, shall be classified as bad.

The WFD explicitly promotes the use of indicators to communicate water pollution, as well as the human activities responsible for these concentrations. The Directive also uses indicators to communicate environmental status and to gauge the current conditions of the environment in relation to the stated objectives. These indicators are essential to understand the dynamics of various water environments. And although the Directive is problematic in its approach to define an indicator or the appropriate criteria they should be founded on, indicators are still mandated nonetheless. These indicators may not always clearly define the current status of the body of water is (i.e. high, good, poor, etc.), or when it has passed from one status to

[48] Council Directive Est. a Framework for Community Action in the Field of Water Policy *supra* note 37 (Annex V(1.2))

another. But they are still essential elements underpinning the WFD and are, at the very least, a first step towards meeting the objectives laid out within the legislation.

5.3.4 The Bathing Water Directive

The Bathing Water Directive (BWD) differs from the WFD in that the former goes beyond simply requiring the deployment of environmental indicators. The BWD mandates specific indicators to measure bathing water quality. Annex I and Table 5.3 below provide the details of these indicators, and define the threshold values to determine the status of the bathing water (i.e. poor, sufficient, good and excellent quality).[49] If the indicator Intestinal enterococcus rises above 200 cfu/100 ml of inland water (found in column B), then the bathing water drops from excellent quality to good quality in response to the increase in bacteria that is now present in the water. Likewise, coastal bathing waters would be classified as poor quality if the Escherichia coli indicator was worse than the 500 cfu/100 ml of coastal water value listed for sufficient water quality in column D. Of course, cases are not always so simple and such factors as short-term pollution and abnormal situations must be taken into consideration, as these will affect the quality of the bathing waters. Thus, Annex II provides greater detail on bathing water assessments and classifications using the poor, sufficient, good and excellent quality descriptors.[50] It mandates that bathing waters are to be classified as 'poor' if the water quality is worse than the 'sufficient' values of Annex I, column D.[51] Likewise bathing waters are to be classified as 'good' if they are equal to or better than the values set out in Annex I, column C.[52]

The indicators mandated in Annex I (i.e. the quantity of Intestinal enterococcus or Escherichia coli) are the state indicators which define the category of the bathing waters. The responses to these levels – i.e. the reaction to reduce and/or prevent bathers' exposure – are the response indicators. They are the measures to prevent, reduce and/or eliminate the very source of the pollution. Specific indicators are mandated within this Directive (unlike the generalized idea to use indicators, as was seen with the WFD), which presents the argument that when human health is at risk, the EU feels that it is better to be over-cautious and mandate specific indicators (in

[49] Council Directive Concerning the Management of Bathing Water Quality and Repealing Directive 76/160/EEC [2006/7/EC] OJEU L 64/37-64/51
[50] Ibid, at Annex II
[51] Ibid, at Annex II (1)
[52] Ibid, at Annex II (3)(1)

this case to protect bathers), than to presume that the correct indicators will be applied by the Member States as the need arises. This demonstrates a strictly top-down approach to indicator development and application. Thus, the BWD mandates specific indicators to protect human health.[53]

Provisions on the quality of indicators are also mandated in the Directive. Thus, the EU must take into account available scientific and technical data, i.e. the Directive mandates that the indicators are to be scientifically valid.[54] This information is to be used to implement the 'most reliable indicator parameters' to predict microbiological health risks and to achieve a high level of protection.[55] The Directive also stipulates the methodology that must be used when undertaking bathing water quality assessments.[56] This ensures that the technical information communicated by the indicators is collected in a standardized manner. Member States can, therefore, conduct more accurate bathing water quality assessments and group them into the classification system provided by the Directive. Other criteria implied by the Directive include communicative, concrete and specific and interpretable and unambiguous.[57] By using indicators to identify levels of pollution, Member States can analyze bathing water, determine those in 'poor' condition, and identify the reasons for the failure to achieve a sufficient level. Hence, indicators are essential to the objectives of this legislation and are crucial to relay information regarding the bathing waters.

Similar to the WFD, although a variety of definitions are given in the BWD, no definition of an indicator is provided. Furthermore, no definition is given for environmental targets, criteria, or qualitative descriptors. Instead, definitions are provided for pollution, bathing water quality assessment, and set of bathing water quality data.[58] Arguably, this is because specific indicators are elucidated within the text as a means of classifying water quality. Furthermore, since the word indicator is not explicit beyond the introduction, perhaps it is more appropriate that the parameters affecting the indicators (i.e. pollution, abnormal situation, cyanobacterial

[53] Council Directive Concerning the Management of Bathing Water Quality *supra* note 49 (Art 1(1)-(2))
[54] Ibid, at Intro (6)
[55] Ibid, at Intro (6)
[56] Ibid, at Art 4 and Annex IV
[57] Ibid, at Art 11
[58] Ibid, at Art 2(5), (10), (11)

proliferation) be defined. There is no need to define the specific term 'indicator' as a matter of law, as the bacteria data is in fact the indicator, which provides precise information as required in Annex I.

Table 5.2: Annex I from the Bathing Water Directive depicting the mandated indicators for bathing water quality and the threshold values for the various quality levels.[59]

For inland waters

	A	**B**	**C**	**D**	**E**
	Parameter	**Excellent quality**	**Good quality**	**Sufficient**	**Reference methods of analysis**
1	Intestinal enterococci (cfu/100ml)	200 (*)	400 (*)	330 (**)	ISO 7899-1 or ISO 7899-2
2	Escherichia coli (cfu/100ml)	500 (*)	1000 (*)	900 (**)	ISO 9308-3 or ISO 9308-1

(*) Based upon a 95-percentile evaluation. See Annex II.
(**) Based upon a 90-percentile evaluation. See Annex II.

For coastal waters and transitional waters

	A	**B**	**C**	**D**	**E**
	Parameter	**Excellent quality**	**Good quality**	**Sufficient**	**Reference methods of analysis**
1	Intestinal enterococci (cfu/100ml)	100 (*)	200 (*)	185 (**)	ISO 7899-1 or ISO 7899-2
2	Escherichia coli (cfu/100ml)	250 (*)	500 (*)	500 (**)	ISO 9308-3 or ISO 9308-1

(*) Based upon a 95-percentile evaluation. See Annex II.
(**) Based upon a 90-percentile evaluation. See Annex II.

Arguably, this is why the BWD is more successful with indicators than the WFD. Because it mandates specific indicators with precise levels and requires that these be based on the four core functions and appropriate criteria, the indicators are

[59] Taken from: Council Directive Concerning the Management of Bathing Water Quality *supra* note 49 (Annex I)

successful and operationally efficient. And although Annex III mandates additional indicators without precise levels defined (i.e. macro-algae, cyanobacteria, phytoplankton), these are supplementary to the indicators of Annex I (i.e. they are meant to communicate additional information as to the status of the bathing water profile).

This thesis argues that the EU mandated specific indicators within the BWD to form bathing water profiles which can protect human health.[60] These profiles provide a plethora of information, including physical, geographical and hydrological characteristics of the bathing water, identification and assessment of the causes of pollution, and the location of the monitoring points. Such indicators include physical parameters, cyanobacterial, phytoplankton, and other biological and geological parameters. Combined with the specific indicators required in Annex I, they provide a more holistic picture of water quality and human impacts.[61] Once again, this sparks the argument that when human health is a factor, the EU will mandate specific indicators, rather than leave application of the correct indicators to the Member States. Thus, indicators are an essential element underpinning the EC Bathing Water Directive.

5.3.5 The Marine Strategy Framework Directive

Similar to the WFD and the BWQAD, the Marine Strategy Framework Directive (MSFD)[62] explicitly calls for the development and application of environmental indicators, both at Community level and at the level of the Member States, to implement the legislation and meet the objectives.[63] These include reducing the pressures on natural resources and the demand for marine ecological services, promoting the integration of environmental considerations into all relevant policy areas of the EU, and promoting the sustainable use of the seas while simultaneously conserving marine ecosystems.[64] The MSFD also seeks to establish a framework

[60] Council Directive Concerning the Management of Bathing Water Quality *supra* note 49 (Art 6 and Annex III)
[61] Ibid, at Annex III
[62] Council Directive Establishing a Framework for Community Action in the Field of Marine Environmental Policy (Marine Strategy Framework Directive) [2008/56/EC] OJ L 164/19-164/40
[63] Ibid, at Art 10(1)
[64] Ibid, at Intro(2)-(4)

where Member States can achieve or maintain good environmental status in their waters by the year 2020.[65]

Although specific indicators are not required within the Directive, explicit qualitative descriptors, characteristics, pressures, impacts, and elements for setting environmental targets are mandated.[66] Annex IV calls for the establishment of measureable targets and associated indicators to monitor and assess the achievement of good environmental status.[67] These indicators must measure specific characteristics including, the topography and bathymetry of the seabed, annual and seasonal temperature regime and ice cover, the predominant seabed and water column habitat type, non-indigenous species introduced by human activities, and contaminants in fish and other seafood for human consumption.[68] These indicators must also be based on appropriate criteria, including policy relevant, easily measurable, concrete and specific, broadly applicable and integrative over space and time, and responsive feedback to management (in addition to the four core functions).[69]

The Directive stresses the need for a transparent and coherent legislative framework, in which indicators would reside.[70] Such a framework can enable action to be taken in a coordinated, consistent and properly integrated manner.[71] Indicators monitor, assess and communicate the effects of human activities on the marine and coastal environments. If properly applied within national strategies, they can ensure that good environmental status is either achieved or maintained. Thus, the MSFD exhibits both a top-down and bottom-up approach to indicator development. It calls upon the development of a comprehensive set of environmental targets and indicators incorporated within rational marine strategies to measure pressures and impacts.[72] These include changes in siltation, marine litter, significant changes in the thermal regime, inputs of fertilizers and other nitrogen and phosphorus-rich substances, as well

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[65] Council Directive Establishing a Framework for Community Action in the Field of Marine Environmental Policy (Marine Strategy Framework Directive) *supra* note 62 (Art 1(1))
[66] Ibid, at Annex I, III and IV
[67] Ibid, at Annex IV(2)
[68] Ibid, at Annex I and III
[69] Ibid, at Annex IV
[70] Ibid, at Intro(9)
[71] Ibid, at Intro(9)
[72] Ibid, at Annex III and IV

as indicators that provide adequate coverage of the elements characterizing marine waters.[73]

Although the term indicator is used repeatedly in the Directive, it is not defined. Article 3 gives important definitions, including environmental status, criteria, environmental target, and qualitative descriptors, but no definition is given for indicators. This is a main tension point between scientists and law makers - i.e. defining what this term indicator actually means as a matter of both law and science. Yet, despite the lack of a definition, an indicator is still important in the context of the Directive. Often it is accompanied in the text by the term environmental target, associating the two as reliant upon one another. An environmental target is defined as a qualitative or quantitative statement on the desired condition of the different components of marine waters, including pressures and impacts, in respect of each marine region.[74] Consequently, it can be inferred that an indicator is a means of measuring progress towards the achievement of an environmental target. This provides some direction as to what an indicator is and how it can help achieve the objectives of the Directive.

As mentioned previously, the Directive does not mandate specific indicators to monitor the marine environment. It recognizes that differences occur both in the marine environment and the national strategies of the Member States. Thus, the Directive calls upon the deployment of any indicators founded on the specified criteria and capable of communicating information relevant to the objectives of the Directive.[75] This grants the Member States freedom of choice on which indicators they can and will develop and use. The Directive does, however, imply standardization of both the indicators used and the methods for monitoring. Given that implementation of the MSFD is on a regional basis, this would require further cooperation in respect of indicator use and development.

Indicators are a fundamental component of the MSFD, hence why they are mandated within the legislation itself. Arguably, the EU has now recognized the importance of indicators as a communication bridge between science and policy/law.

[73] Council Directive Establishing a Framework for Community Action in the Field of Marine Environmental Policy (Marine Strategy Framework Directive) *supra* note 62 (Annex III and IV)
[74] Ibid, at Art 3(7)
[75] Ibid, at Art 10(1)

To understand the current state of the marine environment, in relation to 'good environmental status', one must have a means of measuring the various components of the environment. Marine strategies will be stronger and more comprehensive if they are founded upon indicators defined within good science.

These indicators must be based on the specified criteria of the Directive and founded on the four core functions to be successful and operationally efficient. Indicators provide an analysis of essential features and characteristics of the current state of the environment.[76] They also define the predominant pressures and impacts on marine waters, as well as provide an understanding of the economic and social importance of these marine waters, thereby meeting the objectives of the Directive.[77] Indicators are pertinent in the MSFD because they help Member States to determine when (or if) they have achieved good environmental status, and link marine (and environmental) problems across man-made borders and natural boundaries.

Indicators are crucial in directives, to determine the extent of human impacts on the environment. The example directives provided in this section illustrate that indicators are applied within EU legislation. Whether explicit in the text, or implied as a means to meet regulatory controls, indicators are an important facet of legislation.

But a distinction exists between directives drafted in precise terms for precise purposes (the Bathing Waters Directive) and other that are more open (the Water Framework Directive). From the analysis, it seems that the more ambiguous the directive, the more flexible the implementing mechanisms and the more flexibility that is afforded to the Member Sate. Yet, this creates uncertainty in the use of the indicators. This can be directly tied to the core functions of an indicator, as well as the criteria for successful indicators. The Water Framework Directive provides an example of what happens when indicators are denied the ability to carry out their core function of communicating information. When an indicator does not have appropriate criteria underlying its foundation then it becomes politically driven, not scientifically founded (i.e. it may not be successful and operationally efficient). This then, in turn, can create an issue with compliance; if a Member State fails to implement the

[76] Council Directive Establishing a Framework for Community Action in the Field of Marine Environmental Policy (Marine Strategy Framework Directive) *supra* note 62 (Art 8(1))
[77] Ibid, at Art 8(1)

ambiguous directive correctly, then infraction proceedings can result, where the meaning of uncertain terms or obligations will be determined (which can impact the true spirit of the legislation).

This section analyzed the use of indicators within specific EU legislation, to better evaluate their importance in EU law. What it found, is that science must drive law and policy, otherwise issues will occur where science is being driven by value-laden concepts that are politically derived and drafted in open textured terms. And the indicators developed and applied must be founded on the core functions and appropriate criteria to truly be successful and operationally efficient. Table 5.3 provides a summary of the legislation discussed in Sections 5.2 and 5.3 and their influences on marine environmental indicators.

Table 5.3: A summary of the legislation discussed in Sections 5.2 and 5.3 and a comparison of their influences on marine environmental indicators.

Law	**Explicit Indicators**	**Implicit Indicators**	**Types**	**Top-Down or Bottom-Up**	**Operationally Efficient**
EC Treaty	No	Yes	*None Given	Top-Down	*User dependent *No specific criteria stated
Discharged Pollution Directive	No	Yes	*Persistent, toxic & bioaccumulable substances in List I and II of the Annex: *i.e. Organohalogens Organophosphorus Mercury Cadmium	Top-Down and Bottom-Up	*User dependent *No specific criteria stated, but infers: -Communicative -Scientifically valid -Tightly linked to human activity -Sensitive and responsive
EIA Directive	No	Yes	*No specific indicators mandated *To communicate potential significant environmental effects of projects	Top-Down and Bottom-Up	*User dependent *No specific criteria stated *To be set by Member States, but implies: -Communicative -Policy relevant -Tightly linked to human activity -Broadly applicable and integrative over space and time

WFD	Yes	No	*Descriptive indicators *Performance indicators *Efficiency indicators *Welfare indicators	Top-Down and Bottom-Up	*User dependent *No specific criteria stated
BWD	Yes	No	*2 specific indicators: -Intestinal enterococci -Escherichia coli *Additional indicators: -State and response indicators -Indicators to measure bathing water pollution -i.e. Cyanobacteria -Macro-algae -Phytoplankton	Top-Down	*Specific criteria is given: -Scientifically valid -Communicative -Concrete and specific -Interpretable and unambiguous
MSFD	Yes	No	*No specific indicators required *Appears to imply pressure and impact indicators	Top-Down and Bottom-Up	*Specific criteria is given: -Policy relevant -Easily measurable -Concrete and specific -Broadly applicable and integrative over space and time -Responsive feedback to management

5.4 EU Case Law and Indicators

To address indicators in EU legislation requires that they be analyzed, not only within the formation of law, but within its operation as well. This thesis argues that indicators are instrumental tools vital to both policy and law. Thus, it is imperative to evaluate how indicators are applied within specific cases pertaining to environmental legislation. By analyzing the operational efficiency of indicators in case law and the interpretation of this technical scientific data by non-technical personnel the benefits of these tools become apparent. Consequently, this section analyzes specific cases where indicators were used to apply the law. It evaluates the interpretation of such indicators by regulators and users of the environment. These cases were chosen due to their environmental basis, their influence on environmental legislation and their interpretation of technical data (i.e. indicators). Table 5.4 provides a summary of each case, the indicators deployed, as well as a comparison of the roles of the indicators and an analysis on their level of success.

Table 5.4: A summary of indicators deployed in each case study, as well as a comparison of the roles of the indicators and an analysis on their level of success.

Case Study	Indicators Used	Context	Role of Indicator	Level of Success
1.) Comm. v. UK Case C-56/90	-Total coliforms -Fecal coliforms -Microbiological and physio-chemical parameters -No. of bathers -Facilities in bathing area	*Water quality *Human health *To identify bathing waters	To ensure quality of bathing waters in Blackpool, Formby, and Southport are in compliance with BWD.	-For Blackpool and Southport: Failure: the UK did not apply indicators and criteria in manner required by Directive. -For Ainsdale: Success: Commission did not present indicators challenging UK's assertion. Thus, UK's indicators were successful and operationally efficient.
2.) Comm. v. Germany Case C-298/95	-Permitted residues (should have been 12 and 14 physical and chemical parameters listed in Annex I and II)	*Water quality	To determine if fish and shellfish are safe for human consumption by monitoring water quality.	-Art 3 and 5: Failure because Germany did not develop and apply the appropriate indicators to meet the requirements of these Articles. -Indicators were not flawed, just method in which they were used failed because it didn't meet the objectives of the Directive.
3.) and 4.) Comm. v. Hellenic Republic Cases C-232/95 and C-233/95	-Discharge of waste -Water quality suitable for bathing and for the support of fish life -General environmental conditions (should have been substances in List II)	*Water quality	To reduce the pollution from List II substances in Lake Vegorritis, the Soulos River and the Gulf of Pagasai.	-Failure: Greece did not apply specific indicators to measure for the List II substances, as directed by the Directive.
5.) Comm. v. Germany Case C-184/97	-Emissions of 99 substances identified in List II	*Water quality	To reduce pollution from List II substances.	-Failure: Germany did not develop the water quality objectives and specific discharge limits and emission standards required by the Directive.

6.) Comm. v. Netherlands Case C-152/98	-Should have been 114 priority substance from List I and II	*Water quality	To reduce pollution from List I and II substances to the Scheldt basin.	-Failure: The Netherlands tried to blame one of the indicator criteria (scientifically valid) as their reason for default. But no indicators were developed and applied, therefore, they failed to meet the objectives of the Directive. Thus, the indicators didn't fail, instead the Netherlands were responsible.
7.) Comm. v. France Case C-130/01	-Industrial discharges -Dangerous substances -General water quality (should have been indicators to measure 99 substances of List I)	*Water quality	To reduce pollution from the 99 substances of List I	-Failure: France used general indicators and multivariate indicators to meet the objectives of the Directive, but the ECJ wanted a strict approach (i.e. indicators that monitored for each of the 99 substances in List I). Again, this was not the fault of the indicators.
8.) Comm. v. UK Case C-6/04	-Indicators to measure human impacts on SACs -Surveillance activities	*Human impact on the environment	To protect habitats from human impacts.	-Failure: Again, this was not the fault of the indicators. The UK did not properly implement the Directive and did not bind the appropriate indicators in their national legislation.

5.4.1 *Commission v. United Kingdom*

The first case to be analyzed regarding the application of indicators in EU legislation is *Commission v. United Kingdom.*[78] Within this case, the Commission contended that the UK had failed to take all necessary measures to ensure that the quality of bathing waters in Blackpool, as well as Formby and Southport, conformed to the limit values (measured via indicators) set in accordance with Article 3 of the BWD.[79]

The Directive explicitly mandates a variety of indicators, including total coliforms and fecal coliforms, to measure microbiological and physio-chemical parameters to protect human health and the environment.[80] The UK asserted that it

[78] *Commission v. United Kingdom* [1993] ECR I-4109 Case C-56/90
[79] Council Directive 76/160/EEC Concerning the Quality of Bathing Water supra note 49 (Art 3)
[80] Ibid, at Annex

applied the required indicators and identified twenty seven areas that met the requirements of the Directive.[81] The Commission argued, however, that too much discretion had been used by the UK, and that this was detrimental to the underlying purposes of the Directive. Their indicators were not used correctly and the necessary steps were not taken to ensure that the water quality was maintained according to the mandated parameters. The Court maintained that if the indicators used by the UK showed that the area was not in compliance with the Directive, then they should have prohibited bathing, in accordance with the requirements of the Directive.[82]

Thus, environmental indicators play an important role in the application of law. This case demonstrates that the courts use indicators to determine failure in complying with the requirements of a Directive. If a regulator does not use the correct or appropriate indicators, then they will be unable to properly implement the legislation. In this case, the indicators are clearly defined within both the Directive and the Regulations. Yet the UK maintained that through its discretionary powers it could implement the Directive (and corresponding indicators) as it deemed appropriate, so long as it took the necessary steps to comply with the obligations fleshed out in the Directive.

The Commission argued that an improvement in water quality was needed for the waters at Ainsdale to accurately reflect the parameters fleshed out in the Directive.[83] Yet, the Court rejected this argument, citing that since the Commission did not present indicators to challenge the UK's data, there was no proof that the waters did not comply with the required parameters.[84] Indicators demonstrated that the UK was in compliance with the mandates of the Directive for this particular site.

On the other hand, the UK did not deny that the quality of bathing waters at Blackpool and Southport were not in conformity with the Directive (the indicators demonstrated this).[85] For this argument, the indicators were not being called into question. Instead, the meaning behind the indicators (i.e. the objectives they were designed to monitor) was being debated. The indicators used by the UK for these sites

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[81] *Commission v. United Kingdom supra* note 78 (p 2)
[82] Ibid, at p 3
[83] Ibid, at p 3-4
[84] Ibid, at p 4
[85] Ibid, at p 4

included the number of bathers, and the facilities in the bathing area – i.e. toilets, changing huts, car parking areas, and the presence of lifeguards.[86] The Court reviewed these indicators and found that the UK had previously used them to identify bathing waters.[87] Furthermore, the Court recalled the intent of the Directive and determined that the objectives would not be attained if the waters of the bathing resorts equipped with facilities and supervised by lifeguards could be excluded because the number of bathers was below a certain threshold.[88] Such facilities and the presence of a lifeguard constituted evidence that the bathing area was frequented by bathers whose health must be protected.[89]

Thus, through their interpretation of the indicators, the Court ruled that the UK was out of compliance in Blackpool and Southport.[90] The Court asserted that it is the responsibility of the Member States to take all necessary measures to ensure that bathing waters conform to the limit values set within the Directive.[91] Consequently, even though it is costly to bring the quality of the bathing waters into compliance with the standards of the Directive, the UK must create safe waters for bathers and establish a scientifically valid method to measure and communicate water quality (hence why indicators are so important).[92] They cannot rely on particular circumstances to justify a failure to fulfill that obligation.[93]

5.4.2 *Commission v. Federal Republic of Germany*

The second case to be evaluated with regards to the application of indicators is *Commission of the European Communities v. Federal Republic of Germany*.[94] This case was based on an application that Germany had failed to adopt, within the prescribed period of time, all the measures (and subsequently indicators, standards and

[86] *Commission v. United Kingdom supra* note 78 (p 4)
[87] Ibid, at p 4
[88] Ibid, at p 4
[89] Ibid, at p 4
[90] Ibid, at p 5
[91] Ibid, at p 5
[92] Ibid, at p 5
[93] Ibid, at p 5
[94] *Commission of the European Communities v Federal Republic of Germany* [1996] ECR I-06747 Case C-298/95

targets) necessary to comply with Articles 3 and 5 in both the Fish Directive[95] and the Shellfish Directive.[96]

The aim of the Fish Directive is to protect or improve the quality of fresh waters which support or could potentially support fish.[97] Article 3 requires that Member States set values for the physical and chemical parameters listed in Annex I (including, temperature, dissolved oxygen, pH and petroleum hydrocarbons).[98] These can be measured via indicators, to determine if fish are safe for consumption. Article 5 requires Member States to establish programs to reduce pollution and ensure that designated waters conform to the values set for the parameters.[99] The Shellfish Directive, on the other hand, seeks to protect and improve the quality of coastal and brackish waters to support shellfish life and growth and, thus, contribute to the high quality of shellfish products directly edible by humans.[100] Articles 3 and 5 of the Shellfish Directive are similar to the provisions contained in Articles 3 and 5 of the Fish Directive, with the exception of Article 3(3) concerning the specific effluents "organohalogenated substances" and "metals" discharged into the aquatic environment.[101]

Indicators are of significance within this case. They convey the quality of the waters, thereby demonstrating compliance with both Directives. Germany argued that it implemented limit values for permitted residues (measured via indicators) within their national regulations to ensure that fish were fit for consumption.[102] They did admit, however, that they had not fully implemented Article 3 into national legislation; i.e. they had not developed indicators to measure the mandated parameters from the Directives.[103] The Commission maintained that both Directives are designed to protect human health by monitoring (via indicators) the quality of the waters that

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[95] Council Directive on the quality of fresh waters needing protection or improvement in order to support fish life 78/659/EEC [1978] OJ L 222, 14.8.1978 (p 1)
[96] Council Directive on the quality required of shellfish waters 79/923/EEC EC [1979] OJ L 281, 10.11.1979 (p. 47); *Commission of the European Communities v Federal Republic of Germany supra* note 94 (p 2)
[97] Council Directive on the quality of fresh waters needing protection or improvement in order to support fish life *supra* note 95 (Art 1)
[98] Ibid, at Art 3
[99] Ibid, at Art 5
[100] Council Directive on the quality required of shellfish waters *supra* note 96 (Art 1)
[101] Ibid, at Art 3(3) and 5
[102] *Commission of the European Communities v Federal Republic of Germany supra* note 94 (p 4)
[103] Ibid, at p 4

support fish and shellfish suitable for human consumption.[104] The Directives must be transposed by binding measures.[105] The Court asserted that having residue indicators to monitor food sources which are legally bound in other national legislation was not enough to demonstrate that Germany had complied with the main objectives of both Directives.[106] Although these limit values were implemented in German law, these indicators are not indisputably binding. Furthermore, they do not fully reflect the true objectives of the Directives, which required indicators to communicate an array of physical and chemical parameters beyond permitted residues. Thus, Germany had failed to demonstrate that consumption of fish or shellfish would not present danger to human health, in accordance with Article 3 of the Directives.[107]

With regards to Article 5, the German Government argued that protection of the quality of waters supporting fish life cannot be considered in isolation.[108] It is part of the overall objective to protect the quality of all waters, which is obtained by deploying indicators designed to measure and reduce water pollution.[109] These indicators demonstrated significant improvement in the quality of fresh waters in Germany between 1976 and 1990, which they argued demonstrated compliance with both Directives (even though these indicators had not been designed to meet the objectives of the two Directives).[110] To develop additional programs and indicators to reduce pollution would be redundant and unnecessary.

The Court observed, however, that both directives established 14 and 12 precise physical and chemical parameters in their respective annexes.[111] Member States must set values for these, measured via indicators.[112] Furthermore, the Directives require that 95% of the samples for pH, non-iodized ammonia, nitrates, total residue chlorine, and other parameters measured must comply with the values prescribed in the Directive to truly satisfy it.[113] The Court asserted that the Directive

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[104] *Commission of the European Communities v Federal Republic of Germany supra* note 94 (p 4)
[105] Ibid, at p 4
[106] Ibid, at p 4
[107] Ibid, at p 4
[108] Ibid, at p 5
[109] Ibid, at p 5
[110] Ibid, at p 5
[111] Ibid, at p 5
[112] Ibid, at p 5
[113] Council Directive on the quality of fresh waters needing protection or improvement in order to support fish life *supra* note 95 (Art 6)

requires Member States to establish specific programs to reduce pollution to fresh and shellfish waters and that general water-purification programs did not constitute an adequate transposition of Article 5. The existent national strategy of the German Government was simply not enough. The Court also ruled that even though the shellfish waters met the requirements of the Directive, this did not exempt Germany from the obligation to establish specific programs and indicators.[114] A Member State cannot be released from its obligations simply because a single area at a specific time has met the requirements of that Directive.[115] Consequently, the Court ruled that Germany had failed to fulfill its obligations.[116]

This case demonstrates the importance of indicators and how they are interpreted. Measures were in place which Germany felt were adequate to meet the requirements of the Directive. Furthermore, the indicators demonstrated favorable conditions similar to those mandated within the legislation. Yet, the Courts interpretation was entirely different. They stated that the indicators used to evaluate the parameters of the Directives must be applicable across the entire Member State and must demonstrate progress towards meeting the stated objectives. Furthermore, Member States must have specific programs and indicators aimed at reducing pollution and applicable to all designated waters. The data that Germany provided to the Courts was obtained from indicators taken in a single area at a particular time.[117] According to the Court they did not constitute evidence that the waters met the requirements of either Directive.[118] In other words, the indicators were not successful and operationally efficient because the wrong indicators were used and those used were not based on the four core functions or the appropriate criteria. Thus the indicators were not flawed. Rather, the method in which they were used and the management system responsible for such application was found to be at fault.

In conclusion, the ECJ adopted a strict approach to the use of indicators in this particular case because human health was the underlying concern. Thus, the Directives must be properly transposed and specific indicators must be implemented within the national strategy to protect human health and correctly implement the

[114] *Commission of the European Communities v Federal Republic of Germany supra* note 94 (p 5)
[115] Ibid, at p 5
[116] Ibid, at p 5
[117] Ibid, at p 5
[118] Ibid, at p 5

Directives. Unlike international law, which is more generic in its application, EU law is much more precise and strict in its application, especially when human health is at risk.

5.4.3 *Commission v. Hellenic Republic*

The third and fourth cases to be analyzed regarding the application of indicators are *Commission of the European Communities v. Hellenic Republic*.[119]

The Commission declared that Greece had failed to establish programs and quality objectives to reduce the pollution of List II substances in Lake Vegorritis and the Soulos River (in Case C-232/95) and the Gulf of Pagasai (in Case C-233/95), as well as failed to make industrial and urban waste discharges into these waters conditional based on emission standards.[120] They asserted that no information had been provided to demonstrate that water pollution levels were diminishing or at the very least, that measures had been established to prevent further pollution.[121] Annex II of the Discharged Pollution Directive is very precise on what indicators to measure for (including metals, metalloids, biocides, toxic and persistent organic compounds, etc.). The Commission produced a list of substances currently polluting Greek waters and alleged that their current national legislation was not based on any quality objectives or programs for the reduction of this pollution.[122] In fact, Greece had not produced any indicators on the concentrations of dangerous substances listed in Annex II for these waters.[123]

Greece responded that they had implemented a range of domestic measures (including quality objectives, emission standards, and indicators) within national legislation and that this met the objectives of the Directive.[124] They were using indicators to measure for waste water, discharges, water quality (to determine suitability for bathing and the support of fish life) and general environmental conditions. Furthermore, they were developing a comprehensive program for the

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[119] *Commission of the European Communities v Hellenic Republic* [1998] ECR I-03343 Case C-232/95 and Case C-233/95
[120] Ibid, at Para 1 and 24-26
[121] Ibid, at Para 1, 30 and 31
[122] Ibid, at Para 41
[123] Ibid, at Para 36
[124] Ibid, at Para 7-15 and 32

qualitative and quantitative management of the aquatic resources of the region.[125] Through this program, the level of treatment for effluents and emission standards (measured via indicators) would be scientifically laid down.[126]

The Court did not feel, however, that these measures satisfied the requirements of the Directive. Similar to the previous German case, reducing pollution by general purification programs did not correspond to the more specific objectives of the Directive.[127] Greece had not shown that their indicators were measuring for the substances mentioned in List II, nor had it indicated the quality objectives designed to reduce the pollution caused by those substances.[128] Furthermore, although Greece was designing a new program that could potentially achieve the quality objectives mentioned in the Directive, it was not yet in effect.[129] Thus, they had failed to fulfill their obligations the Directive.[130]

With regards to indicators, the underlying issue in these two cases is specificity. The Court felt that the Directive was specific in its requirements.[131] Thus, Greece needed specific indicators that measured the quality objectives and emission standards for List II substances. Since the Greek authorities failed to adopt these specific measures pursuant to Article 7, they were at fault. Yet the Greek authorities did in fact use scientifically based indicators designed to quantitatively and qualitatively manage the aquatic resources, as well as determine the level of treatment and emission standards that would be appropriate to protect the ecosystem.[132] The issue, however, was that these indicators were not designed to measure the specific substances listed within the Annex. Thus, although this might demonstrate a willingness on the part of Greece to protect their aquatic ecosystems, these indicators and their corresponding programs did not fulfill their obligations to the Directive.

Consequently, indicators offer a means to meet the requirements fleshed out in Directives when they are applied for this specific purpose. A Member State can use

[125] *Commission of the European Communities v Hellenic Republic supra* note 119 (Para 32-33)
[126] Ibid, at Para 16, 32 and 33
[127] Ibid, at Para 35
[128] Ibid, at Para 31, 40 and 49
[129] Ibid, at Para 38
[130] Ibid, at Para 40 and 49
[131] Ibid, at Para 27, 30, 31 and 34
[132] Ibid, at Para 32

indicators to measure impacts on aquatic ecosystems, but if these impacts do not correlate with the requirements of the Directive, then they will fail to fulfill their obligations. Greece ensured that these indicators and corresponding measures were based on a scientific foundation, but they needed to go one step further. They needed to ensure that the indicators used were designed to measure the quality objectives for the specific substances found in List II of the Directive. Due to their misinterpretation of the Directive and the indicators, as well as their lack of specificity, they were guilty of failing to fulfill the requirements of the Directive.

5.4.4 *Commission v. Germany*

The fifth case to be evaluated regarding the use of indicators is *Commission of the European Communities v. the Federal Republic of Germany*.[133]

This case was brought against Germany for failing to adopt programs, including quality objectives and indicators, to reduce pollution from the substances in List II of the Annex (specifically for 99 substances in List II).[134] The German Government responded that through their national legislation, they had adopted limit values (measured via indicators) for emissions from List I and II substances.[135] Yet, similar to the previous case with Greece, the point of contention between the Commission and the German authorities concerned the need to draw up programs and lay down quality objectives, beyond those already adopted by the Government.[136] Germany argued, however, that once limit values had been established for the emissions, measuring them (via indicators) would result in full implementation of the Directive.[137] Furthermore, since there was no pollution in their waters, there was no requirement to lay down quality objectives.[138]

The Court vehemently disagreed for the same reasons described in the previously discussed Greek case. They maintained that laying down limit values for emissions of List II substances within national legislation was not sufficient to exempt

[133] *Commission of the European Communities v Federal Republic of Germany* [1999] ECR [2001] I-06193 Case C-184/97
[134] Ibid, at Para 1, 13, 15, 21 and 22
[135] Ibid, at Para 23 and 24
[136] Ibid, at Para 25, 28, 29, 30 and 54
[137] Ibid, at Para 26 and 38
[138] Ibid, at Para 37 and 38

Member States from drawing up the programs required by the Directive.[139] These programs work hand in hand with indicators to measure the fixed quality objectives, which serve as the point of reference for calculating the emission standards specified in the Directive.[140] The programs must be specific and embody a comprehensive and coherent approach for the reduction of pollution caused by any of the substances in List II.[141] The improvement of water quality in Germany did not conclusively demonstrate that the method chosen was more stringent than the programs mandated by the Directive.[142] The Court asserted that even though the result sought by the Directive may have been attained by an improvement in water quality, it did not release the German Government from its obligation to adopt the measures provided for in the Directive.[143]

With regards to indicators, again the issue is specificity. The German authorities asserted that they adopted rules and standards, measured via indicators, which pertained to the substances within the Directive. They argued that these measures were more stringent than those required by the Directive. Furthermore, the data obtained from the indicators showed that there was no pollution to the aquatic environment in Germany.[144] Thus, they argued that the requirements of the Directive were met. The Court found, however, that no conclusive evidence existed to demonstrate that these measures were stricter or that the results obtained were any different than those that would have been achieved by adhering to the Directive. Furthermore, they asserted that the indicators and programs adopted by the German authorities did not constitute programs, which was a direct requirement of Article 7. By failing to adopt programs, as well as corresponding indicators and quality objectives to reduce pollution by the 99 substances on list I of the Annex, Germany had failed to fulfill its obligations under the Directive.[145] Again, this was not the fault of the indicators (i.e. it was not because the indicators weren't successful and

[139] *Commission of the European Communities v Federal Republic of Germany supra* note 133 (Para 22, 25)
[140] Ibid, at Para 27, 28 and 30
[141] Ibid, at Para 28
[142] Ibid, at Para 37-41
[143] Ibid, at Para 42
[144] Ibid, at Para 59, 61
[145] Ibid, at Para 63 and 64

operationally efficient). This was Germany's fault for failing to implement the Directive in the strict manner that it required.

5.4.5 *Commission v. Netherlands*

The six case to be evaluated concerning the application of indicators is *Commission of the European Communities v. Kingdom of the Netherlands*.[146]

Similar to the previous three cases, the Commission accused the Netherlands of failing to set binding quality objectives and corresponding indicators for the Scheldt basin for substances in List II of the Annex.[147] The Netherlands responded that the Directive drew a clear distinction between the steps taken to eliminate List I substance (dangerous for the aquatic environment) and those to reduce List II substances (deleterious to the aquatic environment).[148] Furthermore, they argued that although List I contained 132 priority substances, it also referred to the groups and families of those substances, equaling to tens of thousands of substances.[149] It would be impossible for any Member State to set quality objectives and indicators relating to such a large number of substances.[150] Thus, they were not opposed to this obligation; they just believed that it was impossible to accomplish. The science/technology was not available to develop quality objectives and indicators for tens of thousands of substances. They argued that if the science is not available then they cannot develop indicators to communicate the effect that these substances from List I has on the marine environment.[151]

The Court disagreed. They did not believe that the Netherlands would have to establish programs containing quality objectives and indicators for an undefined number of substances.[152] Instead, the obligation under the Directive applied only to the 114 priority substances (for which no limit values had been established) that posed a threat in the waters of the Scheldt basin.[153] The Directive fleshes out the measures

[146] *Commission of the European Communities v Kingdom of the Netherlands* [2001] ECR I-03463 Case C-152/98
[147] Ibid, at Para 1 and 26
[148] Ibid at Para 27 and 28
[149] Ibid, at Para 30
[150] Ibid, at Para 30
[151] Ibid, at Para 29
[152] Ibid, at Para 34
[153] Ibid, at Para 34

to be taken for List I substances that do not have emission limit values.[154] Consequently, the Netherlands was obliged to establish programs setting quality objectives and indicators for the List I substances with no limit values.[155]

The Commission also argued that the Netherlands had not set quality objectives and indicators for certain substances in List II.[156] These included titanium, boron, uranium, tellurium and silver.[157] The Netherlands responded that some of these substances were not clearly identified, and that other Member States experienced the same identification difficulties.[158] Furthermore, they cited that it was impossible to establish scientifically founded values for these substances, or set quality objectives that indicators could measure.[159] Thus, the Netherlands did not deny that the quality objectives and indicators for titanium, boron, uranium, tellurium, silver and others had not been set.[160] But they cited technical difficulties and a lack of scientific evidence as reason for this failure.[161] They noted that internationally, no scientific values had been established that could serve as a basis for setting the quality objectives. Thus, because the science was lacking, they could not be held to the requirements of the Directive. Again, the Court disagreed. To cite scientific difficulties as a reason they could not fulfill their obligation to implement the Directive was not justified.[162] Since no studies had been undertaken, and since the Netherlands had not informed the Commission of their dilemma, they were at fault.

Indicators play an important role in this particular case. The quality of the aquatic environment is closely linked to the levels of polluting substances.[163] Member States must produce programs that establish quality objectives and indicators to measure for these substances and prevent deterioration to aquatic environments.[164] The Court's interpretation of this complaint, the Directive, and the corresponding quality objectives, limit values and indicators is interesting. They understood that

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[154] *Commission of the European Communities v Kingdom of the Netherlands supra* note 146 (Para 32-33)
[155] Ibid, at Para 37
[156] Ibid, at Para 38
[157] Ibid, at Para 38 and 44
[158] Ibid, at Para 39
[159] Ibid, at Para 39
[160] Ibid, at Para 41
[161] Ibid, at Para 42-43
[162] Ibid, at Para 42-43
[163] Ibid, at Para 2, 3 and 43
[164] Ibid, at Para 12

laying down limit values and indicators would not necessarily eliminate water pollution. But these measures are of vital importance, as they are a step towards meeting the requirements of the Directive. To be effective, there must be fixed values for these substances that the indicators can measure for. Thus, the Court demonstrated an acute understanding of indicators and their role in marine management. The level at which the limit values are fixed will ultimately determine the success of eliminating the pollution. Consequently, even if limit values are unknown (i.e. the science is lacking), Member States must still establish programs that aim to eliminate pollution using quality objectives and indicators that can measure progress towards such objectives. Thus, the indicators themselves did not fail; instead, the Netherlands was responsible as they did not develop indicators based on the four core functions or appropriate criteria to meet the requirements of the Directive.

5.4.6 *Commission v. France*

The seventh case to be examined concerning the application of indicators is *Commission of the European Communities v. the French Republic*.[165] The Commission accused the French Government of failing to adopt pollution reduction programs, which included quality objectives and indicators, for the 99 dangerous substances listed in Annex I.[166] The French Government responded by describing measures and analogous indicators that were adopted to prevent pollution (including industrial discharges, dangerous substances and general water quality indicators).[167]

The Court ruled in favor of the Commission on all grounds. They cited settled case-law (previously discussed), where it was found that programs must specifically address the objectives of the Directive and indicators must be developed to measure the substances in List II.[168] General rules and ad hoc measures adopted by Member States to protect waters does not lay down quality objectives and indicators that specifically meet the requirements of the Directive.[169] The Court ruled that national measures which do not cover all the substances referred to in List II cannot satisfy the requirements of the Directive.[170] The fact that a Member State may attain a result

[165] *Commission of the European Communities v French Republic* [2003] ECR C2003/184/10 Case C-130/01
[166] Ibid, at Para 1
[167] Ibid, at Para 28, 32 and 33
[168] Ibid, at Para 72, 73, 76 and 77
[169] Ibid, at Para 60
[170] Ibid, at Para 63 and 68

sought by the Directive by improving water quality via other methods does not relieve it of its obligation to establish programs, quality objectives and indicators for List substances.[171]

With regards to indicators, this case illustrates the importance of using these tools, in combination with quality objectives and programs, to adequately implement the Directive. Although the French Government used indicators and other measures to prevent pollution of the aquatic environment, they needed to reduce discharges of the specific substances of List I and II utilizing indicators, quality objectives and programs.[172]

Additionally, the value of using multivariate indicators verses singular measures was also evaluated within this case. The French Government argued for the development and application of aggregated objectives and indicators capable of measuring the combined effects of multiple substances discharged into the aquatic environment.[173] Establishing quality objectives on a substance by substance basis would result in complex and unworkable legislation that would be based on less precise measurements than those obtained from aggregated measures.[174] According to their research, "several parameters are measured in the process of establishing a comprehensive quality objective for water."[175] The question was whether each substance should constitute a parameter with a corresponding quality objective, or whether all substances should be grouped into a single parameter that would be monitored by one indicator and quality objective.[176] According to the French authorities, an aggregated index can communicate more information than univariate measures. It represents precise figures that changes as a function of a mathematically calculable progression of discharges, is cheaper, and is more manageable legislative-wise.[177] They opted for applying an indicator like the biotic index verses using indicators to measure each of the specific substances laid out in the Directive.

[171] *Commission of the European Communities v French Republic supra* note 165 (Para 64-68)
[172] Ibid, at Para 58 and 60
[173] Ibid, at Para 53-56
[174] Ibid, at Para 50
[175] Ibid, at Para 53
[176] Ibid, at Para 53
[177] Ibid, at Para 55

The Court disagreed, however. They argued that quality objectives must measure for every substance in List II and be specific, which is better achieved via individual indicators.[178] In their interpretation, aggregated water quality objectives (which are fixed with reference to a classification system based on five quality levels taking into account a large number of global parameters) may contribute to a general protection of the aquatic environment against pollution, but are not likely to meet the specific objectives laid out in the Directive.[179] Precision is important in meeting the specific requirements of Article 7.[180] Aggregated indicators cannot ensure that exact values are fixed for each individual component, and thus, will be unable to provide a useful basis for defining the emission standards laid down in discharge authorizations.[181] Again, as with the previous case studies, this was not the fault of the indicators, but a failure on the part of France to specifically implement the Directive.

This case is also noteworthy, in that the Commission (and essentially the Court) recognized that quality objectives are in fact indicators of water quality.[182] Without these indicators, programs would be incomplete and therefore the requirements of the Directive would not be met.[183] This thesis has argued that indicators, standards, objectives, bench-mark values, etc. all essentially measure or communicate the same information. This case demonstrates that legislators and the Courts understand indicators to be synonymous with quality objectives as well (thereby validating the argument proposed in this dissertation). The Commission and the Court defined the parameters for these indicators, stating that they must be identified by basin, as well as on the basis of the receiving aquatic environment and must take into account all discharges into that area.[184] Thus, this case demonstrates that indicators play an important role, not just in the creation of legislation, but in its application and interpretation as well.

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178 *Commission of the European Communities v French Republic supra* note 165 (Para 57, 59, 63, 68 and 71)
179 Ibid, at Para 67 and 68
180 Ibid, at Para 66
181 Ibid, at Para 67 and 68
182 Ibid, at Para 61 and 65
183 Ibid, at Para 66 and 68
184 Ibid, at Para 57, 59, 61 and 62

5.4.7 *Commission v United Kingdom*

The eighth and final case to be evaluated with regards to the use of indicators is *Commission of the European Communities v United Kingdom*.[185] Great Britain and Northern Ireland were accused of failing to properly implement the requirements of the Habitats Directive.[186] The Commission claimed that the measures and indicators adopted by the UK were not sufficiently precise and did not cover all areas mandated by the Directive.[187] The UK, on the other hand, maintained that, apart from offshore and territorial waters, they had correctly implemented the Habitats Directive.[188] Yet, the Court disagreed. They felt that the national legislation of the UK was too general and did not implement all provisions in a clear manner (including all measures, targets, and indicators necessary to meet the obligations of the legislation).[189]

In relation to indicators, the Commission argued that the UK had failed to properly implement the Directive because there were no indicators or measures in place to determine the effects of activities, such as water abstraction plans and projects, on SACs. The UK, on the other hand, maintained that it had established a system which used indicators to measure the impacts of human activities on such sites and which proved that these activities were not having a significant effect, although these were not bound by legal provisions. In response, the Court ruled in favor of the Commission.[190] It asserted that if the potential exists for an effect on a SAC, then the precautionary principle must be applied, and the UK must monitor such activities (via indicators or other methods).

The Commission also accused the UK of failing to implement the surveillance obligations required in the provisions (which included indicators).[191] The UK responded that Member States are required to undertake surveillance, but the Directive does not impose any specific requirement on how it is to take place, or be implemented in national law.[192] The Court ruled in favor of the Commission, stating that although

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[185] *Commission v. United Kingdom* [2005] ECR I-09017 Case C-6/04
[186] Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora [1992] 92/43/EEC
[187] *Commission v. United Kingdom supra* note 185 (p 2)
[188] Ibid, at p 2
[189] Ibid, at p 3-4
[190] Ibid, at p 5
[191] Ibid, at p 6
[192] Ibid, at p 6

the UK had a list of surveillance activities monitored by indicators that it carried out, it could not prove that this surveillance was being undertaken effectively.[193]

Lastly, the Commission accused the UK of failing to apply the Habitats Directive beyond their territorial waters, as they had not yet designated SACs, nor laid down protection, measures and indicators for species of concern.[194] Because no indicators had been developed for these waters, no measures existed to communicate information on species, their habitats, breeding and resting places. The UK did not contest the validity of this complaint, and the Court ruled in favor of the Commission.[195]

The majority of issues discussed in this particular case relate to legal certainty, and therefore, are only indirectly pertinent to indicators. Yet, arguably, indicators are important when analyzing this case, as they are implicit within the Directive, which must be implemented into national law. Furthermore, in arguing legal certainty, many issues arose concerning the UK's ability to measure for the provisions of the Directive. Arguably, indicators offer a means to measure the conservation status of natural habitats and of wild fauna and flora, as well as the Natura 2000 sites by communicating the appropriate natural range for the various species and habitats. Furthermore, they illustrate the current status of the area chosen as the SAC, as well as communicate other ecological features of extreme importance to the flora, fauna and habitats. Indicators measure the effects of plans and projects on the SAC, as well as determine the level of deterioration that could potentially occur. Beyond individual indicators, suites of indicators can be used to monitor the status of species, as required by the Directive. These indicators can determine when population numbers decline due to such activities as illegal hunting, disturbance of the animal's breeding site, or encroachment on their habitat.

Thus, this case demonstrates the importance of properly transposing a directive into national legislation, as well as the degree of precision that is required to meet the objectives of the directive. According to case law, directives (and the indicators, and other measure contained within them), must be specifically implemented within

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[193] *Commission v. United Kingdom supra* note 185 (p 7)
[194] Ibid, at p 11
[195] Ibid, at p 11

national legislation. The UK did not provide the detail required by the Directive to fully implement it into national law, and thus was found in failure of their obligations. This is not the fault of the indicators, but a failure on the part of the UK to properly implement the Directive and bind the appropriate indicator in their national legislation. The application of indicators designed to monitor threatened habitats and species is arguably a step towards compliance, so long as these indicators and the values that they are measuring are established in national legislation designed to implement the Directive. The UK, and all Member States, must continue to seek guidance on the transposition of directives, including those directives that explicitly mandate indicators (i.e. the MSFD) and those which imply their use (i.e. the Habitats Directive).

In conclusion, this case review section demonstrates a series of points, each of which is important to the application of indicators. First, general programs and regulations cannot implement specific requirements. Second, a lack of scientific knowledge does not constitute a justified reason for default. Third, promised or planned measures do not justify default from applying the legislation. And fourth, there must be less flexibility in interpreting technical measures. The Commission requires a strict application of the law, as well as a purposive interpretation and the Court tended to agree (as seen in these examples). Furthermore, the indicators must be founded on the four core functions and appropriate criteria. If not, the indicators will not be successful and operationally efficient, thereby failing to prove the intended argument, as was seen in the cases discussed above.

5.5 Concluding Remarks

From this research, the EU appears to be an important source of environmental legislation and a leader in global environmental law. And based on the analysis, indicators seem to be an important facet to environmental legislation. They are a means of communicating complex trends of the environment, as well as the impact of human activities on flora and fauna. They provide tangible methods for the EU to monitor progress towards set policy and legislative agenda and ensure that the Member States are both implementing and enforcing such measures. These indicators also provide a way for the Court system to interpret and enforce EC Directives.

Yet, how effectively are environmental indicators being developed, understood and implemented to achieve set policy and legislative agenda at the EU level? A misinterpretation of an indicator at the EU legislative level can and does trickle down to affect the policies, laws and agenda of the Member States and can cause issues in resulting case law.[196] It is pertinent that the indicators be founded on the four core functions and appropriate criteria – to ensure that they are successful and operationally efficient.

The research and analysis of this chapter illustrates an interesting trend in marine environmental indicator development and application in EU legislation. Initially, the EC Treaty and early environmental directives were implicit on a requirement to use indicators. No specific types of indicators were mandated, nor were specific criteria referenced. Instead, the text implied that indicators should be based on the four core functions and criteria pertinent to the objectives of the regulations. It wasn't until the late 1990's/early 2000's that directives began to explicitly reference indicators and even later before specific criteria was mandated. There seemed to be a top-down and bottom-up approach within the directives from an early date, arguably because the EU is composed of sovereign states and, thus, looks to them for guidance as much as it seems to guide them. An exception to this is where human health is concerned, as these were much stricter and prescriptive in their interpretation, specifically as it related to indicator development and application (i.e. the BWD).

To this end, a pattern is seen between earlier directives that are more open and flexible,[197] and later directives that are drafted in precise terms for precise purposes[198]. It appears that the more ambiguous the directive, the more flexible the implementing mechanisms and the more flexibility afforded to the Member States. Thus, directives (especially more precise directives) can provide the regulatory context within which indicators can be used and often shape the development of such indicators. The BWD, for example, differs from most directives, as it mandates specific indicators to measure bathing water quality. As mentioned previously, arguably, this is because human health is a factor underlying the Directive – thus, more prescriptive methods are required to ensure that the Member States are strictly adhering to the regulations.

[196] As seen through the Water Framework Directive in Section 5.3.3, p 141-145.
[197] See the WFD, pg. 141-145.
[198] See the BWQD, pg. 145-148

Yet, precise interpretation of the directives can cause issues for Member States at the judicial levels. As was seen in the case law section, each Member State failed in their case because they misunderstood or misinterpreted the corresponding directive and thus, applied the wrong indicators (or failed to develop indicators at all). This was not a fault of the indicators – they were unsuccessful or did not meet the operational efficiency because they were not developed and applied correctly by the Member State. They were founded on the wrong criteria or simply the wrong indicators were used altogether (or no indicators were used at all). For example, in Case C-56/90 (Commission v UK), the UK used a general program believing that this would meet the specific requirements of the Directive.[199] They did not apply the indicators and corresponding criteria in the manner required by the Directive. The Courts (in line with the Commission) required a purposive interpretation of the directives and so the UK failed. Thus, EU case law demonstrates the degree of precision that is required to implement the objectives of directives (and their corresponding measures, including indicators).

The analysis of this chapter demonstrates that there is more jurisprudence on the use of environmental indicators in EU environmental law than under international environmental law, as was evident by the EU regulations that specifically mandated indicators and clearly stated the criteria that they should be founded on. Environmental indicators at the EU level are designed to measure progress towards set agenda (both political and legislative) in order to halt the current and rapid deterioration of ecosystems occurring throughout Member States. But, for this to occur, the indicators must be developed within the auspice of science, as well as the spirit of the legislation. They must be applied within policy and law and accompanied by a scientific understanding. This will allow the information achieved to be legally viable and applicable to specific objectives. In other words, they must be successful and operationally efficient. If indicators applied in EU law are founded on the four core functions and appropriate criteria, this will occur.

In conclusion, the EU must continue to pursue environmental protection through the establishment of directives and legislation which use environmental indicators. These indicators must be capable of being articulated within or transposed

[199] See pg. 155-157

into domestic law down to the Member States, and be applicable within their national strategies. This is a challenge that the EU must face head on, but one which can be achieved through consistent dialogue between law-makers, politicians and scientists. Environmental laws cannot be created in isolation from science. This is the very foundation upon which the law must lie to accurately and effectively halt deterioration, while simultaneously promoting economic and social health. This chapter has demonstrated that the EU still struggles with the tension between flexibility in their legislation and certainty in its application, especially with regards to indicators. Yet, the EU does understand the value of indicators and the need to develop successful and operational efficient indicator aligned with the legislation. Science must drive environmental indicator development to ensure these tools are successful and operationally efficient. Consequently, if the EU hopes to remain a leader and an example in global environmental protection, then they must continue to strive forward in the development and application of scientific indicators, as well as fully understand, employ and legally bind these tools within legislation.

Chapter 6: European Union Policy

6.1 Introductory Comments

In recent years, the European Union has become a powerful advocate for the protection of the marine environment and a strong supporter for the implementation of sustainable development objectives. It has set precedents which have guided the formation of national and international environmental policy and legislation. It has also developed some progressive environmental policies, comparable with those of any state in the world, despite the fact that it does not possess many of the formal attributes of a sovereign state.[1] The European Union has undertaken a more holistic approach to marine management, an approach which enshrines economic and social goals with environmental regulations. It has promoted the development and application of indicators founded on criteria that are capable of communicating progress towards set environmental agenda.[2]

The EU's current environmental policy is a recent addition to the initial economic purposes that underlie the Treaty that established the European Community. With the acceptance of sustainable development, the EU has recognized that economic, environmental and social objectives are interwoven. Consequently, it must reconcile its economic objectives, so that they link with developing social and environmental goals.

This chapter analyzes the development and use of indicators within environmental policies of the European Union. It demonstrates that marine environmental indicators have become an important element of all facets of contemporary marine management and regulation within the EU. It assesses these

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[1] Jordan "Introduction: European Union Environmental Policy-Actors, Institutions and Policy Processes" [2002] Environmental Policy in the European Union: Actors Institutions and Processes 15p (p 1)

[2] E Bayer, R A Barnes and H L Rees "The Regulatory Framework for Marine Dredging Indicators and their Operational Efficiency within the UK: A Possible Model for Other Nations?" [2008] ICES Journal of Marine Science 65 pp1402-1406 (p 1402). Much literature exists which explores EU environmental policy and law. These include M Lee *EU Environmental Law: Challenges, Change and Decision-making (Modern Studies in European Law)* (Hart Publishing, 2005) 316pp; L Kramer *EU Environmental Law* (Sweet & Maxwell Ltd, 2012) 566pp; Jans and Vedder *European Environmental Law: After Lisbon* (4th Ed, Europa Law Publishing, 2011) 560pp; Jan Jans *European Environmental Law* (Kluwer Law International, 1996) 416pp; Elisa Morgera *The External Environmental Policy of the European Union: EU and International Law Perspectives* (CUP, 2012) 600pp; Pamela Barnes and Ian Barnes *Environmental Policy in the European Union* (Edward Elgar, 2000) 360pp; Christopher Knill and Duncan Liefferink *Environmental Politics in the European Union: Policy-making, Implementation and Patterns of Multi-level Governance (Issues in Environmental Politics)* (MUP, 2007) 264pp.

indicators against the four core functions (communication, simplification, quantification, and standardization) and appropriate criteria to determine the success and operational efficiency of these indicators, answering research questions 1-2 and 5-6. This chapter also analyzes the evolution of EU environmental policies and their use of marine environmental indicators (whether implicit or explicit) to achieve policy objectives. It analyzes these indicators to determine if EU environmental policy influences law, to what scale and whether there is a top-down or bottom-up approach to indicator development within EU environmental policy (research questions 3, 4 and 7).

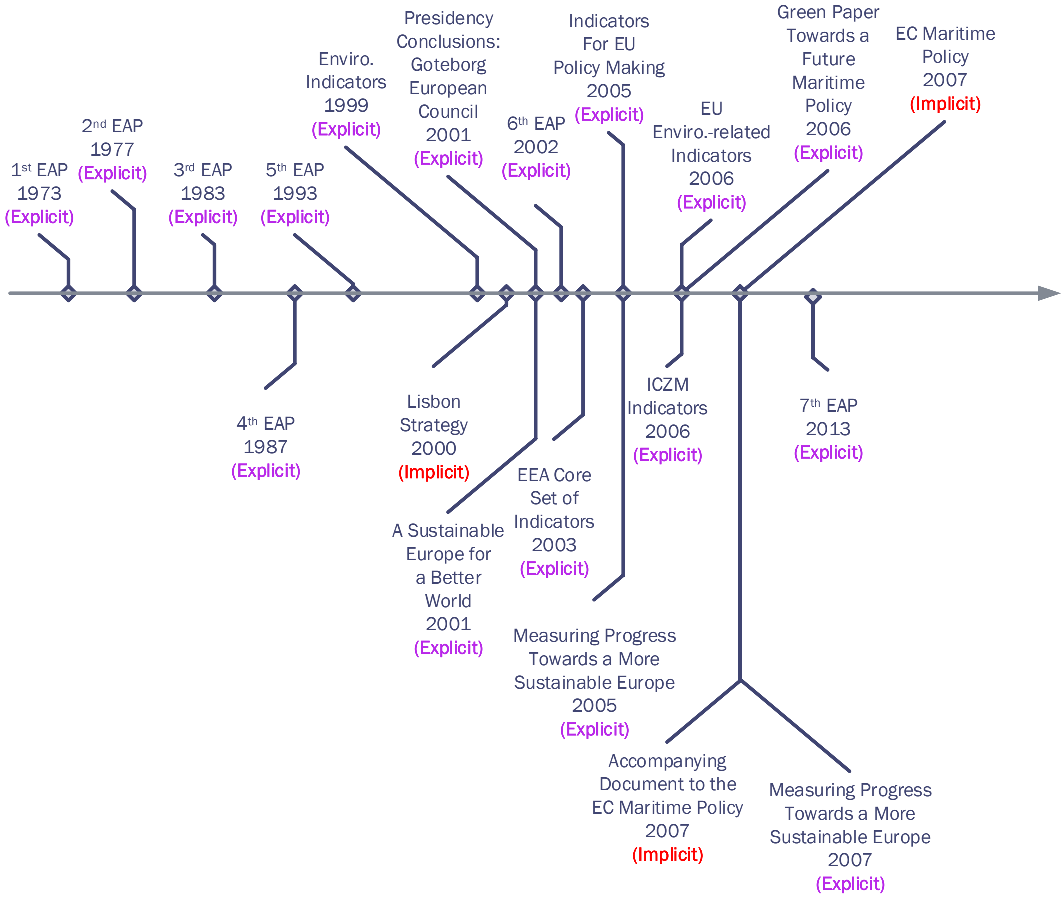

Figure 6.1: Timeline of EU environmental policy documents analyzed in this chapter. These are discussed in chronological order within the appropriate subsection. Each document is listed as explicit or implicit with regards to the use of indicators within the text of the document. The subsequent analysis provided in this chapter explores the progressive development and application of indicators over time in the EU policy forum to answer research questions 1-7 with regards to EU environmental policy.

Specifically, Section 6.2 analyzes the formation of current EU policy, to show the effects that this policy has on Member States, as well as the effects that Member States have on the EU and how this relates to marine and environmental indicator development and application. Section 6.3 focuses on the EU's economic agenda and its connections to environmental and marine protection. It analyzes the role that indicators play in linking these two disciplines at the EU level and assesses whether these indicators are successful and operationally efficient. Section 6.4 discusses the Environmental Action Programs (EAPs) of the EU. It analyzes the progression of environmental policies that gave rise to the use of indicators, as well as the success and operational efficiency of these indicators to meet the requirements of the policy objectives. Section 6.5 discusses the EC Maritime Policy. It analyzes the EU's current vision for the marine environment and the importance of indicators in achieving this goal. It evaluates which indicator criteria are at the heart of the Maritime Policy, and analyzes the success and operational efficiency of these indicators. Lastly, Section 6.6 analyzes the role of indicators in EU environmental policy. This section draws together the analysis of the chapter to determine what makes indicators successful and operationally efficient at the EU level, the influences of EU environmental policy on indicator development internationally and nationally (i.e. top-down or bottom-up approach), as well as the link between environmental policy development and indicator application within the EU. Figure 6.1 illustrates the development of indicators and key European policy documents. It provides a visual assessment of the major discussion points of this chapter.

6.2 Formation of EU Policy

Arguably, it is impossible to understand the environmental policy of any individual Member State without first understanding EU environmental policy. European environmental policy has grown to become the foundation of almost every national strategy and policy agenda of each Member State. Furthermore, the adoption of sustainable development objectives has incorporated EU environmental policy into existing economic and social political agenda, to develop a more mature environmental policy.

Although there has been great progress in the development of an environmental agenda by the EU, this agenda and all policy and legislation, must be explicitly based in EU treaty law. Furthermore, although granted authority to act in all areas relating to environmental policy, the EU must still share competency between each of the Member States.[3] Thus, considerable discretion is conferred to Member States regarding the development of their environmental policies. This has allowed them to meet the set objectives of EU policy, with less prescriptive measures and guidance, as seen in the Sustainable Development Strategy and the 7th Environmental Action Program. Yet, EU environmental policy adds up to considerably more than the sum of national environmental policies.[4] The pre-existing environmental policies of the Member States are no longer politically or legally separate from EU environmental policy.[5] A two-way relationship exists between the EU and its Member States. Consequently, environmental governance occurs within a multilevel system, where Member States directly influence the EU and vice versa.

Yet, although legislation is the primary tool used for the implementation of set policy objectives, it is not the sole means. Other policy instruments exist which are more than adequate in pursuing policy agenda. Referred to as 'New Environmental Policy Instruments' (NEPIs), these non-binding tools are designed to follow a less top down approach at the EU and national levels.[6] Such tools include the Open Method of Coordination; Market-Based Instruments (MBIs); Voluntary Agreements (VAs); Information tools such as eco-labels; and Environmental Management Systems (EMS).[7]

Indicators are directly tied to such policy instruments, just as they were to legislation. They drive environmental policy and communicate information as needed. For example, if a product is packaged with information that includes indicators, then presumably indicators can influence and drive environmental policy (i.e. the description of dolphin safe tuna is an indicator).

Still, these policy tools alone cannot give a complete picture of Community policy, as they only flesh out the intentions of that policy.[8] To determine the extent to which these policy goals are achieved, it is necessary to examine the extent to which they are implemented within the Member States.[9] Community policy cannot be

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[3] IEEP "Manual of Environmental Policy: The EU and Britain" [2006] (2.1, p 1)
[4] Jordan (2002) *supra* note 1 (p 2)
[5] Ibid, at p 2
[6] IEEP (2006) *supra* note 3 (p 1); See Rüdiger Wurzel, Anthony Zito, Andrew Jordan *Environmental Governance in Europe: A Comparative Analysis of New Environmental Policy Instruments* (Edward Elgar, 2013).
[7] IEEP (2006) *supra* note 3 (2.4, p 2)
[8] Ibid, at 2.2, p 1
[9] Ibid, at 2.2, p 1

regarded as an abstract concept that exists on its own and separate from national policies.[10] It only takes effect when it is implemented in the Member States and has been intertwined within national policies and practices.[11] Arguably, indicators assist with such a task. They communicate commonalities between the EU and national policy agendas. Consequently, a discussion on the role of indicators in EU Policy must now be undertaken, in order to examine the extent to which policy goals are being implemented and achieved within the Member States and to determine the success and operational efficiency of the indicators. Table 6.1 provides a summary and comparison of EU policy documents discussed in this chapter and the corresponding indicators used.

Table 6.1: Comparison of the EU policy documents discussed in this chapter and the indicators used to achieve their specific objectives. This information is used to determine the operational efficiency and success of indicators applied in EU environmental policies.

POLICY	EXPLICIT? IMPLICIT? PRESCRIPTIVE?	INDICATOR TYPE	EXAMPLES	OBJECTIVES?	TOP-DOWN? BOTTOM-UP?	EFFICIENT?
Lisbon Strategy (Includes: A Sustainable Europe for a Better World; Indicators for EU Policy Making; Measuring Progress Towards a More Sustainable Europe)	-Initially no mention of the environment or indicators. Then became explicit on using indicators. -Prescriptive on which indicators to use.	*Performance Indicators	-Greenhouse gas emissions -Fish catches -GDP per capita	*To monitor progress towards objectives of the Lisbon Strategy and promote convergence among Member States.	Top-Down and Bottom-Up	-Yes: Specific criteria and indicators given: -Easy to read and understand -Policy relevant -Mutually consistent -*inter alia*
EC Sustainable Development Strategy (Includes: Presidency Conclusions; A Sustainable Europe for a Better World; Measuring Progress Towards a More Sustainable Europe)	-Explicit -Prescriptive on a number of headline indicators, but flexible to developing additional indicators.	*Headline Indicators *Lead Indicators *Action Indicators *Contextual Indicators *Indicators still under development *Based on a 10 Theme Framework	-Total greenhouse gas emissions -CO_2 removed by sinks -Greenhouse gas intensity of energy -Global surface average temperature	*To bring about sustainable development and become the most competitive economy in the world.	Top-Down and Bottom-Up	-Yes: Specific criteria and indicators given: -Policy relevant -Efficient communication -Statistical quality -Robust -Readily available

[10] IEEP (2006) *supra* note 3 (2.2, p 1)
[11] Ibid, at 2.2, p 1

EAPs (Includes: 1st;2nd; 3rd; 4th; 5th; 6th and 7th EAPs)	-Explicit since 1st EAP (except 4th EAP) - Not prescriptive on which indicators to use.	*Indicators of environmental quality *Pollution Indicators *Pressure Indicators *Health Indicators *Headline Indicators *Indicators on the state and trends of the environment *Integration Indicators *Economic Indicators *Qualitative and Quantitative Indicators *Lifestyle Indicators	-Media pollution (water, air) -Biological standards -Exposure limits -Biodiversity -Threatened species -Fish stock declines -Nutrient loadings -Greenhouse gas emissions -Energy consumption -Global forest cover loss -Air quality	*To measure environmental pollution. *To measure environmental quality. *To measure emissions. *To protect natural resources. *To achieve sustainable development.	Top-Down and Bottom-Up	-Yes: User dependent. No specific criteria given until 6th and 7th EAPs: -Communicative -Policy relevant -Scientifically valid -Tightly linked to human activity -Broadly applicable and integrative over space and time -Easily measureable -Simple and robust
EC Maritime Policy (Includes: Green Paper; Accompanying Document)	-Implicit, although indicators are referenced in the Green Paper and the Accompanying Document. -Not prescriptive on which indicators to use.	*No specific indicator types implied in the actual policy document. *Economic and planning indicators specified in the supporting documents.	-Marine pollution -Levels of specific fish stocks -Marine biomass -Water temperatures	*To face challenges: *Globalization and competitiveness *Climate change *Degradation of the marine environment *Maritime safety and security *Energy security *Sustainability	Top-Down and Bottom-Up	-Yes: User dependent. No specific criteria given, but implies: -Communicative -Policy relevant -Broadly applicable and integrative over space and time -Low redundancy

6.3 EU Economic Agenda

6.3.1 Lisbon Strategy

The marine environment is a great contributor to economic prosperity, social well-being and quality of life.[12] Thus, its protection is crucial at a time when the European Union is seeking to revitalize its economy.[13] The Lisbon Agenda was initially designed to address the economic and social dimensions of sustainable development, and made no mention of the environment.[14] There was no mention of indicators, either, although indicators were implied in the original document as a means to communicate economic and social objectives.[15] However, an environmental facet was added via the adoption of the EC Sustainable Development Strategy,[16] which included the marine environment and important industries, such as fisheries and aggregate extraction. With the addendum of this environmental dimension, the Lisbon Strategy came to address economic, social, and environmental renewal and sustainability.[17] The EU justified an environmental constituent within an economic strategy by asserting that links exist between social, economic and environmental policies. They argued that improvements in environmental and marine protection, as well as advances towards environmental sustainability, could enhance employment rates, promote social cohesion and boost the European economy.[18]

The EU developed targets and indicators to monitor progress towards the objectives set by the Strategy.[19] The initial thirty-five indicators of the first report were divided into five areas which did not mention the environment, but instead, focused mainly on economic growth and unemployment.[20] It was not until the following report that the list of indicators was expanded to include the environment

[12] EC "Environment Fact Sheet: Protecting and Conserving the Marine Environment" [2006] A Healthy Environment or Europe: Fact Sheets on EU Environmental Policies (p 2)
[13] Ibid, at p 2
[14] EC "The Lisbon Special European Council (March 2000): Towards a Europe of Innovation and Knowledge" [2000] (p 1); This is similar to the UNEcoSoc, which initially had no mention of the environment (EcoSoc is equivalent to the Lisbon Strategy at the UN level).
[15] Ibid, at p 1
[16] EC *The Lisbon European Council-An Agenda of Economic and Social Renewal for Europe: Contribution of the European Commission to the Special European Council in Lisbon, 23rd-24th March 2000* (DOC/00/7, 2000) (2.4, p 1)
[17] EC *Communication from the Commission: A Sustainable Europe for a Better World: A European Union Strategy for Sustainable Development* (264 FINAL, 2001) (p 2)
[18] EC "A Solid Foundation for Policy-building" [2005] Environment for Europeans' (21) p 6
[19] NSI "Structural Indicators – A Basis of Assessment the Progress in the European Commission Annual Report to the European Council" (2004) <http://www.nsi.bg/AboutNSI_e/StructInd.htm> accessed 3 April 2007 (p 1)
[20] Ibid, at p 1

and marine ecosystems (increasing the indicators from 35 to 42).[21] Currently, there are 79 indicators routinely monitored to assess progress towards the Lisbon Strategy. These include, greenhouse gas emissions, fish catches outside of safe biological limits, and sites designated under the EU Habitats Directive. Yet, indicators are susceptible to political misuse like any other statistic and as such, must be closely monitored to prevent such exploitation. This is not a flaw of the indicators themselves, but instead, is a result of political manipulation to achieve specific results.

Additionally, the Lisbon Strategy called upon improvements in the development and application of the structural indicators. These suggested improvements are another means to enhance the quality of the statistical and analytical tools being deployed to monitor progress towards set objectives.[22] To ensure convergence among Member States and promote a common approach to achieving the objectives of the Strategy and the application of the specific indicators, specific criteria is given by the EU to ensure the indicators are successful and operationally efficient.[23] Beyond the four core functions, these include easy to understand, policy relevant, mutually consistent, available in a timely fashion, available for most Member Stat3es, comparable between countries, selected from reliable sources and statistically feasible.[24] This supports the argument that successful and operationally efficient indicators are developed on a specific set of standards. Such improvements will provide better analytical foundations to assess progress towards the Lisbon Strategy.[25]

Thus, to prevent any further exclusion of the environment from developing economic policies, the Member States and the EU recognize that economic growth, social cohesion, and environmental protection must go hand in hand.[26] The EC's Sustainable Development Strategy must therefore be held as a vital addition to the Lisbon Strategy.[27] An analysis of the policy documents supporting the Strategy demonstrates that the Strategy exhibits a top-down and bottom-up approach to

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[21] NSI (2004) *supra* note 19 (p 1)
[22] Ibid, at p 1-2
[23] Munoz and Mazzi "Capitalism and Entrepreneurship Dynamics: Benchmarking Europe's Growth" [2005] *Indicators for EU Policy Making The Example of Structural Indicators* (p 2)
[24] Ibid, at p 2-3
[25] NSI (2004) *supra* note 19 (p 1-2)
[26] EC "Measuring Progress Towards a More Sustainable Europe: Sustainable Development Indicators for the European Union" [2005] 231pp (p III)
[27] Ibid, at p III

indicator development. As much as the Strategy is designed to promote economic growth, social cohesion and protection of the environment among Member States, it also looks to Member States for guidance on how to meet these objectives through the application of indicators. Consequently, when developing and adopting new policies on the economic and social dimensions of the EU, focus must also be kept on the environmental facet and its contribution. These objectives can be measured via indicators. Only then can Europe achieve the competitive edge it so highly covets, while simultaneously attaining a truly sustainable way of life.

6.3.2 EC Sustainable Development Strategy

The inclusion of environmental issues in the creation and implementation of other Community policies is essential to achieve the objectives of SD.[28] The Gothenburg Declaration forms the core of the EC's sustainable development strategy (EC SDS).[29] This Declaration agreed upon a strategy for sustainable development and added an environmental dimension to the Lisbon process.[30] It targeted environmental priorities for sustainability, including combating climate change and managing natural resources more responsibly.[31]

The initial 2001 SDS revolved around two important pillars. The first pillar proposed objectives and policy measures to tackle a number of key unsustainable trends, including climate change, and sustainable transport.[32] This involved the development and application of environmental indicators to communicate progress towards these set goals, as well as the challenges that existed. One could argue that environmental indicators were fast becoming a tool the EU could use to track progress towards set policy agenda. The second pillar was a revision of the policy-making process itself.[33]

However, it quickly became apparent that the 2001 Strategy was failing to meet its objectives. The EU was increasing in size and this enlargement, combined

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[28] EUROPA "Sustainable Development" <http://europa.eu/scadplus/glossary/sustainable_development_en.htm> (accessed 15 March 2007)
[29] EC "Environment Fact Sheet: Sustainable Development" [2006] (p 2)
[30] EC "Presidency Conclusions: Goteborg European Council 15 and 16 June 2001" [2001] 22p (at p 1)
[31] Ibid, at p 6 and 7
[32] EUROPA Sustainable Development (2007) <http://ec.europa.eu/environment/eussd/> (accessed 15 March 2007) 3pp (p 2)
[33] Ibid, at p 2

with the persistence of unsustainable trends, required a sustainable development strategy with a stronger focus, a clearer division of responsibilities, and more effective implementation and monitoring.[34] Arguably, the existing sustainable development indicators (SDIs) were not successful and operationally efficient because they were not founded on the four core functions or appropriate criteria. Thus, they were unable to concisely communicate information and were susceptible to political manipulation. Instead of measuring progress towards the policy objectives, the indicators blurred understanding between the Member States and the EC. This was similar to the indicator problems found in the Lisbon Strategy.

Consequently, the EC adopted an ambitious and comprehensive renewed SDS for an enlarged EU.[35] This new strategy used more comprehensive indicators (designed upon successful criteria) to measure progress in meeting the newly revised policy agenda and contribute to the successful implementation of the environmental management objectives.[36] These include headline indicators (level 1 indicators), which are robust, readily available indicators that measure the overall objectives of the Strategy.[37] It also includes lead indicators (level 2 indicators), which measure the operational objectives of the Strategy, and action indicators (level 3 indicators), which measure actions outlined in the Strategy.[38] Lastly, contextual indicators are used in the new Strategy.[39] These indicators provide background information on SD issues, but they don't directly monitor the Strategy's objectives and they are not policy responsive.[40] The Strategy also includes indicators which are not yet fully developed, but which are necessary to understand progress towards SD. These indicators are based on a 10 theme framework of SD objectives, including socio-economic development, social inclusion and climate change and energy.[41] Figure 6.1 is an adaptation from the SDI pyramid illustrating examples of the different types of

[34] EUROPA (2007) *supra* note 32 (p 2)
[35] EC "Measuring Progress Towards a More Sustainable Europe: 2007 Monitoring Report of the EU Sustainable Development Strategy" (2007) 330pp (p 15)
[36] Ibid, at p 16
[37] Ibid, at p 17
[38] Ibid, at p 17
[39] Ibid, at p 18
[40] Ibid, at p 18
[41] Ibid, at p 17

indicators currently used by the EC to monitor progress towards minimizing climate change.

Although prescriptive on the headline, lead and action indicators that should be used to measure progress in each of the 10 themes, the EC is flexible and works with the Member States to continually refine these indicators and develop additional indicators.[42] Thus, there is a top-down and bottom-up approach to indicator development and achieving the objectives of SDS. Furthermore, to ensure the indicators are successful and operationally efficient, the EC recommends that they be based on the four core functions and be founded on specific criteria (policy relevant, efficient communication, statistical quality, robust and readily available).[43]

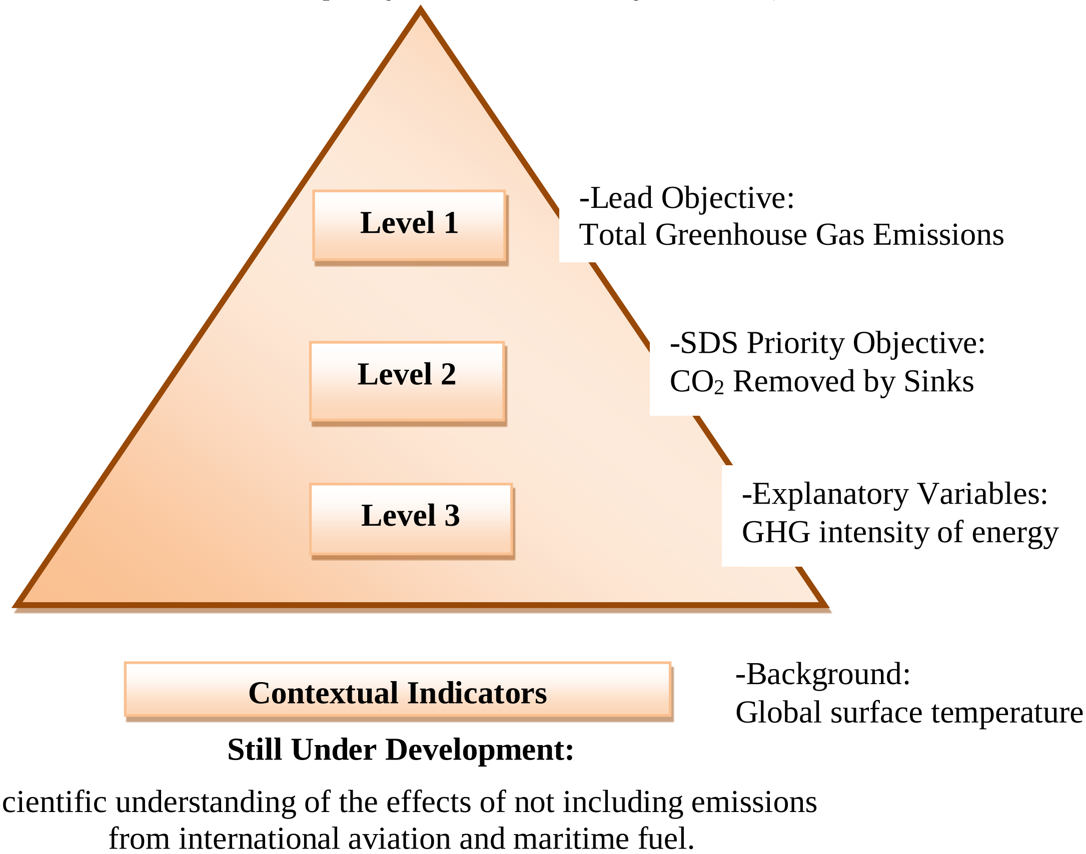

Figure 6.1: Adaptation of the SDI pyramid with examples of specific indicators used to measure progress towards minimizing climate change.44

Consequently, the EC is seeking to improve the EU by integrating SD into all policies. By improving environment-related structural indicators to monitor progress and identify best practices, these objectives can be achieved. But the EC does caution

[42] EC (2007) *supra* note 35 (p 20-21)
[43] Ibid, at p 16
[44] Ibid, at p 18, 49, 52, 55-66, 75-77

that there are limits to their approach, which can and does impact on SD objectives of the Strategy. The indicators adopted in the Strategy are "imperfect and do not always adequately monitor the issue of concern."[45]

They have been chosen on the basis of data currently available, but cannot be considered to provide a full and comprehensive analysis of all trends relevant to SD.[46] To help prevent any more limitations on operational efficiency and success, the indicators must be founded on the four core functions and the previously mentioned criteria. This will ensure that the indicators contribute to measuring progress towards SD at the European level, even if they cannot single-handedly solve the overall issue of achieving total sustainable development.

6.4 Environmental Action Programs (EAP)

The EU's environmental action programs have two main purposes: they outline specific proposals for legislation; and they discuss broad ideas in environmental policy and suggest new directions for the future.[47] As of 2015, seven Environmental Action Programs (EAPs) have been developed and adopted by the EU and Member States to address key issues regarding the approaches to achieve EU environmental policy objectives. The Programs have had tremendous impacts on the formation of environmental policy, legislation, and indicator development within the EU.

The First EAP argued that economic development, prosperity and the protection of the environment were mutually dependent and that environmental protection was the responsibility of the EU.[48] In these early stages, environmental indicators were a new concept, yet the First EAP explicitly called for the use of indicators.[49] A principle objective of the First EAP was to develop minimum standards on environmental pollution and to reduce the levels of pollutants in water intended for human consumption (such as lead, mercury, cadmium).[50] Research was

[45] EC (2007) *supra* note 35 (p 21)
[46] Ibid, at p 21
[47] IEEP (2006) *supra* note 3 (2.1, p 3)
[48] P M Hildebrand "The European Community's Environmental Policy, 1957 to '1992': From Incidental Measures to an International Regime?" [2002] Environmental Policy in the European Union: Actors Institutions and Processes p 19-41 (at p 24)
[49] Declaration of the Council of the European Communities and of the representatives of the Governments of the Member States meeting in the Council of 22 November 1973 on the programme of action of the European Communities on the environment [1973] OJEC C112 (p 26)
[50] Ibid, at p 11

done to understand potential environmental damage from these pollutants, to set appropriate targets, and to develop indicators to measure the EU's progress. Standards on marine pollution were also explored within the First EAP.[51] Particular emphasis was placed on minimizing deliberate dumping of waste at sea and limiting discharges of effluents from land.[52]

In essence, the First EAP represented an initial step and gradualist approach to defining environmental quality objectives, but for a single media only (i.e. water, air, waste).[53] No specific indicator criteria was defined in the first EAP, leaving the success and operational efficiency of these indicators to Member States developing and applying them. Thus, the indicators developed may not have always been successful, but they did begin the initial movement towards introducing indicators into Community policies.

The Second EAP reaffirmed the initial objectives of the first program, as well as expanded on a greater range of issues effecting the environment and the EU as a whole. The Third EAP recognized that environmental policy is driven by environmental resources, which are the basis of and limits to further economic and social development and the improvement of living conditions.[54] It shifted from a quality approach to an emission-oriented approach, which relied extensively on the application of indicators to communicate progress towards set policy agenda. As with the First and Second EAPs, indicators were explicitly mandated in the third EAP as a means to measure environmental quality and emissions.[55] Yet, no specific indicator criteria were recommended, leaving the success and operational efficiency to the Member States.

The Fourth EAP recognized that environmental protection needed to be taken into account with economic decisions.[56] Due to continued environmental

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[51] Declaration of the Council of the European Communities and of the representatives of the Governments of the Member States meeting in the Council of 22 November 1973 on the programme of action of the European Communities on the environment *supra* note 49 (p 19)
[52] Ibid, at p 19
[53] P M Hildebrand (2002) *supra* note 52 (p 24)
[54] Resolution of the Council of the European Communities and of the representatives of the Governments of the Member States, meeting within the Council, of 7 February 1983 on the continuation and implementation of a European Community policy and action programme on the environment (1982 to 1986) [1983] OJ C 046, 17/02/1983 (at p 4)
[55] Ibid, at p 8, 12
[56] Resolution of the Council on the European Communities and of the Representatives of the Government of the Member States, Meeting within the Council of 19 October 1987 on the Continuation

deterioration, the EC felt it was essential to establish strict standards for environmental protection.[57] Interestingly, the term indicator was never explicitly mentioned in the Fourth EAP, but instead, implied as a tool to measure the now stricter standards. These indicators illustrated that an approach focused on emission controls for stationary sources was unlikely to achieve the desired ecosystem and health based quality objectives of the EAP.[58] Thus, the Fourth EAP modified its approach and indirectly supported the development and application of pressure indicators to measure and limit environmental pollution on a more holistic scale.[59] These indicators should measure biological standards, exposure limits, environmental quality standards, emission standards to prevent pollution for all environmental medias.[60] Similar to the earlier EAPs, no specific indicators criteria was given. Thus, the choice of which indicators to develop and apply was left to the Member States, leaving their success and operational efficiency dependent on the user.

The Fifth EAP focused on a more global approach to environmental protection. It enlisted the European Environmental Agency (EEA) and drew a distinction between real and perceived risks, as well as provided a scientific basis (through the application of indicators) for decisions and actions that affect the environment and natural resources.[61] Arguably, operationally efficient and successful indicators combined with the pursuit of a bottom up approach would produce more positive results towards the achievement of set policy agenda.[62]

Thus, the EU was promoting the development of indicators that are founded on the four core functions and appropriate criteria, although it still left selection of these indicators and criteria to the Member States. And it was working closely with

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and Implementation of a European Community Policy and Action Programme on the Environment (1987-1992) [1987] OJ C328 Volume 30 (p 6)

[57] Resolution of the Council on the European Communities and of the Representatives of the Government of the Member States, Meeting within the Council of 19 October 1987 on the Continuation and Implementation of a European Community Policy and Action Programme on the Environment (1987-1992) *supra* note 56 (p 6)

[58] EEB *EU Environmental Policy Handbook: A Critical Analysis of EU Environmental Legislation* (Utrecht, Netherlands, International Books, 2005) 340pp (p 20-21 III.4)

[59] Resolution of the Council on the European Communities and of the Representatives of the Government of the Member States, Meeting within the Council of 19 October 1987 on the Continuation and Implementation of a European Community Policy and Action Programme on the Environment (1987-1992) *supra* note 65 (p 18)

[60] Ibid, at p 18

[61] Towards Sustainability: A European Community Program of Policy and Action in Relation to the Environment and Sustainable Development [1993] OJ C138 (p 13(11))

[62] Ibid, at p 17(34))

Member States to develop meaningful indicators relevant to their national strategies, as well as EU environmental objectives. For each major issue, long-term objectives were developed and indicators were suggested to communicate progress towards meeting theses set objectives.[63] These objectives and indicators did not constitute legal commitments but they communicated progress in attaining sustainable development.[64] Thus, the Fifth EAP further promoted indicators to ensure that set targets were met.[65]

The Sixth EAP aimed for a high level of protection by decoupling environmental pressures and economic growth.[66] It outlined a number of strategic approaches, including integrating the environment into other EU policies and promoting better research, data and indicators to secure more effective policies.[67] Given the complexity in integrating environmental goals within all policies, the Sixth EAP emphasized the need for scientific evidence and sound knowledge of environmental problems to develop effective sustainable development and successful and operationally efficient indicators.[68]

Unlike the previous EAPs, the Sixth references criteria that would ensure the success of the indicators. These included communicative, policy relevant, scientifically valid and tightly linked to human activity.[69] It also called for the development and application of specific types of indicators, including headline environmental indicators, indicators on the state and trends of the environment and integration indicators, although it left the specific indicator selection to the Member States.[70] As discussed in previous chapters, such discretion can be problematic. Since prescriptive indicators are not given, then whichever indicators are chosen must be successful, operationally efficient and compatible between Member States to ensure full compliance with the policy. Consequently, although the objectives of the Sixth

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[63] Towards Sustainability: A European Community Program of Policy and Action in Relation to the Environment and Sustainable Development *supra* note 61 (p 13(12))
[64] Ibid, at p 13 (12)
[65] EEB (2005) *supra* note 58 (p 25, III.6)
[66] Decision No 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 Laying Down the Sixth Community Environment Action Program [2002] OJ L242 15pp (p 3 Art 2(2))
[67] IEEP (2006) *supra* note 3 (2.1, p 3)
[68] Decision No 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 Laying Down the Sixth Community Environment Action Program *supra* note 66 (p 9)
[69] Ibid, at p 4, 9, 14-15
[70] Ibid, at p 15

EAP might be more generalist in nature, the application of successful and operationally efficient indicators provides an early indication of the pressures faced by the environment. This dissemination of information, in turn, can provide transparency as to the effectiveness of the policy itself.

In regards to the types of indicators recommended in the Sixth EAP, each is designed to achieve a different objective. Thus, integration indicators may differ significantly from the economic indicators developed to track production and consumption patterns.[71] They may also differ from the relevant qualitative and quantitative environmental targets, as well as headline indicators, and indicators that are developed on the state and trends of the environment.[72] Regardless of which indicators are used, they are an extremely important corollary of the Sixth EAP and must be successful and operationally efficient, to withstand legal challenges, judicial scrutiny, and to be effective.

The Seventh EAP became effective in 2013 and covers a period until 2020.[73] It seeks to achieve similar objectives to the Sixth EAP, including combating climate change, protecting nature and biodiversity, improving the environment and health and quality of life, and protecting natural resources and water.[74] Similar to the Sixth EAP, the Seventh EAP explicitly calls for the development and application of indicators to achieve the policy objectives, but it leaves the selection of indicators to the Member States.[75] It does, however, suggest the use of pressure indicators and recommends the criteria that the indicators should be founded on.[76] Beyond the four core functions, the Seventh EAP recommends that indicators be credible (scientifically valid), comparable (broadly applicable and integrative over space and time)k quality-assured (easily measurable) and simple and robust.[77]

[71] Decision No 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 Laying Down the Sixth Community Environment Action Program *supra* note 66 (p 5 Art 3(4))
[72] Ibid, at p 6 Art 4(2) and p 14 Art 10(1)(e)
[73] Decision No. 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet' [2013] OJ L354/ pp171-200
[74] Ibid, at p 171
[75] Ibid, at p 174, 183-185
[76] Ibid, at p 173
[77] Ibid, at p 191, 193

Some example indicators provided in the Seventh EAP include greenhouse gas emissions, energy consumption, biodiversity, global forest cover loss and air quality.[78] But, as mentioned above, the Seventh EAP looks to Member States to continue to promote strong knowledge base and to develop successful and operationally efficient indicators to communicate the state of the environment and monitor progress towards existing environmental objectives (such as climate and energy targets, biodiversity targets and resource efficiency milestones).[79] Thus, a top-down and bottom-up approach to indicator development exists within the Seventh EAP.

In conclusion, the EAPs have promoted the use of indicators. Environmental indicators have been and continue to be used to measure progress towards achieving the set standards of various policies and regulations. The criteria which underlies these indicators has also been explored extensively, to determine what creates successful and operationally efficient indicators. As noted in this section, success of the indicators is user dependent, as no specific indicators are required and it wasn't until the Sixth and Seventh EAPs that any indicator criteria was specified. Thus the EU looks to Member States for guidance in environmental indicator development and application to meet the objectives of the EAPs.

Interestingly, unlike previous legislative and policy documents explored thus far in this thesis, the EAPs have made explicit references to indicators since the First EAP in 1973 (with the exception of the Fourth EAP in 1987). This is note-worthy, as most legal and policy documents made no mention of indicators until the late 90's and early 2000's. Arguably, this is because the EAPs were specifically designed to measure environmental impacts to the achievement of sustainable development and a strong economy for Europe, particularly as it relates to pollution and human health. Perhaps these fundamental objectives are responsible for an early recognition of the need for indicators to communicate progress towards these goals. As such, the EAPs have had tremendous impact on indicator development within the EU and represent a major milestone in EU environmental management. They formalized the use of

[78] Decision No. 1386/2013/EU of the European Parliament and of the Council of 20 November 2013 on a General Union Environment Action Programme to 2020 'Living well, within the limits of our planet' *supra* note 73 (p 172)
[79] Ibid, at p 175, 185

environmental indicators to track progress towards set agenda and have provided an effective means of communication regarding environmental conditions.

6.5 EC Maritime Policy

Measures to protect the marine environment are often introduced in isolation, and only take into account the priorities of one policy area without fully assessing the impact or giving equal weight to all the relevant sectors.[80] Alternatively, geopolitical, national or administrative barriers may restrict such initiatives and prevent them from taking a more effective, global approach to the problems of seas, which of course are not bound by frontiers.[81]

The EC Maritime Policy, however, is founded on an integrated approach that covers all aspects of the EU's relationship with the oceans and seas. It provides a coherent policy framework that, although not explicit on environmental indicators, implies the use of these tools to communicate sea-related activities and human impacts on marine ecosystems. The EU has worked to pilot the development of cross-cutting policy tools, such as indicators, to integrate the maritime policy approach at every level and ultimately minimize inefficiencies, incoherencies and conflicts over the uses of Europe's seas and oceans.[82] Arguably to be successful and operationally efficient these indicators should be based on the four core functions and appropriate criteria, although the Maritime Policy leaves the selection of such criteria to the Member States. Thus, the success of the indicator is dependent on the user developing and applying them. It does imply, however, that indicators should be communicative, policy relevant, broadly applicable and integrative over space and time and low redundancy.[83]

This integrated Maritime Policy is based on excellence in marine research, technology and innovation, including the development and application of indicators to demonstrate that all matters relating to Europe's oceans and seas are interlinked.[84] These include maritime surveillance, maritime spatial planning and a comprehensive

[80] EC "Keeping Our Seas Alive" [2005] Environment for Europeans (21) 3-4 (p 3)
[81] Ibid, at p 3
[82] COM *Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions: An Integrated Maritime Policy for the European Union* (575 Final, 2007) (p 4)
[83] Ibid, at p 11
[84] Ibid, at p 2

and accessible source of data and information.[85] Maritime surveillance uses indicators to measure and communicate safety of navigation, marine pollution, law enforcement and overall security.[86] Examples of such indicators include monitoring levels of specific fish stocks, data pertaining to vessel tracking and records pertaining to illegal immigration or acts of piracy.

Maritime spatial planning and integrated coastal zone management (ICZM), on the other hand, uses indicators to exchange information on spatial and temporal patterns in the marine environment and the human activities that impact them. Examples of such indicators include measurements of marine biomass (to indicate changes in species patterns and ecosystem responses to human impacts), geographic ranges of specific species, water temperatures, location of offshore wind farms (as these can help to determine the impacts on local biota), the quantity/scale/speed of marine aggregate extraction activities and their resultant impacts, as well as the evaluation of sediment distribution. These marine aggregate indicators will be discussed in greater detail in Chapter 9 of this thesis.

The Maritime Policy exhibits a top-down and bottom-up approach to indicator development and application. As much as it guides Member States on the maritime areas that should be measured, it looks to Member States for guidance from their national strategies on successful indicators and approaches.[87] However, some problems arise when harmonizing data across Member States.[88] This links to the general problems that arise when trying to manage a complex environment like marine ecosystems. An integrated maritime policy requires an interdisciplinary scientific and technological knowledge base.[89] Observations towards improving marine ecosystems should be monitored by a set of successful and operationally efficient environmental indicators, which will be dependent upon the users developing them. Consequently, a central role must be afforded to environmental indicators and improvements must be

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[85] COM (2007) *supra* note 82 (p 5)
[86] Ibid, at p 5
[87] Ibid, at p 3, 4 and 5
[88] EC *Green Paper: Towards a Future Maritime Policy for the Union. A European Vision for the Oceans and Seas* 275 (Green Paper, 275 Final Volume II Annex, 2006) (p 31)
[89] EC *Commission Staff Working Document: Accompanying Document to the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee, and the Committee of the Regions: An Integrated Maritime Policy for the European Union* (2007) 38pp (p 220)

made in their development, scientific foundation, and application, to precisely track the progress of and guide a sustainable EC Maritime Policy. The EU believes that if marine policy is based on and supported by excellence in marine scientific research, technology and innovation,[90] as well as reliable and concrete indicators, then this will further guarantee Europe's thriving maritime economy.

In conclusion, the EU Maritime Policy implies the use of environmental indicators to communicate progress towards achieving policy objectives. These objectives include, among others, pollution control, the use of renewable marine resources and coastal engineering. To be successful, the indicators must be based on the four core functions and relevant criteria. The quality of these criteria will vary dependent on the user, as the Maritime Policy does not recommend specific criteria (it only implies criteria that it feels is important). As stated previously, because indicators are not explicitly mandated in the document, there is a freedom of choice regarding which indicator to use to measure the appropriate targets that are laid out in the policy document. This assumes, however, that the indicators chosen are appropriate to support the framework and the operational objectives devised. This novel approach undertaken by the Maritime Policy and further monitored by indicators has the potential of linking and reinforcing the European stronghold, for the benefit of the environment, the economy and society as a whole.

6.6 Role of Indicators in EU Environmental Policy Frameworks

The use of indicators in EU environmental policy is increasing in prominence. This is due in large part to a more holistic approach to management, where economic and social goals are increasingly enshrined in environmental regulations. Environmental indicators are tools frequently used by policy-makers and regulators within the EU to identify change in a system and measure progress towards targets.[91] European environmental indicators reflect trends in the state of the environment and monitor progress in achieving environmental policy targets.[92] They are responsive, successful and operationally efficient when founded on the four core functions and appropriate criteria, making them extremely important tools for policy-makers.[93] This section

[90] EC Maritime Forum "ur-EMODNET Thematic Assembly Groups" (2011) <https://webgate.ec.europa.eu/maritimeforum/category/162> accessed 8 April 2012 (p 5)
[91] E Smeets and R Weterings "Environmental Indicators: Typology and Overview" [1999] 19pp (p 4)
[92] Ibid, at p 4
[93] Ibid, at p 4

further discusses the role of indicators in EU environmental policy. It examines how policy goals are implemented and achieved within the Member States, as well as the importance of environmental indicators within the EU. Additionally, it analyzes the development and application of environmental indicators, as well as the type of indicator frameworks used by the EU. Lastly, it analyzes the extent to which the EU promotes indicators and has influenced Member States and their application of environmental indicators.

The EEA develops and applies environment indicators within the EU.[94] It uses the DPSIR framework to report environmental trends to policy-makers, in an effort to guide policy developments, settings and responses.[95] Furthermore, indicators are developed to raise public awareness and strengthen support for environmental matters and corresponding policy measures.[96] However, it has been argued that it has become more difficult for policy-makers to grasp the relevance and meaning of existing environmental indicators, given the diversity of indicators presently in use.[97] And new sets of environmental indicators are still being developed.[98] Thus, there's a need to structure and analyze indicators and related environmental/societal inter-connections.[99] In response, the EEA simplified their indicator approach and defined common standards and appropriate criteria for the development, application and understanding of future indicators, both within their organization and among the Member States.[100] Consequently, they examined and redefined their classification system for environmental indicators, to create a model that was both easy to follow and understood by all Member States.

First, the EEA began with a detailed description of the DPSIR framework and a précis of its methodology.[101] Additionally, they examined where data and information would be most needed for policy-makers.[102] They then categorized the

[94] EEA, *EEA core set of indicators: Revised Version April 2003, Adopted Version for ECCAA Countries May 2003* (2003) (p 8)
[95] E Smeets and R Weterings (1999) *supra* note 91 (p 4-5)
[96] Ibid, at p 5
[97] Ibid, at p 4
[98] Ibid, at p 4
[99] Ibid, at p 4
[100] These standards are represented in the criteria discussed in Chapter 2. Ibid, at p 4
[101] Ibid, at p 4
[102] Ibid, at p 7

typology of indicators used within their system.[103] This was done to simplify the approach taken by each Member State, as well as to organize the indicators into a more meaningful composition for policy-makers and the public.[104] It included 4 groups of indicators: 1.) Type A or Descriptive Indicators, which ask what is happening to the environment and to humans; 2.) Type B or Performance Indicators, which ask if such changes matter; 3.) Type C or Efficiency Indicators, which ask if improvements are being made; and 4.) Type D or Total Welfare indicators, which ask if society is on the whole better off.[105]

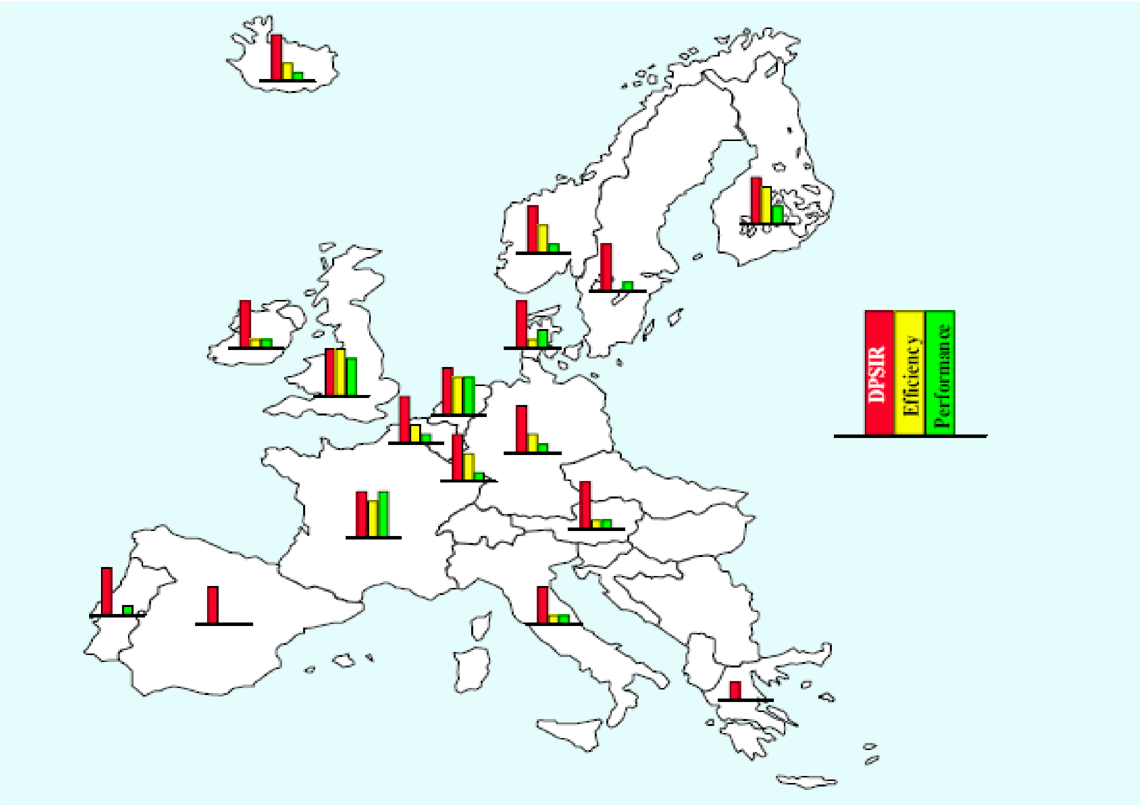

Figure 6.2: Overview of indicator usage & type, in S.O.E. reports of European countries[106]

From their available data, the EEA determined which European countries were most using indicators, as well as which types of indicators were being exercised most frequently. See figure 6.2 for an overview of their results. The length of the columns illustrates the extent to which indicators were being used within each country.[107] The red DPSIR column represents the five types of descriptive indicators, i.e. D, P, S, I,

[103] E Smeets and R Weterings (1999) *supra* note 91 (p 8)
[104] Ibid, at p 8
[105] Ibid, at p 8
[106] Ibid, at p 14
[107] Ibid, at p 14

and R.[108] The yellow column represents efficiency indicators, such as the amount of emissions or energy used per unit of GDP.[109] The green column represents performance indicators, such as acidification, which compares emissions and depositions to critical loads.[110] As is apparent from the figure, descriptive/DPSIR indicators were most readily used amongst countries of the EC. Efficiency indicators were also used, although not as often as the descriptive DPSIR indicators.[111] And performance indicators were less used than either descriptive DPSIR or efficiency indicators.[112] Thus, the EEA's technical report provided guidance on indicator usage across the EU.

Second, the EEA detailed the importance of environmental indicators within ICZM, and noted the ability of indicators to achieve ICZM policy objectives and coastal management.[113] They argued that networking and providing information has made indicators transcend at other spheres.[114] Furthermore, indicators stimulate connections between various actors, and thus, communicate information and guide policy makers. They illustrated the cyclical nature of indicator development and policy-making by analyzing different Member States. It revealed how EU indicators have been applied on a national scale and consequently, how these indicators have been framed within those national strategies.[115] Table 6.2 shows a summary of indicator development and application for the Member States who participated in the study.[116] Essentially, they provided a historic and contemporary review of indicators to assess the methodology used by the EU. They noted the effectiveness of indicator usage in environmental management and provided a comprehensive examination of the operational efficiency of environmental indicators within the EU and corresponding Member States.[117]

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[108] E Smeets and R Weterings (1999) *supra* note 91 (p 14)
[109] Ibid, at p 15
[110] Ibid, at p 15
[111] Ibid, at p 15
[112] Ibid, at p 15
[113] F Breton "Report on the Use of the ICZM Indicators from the WG-ID: A Contribution to the ICZM Evaluation" [2006] 63pp (p 1)
[114] Ibid, at p 1
[115] Ibid, at p 1 – The report follows similar suit to the evaluation that was performed for both this thesis and Defra's project, ME4118, in that it provides a detailed critical analysis of policy and legal frameworks and the corresponding indicators used to achieve set objectives.
[116] Ibid, at p 27-28
[117] This directly ties to the work that was undertaken within this thesis and Defra's project ME4118.

For example, the EEA found that Belgium dedicates a great portion of its national Strategy to indicators, giving special importance to the role of indicators in the ICZM process.[118] France also gives a high importance to the construction of indicators and data.[119] On the other hand, Romania highlighted the importance of monitoring the coastal zone, yet it made no direct mention of the development or application of indicators.[120] Thus, one can see the evolutionary role of environmental indicators within the EU, and more specifically, within the Member States and their national strategies. Yet, although the EEA illustrated which countries were using indicators, it did not necessarily demonstrate how well they were using them. Instead, it demonstrated that indicator progress is still developing in a majority of the countries, which appear to be adapting and applying EU environmental and marine indicators quite successfully.

Third, the EEA addressed the role of indicators within the EU. From assessments of national reports, it determined that indicators were primarily used for four specific functions: 1.) data collection/monitoring; 2.) communication; 3.) assessment for policy or management evaluation; and 4.) support for decision making.[121] Moreover, although monitoring appeared to be the main function of indicators, the EEA stressed the need to understand the application and implementation of such regulatory tools. It was noted that the potential of indicators is still not fully understood.[122] They are technical instruments which communicate information, but they are not perfect.[123] Indicators must be tested to establish appropriate scales and methods for their implementation and refinement.[124] Consequently, it can be argued that within the EU, environmental indicators are important tools to guide policy-makers and regulators, but more work is needed to improve existing indicator sets.

The EU agrees with the indicator work done by the EEA.[125] They are working to develop more successful and operationally efficient indicators capable of effective

[118] F Breton (2006) *supra* note 113 (p 13)
[119] Ibid, at p 15
[120] Ibid, at p 22
[121] Ibid, at p 29
[122] Ibid, at p 29
[123] Ibid, at p 29
[124] Ibid, at p 31
[125] EC, "EU environment-related indicators 2006: Measuring environmental progress in Europe" (2006)

communication and dissemination of information. The EU believes that these indicators must demonstrate progress towards achieving environmental protection targets. Consequently, the EU realizes that both the environment and indicators must be considered important ingredients of their economic strategy and better regulation agenda. This will allow them to satisfy the needs of society, preserve the environment, and ultimately meet the objectives of sustainable development.

Table 6.2 Summary of indicator development and application within Member States.[126]

	Use of specific tailored indicators for National needs	Use of a number of indicators from EU SD or other e.g. CAMP indicators	Developping all the EU SD indicatos in books, webs, observatories	Testing of ICZM progress indicators	Land/Sea/ data/mapping	Participation in WG-ID & DEDUCE	Summary
Belgium	Yes	Yes (SAIL)	Yes	Yes	Yes	WGID + D	☺ ☺ ☺
Cyprus	Yes	Yes (CAMP)	Plan to do	Plan to do	Only marine reserves		☺ ☺
Denmark	---	---	---	---	Unknown		i
Finland					Unknown	WGID	i
France	Yes	Yes	Yes	Yes	Yes	WGID + D	☺ ☺ ☺
Germany	Yes	Yes	Plan to do	Plan to do	Yes	WGID + D	☺ ☺ …
Greece	Yes	Yes		Yes	Only marine reserves	WGID	☺ ☺ …
Italy (reg. Emilia-Romaqna)	Yes	Yes		Yes		WGID	i
Latvia					Yes	D	☺
Lithuania							i
Malta	Yes	Yes	Yes	Yes	Marine reserves	WGID + D	☺ ☺ …

[126] *Taken from* F Breton (2006) *supra* note 152 (p 27-28)

Netherlands	Yes	Yes	Yes	Plan to do	Yes	WGID (seasonal)	☺☺☺
Poland	Yes	Yes BALTC-OAST	Plan to do	Yes	Yes	WGID + D	☺☺…
Portugal	Yes		Yes	Yes			☺☺
Romania						WGID	☺
Slovenia		Yes (CAMP)					☺
Spain	Yes	Yes	Yes	Yes	Yes	WGID + D	☺☺☺
Sweden	Yes	Yes (SEAREG Messina …)					i
UK	Yes	Yes	Yes	Yes	Yes	WGID (seasonal)	☺☺☺
	11	11	7 + 3 (plan to do)	8 + 3 (plan to do)	11	10 + 6	

6.7 Concluding Remarks

In analyzing important EU environmental policies, this chapter has discovered that the EU fully endorses the use of indicators (and the DPSIR model specifically) to communicate progress towards environmental policy and goals. Indicators communicate similarities between the EU and national policy agendas and promote integration between science, policy and law. Furthermore because of the very structure of the EU, an interesting pattern begins to emerge that differs from the patterns seen at the international level. First the EU has generally been explicit on the development and use of environmental indicators since the early 70's (and the beginning of the environmental movement in general). It is arguable that this has occurred because EU environmental policy has been more focused on pollution prevention, protection of natural resources and other objectives that recognize the connections between the environment, human health and the economy. This argument is supported by the fact that sustainable development was embraced by the EU early on and is now being incorporated in EU policies.

But despite being explicit on the use of indicators, the EU has generally been flexible on specific indicators to deploy. It takes a top-down and bottom-up approach to indicator development, recognizing the sovereignty of its Member States and looking to them for guidance on developing and applying successful and operationally efficient indicators and corresponding policies. It does promote the DPSIR model and various aspects of this framework, but often leaves indicator selection to the Member States. Additionally, it provides quite a bit of guidance on recommended indicator criteria. They should be founded on the four core functions as well as policy relevant, communicative, easy to read/understand and other criteria that will make them more successful and operationally efficient across different Member States and their individual national strategies. Thus, environmental governance and indicator development is multi-leveled with the EU influencing Member States and vice versa.

For example, the Lisbon Strategy promotes improvements in the development and application of structural indicators, to enhance their quality and ensure that they are successful in helping the EU meet its economic objectives. Furthermore, the EC SDS underwent multiple revisions to develop the appropriate sustainable development indicators to monitor progress and identify best practices to achieve their sustainable development objectives. Similarly, the EU's EAPs illustrated an interesting progression in environmental policies and indicator application. The first EAP was very specialized and pollution centric in its approach to environmental policy, yet the application of indicators was not as readily apparent. But as time progressed and additional EAPs were developed, policies became more holistic and indicator use became more prominent. Thus, the EAPs eventually formalized the use of indicators within their policies and encouraged their deployment by all Member States. This approach requires Member States to select indicators that are compatible between States, but which are founded on appropriate criteria. The analysis of this chapter has found that the EU has worked closely with Member States to develop successful and operationally efficient indicators that integrate environmental policy approaches at every level, thereby creating a top-down and bottom-up approach to environmental indicator development and policy creation.

The EU is and continues to be a strong supporter of environmental indicators and a leading advocate in environmental policy and protection for the marine environment. Although not originally intended to govern such a sphere, the EU has proven that cooperation and coherence is possible between nations. They are working towards achieving economic growth, while addressing the needs of society and promoting protection of the environment. Furthermore, they continue to stress the importance of successful and operationally efficient indicators to communicate progress towards their policy agenda. The EU works with Member States and their national strategies to develop and apply such indicators. Thus, indicators provide the EU with a bridge to their objectives. The use of marine environmental indicators is cultivating a high degree of political authority and currency within the emergent globalized world. As such, the application of indicators is becoming the foundation and framework for future European marine and environmental policies.

Chapter 7: National (English) Law

7.1 Introductory Comments

In recent years, national environmental and marine legislation has been based on the Government's vision for clean, healthy, safe, productive and biologically diverse oceans and seas.[1] The UK marine area is a vast resource of vital importance.[2] It provides valuable economic, environmental and cultural benefits, and also plays a major role in shaping the climate and sustaining life.[3] Recently, however, environmental indicators have shown that the UK marine area is becoming increasingly crowded, which has placed demands on space, strained resources and exploited the ecosystem.[4] Indicators have also demonstrated significant environmental impacts caused by climate change, including rising sea levels, a changing coastline, increasing sea temperatures, and changes in seawater chemistry.[5]

The objective of this chapter is to analyze national law and its influence on both the development and application of marine environmental indicators. It analyzes the influence that national law has on marine indicators and the ability of these indicators to successfully and efficiently communicate complex environmental problems, answering research questions 1 and 2. National legislation must have the tools that it needs to balance conservation needs with social and economic requirements.[6] Indicators can be designed to facilitate this balance if they are operationally efficient and successful. This chapter also assesses the extent that indicators are required in national law and evaluates these indicators against the criteria for success, answering research questions 5 and 6. Lastly, this chapter analyzes the extent to which indicators are developed and applied within all forms of national law (from legislation to case law) to answer research questions 3, 4 and 7. How does national law influence or is influenced by EU and International law? Are indicators explicitly mandated? What role does policy play?

Section 7.2 evaluates national environmental law and indicators. It explores this type of law and the added values gained by using environmental indicators within

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[1] Defra, *A Sea Change: A Marine Bill White Paper* (2007) 168pp (p 5)
[2] Ibid, at p 4
[3] Ibid, at p 4
[4] Ibid, at p 4
[5] Ibid, at p 4
[6] Ibid, at p 2

such legislation. It assesses the role of successful and operationally efficient indicators in a national legal context. Section 7.3 explores the Marine and Coastal Access Act,[7] which is the main piece of legislation for national seas and oceans. It analyzes the application of indicators within this piece of law to determine their success and operational efficiency. Are indicators explicit within the Act? Section 7.4 explores the role of indicators in national regulations to determine the influence that indicators have had on this legislation. Specifically, it fleshes out the use of indicators within the Natural Habitats Regulations[8], the Bathing Water Regulations,[9] and the Offshore Marine Conservation Regulations.[10] These regulations were chosen, despite the fact that the corresponding EU directives may not have been discussed in Chapter 5, because they create an interesting dialogue regarding indicators in domestic legislation and they support the arguments of this thesis. Lastly, Section 7.5 analyzes the use of indicators within Case Law, including the role they play in the application of law, as well as their interpretation by non-specialists (i.e. judges). What is the role of indicators used and are they successful and operational efficient? It also analyzes the established rules regarding evidence and expert witnesses, to determine how indicators should be developed to ensure success.

These sections and subsequent analyses are used to determine the success and efficiency of marine environmental indicators within national law, as well as discuss the influence this law has on International and EU legislation and its influence on policy across three scales.

[7] Marine and Coastal Access Act 2009, c. 23; Marine (Scotland) Act 2010 asp 5. This Act developed similar provisions for the Scottish marine area.
[8] The Conservation of Habitats and Species Regulations 2010, SI 2010/490
[9] WATER RESOURCES: The Bathing Water Regulations 2013, SI 2013/1675
[10] The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 SI 2007/1842

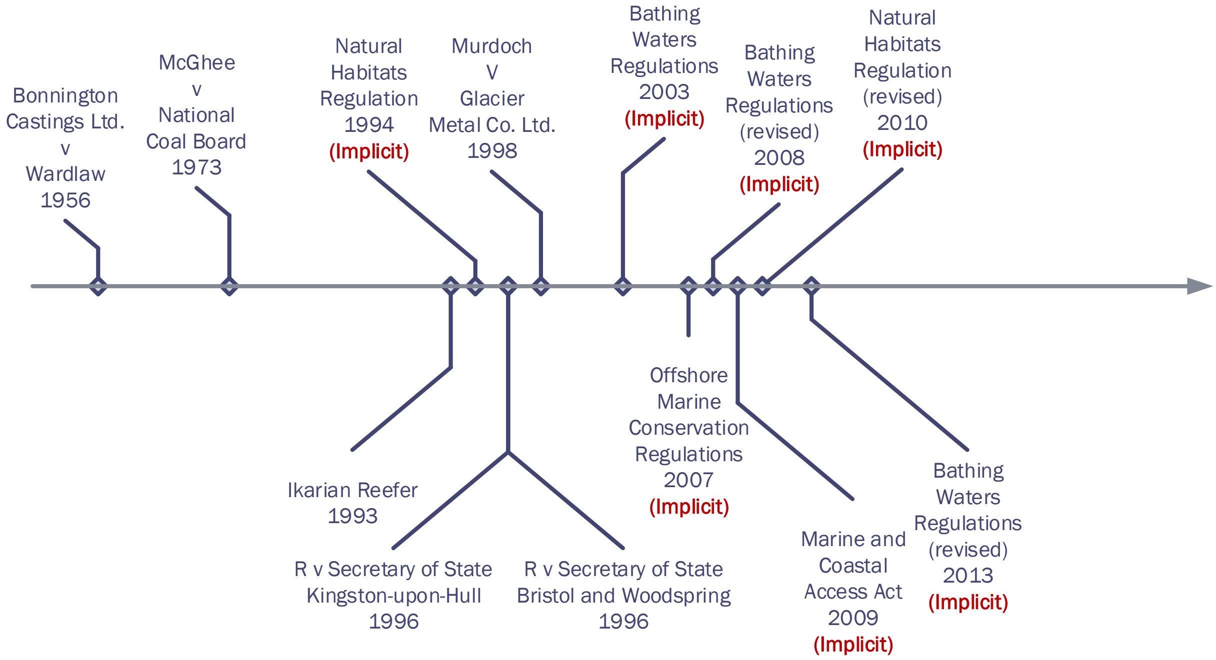

Figure 7.1: Timeline of national legal documents and cases analyzed in this chapter. These are discussed in chronological order within the appropriate subsection. For the Regulations, the timeline identifies whether indicators are implicit or explicit within the text of the document. The subsequent analysis provided in this chapter explores the progressive development and application of indicators over to answer research questions 1-7 with regards to national law.

7.2 National Environmental Law and Indicators

Before examining specific pieces of legislation, it is important to note how indicators are used in national law in general. The rules which make up environmental law result from political aims and goals, as well as scientific standards which form a framework for the law.[11] Environmental protection is a major cross-disciplinary topic, with law comprising only one element of the overall process.[12] Consequently, lawyers need some understanding of the scientific, political, and economic processes involved in environmental degradation.[13] Indicators can provide this understanding by bridging the gaps that exist between the various facets of environmental law and policy. They provide a means of effective communication and aid in the protection of the environment by ensuring that scientific aims are properly embedded within policy and legislative agendas. The scope of this research is focused on public law (not private

[11] S Bell and D McGillivray *Environmental Law* (OUP 2006) 910pp (p 48)
[12] Ibid, at p 4
[13] Ibid, at p 4

law), as indicators are a feature of public law controls, even if defined widely in terms of sources (i.e. rules, policies, guidelines).

National environmental law consists of more than legal rules, as it is comprised of policies, principles, rights and other methods designed to influence direction and developments of such law.[14] Indicators are vital in each of these various aspects of environmental law. When successful and operationally efficient, they communicate relevant information and illustrate how scientific, economic and social goals are interconnected, while fleshing out policy documents and measuring progress towards established targets. They can be developed to be more pragmatic and measure more than purely environmental progress.[15] For example, in the agricultural and fisheries industries some important indicators include changes in gross profit per farm, changes in the number of ships fishing in an area, and changes in labor.[16]

In recent years, national environmental law has fostered a unique identity from other sources of law.[17] Much of this legislation has been developed and sustained by the scientific community.[18] Scientists engage with the law in various forms. They sit on Royal Commissions, provide evidence, collect data on the state of the environment, manage nature reserves, develop sampling techniques and make predictions for environmental assessments.[19] Environmental law is infused with scientific method and language. Furthermore, indicators are being given impetus in national environmental law. They are categorically tied to science and are used to engage the law in many of the areas mentioned above (i.e. to monitor the state of the environment, to provide evidence, to make predictions). A dynamic relationship exists between science (i.e. indicators) and national environmental laws, from the formulation of the law to its implementation and enforcement.[20] Indicators access the objectives of the law, as well as give guidance to regulators on the effectiveness of their policies and legislations.

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[14] S Bell and D McGillivray (2006) *supra* note 11 (p 89)
[15] Wilson and Buller"The Use of Socio-economic and Environmental Indicators in Assessing the Effectiveness of EU Agri-Environmental Policy" [2001] European Environment 11 pp297-313 (p 303)
[16] Ibid, at p 303
[17] Elworthy and Holder *Environmental Protection: Texts and Materials* (Reed Elsevier, 1997) 489pp (p 7)
[18] Ibid, at p 7
[19] Ibid, at p 7
[20] S Bell and D McGillivray (2006) *supra* note 11 (p 59)

Arguably, indicators play a two-fold role in national environmental law. First, they are used in the development and formation of new legislation, to measure progress towards set objectives. Secondly, they are used to interpret when the law has been violated, and to what extent. Thus science often underlies environmental law. The success and operational efficiency of indicators in specific national regulations will now be reviewed to demonstrate the influence of this legislation on the development and application of marine environmental indicators.

7.3 The Marine and Coastal Access Act

The Marine and Coastal Access Act creates a strategic marine planning system that clarifies England's marine objectives and priorities for the future.[21] It directs decision-makers and users towards more efficient, sustainable use and protection of the England's marine resources.[22] It refines the marine licensing regime, establishes the UK Marine Management Organization (MMO), and improves information and data exchange through the development and application of indicators. This section analyzes the Marine and Coastal Access Act and its influence on marine environmental indicators. It evaluates the management of the marine environment and the role that indicators play in meeting the set objectives of the legislation.

Although the Act makes no specific mention of the term indicator, they are nonetheless implied within the legal text. Their use is inferred by such terms as scientific evidence, information, standards, conditions and criteria.[23] For example, a strategic goal of the Act is to improve understanding of the national marine environment, the natural processes and the resulting impacts of human activities by examining scientific evidence.[24] Indicators can help with this objective by describing the state of the environment.[25] The Act also promotes research and an improved understanding of the marine environment (arguably, via indicators).[26] Consequently, indicators allow regulators to collect the information and data needed to assess the cumulative impacts of human activities on marine ecosystems and to have a more

[21] S Bell and D McGillivray (2006) *supra* note 11 (p 7)
[22] Defra (2007) *supra* note 1 (p 7)
[23] Marine and Coastal Access Act 2009 *supra* note 7 (Section 2, 24, 28, 117, 118)
[24] Ibid, at Section 2
[25] Ibid, at p 5, 6
[26] Ibid, at Section 2, 24 and 28

holistic understanding of the national marine environment.

Indicators are also implicit within the mandates for marine policy statements. These statements are prepared by the MMO to help achieve environmental objectives for the national marine area.[27] Arguably, indicators can be deployed to measure such progress. They can communicate the effectiveness of these marine policy statements by illustrating changes that occur in the natural marine environment. Furthermore, they can lay the foundation for the policy statements by providing the baseline data against which environmental changes are compared (i.e. baseline water quality, initial species status, temperature fluxes).

The provisions of the Act are mandated by the MMO, which is designated to collect and interpret information on the environment, including indicators.[28] The MMO must take into account 'all relevant facts and matters,' including scientific evidence, as well as marine research.[29] To be successful, marine management should be based upon a robust evidence base (drawn from indicators). Furthermore, it should encourage the development of successful and operationally efficient indicators that are capable of measuring progress towards set targets.[30] Thus, although no specific criteria for successful and operational indicators are provided, the legislation implies that indicators should be scientifically valid, communicative and policy relevant.[31] It is vital to have a sound evidence base, composed of available and suitable up-to-date data and information relating to the marine area, to make informed policy and management decisions.[32]

The Act mandates that the MMO develop a comprehensive marine database with 'fit for purpose' marine data that is collected, stored and interpreted.[33] Some examples of such indicators include water quality and biological diversity indices, contaminant flux, and sediment toxicity. These indicators can provide a more holistic and conclusive examination of the system and the effectiveness of regulatory controls by communicating essential processes, functions and interactions that occur among

[27] Marine and Coastal Access Act 2009 *supra* note 7 (Section 44, Schedule 5)
[28] Ibid, at Section 2
[29] Ibid, at Section 2(1)(a-c), 24
[30] Defra (2007) *supra* note 1 (p 10)
[31] Marine and Coastal Access Act 2009 *supra* note 7 (Section 2)
[32] Defra (2007) *supra* note 1 (p 16)
[33] Marine and Coastal Access Act 2009 *supra* note 7 (Section 2); Defra (2007) *supra* note 1 (p 16)

organisms and their environment.[34] By using a sound evidence base and an assessment of the costs and benefits of various human activities, the UK can deliver their European and international commitments, alongside domestic priorities.[35]

The Act also promotes the conservation of marine wildlife. It encourages the government to develop a suite of marine objectives that will clarify desired targets for marine ecosystems.[36] Within this system of objectives lies the basis for developing and using indicators that provide 'benchmark values' and progress towards meeting these targets. Indicators can also be deployed to develop marine conservation zones (MCZs) and marine protected areas (MPAs).[37] The data gathered from these indicators can be used to develop conservation profiles, including rare or threatened habitats (i.e. seagrass beds), rare or threatened species (i.e. the sunset cup coral*;* or the long-snouted seahorse*)*, as well as globally or regionally significant areas for geographically restricted habitats or species (i.e. estuary habitats and the spiny lobster – *Panulirus argus*).[38] Other important characteristics of the marine environment can be measured via indicators, including physical marine features and ecological processes, sites of special archaeological or historic interest, spawning and nursery areas, and important seascapes.[39] Thus, through the use indicators, the government can ensure the protection of species and habitats considered of national value and meet the objectives of the Act.

The Act also strengthens and simplifies fishery regulations to help achieve a sustainable and profitable fisheries sector.[40] Indicators hold significant value in this regard. They provide the opportunity to simplify and streamline fisheries legislation by providing data that is more transparent, comprehensible, and easily accessible. The fishing industry is responsible for an extremely important source of income. It provides a major socio-economic foundation upon which marine management resides. Thus, a properly managed and functioning fishing industry, measured via indicators that can communicate the health and status of the marine ecosystem, can have a

[34] Defra (2007) *supra* note 1 (p 21)
[35] Ibid, at p 22
[36] Ibid, at p 65
[37] Marine and Coastal Access Act 2009 *supra* note 7 (Section 116-123)
[38] Defra (2007) *supra* note 1 (p 71)
[39] Marine and Coastal Access Act 2009 *supra* note 7 (Section 123); Defra (2007) *supra* note 1 (p 72)
[40] Ibid, at Section 4-8, 149-153, 187-223

profound effect on the competitiveness and growth of the economy.

In conclusion, the Marine and Coastal Access Act has created a more holistic and integrated approach to national marine management, one which aims to meet the requirements of higher legislation, including the Marine Strategy Framework Directive. It clarifies the Government's legal position on the previously stated marine policy and is the first holistic legislative approach to managing, conserving and protecting marine ecosystems on a national level.

Although not explicit on the use of indicators, it implies the use of these tools to monitor progress towards desired objectives and aid in a holistic management approach. But it leaves the choice of which indicator to deploy to the user. Even further, no specific criteria are given for successful indicators, although it infers that they be founded on the four core functions, as well as be scientifically valid, communicative and policy relevant. Thus, the success and operational efficiency of the indicator is user dependent. No specific indicators are provided and the Act takes a strict top-down approach to the use of environmental indicators and the management of the national marine environment.

Effective and targeted monitoring of the marine environment and corresponding human activities is key to improving marine regulations.[41] The Act implicitly supports the use of indicators that are fit for purpose, successful and operationally efficient. If the government does not know the current state of the marine environment, then it cannot adequately ensure environmental protection or sustainable development.[42] Thus, through this legislation, the UK is making progress towards meeting its vision for improved management within the marine environment via the application of environmental indicators.

7.4 The Role of Indicators in UK Legislation

7.4.1 *The Conservation of Habitats and Species Regulations*

The Habitats Directive aims to protect bio-diversity through the conservation of natural habitats and wild fauna and flora in Member States.[43] It requires Member

[41] Defra (2007) *supra* note 1 (p 135)
[42] Ibid, at p 135
[43] Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora [1992] OJ 92/43/EEC

States to contribute to the Natura 2000 Special Areas of Conservation (SACs) sites by means of their national policies and strategies (including indicators).[44] Thus, the Habitats Regulation was created to transpose the requirements of the EC Directive, and later amended it in 2007 and again in 2010, to meet the stipulations of the ECJ's ruling in 2005.[45]

Although the word indicator is not explicit within the Habitats Regulation, it is implied as a means to meet the legislative objectives. For example, Part II, Paragraph 10 mandates that relevant scientific information be used to identify sites of Community importance.[46] This is in fact a criterion for successful and operationally efficient indicators: scientifically valid. Thus, the regulations imply the use of successful indicators to select sites of species and biological significance. These indicators can communicate the current conditions of the potential sites and the corresponding species, as well as provide a means to measure progress towards meeting the requirements of the legislation. In essence, the successful selection of sites is best accomplished via indicators, as they can help to determine the sites that match the criteria given by the EC in Annex III of the Directive, which is transposed within the UK Regulations.[47] Yet, no specific indicators are mandated, and no specific criteria (beyond scientifically valid) are given. This leaves the success and operational efficiency of the indicators to the user.

Indicators are also implied within the Habitats Regulation as they can monitor adherence to the larger Directive. This thesis has found that national legislation closely follows and is dictated by the Directives they are intended to meet. Thus, if a Directive explicitly mandates specific indicators, then the corresponding Regulations will mandate those indicators. But, if a Directive merely implies the use of indicators (as seen in the Habitats Directive), then the corresponding national Regulation will merely imply the use of indicators, but not mandate specific indicators or quantities

[44] Member States can contribute to these Natura 2000 sites by identification, establishment and enforcement of both species and habitats via legislation – which can be achieved via the application of indicators. Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora (1992) *supra* note 43 (Art 22(a-c) and Art 23(1-3))

[45] The ECJ ruled that the UK failed to properly transpose the EC Directive in the original 1994 Regulations.

[46] The Conservation of Habitats and Species Regulations 2010 *supra* note 8 (Para 10)

[47] Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora *supra* note 43 (Annex III, Stage 1)

for successful and operationally efficient indicators. This is evident in Paragraph 19 of the Regulations.[48] This portion of the Regulations implies that indicators can be used to monitor and assess the damage any particular activity may have upon a selected site.[49] These indicators should specify the flora, fauna, geological or physiographical features of a 'European site', as well as any operations likely to damage these features.[50] But no direction is given as to which indicators should be developed and used. Thus, a top-down approach to indicator development is evident, where guidance on successful and operationally efficient indicators from the higher legislation. Successful indicators can communicate exactly what is occurring within the site, which allows the regulator to prohibit detrimental activities from occurring, but leaves the success of the indicator dependent on the user applying them.[51]

Thus, the indicators implied within the Habitats Regulations should be developed and applied to meet the objectives of the EU Directive. And there should be a consistent and harmonious application of the indicators (whichever are chosen) across the Member States, since the Natura network is not limited to individual States. The indicators must be successful, operationally efficient and compatible between Member States to be relevant and applicable to the objectives of the Regulations.

Consequently, indicators are implied within the Habitats Regulations as a means to monitor human activities and their effects on the environment. They are also essential to determine SACs and sites of Community importance, and help to communicate technical features of the environment in a more simplified manner. Successful and operationally efficient indicators can be used to measure progress towards meeting the set objectives of both the EC Directive, and the corresponding national Regulations.

7.4.2 *The Bathing Waters Regulations*

As discussed in Chapter 5, the primary purpose of the Bathing Water Quality Directive (BWQD) is to protect public health and the environment from fecal pollution of

[48] The Conservation of Habitats and Species Regulations 2010 *supra* note 8 (Para 19)
[49] Ibid, at Para 19
[50] Ibid, at Para 19(2)
[51] Ibid, at Para 19

bathing waters.[52] Incumbent to this purpose, the Directive uses a variety of indicators, such as total coliforms and fecal coliforms, to measure various microbiological and physio-chemical parameters that bathing waters must either comply with ('mandatory' standards) or endeavor to meet ('guideline' standards).[53] The Directive explicitly uses the term indicator, noting that scientific evidence should be used and States should apply reliable indicator parameters for predicting microbiological health risks to achieve a high level of protection.[54] Thus, the new Bathing Waters Directive cements the importance of indicators to communicate findings on the marine environment and regulate human activities, which in turn is implemented into national legislation. National Regulations must comply with the Directive and meet the mandatory quality standards, which are measured via the prescribed set of indicators (total coliforms, faecal coliforms, salmonella, pH, enteroviruses).[55]

In response to the Directive, the UK drafted the Bathing Water Regulations.[56] It seeks to ensure that all bathing waters are classified as 'sufficient', with a view to increasing the number of bathing waters as 'good' or 'excellent' by the end of the bathing season in 2015.[57] Unlike the EC Directive, however, there is no explicit mention of the term indicator within the 2008 Regulation. Yet indicators are implicit throughout. These indicators, and the regulatory provisions which they are intended to measure, are straight from the higher Directive, demonstrating a top-down approach in both the legislation and corresponding indicators. For example, the Environmental Agency must establish a monitoring program for *Intestinal enterococci* and *Escherichia coli,* as well as cyanobacteria, macro-algae and marine phytoplankton.[58] Furthermore, they must undertake visual inspections for waste, including tarry residues, glass, plastic, or rubber.[59] These indicators are identical to those found within the Directive. Once gathered, this information is to be used to establish a bathing water profile that contains a description of the physical, geographical and

[52] Directive 2006/7/EC Concerning the Management of Bathing Water Quality and Repealing Directive [2006] OJ 76/160/EEC (Preamble, Art 3 and Annex)
[53] See Section 4.3.2 for a more detailed discussion on the BWQD. Ibid, at Annex
[54] Ibid, at Intro(6)
[55] Ibid, at p 4
[56] The 2013 Regulations are a revision to the previous Bathing Waters Regulations 1991, 2003 and 2008. *The Bathing Water Regulations 2013 supra* note 9 (Explanatory Note)
[57] Ibid, at Paragraph 5
[58] Ibid, at Part 3(8)
[59] Ibid, at Part 3(8)

hydrological characteristics of the bathing water, as well as the sources of the pollution.[60] The profile must also contain the potential for cyanobacterial, macro-algae, or phytoplankton proliferations, as well as the location of the monitoring points.[61] Again, this is identical to what is prescribed within the Directive. In other words, the UK has complied with its obligations under EU law.

In looking back on the EU cases discussed in Chapter 5, it becomes apparent that the Commission is pursuing and the ECJ[62] is upholding a strict approach to compliance with the directives. As discussed above, the national Regulations on bathing waters are adhering to this strict approach. Arguably, this is because the indicators, and perhaps the format of the BWQD, are simple and specific. Unlike other directives that were discussed in Chapter 5, the BWQD mandates specific indicators, because human health is at risk. And although the success and operational efficiency of the indicators is user dependent, as no specific criteria is stated, the Regulations do infer that the indicators should be developed on the four core functions, as well as be communicative, scientifically valid, easily measureable and tightly linked to human activity.[63] This raises the argument that when human health is involved, the law will be specific, resulting in indicators that are more successful and operationally efficient. This, in turn, allows Member State to uphold strict compliance with the directives by merely enforcing the said indicators.

Successful and operationally efficient indicators communicate the current status of the marine environment in a manner understood by non-technical personnel.[64] The Regulations mandate that the public is made aware of their bathing waters classification and can understand its general description.[65] Thus, by ensuring that the indicators are successful and operationally efficient (i.e. founded on the four core functions) the Regulations can achieve this objective. In other words, if bathing water quality is measured at "poor" status, then the Environmental Agency must be able to explain the findings, and take action to prevent bathers' exposure to the pollution.[66] Using indicators to perform such functions allows the regulators to remain

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[60] *The Bathing Water Regulations 2013 supra* note 9 (Schedule 2)
[61] Ibid, at Schedule 2
[62] Known now as the Court of Justice of the European Union.
[63] Ibid, at Paragraph 10-11
[64] Ibid, at Paragraph 5 and 9
[65] Ibid, at Paragraph 9
[66] Ibid, at Paragraph 13

compatible and coherent with the provisions of the Directive (i.e. to remain within strict transposition). Strict transposition, in turn, enhances the communication function of the indicator, thereby creating a feedback loop.

In conclusion, indicators are a common element found within the EC Bathing Water Directive, as well as the corresponding national Bathing Waters Regulations. They are important tools used to communicate the status of the bathing waters to both technical and non-technical persons. Furthermore, they measure progress towards the stated objectives of both the Directive and the Regulations and are an essential element of bathing waters management.

7.4.3 *Offshore Marine Conservation (Natural Habitats, &c.) Regs.*

Within the Offshore Marine Conservation Regulations, one can see the importance of indicators to meet the requirements of both the Habitats Directive[67] and the Wild Birds Directive.[68] The Regulation specifies that sites eligible for identification as SACs and areas of Community importance must be determined based upon the criteria set out in Annex III (Stage 1) of the Habitats Directive, as well as relevant scientific information (i.e. indicators).[69]

Similar to the Habitats Regulation, although the word indicator is not explicit within the Regulations, the standards given in Annex III of the Habitats Directive are themselves indicators. Yet, the Offshore Marine Conservation Regulations differ from the Habitats Regulations, as it specifically calls upon the use of relevant scientific information.[70] It can be argued that "relevant scientific information" essentially includes indicators that are scientifically valid (a criterion for successful and operationally efficient indicators). Thus, indicators are cemented in the legislative framework as a means to effectively communicate observed trends. Since the Regulations call upon the use of scientific information, then the indicators which are developed and applied must be relevant to the criteria set out in the Habitats Directive,

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[67] *Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora supra* note 43

[68] *Council Directive on the Conservation of Wild Birds* [1979] OJ 79/409/EEC

[69] *The Offshore Marine Conservation Regulations 2007 supra* note 10 (Para 7(2))

[70] Ibid, at Para 7(2)

and must be successful and operationally efficient (i.e. founded on the four core functions and be scientifically valid).

Additionally, the Regulations speak of aquatic species and sites of freshwater and marine importance.[71] Aquatic indicators are critical to clearly define an area that is distinct in its physical and biological features, and which is essential to the life and reproduction of protected species.[72] Relevant indicators are needed to communicate technical information and make informed decisions on establishing a SAC.

Yet, similar to the Habitats Regulations, no specific indicators are mandated. Instead, the Regulations infer the development and application of state and descriptive indicators, such as species population, habitat type and degree of conservation.[73] The Regulations imply that these indicators must be flexible and adaptable to be successful.[74] As science and technology improves, indicators may need to be revised to reflect the newly gained knowledge. Thus, although the success and operational efficiency of the indicator is dependent upon the user (as no specific criteria is mandated), the Regulations infer that they must be sensitive and responsive.[75] Thus, successful and operationally efficient indicators pertinent to the Regulations should be founded on the four core functions, scientifically valid, sensitive and responsive to be truly effective and meet the objectives of the higher Directive. Once again, indicators (used to meet the requirements of the national Regulations) appear to be driven from the top-down.

National legislation closely adheres to the spirit of the EU Directive driving them. If the Directive specifically mandates indicators or provides guidance on what indicators to use and the criteria to base them on, then the Regulations reflect this. Thus, EU law drives national legislation and the resultant indicators that are used. England and the UK may have some influence over higher legislation, but there is

[71] Selection of these species and sites must be based upon the criteria of Annex III (stage 1) of the Habitats Directive. Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora *supra* note 43 (Para 7(4))
[72] The Offshore Marine Conservation Regulations 2007 *supra* note 10 (Para 7(4))
[73] Council Directive on the Conservation of Natural Habitats and of Wild Fauna and Flora *supra* note 43 (Annex III)
[74] The Offshore Marine Conservation Regulations 2007 *supra* note 10 (Para 9(1))
[75] Ibid, at Para 9(1)

clearly a top-down approach occurring, which directly influences indicator development and use.

Indicators are also implied in the Regulations to select and classify sites as Special Protection Areas (SPAs).[76] Once again these sites are directly dependent on the species listed in Annex I of the higher EU Directive (the Wild Birds Directive) and are measured via specific standards.[77] These standards are, in fact, indicators – they connect the importance of the habitat to the species and communicate this information to the relevant authorities. Furthermore, the species referenced in Annex I are subject to special conservation measures concerning their habitat, to ensure their survival and reproduction in their area of distribution.[78] Consequently, state and descriptive indicators are needed to take account of species which are in danger of extinction, vulnerable to specific changes in their habitat, considered rare because of small populations or restricted local distribution, or which require particular attention due to the specific nature of their habitat.[79] The Regulations also call upon the use of relevant scientific information to aid in the selection of SPAs.[80] This essentially mandates the use of successful and operationally efficient indicators that are scientifically relevant (a criteria for successful indicators) to measure these sites, the interactions that occur between species and habitats, and the impacts of human activities on these ecosystems. Furthermore, as mentioned above, the indicator must be sensitive and responsive to be successful, and meet the requirements of the Regulations.

The Regulations also imply that indicators be used be expert personnel as evidence regarding the classification of a site (i.e. its inclusion, modification or classification as a SAC or SPA).[81] Such evidence should be independent of the litigation, be unbiased and supported by research.[82] Thus, another criteria for successful and operationally efficient indicators that is implied in the Regulations is able to survive a process of legal interrogation.[83] Furthermore, indicators can be used

[76] The Offshore Marine Conservation Regulations 2007 *supra* note 10 (Para 12(2))
[77] Council Directive on the Conservation of Wild Birds *supra* note 68 (Art 3 and Annex I)
[78] The Offshore Marine Conservation Regulations 2007 *supra* note 10 (Para 4(1))
[79] Ibid, at Para 4(1)
[80] Ibid, at Para 12(3)
[81] Ibid, at Para 14(1)
[82] CEFAS, *C2343: Environmental Indicators: A Structured Approach to the Evaluation of Impacts Arising from Human Activities at Sea* [2010] 135pp (p 14)
[83] The Offshore Marine Conservation Regulations 2007 *supra* note 10 (Para 14(1)-(2))

not only to classify a site, but to manage activities that can have an impact on the site through an established set of conservation objectives.[84] Thus, the Regulations imply that successful and operationally efficient indicators should also be tightly linked to human activities.[85] The role of scientific evidence in judicial proceedings and the link to human activity will be discussed further in the section on case law.

In conclusion, indicators are implied within the Offshore Marine Conservation Regulations. They are tools used to monitor human activities and their effects on important habitats and species. Furthermore, they measure progress towards the legislative objectives and are an essential element of marine management. They can aid in the determination of SACs and SPAs, and help to communicate technical features of the environment in a more simplified manner. Similar to the Habitats Regulations, no specific indicators are mandated within the Regulations. Instead, the Regulations infer the development and application of state and descriptive indicators to meet the objectives of the higher EU Directive. As argued previously, the indicators (whichever are chosen) must be successful, operationally efficient and compatible between Member States. The success of these indicators will be user dependent, but the Regulations imply that they should be scientifically valid, sensitive and responsive, able to survive a process of legal interrogation and tightly linked to human activity. Furthermore, they must be founded on the four core functions to meet the objectives of the Regulations, which are driven from the top-down by the higher EU Directives. Failure to do so can result in rulings against the Member State by the ECJ (as discussed in Chapter 5).

It is interesting to note, however, in looking at the summary of legislation discussed in this chapter that no single national regulation explicitly calls for the development and use of indicators. All of the regulations strictly adhere to the requirements of the higher directives (i.e. a strong top-down approach is present). But even when the directive specifically and explicitly requires the use of indicators, the national regulations are still implicit (not explicit) in regards to indicator development and application. Even more interesting, some of the national regulations are specific on the criteria that the indicator should be developed on, even though they do not

[84] The Offshore Marine Conservation Regulations 2007 *supra* note 10 (Para 18)
[85] Ibid, at Para 14(1)-(2)

explicitly call for the use of indicators. In comparing International legislation to EU and national regulations, indicators appear to be more explicitly used and enforced at an EU level. This does trickle down to the national level, as a strict adherence to the directive is a requirement of the EC Treaty, but interestingly, in an implicit manner. Table 7.1. provides a summary of the legislation discussed in Sections 7.3 and 7.4 and their influences on marine environmental indicators.

Table 7.1: A summary of the legislation discussed in Sections 7.3 and 7.4 and a comparison of their influences on marine environmental indicators.

Law	Explicit Indicators	Implicit Indicators	Types	Top-Down or Bottom-Up	Operationally Efficient
Marine and Coastal Access Act	No	Yes	*None Given *Infers such indicators as: -water quality -Biological diversity indices -contaminant flux -sediment toxicity	Top-Down	*User Dependent *No specific criteria stated, but infers: -Scientifically valid -Communicative -Policy relevant
Natural Habitats Regulations	No	Yes	*None Given *Infers indicators that can measure the flora, fauna, geological and physiographical feature of a European site	Top-Down	*Specific criteria is given: -Scientifically valid

Bathing Waters Regulations	No	Yes	*Specific indicators given: -*Intestinal enterococci* -*Escherichia coli* -Cyanobacteria -Micro-algae -Marine Phytoplankton -Wastes (including terry residues, glass, plastic, rubber)	Top-Down	*User Dependent *No specific criteria stated, but infers: -Communicative -Scientifically valid -Easily measurable - Tightly linked to human activity
Offshore Marine Conservation Regulations	No	Yes	*None Given *Infers such indicators as: -species population -habitat type -degree of conservation -other state and descriptive indicators	Top-Down	*Specific criteria is given: -Scientifically valid -Sensitive and responsive -Able to survive a process of legal interrogation -Tightly linked to human activity

We've explored how indicators are used in national legislation and the fact that they are often implied vs. mandated. Now it is appropriate to explore how indicators are developed and used in the application of the law (i.e. case law).

7.5 Case Law

To address indicators in national legislation requires that they be assessed, not only in the creation and establishment of law, but within its operation as well. As this thesis seeks to illustrate that environmental indicators can be relevant to both policy and legislation (in an instrumental manner), it is imperative that it address and evaluate specific national cases where indicators were used to apply law. Furthermore, it must assess the interpretation of such indicators by regulators and non-specialists. Since courts are routinely presented with scientific evidence (i.e. indicators), with non-technical personnel determining the significance of such indicators, this scientific evidence will often become the subject of legal challenges.[86] It is important to

[86] CEFAS (2010) *supra* note 82 (p 14)

understand these legal challenges, as interpretation of indicators by judges (i.e. non-technical personnel) can have a direct impact on the court proceedings, particularly when "experts" are giving conflicting scientific evidence.[87] It has been argued that in such circumstances, courts must "rely on a common sense approach" when determining the meaning of such indicators.[88] Thus, the following cases are presented to analyze the role of indicators, how they are interpreted by the Courts, and their level of success. Table 7.2 provides a summary of each case, the indicators deployed, as well as a comparison of the roles of the indicators and an analysis on their level of success.

Table 7.2: A summary of indicators deployed in each case study, as well as a comparison of the roles of the indicators and an analysis on their level of success

Case Study	Indicators Used	Context	Role of Indicator	Level of Success
1.) Bonnington Castings Ltd. v Wardlaw	-Health indicators (i.e. pneumoconiosis) -silica dust	*To demonstrate that the silica dust from the dress shop caused/contributed to the employee's illness	Human health	-Successful: Where human health is concerned and the indicators are inconclusive or lacking, the Courts will take a conservative approach, infer common sense and rule in favor of protection of human health
2.) McGhee v National Coal Board	-Health indicators (i.e. dermatitis) -brick dust	*To demonstrate that the brick dust and lack of washing facilities contributed to the employee's illness	Human health	-Successful: Similar to *Wardlaw*, where human health is concerned and the indicators are inconclusive or lacking, the Courts will take a conservative approach, infer common sense and rule in favor of protection of human health
3.) The Ikarian Reefer	-The Ikarian Reefer ship -Quick closing stop valve -#2 generator -The tap	*To determine if the ship was deliberately grounded and set on fire	Tampering to the ship Fraud	-Failure: The indicators presented to the Court could not prove fraud or deliberate grounding and fire -This case establishes the court's position on the treatment of evidence and how this relates to the success and operational efficiency of indicators.

[87] CEFAS (2010) *supra* note 82 (p 14)
[88] Ibid, at p 14

4.) R v Secretary of State Kingston-upon-Hull	-The size of the discharge agglomeration -Character of waters receiving discharge (estuary or coastal?) -Salinity -Topography -Economic indicators -Poor water exchange -Significant suspended sediment concentration -Dissolved oxygen depletion	*To protect and promote a healthy and resilient ecosystem by properly treating urban waste water discharge *The location of the boundary separating estuary and coastal waters	Water quality Human health To determine environment al boundaries	-Successful: The applicant was successful because their understanding of the indicators and the implications of the higher Directive aligned with the interpretation of the Court -However, when no specific indicator or corresponding criteria are mandated, the success of the indicators will be dependent on the user and their interpretation of the data.
5.) R v Secretary of State Bristol and Woodspring	-The size of the discharge agglomeration -Character of waters receiving discharge (estuary or coastal?) -Salinity -Topography -Economic indicators -Poor water exchange -Significant suspended sediment concentration -Dissolved oxygen depletion	*To protect and promote a healthy and resilient ecosystem by properly treating urban waste water discharge *The location of the boundary separating estuary and coastal waters	Water quality Human health To determine environment al boundaries	-Successful: The applicant was successful because their understanding of the indicators and the implications of the higher Directive aligned with the interpretation of the Court -However, when no specific indicator or corresponding criteria are mandated, the success of the indicators will be dependent on the user and their interpretation of the data.
6.) Murdoch v Glacier Metal Co. Ltd	-Noise levels -Glare	*Did the noise and glare constitute a nuisance? *Was it sufficient to effect human health? *Which standard should the indicator be measured against?	Human health Sleep disturbance	-Failure: The indicators and the criteria that they were measured against could not prove that noise and glare from the factory disrupted sleep

7.5.1 *Bonnington Castings Ltd v Wardlaw*

The *Bonnington Castings Ltd v Wardlaw*[89] case is not a case regarding a violation of environmental legislation or indicators. Instead, it is a relevant case that has laid the foundation for how Courts assess evidence and expert testimony in legal proceedings. Limits exist in scientific knowledge, yet this has not prevented Courts from exercising their judicial functions and basing decisions on less than full proof.[90] When the indicators lack a concrete foundation, the courts often use a ‘common sense’ approach to fill the gaps (i.e. they infer what the indicator is meant to communicate).[91] This directly impacts upon the indicator/evidence, as well as the legal application, thereby

[89] *Bonnington Castings Ltd v Wardlaw* [1956] AC 613

[90] Barnes and Bayer, “(Draft) Risk Assessment Guidelines for the Effective Employment of Environmental Indicators (Defra Project ME4118)” [2007] 81pp (p 71, 6.2.9)

[91] Ibid, at p 71, 6.2.9

warranting a brief discussion here. Thus indicators applied in a court context must be at a minimum based on the four core functions to allow for a 'common sense' approach and to be considered successful and operationally efficient. This case guides the way in which evidence is evaluated (whether given in court, or otherwise) and demonstrates the approach undertaken when the data may be lacking.

The *Bonnington Castings Ltd v Wardlaw* case resulted from an employee's complaint that he contracted pneumoconiosis by inhaling air which contained particles of silica during his employment at a dress shop.[92] Although the defendant admitted that they violated health regulations, as there were periods of time when considerable dust was released into the shop (but was unable to escape to the outside air), they maintained that the claimant's disease was not solely caused by their operations.[93] The Court disagreed. They found that the burden of proof resided on the employee, but that he only needed to demonstrate that the dust from the shop contributed to his disease, not that it was the sole cause.[94]

This case is interesting, as it demonstrates that when concrete evidence is lacking (in this case, no evidence could substantially demonstrate which dust or what amount caused the illness), the Court will use infer a conclusion, and where human health is concerned, they will take a conservative approach (in this case in favor of the plaintiff). The plaintiff provided enough evidence through health indicators to allow the Court to infer that the defenders (his employers) materially contributed to his illness by not installing an extractor fan.[95] It appears that where human health is concerned, and the indicators are inconclusive or lacking, the Courts will take a conservative approach, infer common sense and rule in favor of protection of human health.

Caution must be taken when using evidence and expert testimony in a court proceeding. If the Court uses 'common sense' approach and infers a conclusion based on precaution, the outcome may not be the one hoped for. The case then becomes similar to a 'keeping your fingers crossed' approach and hoping that your evidence (although inconclusive or incomplete) might grant the outcome that you desire. For

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[92] *Bonnington Castings Ltd v Wardlaw supra* note 89 (p 1)
[93] Ibid, at p 2
[94] Ibid, at p 2-6
[95] Ibid, at p 6

this particular case, the indicators may have been inconclusive, but the outcome was successful for the plaintiff (arguably because human health was involved). But to avoid such a haphazard approach, one must ensure that the indicators vused are founded on the four core functions, successful and operationally efficient. Arguably, this will help allow for a favorable outcome (when the data is lacking).

7.5.2 *McGhee v National Coal Board*

Similar to the case discussed above, the *McGhee v National Coal Board*[96] case is one that demonstrates further how Courts assess evidence and expert testimony in legal proceedings, specifically when the scientific evidence may be lacking. As discussed above, when the scientific knowledge is lacking concrete certainty, the Courts often exercise their judicial decisions on a 'common sense' approach to fill the gaps.[97] This directly impacts upon the indicator, as well as the legal application, thereby warranting a brief discussion here. As mentioned previously, these types of cases illustrate that indicators applied in a judicial context must be founded upon the four core functions and be successful and operationally efficient to allow a 'common sense' approach to be effectively deployed.

The *McGhee v National Coal Board* case was based on an employee's accusations that he was exposed to large amounts of brick dust, and because no washing or showering facilities were provided, this resulted in dermatitis.[98] The defendant argued that, although it was their duty to provide adequate washing facilities, no proof existed that failure to carry out such duties caused this disease.[99] Furthermore, the defendant used *Wardlaw's* case as an example. They argued that *Wardlaw* had 'proved that every particle of dust inhaled played its part in causing the onset of the disease, whereas, in this case, it [was] not proved that every minor abrasion played its part.'[100] The Courts disagreed with this argument, however. They noted that the medical evidence demonstrated that the dust caused the dermatitis and that the defendants added to the claimant's potential to contract this disease because they did not provide proper washing facilities.[101] They cited that when 'it is proved,

[96] *McGhee v National Coal Board* [1973] 1 WLR 1
[97] Barnes and Bayer (2007) *supra* note 90 (p 71, 6.2.9)
[98] *McGhee v National Coal Board supra* note 96 (p 1)
[99] Ibid, at p 1
[100] Ibid, at p 2
[101] Ibid, at p 2

on a balance of probabilities, that an employer has been negligent and that his negligence has materially increased the risk of his employee [to contract] an industrial disease, then he is liable in damages to that employee if he contracts the disease.'[102]

Again, this case is interesting. The argument was not that evidence was lacking (as the medical experts agreed in their testimony). Instead, it questioned who was responsible for the employee's illness and if the employer was guilty of increasing his risk of injury.[103] The Court based their decision on common sense (i.e. 'the practical way in which the ordinary man's mind works in the every-day affairs of life'), and determined that the employer was negligent: providing wash facilities could have reduced the risk of contracting dermatitis.[104]

This approach was similar to the one in the proceeding case analysis. Thus, as noted previously, when using evidence and expert testimony in a court proceeding, the court will often use 'common sense' and infer a conclusion that is more conservative when human health is at risk. In regards to indicator application, th8is case showed success and operationally efficiency, not because the indicators were flawless, but because the evidence base which was provided allowed the Court to apply common sense. Although such decisions do not establish legally binding obligations on indicator development, they demonstrate that indicators must be operationally efficient and successful in court proceedings.[105] Thus, although there is little direct scrutiny of indicators in formal legal proceedings, the Courts have developed rules on the treatment of evidence and expert witnesses. This reveals how indicators are treated within court proceedings. To be successful and provide value, they must be designed on the four core functions and the basic criteria discussed in Chapter 2.

7.5.3 *The Ikarian Reefer*

Similar to the previous cases analyzed, *The Ikarian Reefer* case does not involve a violation of environmental legislation or indicators. It is included in this chapter to further analyze the Court's approach to evidence and expert testimony in legal proceedings. Since indicators are often used within such proceedings and since a basic

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[102] *McGhee v National Coal Board supra* note 96 (p 9)
[103] Ibid, at p 1
[104] Ibid, at p 8
[105] Barnes and Bayer (2007) *supra* note 90 (p 73, 6.2.13)

criterion for successful indicators includes the ability to survive a process of legal interrogation, this case warrants a brief discussion here. It provides the foundation on how evidence should be prepared to withstand legal scrutiny.[106]

The Ikarian Reefer case was based on accusations that this ship had been deliberately grounded and set on fire.[107] The Court found that the evidence presented during trial did not prove that the defendants had deliberately set fire or grounded the ship, nor did it prove that the owners had any knowledge or contributed in any way to these actions.[108] The evidence presented by the plaintiffs was circumstantial and, in the Court's opinion, unfounded. The circumstances of this case, in the opinion of the Court, were due to the negligence of the navigator, which caused the subsequent fire and destruction of the ship.[109]

Following these conclusions, Justice Cresswell defined the duties and responsibilities of experts, as he felt that this trial resulted from a "misunderstanding on the part of certain expert witnesses."[110] He cemented specific criteria that all expert witnesses should adhere to.[111] These included:

1.) Expert evidence should be independent and uninfluenced by the exigencies of litigation;[112]

2.) An expert witness should provide an unbiased opinion regarding matters within his/her expertise;[113]

3.) An expert witness should never assume the role of an advocate;

4.) An expert witness should make it clear when a particular question or issue falls outside his/her expertise;

5.) An expert witness should state the facts or assumption upon which his/her opinion is based.[114] He/she should not omit material facts which could detract from his concluded opinion, specifically in the areas of scientific uncertainty;

6.) If an expert's opinion is not fully supported/researched due to insufficient data,

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106 Barnes and Bayer (2007) *supra* note 90 (6.2.11)
107 *Nat'l Justice Compnia Naviera SA v Prudential Assurance Co Ltd* [1993] 2 Lloyd's Rep 68 (p 68)
108 Ibid, at p 68 (5),(6) and (7)
109 Ibid, at p 68 (1)
110 Ibid, at p 69
111 Ibid, at p 69 – for criteria #1-8
112 See further L. Wilberforce in *Whitehouse v. Jordan,* [1981] 1 W.L.R. 246 at p. 256.
113 See further Garland, J. in *Polivitte Ltd. v. Commercial Union Assurance Co. Plc.,* [1987] 1 Lloyd's Rep. 379 at p. 386; Cazalet, J. in *Re J.* [1990] F.C.R. 193.
114 *Re J,* Ibid.

then it must be noted that the opinion is no more than a provisional one.[115] Also, where an expert witness cannot assert that a report contains the truth, the whole truth and nothing but the truth without some qualification, that qualification should be stated in the report;[116]

7.) If an expert witness changes his/her view on a material matter after having read the other side's report, this change of view should be communicated without delay.

8.) Where expert evidence refers to photographs, plans, calculations, analyses, measurements, survey reports or other similar documents (i.e. indicators) , these must be provided to the opposite party when reports are exchanged.

In addition to these factors some further guidelines on the treatment of evidence and expert opinion in court can be drawn from case law:

1.) Do not introduce too much complexity into the presentation of evidence. For example, Rose LJ, rejected the unnecessary introduction of Bayes Theorum in R v Adams;

2.) As was noted above, the impartiality of the evidence/witness is crucial. More specifically, the selection of witnesses should avoid conflicts of interests;[117]

Although these criteria do not establish legally binding obligations concerning indicators, they are generally accepted by the courts, and thus, demonstrate factors which can affect indicators within court cases.[118] Chapter 2 discussed the four core functions and vital criteria that must be implemented when developing indicators to ensure their success and operational efficiency. This particular case law demonstrates another set of factors (independent, unbiased, explicit on knowledge limits and assumptions, the extent of the evidence base) which are necessary and which reaffirm some of the criteria for developing successful and operationally efficient indicators. This was discussed in the previous case law sections. If the indicators are not founded on the four core functions and the appropriate criteria, then they will not be able to withstand legal interrogation, and will not be successful and operationally efficient. Although the Courts may not be competent to decide between conflicting claims of scientific experts, they will still exercise their judicial functions and determine cases

[115] *Re J*, Ibid.
[116] *Derby & Co. Ltd. And Others v. Weldon and Others.* As per Lord Justice Staughton.
[117] Liverpool Roman Catholic Archdiocesan Trustees Inc. v Goldberg [2001]
[118] Barnes and Bayer (2007) *supra* note 90 (p 73, 6.2.13)

before them on the basis of full proof.[119] Thus, indicators have a great sway on the application of the law and must be developed to be successful and operationally efficient, or support a 'common sense' approach when the scientific evidence is lacking.[120]

7.5.4 *R v Secretary of State Kingston-upon-Hull City Council*

The fourth case to be analyzed regarding the application of indicators is *R v Secretary of State for the Environment ex parte Kingston-upon-Hull City Council*.[121] Arguably, this case is an example of the problems that arise if a regulator does not properly understand – or chooses to ignore - the science (i.e. the indicators) when transposing a directive into national legislation. The issues resulted from ambiguity in the EC Urban Waste Water Directive[122] regarding the definitions of an estuary versus coastal waters. This Directive was adopted to protect and promote a healthy and resilient ecosystem and to set EC-wide standards (indicators) for the treatment of urban waste water discharge into the marine environment.[123] It uses indicators to determine an estuary from coastal waters, including the size of the discharge agglomeration and the character of the waters receiving the discharges (estuary or coastal water), both of which determines the level of sewer treatment.[124]

This case argued the degree of treatment required for urban waste waters discharged to the Humber estuary, as well as the location of the boundary separating estuary and coastal waters (as these directly affect the question whether primary or secondary treatment is required).[125] There were two points contested. First, whether the respondent failed to act in accordance with the Directive's definitions of both an estuary and coastal waters.[126] Second, whether the delineation of the boundary at the bridge took into account irrelevant economic considerations, and/or failed to take into

[119] Barnes and Bayer (2007) *supra* note 90 (p 71, 6.2.8-6.2.9)
[120] Ibid, at p 71, 6.2.9
[121] *R v Secretary of State for the Environment ex parte Kingston-Upon-Hull City Council and R v Secretary of State for the Environment ex parte Bristol City Council and Woodspring District Court* [1996] 8 JEL 336, ELR 248, 8 Admin LR 509
[122] Council Directive of 21 May 1991 Concerning Urban Waste Water Treatment [1991] OJ 91/271
[123] Ibid, at Article 2, p 41
[124] Ibid, at Articles 4, 5 and 7, p 41-43
[125] *R v Secretary of State for the Environment ex parte Kingston-Upon-Hull City Council and R v Secretary of State for the Environment ex parte Bristol City Council and Woodspring District Court supra* note 121 (p 336)
[126] Ibid, at p 337

account material considerations (i.e. the salinity and topography of the receiving waters – environmental indicators).[127]

To analyze this case, the scientific and economic indicators which underlined the court's ruling must be assessed in light of the requirements of the Directive. The Directive called upon a general need for secondary treatment of urban waste water, but in some less sensitive areas, primary wastewater treatment could be considered appropriate.[128] Arguably, indicators affect the decisions to implement primary or secondary treatment, as they communicate the effect of human effluence on the marine environment.[129] Consequently, when implementing the Directive at a national level one must have an economic understanding of the situation at hand (as secondary treatment is far more expensive than primary treatment), as well as a scientific understanding of what constitutes an estuary and how it is effected by human waste water. In other words, successful and operationally efficient indicators must be used and understood to properly transpose the Directive to national legislation.

In this case, confusion occurred, not with the first indicator – i.e. the size of the agglomeration, as that was concisely defined within Article 2 of the Directive,[130] but with the nature of the receiving waters.[131] The Respondent stated that the definitions were circular, in that an estuary is determined by reference to 'coastal waters' which, in turn, are identified by reference to the 'outer limit of an estuary.'[132] It was argued, however, that the Regulator did not understand the role of science within the legislation. The applicant claimed that the Directive requires the boundaries of an estuary to be based upon scientific data (i.e. indicators, such as, salinity, topography, and other changes which occur between fresh and sea water), and not economic factors (such as the cost of secondary treatment).[133] Expert testimony was given and indicators were used to demonstrate the physical differences between

[127] *R v Secretary of State for the Environment ex parte Kingston-Upon-Hull City Council and R v Secretary of State for the Environment ex parte Bristol City Council and Woodspring District Court supra* note 121 (p 337)
[128] Ibid, at p 337 – taken from 3rd and 4th recitals of the preamble of EC Urban Waste Water Directive
[129] Ibid, at p 337 – taken from Art 2 of EC Urban Waste Water Directive 91/271
[130] The size of the agglomeration was defined in Article 2 through a population equivalent (p.e.). Ibid, at p 337 – taken from Art 2 of EC Urban Waste Water Directive
[131] Ibid, at p 337 – taken from Art 2(12) and 2(13) of EC Urban Waste Water Directive 91/271
[132] Ibid, at p 342
[133] Ibid, at p 339

estuaries and coastal waters.[134] It was argued that in this case environmental factors held more importance than economic ones.[135]

Yet, due to the circular nature of the definitions, the respondents argued that the Directive did not contain any criteria (indicators) to be applied when determining the outer limit of an estuary, except that it must be a transitional area at the mouth of a river between fresh water and coastal waters.[136] It would be a waste of money to incur the extra cost of secondary treatment for each estuary, when no additional environmental benefits would result from it (as determined from the indicators used by the NRA).[137]

The Court ruled that the Directive did not specify any criteria (or indicators) that a Member State must apply when establishing an outer estuarine limit, thereby granting them discretion in their choice.[138] Consequently, although salinity and topography are important, there can be other relevant considerations.[139] But to redraw the boundary based on cost considerations would result in an estuary which was not really an estuary at all, but instead, an area of water defined to avoid the obligations of the Directive.[140] In the court's understanding, science and the corresponding environmental indicators underline the Directive and drive the location of the outer estuarine limit, not economic factors. The purpose of the Directive is to prevent environmental effects, which requires indicators to determine the characteristics of the receiving waters when establishing the outer estuary limits.[141] As the Court interprets it, the Directive distinguishes between estuaries and coastal waters because an estuary is less able to assimilate the discharge of waste waters into it.[142] Although the boundary of the estuary does not necessarily have to be defined upon specific scientific indicators, it should, nonetheless be defined on science. No explanation, consistent

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[134] *R v Secretary of State for the Environment ex parte Kingston-Upon-Hull City Council and R v Secretary of State for the Environment ex parte Bristol City Council and Woodspring District Court supra* note 121 (p 339)
[135] Ibid, at p 341
[136] Council Directive Concerning Urban Waste Water Treatment *supra* note 122 (Article 2, p 41)
[137] *R v Secretary of State for the Environment ex parte Kingston-Upon-Hull City Council and R v Secretary of State for the Environment ex parte Bristol City Council and Woodspring District Court supra* note 121 (p 342)
[138] Ibid, at p 343
[139] Ibid, at p 343
[140] Ibid, at p 343
[141] Ibid, at p 343
[142] Ibid, at p 343

with a rational and genuine assessment of what constitutes an estuary, had been given on how this bridge came to be chosen as the outer limits of the estuary.[143]

This point of contention is interesting, in that it further supports the argument from Chapter 5 that the Commission and the ECJ uphold a strict approach to compliance with directives, which in turn, trickles down to the national level. In this instance, the defendant adhered to a strict approach regarding the size of the agglomeration indicators for the Humber Estuary, as this was simple and specifically defined in Article 2. Their issue resided upon the nature of the receiving water, which was not strictly defined. The applicant was successful in this case because their understanding of the indicators and the implications of the higher Directive aligned with the interpretation of the Court. Thus, the transposition of indicators from EU into national law is more easily facilitated by successful and operationally efficient indicators. However, when no specific indicators or corresponding criteria are mandated, the success of the indicators will be dependent on the user and their interpretation of the data.

Thus, complications arise in using indicators within legislation. Since indicators are used at the interface of science and law/policy disciplines, a change in the perception in one field will affect the other. Furthermore, one person's interpretation of the data may differ from another, especially when establishing an appropriate balance between environmental protection and economic costs. Although it appears that this case merely regarded the geographic extent of the estuary, the interpretation of the geographical extent of the estuary would impact upon how indicators are used to test for the agglomeration of waste. Therefore, this case warranted a discussion on how science is used to define the scope of a concept central to the operation of this Directive. The way in which the law accommodates science is relevant to the way in which indicators are more narrowly defined.

7.5.5 *R v Secretary of State Bristol and Woodspring*

The fifth case to be analyzed regarding the application of indicators is *R v Secretary of State for the Environment ex parte Bristol City Council and Woodspring District*

[143] *R v Secretary of State for the Environment ex parte Kingston-Upon-Hull City Council and R v Secretary of State for the Environment ex parte Bristol City Council and Woodspring District Court supra* note 121 (p 344)

Council.[144] Similar to the previous case discussed, this case involved the establishment of the outer estuarine limits of the Severn Estuary, as well as the designation of the HNDAs.[145] This case argued the degree of treatment required for urban waste waters discharged to the estuary, as well as the location of the boundary between the estuary and the coastal waters.[146] Thus, interpretation of the indicators, combined with the correct interpretation of the definitions provided for within the Directive, became the basis for the rulings. As in the previous case, there were two points which were contested. First, whether the respondent failed to act in accordance with the Directive's definitions of both an estuary and coastal waters.[147] Second, was whether the delineation of the boundary at the bridge took into account irrelevant economic considerations, and/or failed to take into account environmental considerations (i.e. environmental indicators).[148]

Similar to the previous case, the science and economics (i.e. the indicators) which were used to substantiate the court's ruling need to be assessed in light of the requirements of the Directive. As in the prior case, confusion occurred regarding the nature of the receiving waters and the boundary for the estuary.[149] The Respondent stated that the definitions provided in the Directive were circular in nature.[150] They argued that it was in their full discretionary powers to place the outer limit of the estuary where they did, so long as it met the underlying requirements of the Directive, which did not contain specific criteria (indicators) to be applied when ascertaining the outer limit of an estuary.[151] The applicant claimed, however, that the Directive requires the boundary of the estuary to based upon relevant scientific data (i.e. indicators), and not economic reasons.[152] They used testimony from experts (who applied indicators) to explain the physical differences between estuaries and coastal

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[144] *R v Secretary of State for the Environment ex parte Kingston-Upon-Hull City Council and R v Secretary of State for the Environment ex parte Bristol City Council and Woodspring District Court supra* note 121 (p 344)
[145] The Severn Road Bridge was marked for the Severn outer estuary. *R v Secretary of State for the Environment ex parte Kingston-Upon-Hull City Council and R v Secretary of State for the Environment ex parte Bristol City Council and Woodspring District Court supra* note 121 (p 337, 339)
[146] Ibid, at p 336
[147] Ibid, at p 337
[148] Ibid, at p 337
[149] Ibid, at p 337 – taken from Art 2(12) and 2(13) of EC Urban Waste Water Directive 91/271
[150] Ibid, at p 342
[151] Council Directive Concerning Urban Waste Water Treatment *supra* note 122 (Article 2, p 41)
[152] *R v Secretary of State for the Environment ex parte Kingston-Upon-Hull City Council and R v Secretary of State for the Environment ex parte Bristol City Council and Woodspring District Court supra* note 121 (p 339)

waters.[153] They argued that environmental factors, not economic factors, should determine the boundary of the estuary.[154]

The judge agreed that there can be other relevant considerations beyond basic salinity and topography, but there must be a rational assessment (via indicators) as to how the boundary was chosen, beyond the cost of treatment, which is not relevant.[155] As with the Humber case, the Court recognized that science and the corresponding environmental indicators are at the heart of the Directive and, therefore, drive the location of the outer estuarine limit. Science must drive the establishment of the boundary, because an estuary is less able to assimilate the discharge of waste waters and the purpose of the Directive is to prevent environmental effects to the estuary.[156] Once again, the Court found that although the boundary of the estuary did not have to be defined upon specific scientific indicators, it should, nonetheless be defined on science.

This case demonstrates some important lessons on how indicators are understood and interpreted in the application of the law. First, if too much discretion is granted with indicators, then they risk losing success and operational efficiency, which can result in a less strict approach to compliance with the regulations. When the indicators that are mandated are specific (as was the case with the agglomeration), transposition of the EU Directive is much more streamlined and straight forward. In the case of the nature of the receiving waters and the establishment of the boundary for the estuary, the indicators were explicitly required, but no specific indicators were mandated. Thus, the success of the indicators fell on the user and their interpretation of the data (which in this case did not align with the Court's interpretation of the Directive.

The indicators used to define the characteristics of the receiving waters in this case were unclear (i.e. not successful). Secondly, there was the argument of economic verses environmental indicators in environmental legislation. The Court interpreted

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[153] *R v Secretary of State for the Environment ex parte Kingston-Upon-Hull City Council and R v Secretary of State for the Environment ex parte Bristol City Council and Woodspring District Court supra* note 121 (p 339)
[154] Ibid, at p 341
[155] Ibid, at p 343
[156] Ibid, at p 343

the Directive as giving more credibility to the scientific reasons for establishing the boundaries of an estuary as opposed to cost factors. In the face of ambiguity, the Court looked beyond the wording of the Directive to determine the intention of those who drafted it.[157] Since it was designed to protect the environment, the scientific indicators, such as salinity, topographical features, poor water exchange, significant suspended sediment concentrations, and dissolved oxygen depletion should be used to define estuarine waters, and not economic factors.[158] Thus, as argued previously, transposition of indicators from EU into domestic law is more easily facilitated by certain types of indicators, i.e. those which are clearly defined, specific, successful operationally efficient and founded on the four core functions.

Thus, sometimes difficulties arise in applying scientific knowledge within legislation, especially when establishing an appropriate balance between environmental protection and economic costs. As with the Humber Estuary case, this case does appear to only regard the geographic extent of the estuary. Yet, the interpretation of the geographical extent of the estuary impacts upon how indicators are applied to test for the agglomeration of waste. Therefore, this case warranted a discussion on how science is used to define the objectives of this Directive. Once again, the way in which the law accommodates science is relevant to the way in which indicators are more narrowly defined.

7.5.6 *Murdoch v Glacier Metal Co. Ltd*

The final case to be analyzed with regards to the application of environmental indicators is *Murdoch v Glacier Metal Co. Ltd* [1998].[159] Although this is not a case related to the marine environment, it demonstrates the importance of environmental indicators in regulatory compliance cases, as well as the varied interpretations of the indicators that can occur.

The Murdochs were appealing the previous ruling of their case, thus, the standards (i.e. indicators) from the original case were reanalyzed to determine if the initial decision was accurate. According to the initial findings, the complaint resided

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[157] *R v Secretary of State for the Environment ex parte Kingston-Upon-Hull City Council and R v Secretary of State for the Environment ex parte Bristol City Council and Woodspring District Court supra* note 121 (p 350)
[158] Ibid, at p 341
[159] *Murdoch v Glacier Metal Company Limited* [1998] ELR 732 CCRTF 96/1472/C

on whether the noise and glare constituted a nuisance.[160] Well-qualified noise experts were called on both sides to provide scientific testimony.[161] A letter from the local environmental health officer, as well as scientific noise readings, was also presented as evidence.[162] There was no dispute regarding the accuracy of these scientific indicators.[163] Instead, there was a dispute on which standards should be used as the baseline.[164]

One expert used British Standard 4142 for his interpretation, whereas the other referenced the World Health Organization's standard.[165] Having heard both arguments, the Court ruled that the noise levels were nearly the same as the WHO standard and due to the character of the neighborhood, as well as the lack of complaint from immediate neighbors, determined that it did not constitute a nuisance.[166]

In their appeal, the Murdochs asserted that the Court had misinterpreted the WHO standards of 35dB(A) (the indicator).[167] They argued that the noise from the factory fluctuated in level and so the acceptable noise level (which is viewed as an average) should be lower than 35 dB(A).[168] The Murdoch's expert cited noise measurements of 35dB(A), 40dB(A) and 34dB(A), which were clearly audible and distinguishable above background noise levels within the bedroom.[169] The appeals Court interpreted the data presented by the Murdochs and, based on their findings, concluded that the initial ruling did consider the evidence regarding noise fluctuation.[170] Consequently, they dismissed the Murdoch's appeal and asserted that the initial ruling was based on witnesses, site visits and scientific evidence, which was sufficient reason for the outcome.[171]

Indicators play an interesting and important role within this case. The arguments resided on the standards applied to test the validity of the complaint. These

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[160] *Murdoch v Glacier Metal Company Limited supra* note 159 (p 2-3)
[161] Ibid, at p 4
[162] Ibid, at p 4
[163] Ibid, at p 4
[164] Ibid, at p 4
[165] Ibid, at p 4
[166] Ibid, at p 5
[167] Ibid, at p 5
[168] Ibid, at p 6
[169] Ibid, at p 6
[170] Ibid, at p 7-8
[171] Ibid, at p 9

standards are indicators used to measure the level of noise that was emitted from the factory. There was no dispute as to the accuracy of the noise readings and the standards (i.e. indicators) used by either expert.[172] The scientific foundation underlying these indicators was accepted by both parties. Instead, it was the interpretation of these indicators within the context of the law that was an issue. The experts disputed which indicator/standard was appropriate to apply in this case.[173]

The key issue rested upon how the courts treat expert evidence and standards/indicators. Both sides agreed there was proof of noise. The argument was on the interpretation of this data, i.e. at what level was sleep disturbed and how important was undisturbed sleep to human life. The Court had to decide which indicator more accurately portrayed the situation. The Murdoch's expert argued that the factory noise was clearly audible and distinguishable above background noise levels within the bedroom and created adverse effects on sleep.[174] This was his interpretation of the indicators. Yet, the Glacier Metal Co.'s expert, and subsequently the Court, disagreed. Although a nuisance law does exist if sleep in a house is disturbed, other factors (i.e. indicators), beyond sleep, must be considered.[175]

The Court cited the lack of complaints from neighbors as reasoning why the noise was not a nuisance. Yet, the Murdochs demonstrated that the effects of noise can vary considerably between properties, due to contours of the land and the reflection of noise from surfaces.[176] Arguably, many factors can affect the measurements obtained from indicators. Yet, the Court maintained that it was not their duty to take account of such factors, but rather, the responsibility of the Applicant to make such indicators known.[177] Thus, the indicators in this case and the criteria they were measured against failed because they could not adequately prove that noise and glare from the factory disrupted sleep. This was not necessarily the fault of the indicator, but of the user applying them (the Murdoch's expert). He could not justify the validity of his argument because his data was incomplete and was not sufficient enough to justify his claims. Arguably, the indicators were not successful and

[172] *Murdoch v Glacier Metal Company Limited supra* note 159 (p 4)
[173] Ibid, at p 4
[174] Ibid, at p 6
[175] Ibid, at p 7
[176] Ibid, at p 7
[177] Ibid, at p 7

operationally efficient because they were not founded on the fundamental four core functions, nor on appropriate criteria. Thus, the Court's interpretation of the indicators was not wrong, just incomplete.

In conclusion, indicators play a vital role in the application of law. This is evident through the case law examples provided in this section. Complications arise when scientific knowledge (i.e. indicators) is mandated within legislation. If those indicators are not properly applied or understood, the consequences can be costly. Failure to deploy successful indicators may result in non-compliance with the legislation. And even if the indicators are used correctly, regulators must still take the necessary steps to monitor the indicators and ensure that the objectives are met and maintained according to the parameters fleshed out within the regulations. Ton be successful and operationally efficient, indicators must be founded on the four core functions and appropriate crtieria. If does not occur, then they will not hold up against legal scrutiny (as was seen in the *Ikarian Reefer* and *Murdoch* cases above). Indicators are tools that provide a conceptually simple expression of extremely complex and technical information. They communicate essential features of the marine environment and help to focus management efforts accordingly. But since one person's interpretation may differ from that of another, and due to the conceptual debates surrounding the choice of indicators to use (when they are not mandated within the legislation), misinterpretation of the data can prove to be a costly.

7.6 Concluding Remarks

National legislation has continued to pursue its political agenda of clean, healthy, safe, productive and biologically diverse oceans and seas.[178] Through both the creation and application of national environmental law, indicators have and do continue to play a vital role. They can measure progress towards set agenda (both political and legislative) – in an effort to halt the current and rapid deterioration occurring within marine ecosystems all around the UK.

National law is subject to EU law, therefore a similar approach as that discussed in Chapter 5 (i.e. precision and adherence to regulatory standards) guides domestic environmental legislation. Thus, the Commission is pursuing and the ECJ

[178] Defra (2007) *supra* note 1 (p 5)

is upholding a strict approach to compliance with directives. In assessing the specific national regulations within this Chapter, an interesting trend in environmental indicator development and application becomes apparent. All national regulations analyzed in this chapter were implicit on a requirement to use indicators, even when the higher directive was explicit on indicator usage. No specific types of indicators were mandated, nor were specific criteria referenced (apart from the *Offshore Marine Conservation Regulations)*. Instead, the text implied that indicators should be used and that they should be based on the four core functions and criteria that can help them meet the objectives of the Regulations.

In comparing International legislation to EU Directives and national regulations, indicators are more explicitly used and enforced at an EU level. All of the national regulations strictly adhere to the requirements of the higher directives (i.e. there exists a strong top-down approach), but yet they are all implicit on the development and use of indicators. Arguably, the indicator concept is still being developed and understood at a national level, so the regulations reflect a cautious approach until this tool is better understood.

Additionally, the national courts take an interesting approach to the application of evidence and expert testimony in court. Courts are routinely presented with scientific evidence (i.e. indicators), but often times, the science becomes the subject of legal challenges. In such circumstances, the courts will rely on a common sense approach, i.e. they will exercise their judicial functions based on the practical way in which the mind works in everyday life. Thus, when no specific indicators or corresponding criteria are mandated in the legislation, the success of the indicators at case law level will be dependent on the user, their ability to communicate the facts, and the Court's interpretation of the data. Furthermore, this case law review found that where human health is concerned and the indicators are implied or inconclusive, the Courts will take a conservative approach, infer common sense and rule in favor of protection of human health. So, if the applicant's understanding of the indicator does not align with the interpretation of the Court, they will not be successful in their case. Consequently, although there is little direct scrutiny of indicators in formal domestic legal proceedings, the Courts have developed rules on the treatment of evidence and expert witnesses. Thus, these factors (along with the four core functions and pertinent criteria) must be accounted for in the design of indicators.

In conclusion, national environmental regulations must continue to adhere to the higher directives they are meant to transpose, although progress is still needed on the explicit development and use of marine and environmental indicators. National environmental law has fostered a unique approach, which requires significant input from the scientific community, particularly at the case law level. This thesis argues that the use of indicators within marine policy and legislation is a developing phenomenon worldwide. Although not always explicitly identified in the legislative texts (as seen in these national regulations), indicators are nonetheless implied. They are tools that can be used by legislators to control and monitor human activities that impact the ecosystem, as well as to describe the current state of the environment. Whether they are prescriptive or allow for more discretion, indicators communicate valuable information between regulators, policy-makers and scientists. They manifest themselves both in the creation of national law (although implied), as well as in its application (i.e. case law). This provides a solid foundation for the argument that science is driving law and policy. Yet, as was seen in the case studies, when specific indicators are not mandated, then the success and operational efficiency of the indicators will be based on the user. Furthermore, the national courts will infer conclusions and use a common sense approach when the indicators are inconclusive. Thus, scientists are needed in both the creation and application of national environmental legislation to effectively develop and apply the science (i.e. the indicators). This will allow the indicators to become more prominent within national legislation and ultimately work within the mandates of the regulations.

Chapter 8: National (English) Policy

8.1 Introductory Comments

The Government's vision for the marine environment is one of clean, healthy, safe, productive and biologically diverse oceans and seas through an ecosystem based approach to marine management.[1] Such an approach assimilates economic and social goals within environmental regulations and represents the present foundation for national marine policy and legislation.[2] It requires a deeper understanding on how scientific, economic and social goals are interconnected, which allows a balance between human uses of the environment and the effects that these activities have on ecosystems. Environmental indicators can be used to meet these objectives. Scientists and regulators can use indicators to exchange information on spatial and temporal patterns in the environment, thereby ensuring that human activities remain compatible with environmental management needs while meeting wider policy agenda (i.e. sustainable development, healthy seas, precautionary principle). Thus far, this research has found that an approach to marine management that is founded upon confident and scientifically sound environmental indicators has a high degree of political legitimacy and currency.[3]

The Government recognizes, however, that more than just a single indicator is required to achieve this management.[4] Thus, it has adopted the DPSIR model as the most suitable indicator framework, since it is capable of supporting a complex array of indicators and system interactions.[5] It is also considered to be an extremely practical and analytical tool that will ensure their environmental vision is fostered on vigorous and transparent foundations.[6] Through the application of the DPSIR model, the UK Government seeks to develop indicators that are successful and operationally efficient. As argued throughout this thesis, these indicators should be founded on the four core functions and appropriate criteria to achieve this goal. The DPSIR model

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[1] Defra, *Safeguarding Our Seas: A Strategy for the Conservation and Sustainable Development of our Marine Environment* (2003) 82pp (p 3)

[2] Defra, *Seas of Change: The Government's Consultation Paper to Help Deliver Our Vision for the Marine Environment* (2002) 23pp (p 9)

[3] Defra, *The Government's Responses to Its Seas of Change Consultation to Help Deliver Our Vision for the Marine Environment* (2004) 27pp (p 7)

[4] SDU, *Quality of Life Counts: Indicators for a Strategy for Sustainable Development for the United Kingdom: A Baseline Assessment* (1999) 290pp (p 18)

[5] Ibid, at p 18

[6] Ibid, at p 18

creates an analytical tell-tale method, indicative of progress towards set objectives, upon which current and future national marine policies and regulations can be founded.

This chapter analyzes the development and use of environmental indicators in national policies to demonstrate that the indicator concept has become an important element of contemporary marine management, most particularly as it pertains to set policy agenda. It assesses these indicators against the four core functions and appropriate criteria to determine the true success and operational efficiency of the indicators in meeting policy objectives. This answers research question 1-2 and 5-6. Additionally, this chapter analyzes the indicators used nationally to determine if they are consistent with those found at the EU and International levels (as discussed in previous chapters). How does national environmental policy influence policy at the EU and international levels? What influence, if any, does it have on national, EU or international law? This is used to determine if a top-down or bottom-up approach to indicator development within national environmental policy exists (research questions 3, 4 and 7). Ultimately, this chapter seeks to analyze where national policy is in terms of the development of indicators compared to Europe and internationally.

Section 8.2 reviews major policy documents that are responsible for establishing the parameters for marine management. An in-depth analysis is undertaken to assess indicator usage within such texts, as well as the success and operational efficiency of these indicators. An analysis is undertaken to determine if the UK's application of environmental indicators corresponds with the use of indicators discussed in previous chapters. What influence does national policy have on EU and international policy and law and how does this affect indicator development? Section 8.2.1 evaluates the policy report, A Better Quality of Life,[7] to determine the role of indicators in achieving political objectives for the marine environment and to ascertain whether these indicators are truly successful and operationally efficient. Section 8.2.2 explores the policy report Quality of Life Counts,[8] which provides a baseline assessment of the 150 indicators laid out within A

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[7] SDU, A Better Quality of Life – Strategy for Sustainable Development for United Kingdom (1999) 100pp

[8] SDU (1999) *supra* note 4

Better Quality of Life.[9] Here, the quality of indicators is evaluated, to determine if these indicators are successful and operationally efficient. What criteria are they based on and have EU and international policies had any effect on national indicator development? Section 8.2.3 focuses on Safeguarding Our Seas,[10] exploring the role of indicators in achieving the Government's vision for the marine environment. It examines these indicators in light of the discussions on evidence and legal scrutiny discussed in Chapter 7. Section 8.2.4 investigates the policy report Better Regulation Executive.[11] It fleshes out the connections between the economy and the marine environment, and the importance of indicators in linking these two areas.

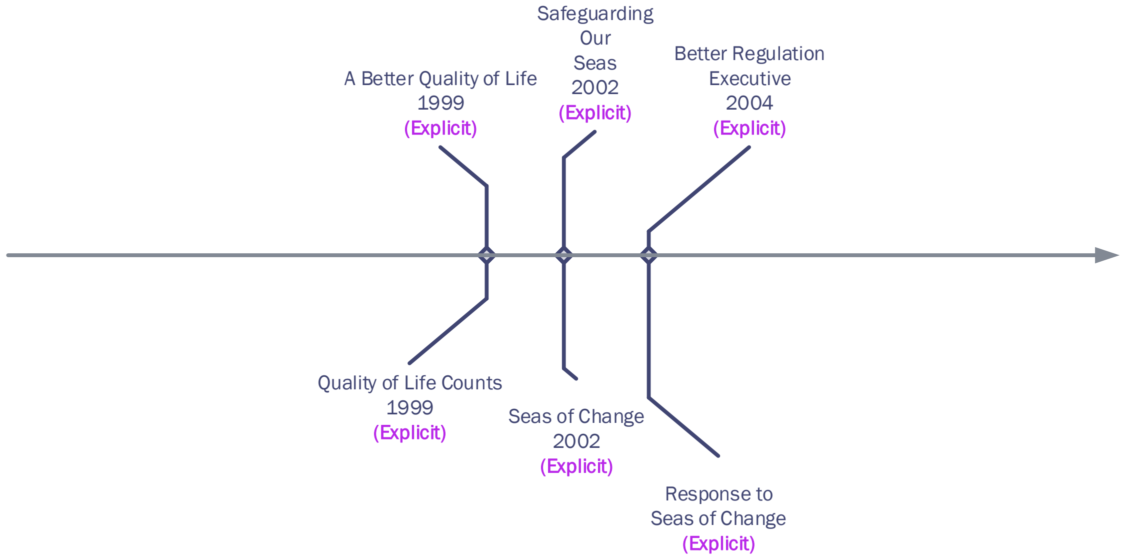

Figure 8.1: Timeline of national environmental policy documents analyzed in this chapter. These are discussed in chronological order within the appropriate subsection. Each document is listed as explicit or implicit with regards to the use of indicators within the text of the document. The subsequent analysis provided in this chapter explores the progressive development and application of indicators over time in the EU policy forum to answer research questions 1-7 with regards to national environmental policy.

Lastly, Section 8.3 analyzes literature on indicators and their roles within national marine policy. It explores the historic utilization of indicators nationally, to evaluate how indicators continue to evolve within domestic policy frameworks. How doe indicators used in national policies compare with those used at an EU and

[9] SDU (1999) *supra* note 4
[10] Defra (2003) *supra* note 1
[11] Ruth Kelly, *Budget 2004, Prudence for a purpose: A Britain of Stability and Strength, Economic and Fiscal Strategy Report and Financial Statement and Budget Report* (2004) 308pp (p 155)

international level? This section draws together the analysis of the chapter to determine what makes indicators successful and operationally efficient at the national level, the influences of national policy on indicator development at the European and international levels, as well as the link between environmental policy development and indicator application nationally. Figure 8.1 illustrates the development of indicators and key national policy documents. It provides a visual assessment of the major discussion points of this chapter.

8.2 Pertinent National Policy Documents

As mentioned previously, although not always explicitly identified within legislation and policy texts, indicators are nonetheless used widely in both.[12] Often their utilization is masked by a variety of other terms. Table 8.1. provides a summary and comparison of national policy documents discussed in this chapter and the corresponding indicators used.

Table 8.1: Comparison of national policy documents discussed in this chapter and the indicators used to achieve their specific objectives. This information is used to determine the operational efficiency and success of indicators applied in national environmental policies.

POLICY	EXPLICIT? IMPLICIT? PRESCRIPTIVE ?	INDICATOR TYPE	EXAMPLES	OBJECTIVE	TOP-DOWN? BOTTOM-UP?	OPERATIONALLY EFFICIENT?
A Better Quality of Life	-Explicit -Prescriptive: provides a suite of 150 sustainable development indicators and within these, important headline indicators. The document is flexible, however, to developing additional indicators based on the responses received from applying these indicators.	*Sustainable Development Indicators *Pressure Indicators	-Concentration of persistent organic pollutants -Dangerous substances in water -Emission of greenhouse gases -Sea level rise	*To improve overall quality of life and to achieve greater prosperity with less environmental damage through the improvement of societal conditions	Top-Down and Bottom-Up	-Yes: Specific criteria and indicators given: -Scientifically valid -Transparent -Anticipatory -Communicable -Sensitive and responsive -Tightly linked to human activity

[12] Defra (November 2002) *supra* note 2 (p 7, 21)

Quality of Life Counts	-Explicit -Prescriptive: evaluates the suite of 150 sustainable development indicators from *A Better Quality of Life* by organizing them into key themes and developing a national core set of sustainable development indicators.	*Sustainable Development Indicators *Pressure Indicators	-Climate change -Dangerous substances in water -Concentration of persistent organic pollutants -Sea level rise -Nutrients in water	*To determine the extent to which economic growth has historically been responsible for environmental impacts	Top-Down and Bottom-Up	-Yes: Specific criteria and indicators given: -Ensure the indicators are state of the nation indicators reflecting international, EU and national commitments -being representative -scientifically valid -simple and easy to interpret -showing trends over time -sensitive to change -based on readily available and adequately documented data
Safeguarding Our Seas	-Explicit -Not prescriptive on which indicators to use.	*Pollution Indicators *Ecological Quality Objectives *Tourism Indicators *Performance Indicators *State Indicators *Impact Indicators *Community Structure Indicators	-Algal concentrations -Inputs of hazardous substances -Nutrient concentrations -Radioactive substances -Seal population trends in the North Sea -Density of opportunistic species -Sustainable fisheries -Levels of cetacean by-catch -Marine ecosystem integrity -Impacts of invasive marine species	*To achieve a more holistic and integrated evaluation of the state of the marine environment (ecosystem-based management) *To sustainably manage the marine environment	Top-Down and Bottom-Up	-Yes: Specific criteria and indicators given: -Scientifically valid - Anticipatory -Robust -Broadly applicable -Integrative over space and time -Simplicity -Interpretable -Unambiguous

Better Regulation Agenda	-Explicit -Provides a list of suggested indicators, but not prescriptive on using only these indicators. Flexible to developing indicators that can measure economic and environmental objectives.	*Financial indicators *Business indicators *Productivity indicators *Performance indicators	-Household consumption -Net worth and income -Emissions of greenhouse gas -Household wastes -Populations of wild birds	*To measure progress towards fiscal and environmental objectives and regional performance targets	Top-Down and Bottom-Up	-Yes: But user dependent. No specific criteria given. -Implies: -Communicative -Policy relevant -Interpretable and unambiguous -Sensitive and responsive

8.2.1 A Better Quality of Life

A Better Quality of Life[13] seeks to protect the environment, maintain superior and stable levels of economic growth and employment, and use natural resources efficiently and sensibly.[14] The focus of this report is to achieve greater prosperity with less environmental damage through the improvement of societal conditions.[15]

These objectives are measured via the development and application of a suite of 150 sustainable development indicators.[16] These indicators include concentrations of persistent organic pollutants, dangerous substances in water, emissions of greenhouse gases, and sea level rise, among others.[17] Founded upon the four core functions and such criteria as scientific valid, communicable, policy and legal relevance and tightly linked to human activities, these indicators correlate with those used at the EU and international level. Thus, an analysis of this policy document demonstrates that the strategy exhibits both a top-down and bottom-up approach to indicator development. Arguably, this is because EU and international economics influence national policies on sustainable development. So as much as the strategy is designed to promote national economic growth, social cohesion and protection of the environment, the Government looks to higher policies and legislation from the EU and internationally to help meet their intended objectives through the application of indicators.[18] Simultaneously, national policies, such as *A Better Quality of Life,*

[13] SDU (1999) *supra* note 7
[14] Ibid, at summary p 2
[15] Ibid, at Para 1.8 and 3.3
[16] Ibid, at Para 1.8 and 3.3
[17] Ibid, at Para 8.18
[18] Ibid, at Para 2.1, 2.2, 2.6-2.8, 3.5

directly influence indicator development at the EU and international level (hence the bottom-up approach).

The policy recognizes, however, that although it is prescriptive on the 150 sustainable development indicators, it must be flexible and develop additional indicators in the future that can successfully help to achieve these objectives.[19] A Better Quality of Life provides guidance on the development of indicators to measure progress towards sustainable development.[20] This guidance supports the development of successful and operationally efficient indicators founded on the four core functions and appropriate criteria to ensure that the indicators used are aligned with the policy objectives. These criteria include scientifically valid, transparent, based on the precautionary principle (anticipatory), communicable, sensitive and responsive.[21] The suite of 150 indicators in A Better Quality of Life are founded on these criteria to ensure their success and ability to withstand political and legal scrutiny. And by being operationally efficient, these indicators can demonstrate the connections between the economy, society and the environment, thereby meeting the objectives of sustainable development. Thus, through political cooperation and the development of successful indicators, environmental problems can be resolved and economic prosperity can be achieved.[22]

Within the suite of 150 indicators, a series of headline indicators have been developed. These headline indicators provide a high level overview of progress and are a powerful tool for simplifying and communicating the main messages for the public.[23] Founded on the four core functions and appropriate criteria to ensure their success, these indicators allow the Government to better adjust and re-strategize policies according to current needs.[24] For example, environmental damage is often tied to economic growth (i.e. a decline in fish stocks can be due to a significant increase in fishing or a large output of industrial hazardous waste).[25] Thus, policies must be examined collectively alongside indicators, particularly the crucial headline

[19] SDU (1999) *supra* note 7 (Para 3.10)
[20] Ibid, at Para 1.11
[21] Ibid, at Para 3.7 and 4.1
[22] Ibid, at Para 3.2 and 9.1
[23] S Gubbay "A Review of Marine Environmental Indicators: Reporting on Biodiversity Aspects of Ecosystem Health" [2004] 73pp (p 8)
[24] SDU (1999) *supra* note 7 (Para 3.7)
[25] Ibid, at Para 3.27

indicators, to ensure that by improving economic growth the Government is not damaging the environment.[26] This would ensure that neither the environment nor society suffers from economic prosperity.[27]

The Government recognizes that sustainable development is an important element globally.[28] By using indicators within this strategy, they can meet the needs of the current and future nation and simultaneously identify targets for social development, environmental protection, resource utilization, and economic expansion. Environmental indicators have shown that uncontrolled economic growth can damage the environment and quality of life.[29] Indicators link the environment, society and the economy by illustrating the synergies between health, poverty, poor housing and degraded local environments (i.e. an increase in pollution or degradation to the environment will result in deterioration in human health and society as a whole).[30] Thus, poverty and the environment are intimately linked and measured via indicators, which are developed to measure progress toward the objectives fleshed out in a Better Quality of Life.[31]

When indicators are successful and operationally efficient, they are understood by stakeholders, can communicate current trends in the environment and influence higher European and international policies and laws. The 150 headline indicators described in this report have been the main driving force underlying the Government's sustainable development strategy and align with those found at the EU and international level.[32] They represent a 'quality of life barometer' and demonstrate progress made towards creating a healthy environment, and improving employment, education and health, while minimizing crime and waste.[33] Because they are successful and operationally efficient, these indicators are tools for accountability and

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[26] SDU (1999) *supra* note 7 (Para 3.27)
[27] Ibid, at Para 3.13
[28] Ibid, at Para 9.1
[29] Ibid, at Para 3.27
[30] Ibid, at Para 7.2
[31] Ibid, at Para 9.2
[32] SDU, Quality of Life Counts Indicators for a Strategy for Sustainable Development for the United Kingdom: 2004 Update (2004) 158pp (at p 4)
[33] Ibid, at p 4

measure progress towards the many facets of sustainable development, including marine management.[34]

8.2.2 Quality of Life Counts

Quality of Life Counts provides a baseline evaluation of the 150 indicators in the strategy A Better Quality of Life.[35] It takes a more comprehensive look at the indicators, assesses their significance, and provides benchmark values to gauge progress.[36] Dependable and comprehensive indicators are an essential part of the toolkit needed to achieve sustainable development.[37]

This report organized sustainable development objectives and their corresponding indicators into key themes.[38] Within these themes, a national core set of indicators has been developed.[39] These include climate change, environmental reporting, dangerous substances in water, concentrations of persistent organic pollutants, sea level rise, and nutrients in water (among others).[40]

To ensure success and operational efficiency, these indicators are founded on a specific set of policy and scientific criteria.[41] Policy criteria include ensuring the indicators are 'state of the nation' indicators, reflecting key international, EU and national commitments.[42] Thus, similar to A Better Quality of Life, this policy exhibits both a top-down and bottom-up approach to indicator development. Again, arguably this is because EU and international economics influence national sustainable development policies, with the Government looking to higher policies and legislation for guidance on meeting sustainable development objectives. Simultaneously, the UK is heavily involved in international and EU consultations regarding sustainable development, thereby directly influencing indicator development at the EU and international levels. Thus, a top-down and bottom-up approach to indicator development is evident in this strategy. Beyond the policy criteria, scientific criteria include being representative, scientifically valid, simple and easy to interpret, showing

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34 SDU (1999) *supra* note 4 (p 92)
35 Ibid, at p 3
36 Ibid, at p 3 and Para 1.8
37 Ibid, at p 3 and 5
38 Ibid, at Para 2.8
39 Ibid, at p 11, 41, 84 and 89
40 Ibid, at p 11, 41, 84 and 89
41 Ibid, at Para 2.13
42 Ibid, at Para 2.13

trends over time, sensitive to change, and based on readily available and adequately documented data.[43]

Quality of Life Counts uses indicators to determine the extent to which economic growth has historically been responsible for environmental impacts in key areas, as well as any recent improvements.[44] For example, sea level rising indicators have demonstrated a rise in historic mean sea level around the UK (arguably related to global warming).[45] Similarly, higher levels of nitrate and phosphate concentrations were found in waters around the UK (most particularly central and eastern England), reflecting sewage effluent, agricultural and even geological pressures.[46]

The Government recognizes that work is still needed to improve indicators.[47] Since 1999, Quality of Life Counts has become a model and resource for other indicator initiatives.[48] Furthermore, the Quality of Life Counts indicators have been adopted in many other indicator sets.[49] Consequently, through the publication of this report and the establishment of the set of national headline indicators, the UK has become one of the leading countries in terms of indicator development.[50]

8.2.3 Safeguarding Our Seas

Safeguarding Our Seas is the Government's report for the marine environment.[51] It promotes integrated marine management via the setting of targets and the use of performance indicators to measure change and progress.[52] This first Marine Stewardship Report emphasizes that a more holistic and integrated evaluation of the state of the marine environment can be achieved via the development of a network of environmental indicators (Ecological Quality Objectives).[53] It is believed that through

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43 SDU (1999) *supra* note 4 (Para 2.14)
44 Ibid, at Para 1.13
45 Ibid, at p 91
46 Ibid, at p 101
47 Ibid, at Para 8.1
48 SDU (2004) *supra* note 32(p 4)
49 Ibid, at p 4
50 Ibid, at p 4
51 Defra, "Safeguarding our Seas: A Strategy for the Conservation and Sustainable Development of our Marine Environment" (2003) <http://archive.defra.gov.uk/environment/marine/legislation/strategy.htm> accessed 5 May 2003
52 Defra (2002) *supra* note 2 (p 21, 76)
53 Defra (2003) *supra* note 1 (p 3-4, 11)

environmental indicators, the government will be able to better assimilate environmental and economic decision-making.[54]

The Government has committed to principles which support the development of indicators. These must now be discussed to gain a better understanding of the Government's approach to marine management and indicator development.

The first principle is the polluter pays principle, which promotes environmental indicators to identify sources of pollution. This allows regulators to determine who is responsible and should be held accountable for the resulting environmental impacts. Some examples of these indicators include algal concentrations in coastal waters and inputs of hazardous substances (i.e. heavy metals, such as cadmium, mercury, lead or copper).[55] Another example of such an indicator is nutrient concentrations (i.e. nitrogen or phosphorous concentrations).[56] If these indicators can establish a gradient, then the regulator might identify the polluter(s). Thus, if larger algal blooms or higher amounts of hazardous substances/nutrient loads are found closer to a particular area but gradually lessen as one moves away from it, then a source of the pollution can be inferred. The polluter, in turn, can be fined for their activities.

Safeguarding Our Seas emphasizes the importance of and need for robust scientific research in the development of marine indicators.[57] Where such scientific evidence is not conclusive, the document stresses the use of the precautionary principle, the second principle highlighted in this policy document.[58] The precautionary principle helps to shape the way in which indicators are used, and is applied qualitatively to all indicators. It is imperative that indicators used in conjunction with the precautionary principle are successful and operationally efficient, most specifically that they be anticipatory. This will ensure that the indicators developed on this principle will be able to withstand scrutiny and legal challenges. Sometimes when scientific evidence is lacking, regulators must infer the cause of pollution. These inferences should be based upon common sense, and supported

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[54] S Gubbay (2004) *supra* note 23 (p 11)
[55] Defra (2003) *supra* note 1 (p 25, 31, 54-63)
[56] Ibid, at p 25, 31, 54-63
[57] Ibid, at p 7
[58] Ibid, at p 7

(where possible) by successful indicators (as was seen in the previous case law discussions).

Two more principles explored in Safeguarding Our Seas that support the development and application of environmental indicators include the best available techniques (BATs) and best environmental practices (BEPs) principles.[59] Similar to the precautionary principle, BATs and BEPs shape how indicators are used by requiring that the best available scientific data be used to develop the indicators (i.e. indicators should be scientifically valid and robust). Furthermore, improvements in science and technology inevitably result in changes to the associated indicators. The ability to predict and interpret human impacts on the environment with reasonable certainty depends on the degree of prior knowledge of the environment (i.e. state indicators), as well as impact indicators to measure the effects of human activities on the environment.[60] These indicators must be successful and operationally efficient. They should be founded on the four core functions and be broadly applicable and integrative over space and time, to provide a holistic assessment and allow comparisons with previous data.

Another important principle discussed in Safeguarding Our Seas is the conservation of biological diversity.[61] It requires specific types of indicators to communicate spatial and temporal patterns (both natural and anthropogenic) that exist in the marine environment. Biodiversity indicators often fall into 2 categories: 1.) those that describe the state of a particular species or habitat (i.e. seal population trends in the North Sea) and 2.) those that report on aspects of community structure (i.e. the density of opportunistic species).[62] Other indicators include sustainable fisheries, inputs of hazardous substances to the marine environment, levels of cetacean by-catch, marine ecosystem integrity (i.e. the size of fish in the North Sea) and the impact of invasive marine species. These indicators have been proven to be successful and operationally efficient, as they are founded on the four core functions, are developed on the appropriate criteria and have been assessed and repeatedly revised to

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[59] Barnes and Bayer, "(Draft) Risk Assessment Guidelines for the Effective Employment of Environmental Indicators (Defra Project ME4118)" [2007] 81pp (p 7)

[60] E Bayer, R A Barnes and H L Rees, "The Regulatory Framework for Marine Dredging Indicators and their Operation Efficiency within the UK: A Possible Model for Other Nations?" [2008] ICES Journal of Marine Science 65 pp1402-1406 (p 1404 and 1405)

[61] Defra (2003) *supra* note 1 (p 3)

[62] S Gubbay (2004) *supra* note 23 (p 66)

communicate progress towards the Government's political vision for marine conservation.[63]

Stakeholder involvement is another principle in Safeguarding Our Seas that influences the development and application of indicators.[64] This requires specific indicator criteria, such as simplicity, interpretable and unambiguous. Often these indicators are used in different stakeholder contexts, such as, general public hearings (which may require simple headline indicators), or expert testimony (which may require more complex or specialist indicators). Stakeholders should be involved in developing indicators to ensure that they are aligned with national, EU and international objectives and to ensure that the indicators are understood by the wider public. National policies emphasize a need for full stakeholder involvement in the development of marine policy and indicators to support it.[65]

These principles promote the Government's vision for the marine environment and emphasize the importance of indicators to achieve a more holistic approach to marine management. The Government's environmental policies stress the need for a set of environmental indicators to communicate the status of the environment and the impact of current policies and regulations.[66] These indicators must be successful and operationally efficient to ensure their usefulness and to align with indicators used at the EU and International level, thereby creating synergies between similar political objectives across different tiers of government.

Safeguarding Our Seas is a key national marine policy that has been influenced by higher policy and legislation from the EU and internationally. Thus, the environmental indicators discussed are influenced by decisions made on a global scale. At the same time, this national policy works to influence and participate in EU and international policies that are important on a national scale (i.e. biodiversity, bathing water quality, sustainable tourism, reduction in radioactive pollution and an ecosystem-based approach).[67] Thus, a strong top-down and bottom-up approach to

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[63] Defra, *Measuring Progress: 2010 Assessment A Biodiversity Strategy for England* (2010) (p 2, 6-7)
[64] S I Rogers and B Greenaway, "A UK Perspective on the Development of Marine Ecosystem Indicators" [2005] Marine Pollution Bulletin #50 p 9-19 (p 15)
[65] Defra (2003) *supra* note 1 (p 12)
[66] Ibid, at p 5-6
[67] Ibid at Paragraphs 2.42, 3.31, 4.27 and 4.39

indicator development is evident in Safeguarding Our Seas. An example of an indicator used at an EU and international level is measurements of fish declines, which can be representative of global warming. As ocean waters warm, fish species that require specific temperatures to thrive begin to decline. Another indicator that is used at a national level and which is pertinent at an EU and international level is water quality.[68] Water quality measurements can determine the amount of pollution from human activities.[69] Still, other examples of pertinent indicators important nationally, regionally and internationally include trends in abundance and distribution of selected species and habitats, seabird population trends, and the density of opportunistic species.[70] These indicators have proven successful and operationally efficient at a national, EU and international level.[71] Thus, the Government seeks to strengthen co-operation, both horizontally (within its own infrastructure), as well as vertically (between national, EU and international policies) to create more effective environmental management.[72]

In summary, the Government promotes successful and operationally efficient indicators within Safeguarding Our Seas to create a more effective approach to marine management by understanding the interactions that occur between the environment and anthropogenic activities.[73] This, in turn, will lead to the formation of more effective marine policies and legislations based upon scientifically driven environmental indicators that are founded on the four core functions and appropriate criteria and able to deliver the Government's vision for the marine environment.

8.2.4 Better Regulation Executive

It is important to address national economic objectives when dealing with national environmental policy and indicator development because economic objectives have become a significant driving force behind both. As the government begins to take a more holistic approach to marine management, it is inevitable that economic and social goals will combine with scientific objectives. These, in turn, will increasingly become enshrined in environmental policy and regulations. Indicators are an

[68] Defra (2003) *supra* note 1 (p 46-47)
[69] Ibid, at p 46-47
[70] S Gubbay (2004) *supra* note 23 (p 50-52)
[71] Defra (2003) *supra* note 1 (Paragraphs 2.42, 3.31, 4.27 and 4.39)
[72] Ibid, at p 8-9
[73] Ibid, at p 76

important element of such legislation and policy texts. Consequently, it is imperative to reach an understanding as to how scientific, economic and social goals are interconnected, and how these in turn influence indicator development.

The Better Regulation Executive parallels A Better Quality of Life and Safeguarding Our Seas. It recognizes the need for transparency and accountability to achieve and maintain sustainable development and thus, environmental and marine conservation. Indicators, if successful and operationally efficient, offer a better opportunity to measure progress towards fiscal and environmental objectives, as well as performance targets, which are the main objectives of indicators in The Better Regulation Executive.[74] This policy document explicitly calls for the use of financial, business, productivity and performance indicators.[75] And although it provides a list of suggested environmental indicators in Table 7.2 of the document, this list is by no means exhaustive. The policy is flexible to developing indicators that can measure economic and environmental objectives.

Examples of financial and environmental indicators referenced in this policy document include household consumption, net-worth and income, emissions of greenhouse gases, household wastes and populations of wild birds.[76] Britain uses national indicators, such as these, to help promote a productive economy and influence higher policies and legislation.[77] But it also looks to the global economy and international organizations to determine the direction it should move, including the U.S., the EU and the OECD.[78] Thus, both a top-down and bottom-up approach to indicator development exists in this policy document. And these indicators are operationally efficient, but their success is user dependent. No specific indicator criteria are given to ensure their success. The document only implies that indicators developed to meet the objective of The Better Regulation Agenda be founded on the four core functions, including communicative and be policy relevant, interpretable, unambiguous, as well as sensitive and responsive.

[74] Ruth Kelly (2004) *supra* note 11 (Paragraph 3.4)
[75] Ibid, at Paragraphs 2.55, 3.4, 4.44, 5.9, 7.76, B2, B7, B12, B26, B60, C5, C8 and C70
[76] Ibid, at Paragraphs 4.44, 5.8, B60, C8 and Table 7.1
[77] Ibid, at p 172, B2 and B7
[78] Ibid

Indicators can help the economy through improved efficiency and monitoring. Yet, the use of indicators is shaped by not only science, but also by such facets as the economy or society. In essence, the Government understands that economic stability provides the foundation for future prosperity, social justice and financial investments. Yet economic stability must be achieved alongside environmental protection, as well as efficient and responsible utilization of natural resources.[79] For example, the impacts of climate change include increased weather variability, which could cause damage to infrastructure and lead to transport disruption, reduced reliability of the energy supply, and higher costs for building repairs and refurbishment.[80] Consequently, the Government must ensure that as the economy continues to grow, the environment does not suffer unnecessary damage. Hence, they must embrace the use of indicators to gauge the extent of environmental impacts due to economic growth. Economic instruments and the corresponding environmental indicators allow the country to remain environmentally friendly, meet social objectives and maintain its international competitive edge.[81]

8.3 Indicator Usage within National Marine Policy

In recent decades, the Government has developed a range of policies and introduced statutory and non-statutory measures for the conservation of marine biodiversity, which includes the use of environmental indicators.[82] Successful and operationally efficient indicators are those which show precisely how well policy objectives are being met. The indicators discussed thus far in this chapter are by no means exhaustive. They are used to measure progress towards national environmental and social objectives. However, they do not preclude the use of other indicators. This section reviews and analyze literature on indicators and their roles within national marine policy. It looks at the analysis of Susan Gubbay and compares her arguments against other indicator experts. Table 8.2 provides a summary of Gubbay's key points and compares them against other literature referenced in this section.

[79] Ruth Kelly (2004) *supra* note 11 (p 169)
[80] Ibid, at p 156
[81] Ibid, at p 155
[82] S Gubbay (2004) *supra* note 23 (at p 7)

Table 8.2: A comparison of Susan Gubbay's key points from her article "A Review of Marine Environmental Indicators: Reporting on Biodiversity Aspects of Ecosystem Health" against points made by other indicator experts and their articles referenced in Section 8.3.

Key Points	**Who Agreed?**								
	Kirby (2003)	Rees *et al* (2006)	Rogers & Greenway (2005)	Atkins *et al* (2011)	Rice & Rochet (2005)	Ehler (2003)	Rogers & Tasker (2005)	Pinn (2010)	Jones (2002)
Theme 1: Role of indicators in national policies and the underlying basis of their success									
Performance indicators inform decision-making.	✓	✓	✓	✓	✓	✓	✓	✓	✓
UK lacks a cohesive suite of indicators to report on ecosystem structure and function.	✓	✓	✓			✓	✓	✓	✓
Indicators need to be successful and operationally efficient to be useful (although how that success is defined can vary depending on the expert).	✓	✓	✓	✓	✓		✓		
Indicator criteria must be routinely reviewed and revised to ensure success and operational efficiency.		✓			✓				

Theme 2: National marine indicators									
National marine indicators must be developed and incorporated into national headline indicators.	✓		✓		✓		✓		
National marine indicators should evaluate all aspects of the environment, including economic and social objectives (take an ecosystem based approach).		✓	✓	✓		✓	✓	✓	
Currently national marine indicators are being developed for areas with the most scientific knowledge. But there needs to be a focus on areas which are less understood or developed.		✓	✓				✓		
A suite of indicators, rather than a single indicator, should be used to measure objectives and ensure an ecosystem based approach.		✓	✓		✓		✓	✓	

An extensive set of literature on national marine indicators is available for review.[83] Within this section, a small assortment of literature is discussed to analyze

[83] Kirby, "UK Marine Biodiversity Indicators: A Report from the Second Meeting of the UK Biodiversity Indicators Forum" [2003] Joint Nature Conservation Committee 9pp; Pinn, "Healthy and Biologically Diverse Seas Evidence Group: Evaluation and gap analysis of current and potential indicators for Cetaceans" [2010] Joint Nature Conservation Committee_76pp; H L Rees *et al*, "Role of Benthic Indicators in Regulating Human Activities at Sea" [2006] Environmental Science & Policy 9 496-508pp; Elliott, "The Role of the DPSIR Approach and Conceptual Models in Marine Environmental Management: An Example for Offshore Wind Power" [2002] Marine Pollution Bulletin 44(6): iii-vii; Rice and Rochet, "A Framework for Selecting a Suite of Indicators for Fisheries Management" [2005] ICES Journal of Marine Science 62: 516-527pp; Ehler, "Indicators to measure governance performance in integrated coastal management" [2003] Ocean and Coastal Management 46: 335-345; Aubry and Elliott, "The Use of Environmental Integrative Indicators to Assess Seabed Disturbance in Estuaries and Coasts: Application to the Humber Estuary, UK" [2006] Marine Pollution Bulletin 53: 175-185pp; Elliott *et al*, "Integrated marine management and administration for an island state - the case for a new Marine Agency for the UK" [2006] Marine Pollution Bulletin 52(5) 469-474; Elliott, "Marine Science and Management Means Tackling Exogenic Unmanaged Pressures and Endogenic Managed Pressures – A Numbered Guide" [2011] Marine Pollution Bulletin 62: 651-655; Atkins *et al*, "Management of the Marine Environment: Integrating Ecosystem Services and Societal

the key issues surrounding indicators and focus a discussion on indicator use within marine policy that is most effective for this thesis.

Gubbay's report "A Review of Marine Environmental Indicators: Reporting on Biodiversity Aspects of Ecosystem Health" gives a detailed history and critical analysis of national indicator development and use within policy and legislation. This analysis is grouped into two themes and starts with a focus on the role of indicators in national policies and the underlying basis of their success (theme 1). Gubbay observes that performance indicators are used to inform decision-making.[84] They help measure and report on environmental changes and progress towards environmental goals and objectives.[85] Kirby agrees with this point, noting that indicators can monitor and track pressures and impacts, determine response actions, and assess the effectiveness of such responses.[86]

Gubbay notes, however, that although the UK recognizes the benefits of using indicators, they lack a cohesive suite of indicators to report on ecosystem structure and function.[87] Rees *et al* agreed, stating that a range of factors will influence operational effectiveness; therefore, attention should be given to the criteria that are used to develop indicator sets, to ensure that the indicators are fit for purpose.[88] Rice and Rochet also agreed, stating that published lists of criteria, although generally similar, should be evaluated on a routine basis.[89] Criteria are of significant value to indicators, as they are the standard upon which the indicator is developed..[90] In other words, indicators must be successful and operationally efficient, which is dependent on the criteria that they are developed on, to be useful. This directly correlates with the hypothesis of this thesis and demonstrates that the research undertaken is a valuable and necessary supplement to understanding the role that indicators play in the formation and application of policy and law.

Benefits with the DPSIR Framework in a Systems Approach" [2011] Marine Pollution Bulletin 62(2): 215-226

[84] S Gubbay (2004) *supra* note 23 (p 7)
[85] Ibid, at p 7
[86] Kirby (2003) *supra* note 86 (p 1)
[87] S Gubbay (2004) *supra* note 23 (p 9)
[88] H L Rees *et al* (2006) *supra* note 86 (p 499, 505)
[89] Rice and Rochet (2005) *supra* note 86 (p 518)
[90] H L Rees *et al* (2006) *supra* note 86 (p 505)

Similar to Gubbay and Rees *et al*, Rogers and Greenway recognize that many of the indicators needed to support national marine management are currently under development in the international science community. [91] Although these indicators are being developed, Rogers and Greenway are concerned on their ability to measure whole ecosystem functions.[92] If the indicators cannot successfully measure ecosystem structure and function, then they will be unable to communicate the interactions that occur within an ecosystem, making them unsuccessful.[93] Atkins *et al* disagree on this point, however. They note that although management of a complex ecosystem requires measuring the complexities of the system and incorporating all users of the environment, they argue that an integrated methodology based on the DPSIR framework can achieve such an objective.[94]

The agreed upon point here is that if indicators are not successful and operationally efficient, they will not be able to communicate important information and, therefore, will lose value. This thesis agrees with Gubbay, Rees, and Rogers and Greenway that this success is based upon two things: 1.) the criteria upon which the indicators are based and 2.) the user developing and applying them. If based on the four core functions and appropriate criteria, the indicators can meet the objectives they were designed for.

Theme 2 of this analysis focuses on national marine indicators. Rogers and Greenway noted that many indicators for the marine environment have been incorporated into the larger suite of 150 sustainable development indicators, but none are included in the 15 headline indicators discussed in the report *A Better Quality of Life*.[95] They argued that if marine indicators are incorporated into the 150 sustainable development indicators, but are NOT represented in any of the 15 headline indicators, then a comprehensive assessment of marine ecosystems cannot be undertaken. Kirby agreed with this point, noting that marine biodiversity indicators are of great importance, but are the least developed indicators. Marine indicators must be developed and applied to help meet the objectives of the national marine strategy.

[91] S I Rogers and B Greenaway (2005) *supra* note 64 (p 10)
[92] Ibid, at p 10
[93] Ibid, at p 10
[94] Atkins *et al* (2011) *supra* note 86 (p 3, 4 and 11); Rice and Rochet agree with Atkins *et al* on this point that suites of indicators are needed to give an adequate and holistic understanding of the marine environment. Rice and Rochet (2005) *supra* note 86 (p 516)
[95] S I Rogers and B Greenaway (2005) *supra* note 64 (p 9)

They should be founded on the four core functions and appropriate criteria to ensure their success and operational efficiency. Successful indicators can provide a holistic approach to marine management and support national policy makers and legislators in their decision making.[96]

National marine indicators should also evaluate all aspects of the environment, including marine biodiversity, ecosystem health, physio-chemical parameters, and the economic value of marine goods and services. This would create a more holistic assessment of the national marine environment, allowing indicators to be successful and fit for purpose. Gubbay notes that national environmental indicators are now used to define more than just environmental objectives.[97] They are used to describe the current state of the economy and society, thus, measuring progress towards national sustainable development objectives. Ehler agrees, stating that indicators can include resources allocated for staff, budget, and facilities, as well as institutional arrangements for planning and implementation to ensure Integrated Coastal Management (ICM).[98]

Rogers and Greenway agree with Gubbay and Ehler on this point. The aim of national marine policy is to provide a healthy marine ecosystem that can sustain human demands on environmental goods and services.[99] Thus, it is imperative to develop successful and operationally efficient indicators to manage human activities in the marine environment and measure the extent of human impacts. [100] Rogers and Greenway note that indicators can do just that.[101] In some sectors, the ecosystem-based approach has been developed using such frameworks as the DPSIR and PSR, which directly impacts the development of these indicators, which often focus on environmental quality.[102] Atkins *et al* further supports this argument and demonstrates that links do exist between policy and legal approaches (in this case, the Ecosystem, the DPSIR and the ES&SB approaches).[103]

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[96] Atkins *et al* (2011) *supra* note 86 (p 1)
[97] S Gubbay (2004) *supra* note 23 (p 15)
[98] Ehler (2003) *supra* note 86 (p 337)
[99] S I Rogers and B Greenaway (2005) *supra* note 64 (p 10-11)
[100] Rice and Rochet (2005) *supra* note 86 (p 525); Rogers & Greenaway (2005) *supra* note 64 (p 11)
[101] S I Rogers and B Greenaway (2005) *supra* note 64 (p 14)
[102] Ibid, at p 14; Elliott (2002) *supra* note 86 (p iii); Atkins *et al* (2011) *supra* note 86 (p 1,3); S I Rogers and B Greenaway (2005) *supra* note 64 (p 14)
[103] Atkins *et al* (2011) *supra* note 86 (p 11)

As management of the marine environment improves, emphasis is being placed on objectives (and their corresponding indicators) for areas with the most scientific knowledge. This results in the development of indicators in areas where indicators are already known or for sectors that are more understood, such as marine biodiversity. But there needs to be a focus on areas which are less understood or developed.

Rogers and Greenway agree; they stress the need for indicators to monitor the progress toward economic and social objectives related to the environment.[104] Thus, in addition to developing physical and biological indicators, there needs to be national marine economic and social indicators that are developed and incorporated into the national framework.[105] Currently, there are environmental indicators that measure economic and social objectives, but few to no indicators of this nature for the marine sector. Similar to the other key points made for Theme 2 of this analysis, it appears that marine environmental and corresponding national marine indicators have been under developed. This should be remedied to ensure that objectives are met for the national marine strategy.

Lastly, when developing indicators based on an ecosystem approach, a suite of indicators rather than a single indicator should be used to adequately report on ecosystem health, structure and function.[106] No single indicator exists which can adequately report on the whole ecosystem. A series of indicators is needed to describe all ecological, social and economic facets of the marine environment. These suites of indicators should be grouped under specific headings, such as ‘objectives which define ecosystem health’ or ‘indicators which describe ecosystem structure.’ Pinn agreed with this approach. Through the *Healthy and Biologically Diverse Seas Evidence Group Technical Report*, he evaluated a set of indicators against appropriate scientific and economic criteria to identify successful and operationally efficie3nt indicators that could provide a holistic assessment of all ecosystem components, as well as identify future indicator development needs.[107] He agreed with Gubbay and Rogers and

[104] S Rogers and M Tasker, “The Manchester Workshop on Marine Objectives: A Workshop to Identify Objectives in Support of the UK Vision for the Marine Environment” [2005] (CEFAS unpublished report) 43pp (p 5)
[105] S Rogers and M Tasker (2005) *supra* note 104 (p 5)
[106] Ibid, at p 21
[107] Pinn (2010) *supra* note 86 (Preface)

Greenway that indicators can be developed to communicate the quality, state and function of marine ecosystems and all of their components. Only with successful and operationally efficient marine indicators that can measure all aspects of the marine environment can an ecosystem based approach be achieved.[108]

Developing successful and operationally efficient environmental and marine indicators remains an extensive and demanding task. It is a work in progress, with incremental steps towards the desired objectives. But it is one that must continually be pursued at a national level to ensure that the UK's vision for a healthy marine environment, a stable social order and a growing economy become a reality. Because this is a continually evolving area, with new experts and various theories emerging every day, and national environmental and marine policies routinely changing and adapting, our understanding of indicator used in marine policy will continue to grow. The current literature review is by no means exhaustive. It is a starting point for a larger assessment that will continue to grow as our understanding of national environmental and marine indicator development progresses.

8.4 Concluding Remarks

The emphasis of this chapter has been the relevance of marine and environmental indicators within national policy. In the UK, indicators are being developed to measure progress towards sustainable development objectives.[109] This includes indicators designed to measure the environment, economic and social facets within national policy.

The research in this chapter has found that the UK fully endorses the use of indicators and the development of successful and operationally efficient indicators fit for purpose and designed to aid in their national policy objectives. In analyzing various national policy documents that directly impact the environment, a pattern has emerged. Nationally, the UK has been explicit on the development and use of environmental indicators in all pertinent environmental documents. Moreover, there has been a bottom-up and top-down approach to indicator development, demonstrating that as much as the UK is guided by the EU and international policies, it strongly influences these regimes. National environmental policy tends to focus on resource

[108] S Gubbay (2004) *supra* note 23 (p 70); Pinn (2010) *supra* note 86 (Summary)
[109] S Gubbay (2004) *supra* note 23 (p 15)

protection, biodiversity, economic stability and the protection of human health (i.e. major objectives of sustainable development). But because the economy plays such a large role in national environmental policies, the UK remains a strong player in the global pursuit for successful and operationally efficient indicators.

Besides being explicit on the use of indicators, national policies tend to be specific on the criteria that the indicators should be developed on and even the types of indicators that should be used. Arguably, these policies and their corresponding indicators are successful and operationally efficient because of this specificity. Indicators should be founded on the four core functions, as well as scientifically valid, anticipatory, policy relevant and other criteria to ensure their success, operationally efficiency and ability to communicate political objectives. Thus, the UK is an important player and advocate for indicator us, influencing higher level policies as much as it is influenced by them.

For example, Safeguarding Our Seas was explicit on the use of indicators, although it was not prescriptive on which indicators should be developed. It promoted a variety of indicators to measure pollution, ecological quality objectives, performance, environmental, state, etc. Although not specific on the indicators that should be developed and implemented, it was specific on indicator criteria. To meet the objectives of Safeguarding Our Seas, indicators should be founded on the four core functions, be scientifically valid, anticipatory, robust and broadly applicable, among others. Similarly, A Better Quality of Life promoted specific indicator criteria for success and operational efficiency. Beyond the four core functions, this included scientifically valid, transparent and anticipatory. But unlike Safeguarding Our Seas, A Better Quality of Life is prescriptive on which indicators to develop and use. It provides a suite of 150 sustainable development indicators to improve overall quality of life and to achieve greater prosperity with less environmental damage through improvement of societal conditions.

Although there are similarities between them, these policy documents recognize that indicators can be developed and applied in a variety of manners and still be successful and operationally efficient. Indicators can be used in different contexts and for different purposes. No single indicator or its corresponding criteria is more important than the next, nor can a single indicator measure all national policy objectives. The development and application of national indictors, although influenced by and contributing to higher policies, will be dependent on the user and objective the policy is designed to meet.

As discussed above, national policies influence and are influenced by policies and regulations that flow down from the EU and internationally. Thus, there is synergy between national environmental indicators and those used at the EU or internationally. This creates more effective management of the marine environment and points to a wider democratic function for indicators. For example, A Better Quality of Life is similar in approach to the EC's Sustainable Development Strategy, in that it seeks to use indicators founded upon specific criteria that will allow them to link the economy, society and the environment in a manner that transcends traditional sustainable development approaches. By aligning national objectives and corresponding indicators with those at the EU and international level, the Government can ensure standardization and effective communication of data, thereby improving the chances to achieve their environmental political objectives. This research has found that the use of marine indicators is cultivating a high degree of political authority and currency within national environmental policies. As such, it is becoming the foundation and framework for future marine policies and legalities.

Chapter 9: Marine Dredging and Aggregate Extraction Case Study

9.1 Introductory Comments

As this thesis has demonstrated, indicators are an important facet of contemporary marine management and regulation.[1] Yet, these indicators must be revised and updated periodically as our understanding of the marine environment develops. Through effective communication, provided by successful and operationally efficient marine and environmental indicators, scientists and regulators can work together to more accurately assess the impacts of human activities on the environment. To further explore the role and importance of environmental and marine indicators, a case study must be undertaken, where indicators can be examined more thoroughly in the context of an industry of significant national economic importance.

This chapter addresses the use of national indicators in the marine aggregate and dredging industry. This case study was prioritized by Defra, as they wanted an analysis of an economically important national industry that is heavily influenced by international, regional and national law and policy. The national marine aggregate industry crosses multiple disciplines, including science, law and economics, and reveals the utility of environmental indicators in a regulatory context. Although other case studies were available (i.e. fisheries, tourism), marine aggregate extraction was chosen because it was felt that an appropriately scaled analysis could be conducted and important facets of indicator development and use could be better addressed with this industry. This industry is complex, extremely important financially, but when addressed at a national scale, is manageable in terms of an analysis on successful and operationally efficient indicators. Although some international and EU laws and policies may be touched on in this chapter, the focus is more towards national laws and policies. This was to ensure that all Defra requirements for ME4118 were met, and to ensure that the research remained focused and effective.

[1] Atkins, *et al*, "Management of the Marine Environment: Integrating Ecosystem Services and Societal Benefits with the DPSIR Framework in a Systems Approach" [2011] Marine Pollution Bulletin **62**(2): pp 215-226; Aubry and Elliott, "The Use of Environmental Integrative Indicators to Assess Seabed Disturbance in Estuaries and Coasts: Application to the Humber Estuary, UK" [2006] Marine Pollution Bulletin 53: 175-185pp; Belfiore, "The growth of integrated coastal management and the role of indicators in integrated coastal management: introduction to the special issue" [2003] Ocean and Coastal Management **46**: 225-234.

Section 9.2 analyzes the indicators used by the industry to determine their success and operational efficiency. What are the driving forces behind historical and contemporary indicator development within national marine extraction and dredging? What key criteria, beyond the four core functions, makes an indicator successful within this industry? Are these indicators politically or scientifically driven and how does this impact upon their success? Section 9.3 reviews the national regulatory framework for the marine aggregate and extraction industry, and compares it with EU statutory requirements. It questions whether indicators are being successfully developed and efficiently implemented in both national policy and law for this industry. Are indicators successful and operationally efficient; are they meeting the objectives that they are designed for? What value do indicators hold for this industry? It draws upon specific scientific research to answer these questions and determine the current and future role of marine and environmental indicators in this industry. Lastly, section 9.4 examines the integration of law and science in indicator development and use. It provides an analysis on developing successful and operationally efficient indicators and applying those successful indicators within the current legal framework, to meet regulatory objectives.

9.2 Current Scientific Research/Indicators

Science is a curious companion to policy and law. Yet it is the foundation upon which indicators rest. Thus, it must be investigated and its relationship with these disciplines must be analyzed to determine whether the indicators used are policy driven, or based solely on science. As discussed throughout this thesis, to be successful and operationally efficient, indicators must be founded on the four core functions and appropriate criteria. These criteria include being scientifically valid and policy relevant. Thus, science and policy must be the foundation upon which environmental indicators are developed.

This section analyzes a variety of indicators pertinent to the aggregate industry to examine the underlying foundation for their success and operationally efficiency. It draws upon a study by Rees *et al*[2] and compares their work against similar studies on environmental and marine indicators in the national aggregate sector. It ties to the

[2] H L Rees *et al*, "Role of Benthic Indicators in Regulating Human Activities at Sea" [2006] Environmental Science & Policy 9 pp 496-508

main research questions of this thesis, as it asks if these indicators are truly successful and operationally efficient, and uses this information to determine the driving forces behind the indicators (Does law influence policy or policy influence law? What role does science play?).

The role of indicators in the marine aggregate dredging industry is examined by a variety of experts including Cooper,[3] Stiezenmuller *et al*,[4] Rice *et al*,[5] Alder *et al*,[6] Ware *et al*,[7] and Rees *et al*, among others.[8] This section explores a study undertaken by Rees *et al,* which investigates the relationship between science, policy and law to determine the characteristics of successful and operationally efficient indicators. It compares this study against other studies undertaken to uncover the driving force behind marine and environmental indicator development, and to determine whether indicators have made a significant impact upon the marine aggregate industry (research questions 7 and 8).

As discussed in Chapter 2, there are many criteria for the development of successful and operationally efficient indicators – often times criteria selection is user dependent. These criteria help ensure that the indicators can measure change with confidence and communicate this information to the appropriate decision-makers.

Indicators can be driven by policy or science, dependent on the type of criteria that they are founded on and the reasons behind their development. This is demonstrated by Hauge *et a*l, who argued that when indicators are selected to meet policy objectives, it is ultimately a political choice, not a scientific one.[9] Thus, if indicators are selected to meet political objectives, what role does science play? Is science marginalized for political purposes? To fully answer the questions of this thesis, we must now examine how indicators have been developed and applied in

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[3] Cooper, "Setting limits for acceptable change in sediment particle size composition following marine aggregate dredging" [2012] Marine Pollution Bulletin 64 pp 1667-1677

[4] Stiezenmuller *et al*, "Towards a spatially explicit risk assessment for marine management: Assessing the vulnerability of fish to aggregate extraction" [2010] Biological Conservation 143 pp 230-238

[5] Rice *et al*, "Indicators for sea-floor integrity under the European Marine Strategy Framework Directive" [2012] Ecological Indicators 12 pp 174-184

[6] Alder *et al*, "Aggregate performance in managing marine ecosystems of 53 maritime countries" [2010] Marine Policy 34 pp 468-476

[7] Ware *et al*, "Performance of selected indicators in evaluating the consequences of dredged material relocation and marine aggregate extraction" [2009] Ecological Indicators 9 pp 704-718

[8] H L Rees *et al* (2006) *supra* note 2

[9] K H Hauge *et al*, "A Framework for Making Qualities of Indicators Transparent" [2004] ICES Journal of Marine Science 62(3) pp 552-557 (p 552)

recent case studies relating to the effects of a specific industry, in this case, the national marine aggregate dredging and extraction industry. These case studies analyze the environmental impacts of marine aggregate dredging, as well as the effectiveness of indicators in communicating these changes to regulators.

Within these scientific studies, similar techniques and indicators were used to assess human impacts on the benthos from dredging and extraction activities – see Whomersley *et al*,[10] Boyd *et al*,[11] Cooper (2012),[12] Stiezenmuller *et al* (2010),[13] *inter alia*. Five specific studies will be examined here, which are directly linked to indicators and the marine aggregate dredging industry. Table 9.1. summarizes these case studies and compares them against the study by Rees *et al.*

Table 9.1: Summary of the case studies reviewed in this section, which are compared against the study by Rees *et al.*

Case Study	Indicator(s) Reviewed	Purpose of Indicators?	Analysis / Drivers of Indicator Development	Criteria	Successful?	Source
Sewage Sludge Disposal off the Tyne Estuary	- Macrofauna abundance (univariate variable)	To measure benthic communities after human impact	-Instantaneous measure of ecosystem structure -Activity specific -Natural variations occur -Multiple activity levels -Not developed specifically for these case studies -Single mode of application	*Scientifically valid *Simple *Easy to communicate *Show spatial or temporal trends *Sensitive *Cost-effective	Yes – no specific criteria were given, but criteria were inferred and the indicators met the objectives they were designed for. Also, the indicator would be accepted by the scientific community.	Rees *et al*

[10] Whomersley *et al*, "The Use of Time-Series Data in the Assessment of Macrobenthic Community Change After the Cessation of Sewage-Sludge Disposal in Liverpool Bay (UK)" [2007] Marine Pollution Bulletin 54 pp 32-41
[11] Boyd *et al*, "Assessment of the Re-habilitation of the Seabed Following Marine Aggregate Extraction" [2004] Science Series Technical Report 121 154pp
[12] Cooper (2012) *supra* note 3
[13] Stiezenmuller *et al* (2010) *supra* note 4

Changes to benthic communities following the cessation of marine aggregate extraction off the Thames estuary	-Number of taxa (univariate variable)	To measure changes in species densities and diversity following the cessation of dredging.	-Instantaneous measure of ecosystem structure -Activity specific -Natural variations occur -Multiple activity levels -Not developed specifically for these case studies -Single mode of application	*Scientifically valid *Simple *Easy to communicate *Shows spatial or temporal trends *Sensitive *Cost-effective	Yes – no specific criteria were given, but criteria were inferred and the indicators met the objectives they were designed for. Also, the indicator would be accepted by the scientific community.	Rees *et al*
Marine aggregate dredging and benthic macrofauana	-Species Biomass (univariate variable)	To measure the state of benthic communities due to intensive human impacts.	-Measure of environmental /ecological quality status -Composed of primary variables -Instantaneous measure of ecosystem structure -Activity specific -Multiple activity levels -Single mode of application	*Scientifically valid *Responsive *Simple and easy to communicate *Shows spatial and temporal trends *Sensitive	Yes – no specific criteria were given, but criteria were inferred and the indicators met the objectives they were designed for. Also, the indicator would be accepted by the scientific community.	Newell *et al*

Cumulative impacts of multiple sites of aggregate extraction on macro-invertebrate communities	-MDS plots -Pair-wise similarity -Cluster analysis (multivariate variable)	To measure changes to benthic communities, sediment structures and taxonomic composition within the extraction area and those located in non-impacted areas.	Drivers are similar to the 3 case studies above: -Measure of environmental /ecological quality status -Activity specific -Multiple activity levels	*Scientifically valid *Responsive *Sound and statistically robust *Cost effective Criteria that they should be founded on, but which they were not: *Show spatial and temporal trends *Sensitive *Provide early warning	Somewhat – because they are more complex derivations, they can be more readily misunderstood. Plus, they could not communicate all criteria that they should have. Thus, their success and operational efficiency is user dependent, and not as effective in this study as their univariate counterparts.	Cooper *et al*
Biological Indicators and Human Activities at Sea	-Number of species -Number of individuals -Shannon-Weiner Diversity Index -Total Taxonomic Diversity -Average Taxonomic Diversity	To measure human impacts from marine dredging and aggregate extraction activities	-Drivers are similar to the cases discussed above	*Easily understood *Sensitive *Linked to specific activities *Responsive *Subject to small error	Yes – Number of species, Number of individuals, Shannon-Weiner Diversity Index and the Average taxonomic diversity were found to be the most successful. Success depends on the underlying science, as well as indicator criteria, survey design and how the indicator is applied.	Sneddon *et al*

9.2.1 Case Studies 1 & 2: Sewage Sludge Disposal & Aggregate Extraction

The first two case studies were scientific studies undertaken by Rees, *et al*. Case study 1 assessed the effects of sewage-sludge disposal off the Tyne estuary. It examined indicators developed to evaluate the status of benthic communities after human impacts.[14] It compared these indicators against the targets established for acceptable change.[15] This particular study adopted the 'the control/treatment pairing principle', which communicates ecological changes via the application of biological EQSs (a.k.a. 'Action Points' or limit values).[16] The study found similarities between macrofauna abundance in the sewage-sludge disposal sites of the Tyne estuary and reference stations located further to the south.[17] Thus, a comparison can be made of macrofauna abundance between both stations.[18] The study also used other indicators (such as plots of ratios of abundance) to demonstrate that the activities were in compliance for the duration of the disposal.[19]

Case study 2, on the other hand, addressed changes to benthic communities following the cessation of marine aggregate extraction off the Thames estuary. Data on T/R ratios[20] was gathered for macrofauna abundance and numbers of taxa.[21] These ratios were used to determine changes in species densities and diversity following the cessation of dredging activities.[22] The macrofauna abundance and taxa was collected for a reference site, an area of low dredging intensity, and a site of high dredging intensity.[23] The T/R ratios suggest that species abundance improved in 2002 at the site of low dredging.[24] Furthermore, taxa ratios for this area were close to equal for all years, suggesting that natural sediments and deposits are nearly identical in terms of community structure.[25] On the other hand, macrofauna abundance and taxa were significantly lower for the site with high dredging, suggesting that dredging leads to an initial reduction in species densities and diversity.

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[14] H L Rees *et al* (2006) *supra* note 2 (p 500)
[15] Ibid, at p 500
[16] Ibid, at p 500
[17] Ibid, at p 500
[18] Ibid, at p 500
[19] Ibid, at p 500
[20] T = 'Treatment' stations and R = 'Reference' stations.
[21] Ibid, at p 500-501
[22] Ibid, at p 500-501
[23] These were collected from surveys undertaken between 2000 and 2002.
[24] Ibid, at p 501-502
[25] Ibid, at p 502

The univariate indicators[26] used in these two case studies (macrofauna abundance and taxa) were developed to link the impacts of two human activities (sewage-sludge disposal and aggregate extraction) to changes in benthic assemblages. They are univariate variables, which are also instantaneous measures of ecosystem structure.[27] Furthermore, these two indicators are activity specific – they measure change in the surrounding environment based on the human activity that is occurring. And although natural variations do occur in species numbers and densities, it is highly likely that the changes observed in these case studies are caused by human impact. These two indicators can be applied across multiple activity levels, including local and national activities.[28] They were not developed specifically for the Tyne and Thames case studies, but instead, were designed to measure the impacts of these types of activities. Furthermore, Rees *et al* chose a singular mode of application for these two indicators – i.e. they were used as 'stand-alone' measures to communicate changes in the benthic communities.

According to the research of Rees *et al*, an indicator is accepted by the scientific community if it is successful, operationally efficient, able to determine the boundaries for acceptable change in the environment and based on expert judgment.[29] An empirical model was used to generate the indicator macrofauna abundance used in the case study of the Tyne estuary. This model required knowledge of the current state of the macrofauna abundance, as well as a historical knowledge of sewage disposal at the site and the dispersive characteristics of the receiving waters.[30] Thus, this indicator is proven to be scientific valid and are accepted by the scientific community.[31] On the other hand, historical knowledge of the number of taxa used in the Thames estuary case study was not as abundant.[32] Thus, more current information was applied, which

[26] A univariate measure can be primary or derived variables each of a single number (i.e. S, A, B, H', *inter alia*.), whereas multivariate measures encompass more than one variables, e.g. tests based on all species in a community.
[27] They quantify values of direct measurement, as opposed to measuring processes or functions, such as sediment toxicity or nutrient flux.
[28] They were locally applicable because they demonstrated the effects of sewage dumping and aggregate extraction on the biological benthic communities of the sites under investigation. They were nationally applicable because they demonstrated the effectiveness of current policy/management strategies.

according to Rees *et al*, still makes the indicator scientifically valid and accepted by the scientific community.

The success of these two indicators is also determined by the criteria they are founded upon and their ability to communicate the objectives they were designed for. No specific criteria for indicator success is mentioned within these two studies. However, an analysis of the indicators that they used found that beyond the four core functions, the indicators should be scientifically valid, simple and easy to communicate, show spatial or temporal trends, be sensitive (i.e. provide early warning of adverse effects), and be cost-effective.[33] From this analysis, it is arguable that the indicators used in these two case studies met these criteria, and thus, were successful and operationally efficient. The indicators met the objectives that they were designed for and communicated the intended information. Thus, these indicators illustrate one approach to monitor for human impacts on benthic communities in national waters.

9.2.2 Case Study 3: Marine Aggregate Dredging & Benthic Macrofauna

Newell *et al* examined the impacts of marine aggregate mining on key features of benthic biological community structures.[34] They assessed the extent of the impacts beyond the immediate dredged area, as well as the nature and rate of recolonization and recovery within the dredged areas.[35] This study used similar indicators to those developed by Rees *et al*. These included such measures as the total number of taxa, the mean number of species (the species variety), and the mean number of individuals (the population density).[36] Additional indicators were also developed to support the hypothesis that intensive dredging can result in a reduction in species variety, number of individuals, and biomass of the marine benthos, thereby having an adverse impact on community composition of the benthic macrofauna.[37] These indicators included such measures as species diversity, mean biomass of the samples collected, mean body size of the organisms (the growth of the individuals), and sediment particle type and size.[38] Additionally, such indicators as percent reduction of each indicator compared to average background values, species area curves, K dominance curves, community

[33] H L Rees *et al* (2006) *supra* note 2 (p p 500)
[34] R C Newell *et al*, "Impacts of Marine Aggregate Dredging on Benthic Macrofauna off the South Coast of the United Kingdom" [2004] Journal of Coastal Research 20 (1) p 115-125 (p 116)
[35] Ibid, at p 116
[36] Ibid, at p 118, 120 & 122
[37] Ibid, at p 115 & 123
[38] Ibid, at p 117 - 122

composition for the infauna of deposits in the dredged site (determined through multivariate analysis techniques), and the distribution of the main faunal communities were also used in this study.[39]

One univariate indicator, species biomass, was analyzed to determine its success and operational efficiency, as well as its ability to assess the effects of dredging activities on benthic communities and influence management decisions regulating such activities.

In assessing the drivers of species biomass, it is evident that the indicator is a measure of environmental/ecological quality status. It measures the state of benthic communities due to intensive human impacts. Furthermore, since it is a univariate measure, it is composed of primary variables.[40] This indicator also represents an instantaneous measure of ecosystem structure – it quantifies a value of direct measurement of the environment. The indicator is activity specific, in that its response to change in the surrounding environment is directly related to the activity (i.e. the aggregate dredging). Data taken from sites outside the vicinity of the dredging activity showed little evidence of impact on benthic community structures. This indicator is locally and nationally applicable – it can demonstrate the effects that intensive aggregate dredging has on benthic macrofauna and community structure, as well as contribute to policy frameworks and implementation of legislation. Arguably, this indicator can also be applied at an international level, in that the authors sought to contribute their data to a larger sea assessment. Newell *et al* chose a singular mode of application for this indicator. It is a stand-alone measure of change resulting from human impacts.[41] However, biomass alone is not necessarily evidence of impacts from aggregate dredging. Hence it is combined in the study with other indicators, such as species numbers, number of individuals, and body size – to provide further proof of the negative impacts of intensive dredging.

To determine if species biomass is an acceptable indicator for measuring changes in the environment within the scientific community, we must determine how this indicator was generated. Newell *et al* used a conventional and widely-accepted

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[39] R C Newell *et al* (2004) *supra* note 34 (p 117 – 122)

[40] Although achieved from conversion factors, biomass is not considered a multivariate or derived value, as these are composed of indices and complex suites of indicators.

[41] H L Rees *et al* (2006) *supra* note 2 (p 498)

conversion factor for each of the faunal groups to determine the ash free dry weight (AFDW – taken from Eleftheriou and Basford[42]). They combined this with data that they had recently collected, as well as historical information to determine the impact of the dredging activity on the site. Thus, since the indicator is based upon data collected in accordance with scientific due process, as well as acceptable and conventional means for sampling biomass, the indicator would be accepted by the scientific community.

But the success of this indicator also depends upon the criteria on which it was developed. This indicator is a univariate measure used in field surveys of benthic communities. It appears frequently throughout the literature as a tool to measure and communicate national dredging and extraction activities (Sneddon *et al*[43]; Boyd *et al*[44]; Reiss and Kroncke[45]). For example, Sneddon *et al* argued that basic information, such as the number of species and individuals, can be an important way to identify the effects of anthropogenic activities on the benthos.[46] Furthermore, Pearson and Rosenberg asserted that the basic quantitative parameters in almost all benthic ecological investigations are the number of species, their abundance, and biomass.[47] Additionally, it is responsive to disturbances and can measure impacts along well-defined and known gradients. Thus, as mentioned above and further proven here, species biomass is scientifically valid. The data is simplistic in nature and readily understood by non-technical personnel (simple and easy to communicate). Species biomass also shows spatial and temporal trends due to human impacts. Newell *et al* provided clear evidence that stations located outside of areas of extensive dredging displayed macrofaunal assemblages that were 419% higher in biomass than similar sites within the licensed dredged area.[48] Furthermore, biomass was suppressed by 80-90% in previously dredged sites and this suppression persisted for periods in excess

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[43] Sneddon *et al*, "Comparative Evaluation of Biological Indicators of Change in Response to Human Activities at Sea" [2006] Monitoring of the Quality of the Marine Environment, CEFAS Science Series Technical Report No. 58 p 82-97
[44] Boyd *et al* (2004) *supra* note 11
[45] Reiss and Kroncke, "Seasonal Variability of Benthic Indices: An Approach to Test the Applicability of Different Indices for Ecosystem Quality Assessment" [2005] Marine Pollution Bulletin 50 pp 1490-1499
[46] Sneddon *et al* (2006*) supra* note 43 (p 82)
[47] T H Pearson and R Rosenburg, "Macrobenthic Succession in Relation to Organic Enrichment and Pollution of the Marine Environment" [1978] Oceanography and Marine Biology Annual Review 16 pp 229-311 (p 231)
[48] R C Newell et al (2004) supra note 34 (p 121)

of 18 months after cessation of dredging.[49] Species biomass is also sensitive and can provide early warnings of adverse effects and significant change.[50] Thus, a change to species biomass (such as a decline in calculated AFDW), infers negative impacts on the benthos from human activities. Lastly, species biomass is cost effective. It is easily derived from either readily-available data, or from surveys undertaken in various dredging and extraction sites.

Thus, although no specific indicator criteria were required by this study, the criteria discussed above was inferred. And since the indicator analyzed in this subsection was founded on pertinent criteria and met the objectives that it was designed for, and since it is accepted by the scientific community, it can be argued that this indicator is successful and operationally efficient. Species biomass can successfully assess the effects of human impacts on benthic communities, as was demonstrated in the above study and further examined in this analysis.

9.2.3 Case Study 4: Impacts of Aggregate Extraction on Macro-invertebrates

Cooper *et al* investigated the cumulative impacts from multiple sites of aggregate extraction on benthic macro-invertebrate communities.[51] Similar techniques and indicators to those used by Rees *et al* and Newell *et al* were used to investigate these impacts. Their survey included such univariate indicators as the total number of individuals, the total number of species and particle size distribution of sediments. Furthermore, it included such multivariate indicators as multidimensional scaling ordination (MDS) plots, pair-wise similarity calculations, data clustering, similarity profiling, and the BIOENV procedure.[52] These multivariate techniques were undertaken for both macrofaunal assemblage data and percentage particle size data.

Three multivariate indicators were chosen to analyze their success and operational efficiency: MDS plots, pair-wise similarity and cluster analysis. These indicators are used to evaluate the difference between groups of samples, as well as to identify the level of 'within-group' sample similarity.[53] They are complex indicators

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[49] R C Newell et al (2004) supra note 34 (p 122)
[50] H L Rees *et al* (2006) *supra* note 2 (p 503)
[51] Cooper *et al*, "Cumulative Impacts of Aggregate Extraction on Seabed Macro-Invertebrate Communities in an Area off the East Coast of the United Kingdom" [2007] Journal of Sea Research 57 pp 288-302 (p 288)
[52] Ibid, at p 291-294
[53] Ibid, at p 294

that combine the data from univariate measures to communicate the distribution of the various macrofaunal communities both within the extraction area and those located in non-impacted areas.

These three multivariate indicators were developed to measure human impacts from dredging and extraction activities (similar to the univariate indicators discussed above). Cluster analysis, MDS ordination plots, SIMPER analysis, and pair-wise similarity are techniques that are used frequently in field surveys to assess human impacts on the environment. They frequently appear in the literature (Whomersley *et al*[54]; Boyd *et al*[55], Bolam *et al*[56]) and can measure changes to benthic communities, sediment structures, and taxonomic composition over time.[57] Furthermore, these measures are often responsive to disturbances within the environment, and therefore, can measure impacts along well-defined gradients. These multivariate indicators have been accepted in the global scientific community (as is evident by the literature), and are sound and statistically robust. Thus, they are scientifically valid. Arguably, these multivariate indicators are not as simple and easy to communicate. The statistics underlying these indicators are highly technical, which can make it difficult for non-scientists to understand these indicators. Thus, although these indicators are effective, their success and operational efficiency will be user dependent due to the complex derivations that they are founded on. Nevertheless, multivariate indicators offer tremendous insight into the complexities and variability of the environment – something their univariate counterparts often lack. Additionally, these three multivariate indicators are cost effective. They are easily derived from data obtained during surveys and multiple analyses can be calculated from the same raw data.

Arguably, these multivariate indicators can show spatial and temporal trends. Yet, this was not achieved in the Cooper *et al* study. They found that although the measures are theoretically capable of displaying trends in both time and space, the multivariate analyses of the macrofaunal data were unable to discriminate between

[54] Whomersley *et al* (2007) *supra* note 10
[55] Boyd *et al* (2004) *supra* note 11
[56] Bolam *et al*, "Maintenance Dredged Material for Habit Restoration: Furthering our Understanding of Invertebrate Recolonization Processes" [2006] Monitoring of the Quality of the Marine Environment, CEFAS Science Series Technical Report No. 58 168pp
[57] This goes beyond the scope of the more simplistic univariate indicators, but it's important to note that these multivariate analyses are intended to complement the data based on the univariate measures.[57]

'direct', 'indirect' and 'reference zones.[58] For example, the MDS ordination plots should have demonstrated statistical differences between the sample groups across the three zones, but this did not occur.[59] Mean numbers of species (S) and individuals (N) (univariate indicators used in the study), however, were able to illustrate the statistically significant differences between the 'direct' and 'reference' areas.[60] Thus, the credibility of these multivariate measures to show spatial and/or temporal trends was weakened, which arguably does impact on the true success and operational efficiency of the indicators.

Furthermore, these three multivariate indicators can be sensitive and provide early warning of adverse effects.[61] However, again, this was not clearly illustrated within the Cooper *et al* study. The cluster analysis and pair-wise similarity indicators were able to determine small statistical differences between the various faunal groups, thereby illustrating the negative impacts that aggregate extraction inflicts on the benthic communities. However, the MDS ordination plots were unable to depict such sensitivity.[62] They showed no significant difference between sample groups from the three impact zones.[63] Yet, once again, plots of the mean numbers of species (S) and individuals (N) suggested a negative correlation between the status of the benthic fauna and the severity of impact, which was evident across all major taxonomic groups.[64] Thus, univariate indicators were more sensitive in this study than multivariate indicators.

In conclusion, these three multivariate indicators are somewhat successful and operationally efficient. Because they are derived complex computations, they can be more readily misunderstood. Plus, they were not founded on all appropriate criteria that they should have been. In this study, they were lacking spatial and temporal trends, sensitivity and communicating early warnings. Thus, their success and operational efficiency was not as prevalent as it could have been and arguably is user

[58] Cooper *et al* (2007) *supra* note 51 (p 300)
[59] Ibid, at p 298
[60] Ibid, at p 300
[61] H L Rees *et al* (2006) *supra* note 2 (p 503)
[62] Cooper *et al* (2007) *supra* note 51 (p 298)
[63] Ibid, at p 298
[64] Ibid, at p 298-299

dependent. This analysis found that these three multivariate indicators were not as effective in this study as their univariate counterparts.

9.2.4 Case Study 5: Biological Indicators and Human Activities at Sea

Sneddon *et al*[65] analyzed summary measures of benthic community structures and found that specific univariate measures were more adept at depicting changes from human activities than their multivariate counterparts. These measures are listed in Figure 9.1. Sneddon *et al* rationalized each of these indicators and their ability to measure human impacts from marine dredging and aggregate extraction activities. For example, they reasoned that the number of species (S) and individuals (N) represent the simplest and most widely used univariate expressions of ecosystem structure, while the Shannon-Weiner Diversity Index (Shannon and Weaver, 1949) combines the species richness and dominance components of diversity.[66]

They chose four sites around England to test these indicators and ranked them on a scale of 1 (poor) to 5 (good) according to the following criteria: easily understood, sensitive, linked to specific activities, responsive, and subject to small error.[67] The number of species, the Shannon-Weiner Index, the number of individuals and the Average Taxonomic Diversity were found to express the biological data in a way that best fit the desired criteria for an environmental indicator.[68] The drivers of indicator development are similar to the ones discussed in the previous case studies, and so, will not be discussed here. Sneddon *et al* stressed that the success of an indicator depends on a variety of factors beyond science, including survey design, how the indicator is applied, and the criteria upon which the indicators are founded.[69] Consequently, factors beyond science can influence the success of an indicator.

9.2.5 Summary

In conclusion, there are many indicators of community structure used in the aggregate dredging and extraction industry. These aim to show the natural and human-induced changes to an area. They are sometimes based on an accepted paradigm (such as the Pearson & Rosenberg model). They must also show inherent variability and then build

[65] Sneddon et al (2006) *supra* note 43
[66] Ibid, at p 83-84
[67] Ibid, at p 92
[68] Ibid, at p 96
[69] Ibid, at p 96, 92

this into a signal: noise ratio. The indicators explored in this Section are founded on science, but are often heavily influenced and driven by policy in both their development and use. As noted by Hauge *et al*, when indicators are selected by regulators to meet policy agenda it is a political choice, not necessarily a scientific one, as these indicators are designed to meet specific policy objectives.[70] This can create tension between scientists and regulators. Arguably, science can objectively evaluate indicators because it is driven by the data itself, and not political objectives.

Consequently, section 9.3 will assess national policies and regulations of the marine aggregate and extraction industry, to determine the success of the regulatory framework in using environmental indicators for their intended scientific rationale. Science maintains a firm foothold in the development of environmental quality indicators. But is scientific validity lost in the cross-over between science and policy/regulation – i.e. is the science marginalized by both the desire to meet set political agenda and the necessity to establish a firm regulatory framework?

9.3 National Regulatory Framework

The national marine aggregate and dredging industry is highly complex, involving a wide array of agencies, regulators and stakeholders. It is subject to a range of policies, legislation and other regulatory control. Historically, government activity in this area has been seen as fragmented, overlapping and cumbersome.[71] Figure 9.2 illustrates the geographical range of controls for principal marine works in England and Wales. Although some of these regulations are now out of date (i.e. FEPA), they are still important for a discussion on the historical and current development and application of indicators in marine aggregate dredging and extraction.

This section is divided into four subsections that address important historic and contemporary legislation influencing indicator development in the marine aggregate dredging and extraction industry. Section 9.3.1 reviews the Coast Protection Act (CPA),[72] its historic impacts on marine aggregate dredging and extraction, and its influence on contemporary indicator development within this industry. Section 9.3.2

[70] K H Hauge *et al* (2004) supra note 9 (p 552)
[71] Boyes *et al*, Regulatory Responsibilities & Enforcement Mechanisms Relevant to Marine Nature Conservation in the United Kingdom' [2003] Report 2 to JNCC 52pp (p 47)
[72] *Coast Protection Act 1949* (c.74) (Para 1-50)

discusses the Food and Environment Protection Act (FEPA),[73] its influence on the marine aggregate dredging and extraction industry, and the historical context for indicator development that resulted from this legislation. Section 9.3.3 analyzes the importance of indicator development within the 2007 Extraction of Minerals by Marine Dredging Regulations.[74]Lastly, Section 9.3.4 analyzes the Marine and Coastal Access Act 2009 (MCAA),[75] its influence on the marine aggregate dredging and extraction industry and the importance of indicators within these current regulations.

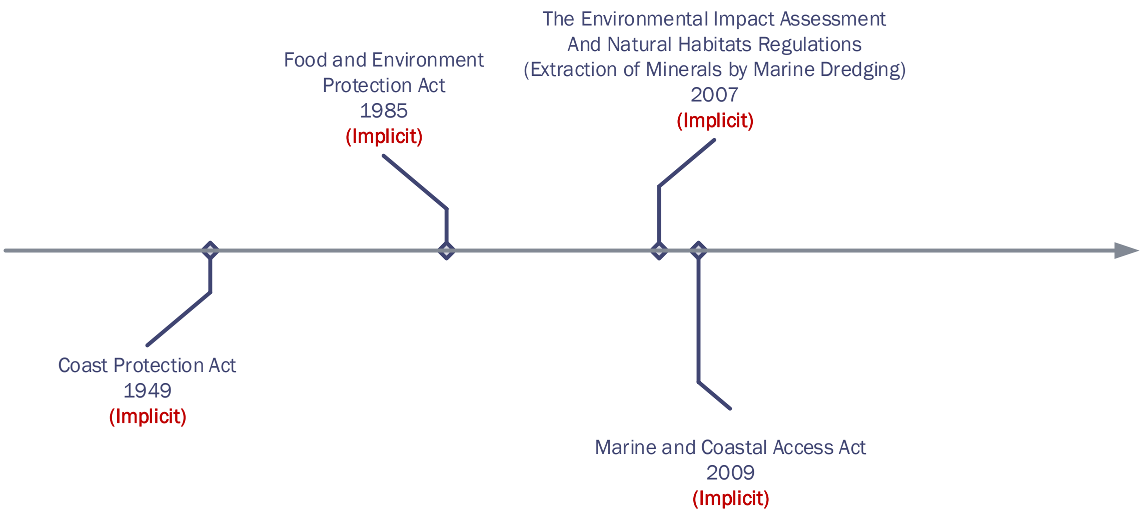

Figure 9.1: Timeline of national legal instruments governing the marine aggregate dredging and extraction industry which are analyzed in this section. These are discussed in chronological order within this section. The timeline demonstrates that for all four statutory legislations, indicators are implicit within the text of the document. The subsequent analysis provided in this chapter explores the progressive development and application of indicators over to answer research questions 1-7.

As seen in Figure 9.1, although the word indicator is not explicit in the regulations that will be discussed in this section, they are nonetheless implied, often times through the use of 'relevant scientific information'.[76] These regulations have in one way or another influenced indicator development within this industry and thus, warrant a discussion here.

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[73] Food and Environment Protection Act 1985, c. 48

[74] The Environmental Impact Assessment and Natural Habitats (Extraction of Minerals by Marine Dredging.) (England and Northern Ireland) Regulations 2007, SI 2007/1067

[75] Marine and Coastal Access Act 2009, c. 23

[76] As found in Paragraph 7(2) of the Offshore Marine Conservation Regulations

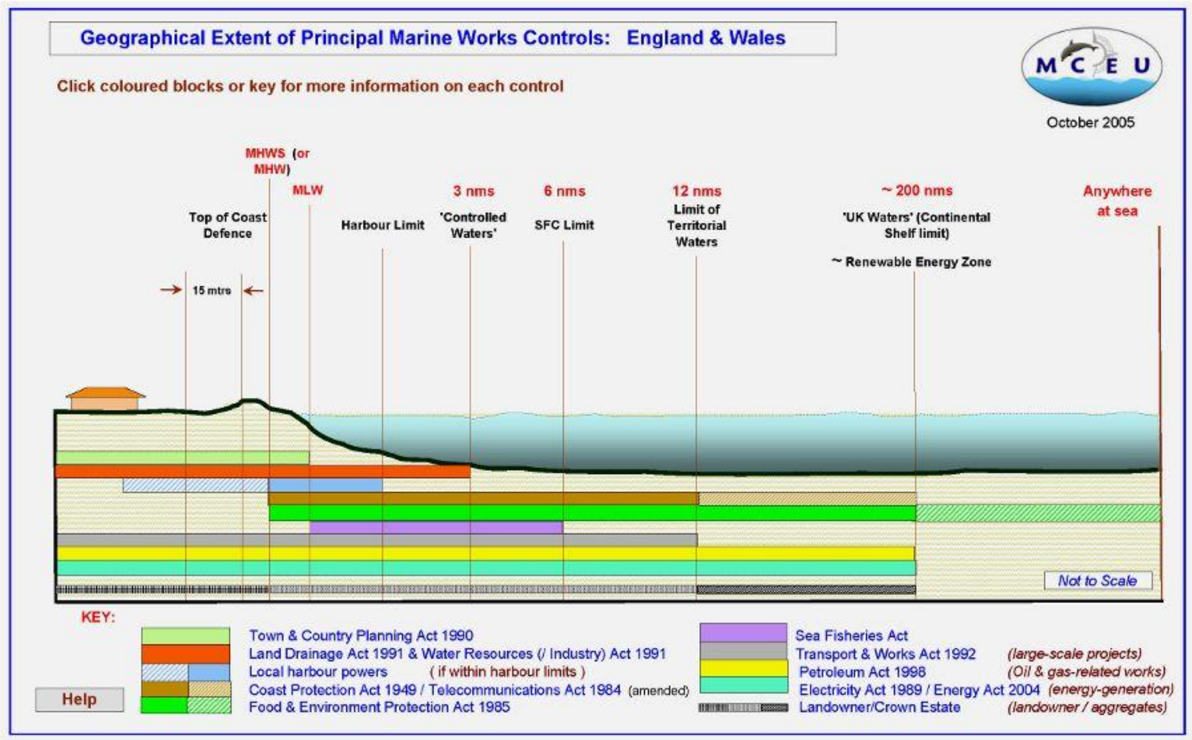

Figure 9.2: Schematic diagram illustrating the historic regulatory controls on aggregate extraction and marine dredging within England and Wales. As is seen from this diagram, the regulations have historically been fragmented, overlapping and cumbersome. Taken from MCEU (2007) <http://www.mceu.gov/MCEU_LOCAL/IMAGES/consentsprofile.pdf>[77]

9.3.1 CPA

The CPA was designed to protect the English coast by regulating harbor works, deposits of materials on the seashore, and the removal of materials from the seashore below the mean low water springs (MLWS).[78] This regulation is important in a chapter discussing marine dredging and aggregate extraction, as historically, the CPA was one of the pieces of legislation regulating this industry. This has since been replaced by the new Marine and Coastal Access Act 2009 (which will be discussed later in this section), but nonetheless, this legislation had an early impact on the development and use of marine indicators within this industry.

There are no requirements within the regulation for the use of scientific information or indicators to issue a consent. As a matter of fact, indicators are not even implied within the main text of the CPA. Indicators would only become important once a consent to perform harbor works is granted. If a proposed project

[77] MCEU, "What Consents Apply…and Where? Controls: Geographical Jurisdiction" (2007) <http://www.mceu.gov.uk/MCEU_LOCAL/fepa/Consents-extent.htm> accessed 8 October 2007
[78] Coast Protection Act *1949 supra* note 72 (Para 34(1))

was deemed a 'relevant project', then the applicant would be required to produce an Environmental Statement (ES) and include all pertinent information. An ES is a systematic means of drawing together a project's likely significant environmental effects through such data as environmental indicators, making indicators an important function of the ES.[79] It ensured that human impacts from the project were minimized and communicated to the public and the relevant authorities.[80] Furthermore, an ES used indicators to provide environmental assessments to avoid or mitigate adverse effects from these proposed projects, where possible.[81]

The information that was required in an ES to grant consent for a proposed project was fleshed out in Schedule 1 of the regulation.[82] It is here where indicators are implied to measure such aspects as water and air quality, soil composition, changes in water temperature, changes in fish population assemblages, the estimated tonnage that will be removed during the project, the length of time that the project will run, and the number of hours dredged daily. Successful and operationally efficient indicators could communicate projects which have the least amount of environmental impact, thereby meeting the requirements of Schedule 1 to prevent, reduce, remedy or offset any significant adverse effects on the environment.[83]

Schedule 1 also required the ES to include a description of the environment likely to be significantly affected by the proposed project.[84] Thus, indicators could be used to measure population changes, fauna and flora, soil composition, climatic factors (such as carbon dioxide, nitrogen or other greenhouse gases), as well as architectural and archaeological points of interest. Indicators were also needed to measure the likely significant effects of the proposed project on the environment.[85] These included such indicators as macrofauna abundance data, organic enrichment of the sediment at the activity site, biological EQSs for acceptable levels of change, the percent reduction of each indicator compared to average background values, as well as the numbers of taxa, species variety and population density of organisms located in

[79] CEFAS *Offshore Wind Farms: Guidance Note for Environmental Impact Assessment in Respect of FEPA and CPA Requirements* (2004) 48pp
[80] Ibid, at p 4
[81] Ibid, at p 4
[82] Coast Protection Act 1949 *supra* note 72 (Schedule 1)
[83] Ibid, at Schedule 1
[84] Ibid, at Schedule 1
[85] Ibid, at Schedule 1

the activity site. Hence indicators were an important part of the ES process within the CPA.

Schedule 2 of the CPA also implied the use of indicators to determine whether the proposed project constituted a relevant project.[86] This included indicators for existing land use, the mean biomass of samples collected (before, during and after the activity), as well as the spatial extent of the area dredged, the size of the affected population, MDS plots, and cluster analysis.

The success and operational efficiency of these implied indicators was historically user dependent, as no specific indicator criteria was provided within the regulations. Based on what has been discovered during the course of this thesis, the indicators should have been founded on the four core functions and relevant criteria for the situation, to ensure that they were fit for purpose and could measure the objectives they were intended for. Since each ES was project specific, the indicators and the criteria upon which they were based was specific to that ES, to ensure the proper information was communicated.

In conclusion, although protection of the environment was not stipulated within the CPA and indicators were not explicit, they were valuable to the Harbor Works Regulations. Without the data provided by indicators, licensing authorities would be unable to adequately assess the effects of the proposed project and thus, unable to issue a consent under the guidelines of the CPA. Historically, indicators helped achieve the objectives of this regulation.

9.3.2 FEPA

FEPA was designed to govern such works as dredging, waste disposal, marine developments, and coastal defenses.[87] Similar to the CPA, this regulation warrants a discussion in a chapter on marine dredging and aggregate extraction, as historically, the FEPA was one of the pieces of legislation regulating this industry. It has since been replaced by the new Marine and Coastal Access Act 2009, but nonetheless, had an early impact on the development and use of marine indicators within this industry and so must briefly be analyzed here.

[86] Coast Protection Act 1949 *supra* note 72 (Schedule 2)
[87] Food and Environment Protection Act 1985 *supra* note 73 (Para 8(3)(a)(i) and 8(4)(a)(i))

The objectives of the licensing controls within FEPA was to protect the marine environment, living resources and human health.[88] The licensing authority could require additional information, including indicators, to communicate the effects of an activity on the surrounding environment. Consequently, although not explicit on indicators, FEPA implied their use to monitor national marine aggregate dredging and extraction activities. Indicators were implied in Schedule 4 of the legislation, which required applicants to obtain information about the environment in order to minimize potential environmental effects.[89]

FEPA did not specify which criteria the indicators should be founded on, other than that they should communicate sufficient information for the regulator to make a decision (i.e. be founded on the four core functions). In other words, it required that the licensing authority have regard to the marine environment and all living resources when issuing a license, but left the choice, success and operational efficiency of the indicator to the user (i.e. the regulator).[90] They could mandate the criteria for the indicators (to maximize success) within the provisions of the license, but that was based on the regulators interpretation.[91]

Some examples of the indicators that could be used to meet these requirements included the tonnage of sediment removed from the sea bed, the amount of emissions released into the air or water from mechanical equipment, the duration of the marine works, the size of the project, the spatial extent of the area impacted by the project, and the percent reduction of each indicator in comparison with background conditions or natural variations. Other indicators included biological aspects, such as species numbers, numbers of taxa, species variety, population density and macrofauna abundance data. Physiochemical and geological indicators included water quality, organic enrichment of the sediments at the activity site, sediment particle type and size, the effects on seabed morphology and the amount of resources used during the project. If the information communicated from the indicators demonstrated negative impacts on the marine environment, the licensing authority could deny the application,

[88] Food and Environment Protection Act 1985 *supra* note 73 (Para 8(1))
[89] Ibid, at Schedule 4(9)
[90] Ibid, at Para 8(3) and (5)
[91] Ibid, at Para 8(4)

could approve the application with stipulations and provisions, or could suggest that the applicant use alternative methods to those proposed within the application.

In conclusion, although indicators were not mandated or explicit within FEPA, they were nonetheless valuable to achieving the objectives of the regulations. Similar to the CPA, FEPA helped lay the foundation for the development and use of indicators in the current legislation governing marine dredging and aggregate extraction today. Their success was user dependent, which allowed human error to affect decisions from time to time, but overall, indicators represented an important source for information regarding the licensed activity that was regulated under FEPA.

9.3.3 2007 Regulations

The Environmental Impact Assessment and Natural Habitats (Extraction of Minerals by Marine Dredging) (England and Northern Ireland) Regulations 2007 formalize and mandate the application process for marine mineral extraction projects.[92] It requires Environmental Statements, that must include at the very least the information set out in Part 1 of Schedule 1 (Minimum Requirements) and any additional information laid out in Part 2 of Schedule 1 (Additional Requirements) in order to assess all environmental effects related to the proposed project.[93] Although there is no explicit requirement for indicators within the 2007 Regulations, similar to the CPA, indicators are implied as a means to communicate the information needed for the ES.

The minimum requirements which must be addressed in the ES include such information as the site, design and size of the project, as well as measures to mitigate or remedy significant adverse effects that the project could have on the environment.[94] The additional requirements include such information as an estimate of expected residues and emissions by type and quantity (water, air and soil pollution, noise, vibration, light, heat, radiation), as well as a description of the aspects of the environment likely to be significantly affected by the proposed project (i.e. population, fauna, flora, soil, water, air).[95] Some examples of indicators that can measure the data required in Parts 1 and 2 of Schedule 1 include water and air quality, soil composition,

[92] The Environmental Impact Assessment & Natural Habitats Regulations 2007 *supra* note 74 (Para 10(1))
[93] Ibid, at Para 7(1)
[94] Ibid, at Schedule 1 Part 1
[95] Ibid, at Schedule 1 Part 2

flora and fauna species present at the site, changes in water temperature, and population numbers. Other potential indicators include the estimated tonnage that will be removed during the project, the length of time that the project will run, the number of hours dredged daily, natural vs. anthropogenic radiation levels, noise levels, and archaeological points of interests in and/or near the proposed activity site.

Schedule 2 of the Regulations further imply the use of indicators to meet the objectives of the Regulations.[96] Beyond the data mentioned above, Schedule 2 calls for an assessment of the production of waste, pollution and nuisances created by the project, the risks of accidents, the relative abundance, quality and regenerative capacity of natural resources in the area, and the environmental sensitivity of the ecosystem.[97] Combined with Schedule 1, these metrics are to be used within the ES.[98] Some examples of indicators that can measure the data required in Schedule 2 include biological EQSs (i.e. Action Points) for acceptable levels of change (to measure the responses of benthic communities to organic enrichment), macrofauna abundance data (to determine the influence of pollution and waste on the activity site), and organic enrichment of the sediments at the activity site. Additional indicators include numbers of taxa, species variety, population density, sediment particle type and size, as well as mean biomass of samples collected before, during and after the activity, and percent reduction of each indicator compared to average background values. These indicators can illustrate the environment's ability to absorb the effects of human activities (see Table 9.3). Consequently, it is within these two schedules where indicators are implied.

As mentioned above, the 2007 Regulations do not mandate specific indicators, nor do they require explicit criteria. Thus, the success and operational efficiency of the indicators used in the ES will be user dependent. If the user understands the requirements of the Regulations and, more importantly, understands the information that must communicate to the regulator, then the indicators in theory should be successful. At a minimum, they should be founded on the four core functions (as

[96] The Environmental Impact Assessment & Natural Habitats Regulations 2007 *supra* note 74 (Para 6(1)(a) and Schedule 2)
[97] Ibid, at Schedule 2 (1)-(3)
[98] Ibid, at Para 6(1) and 7(1)

discussed through this thesis). Beyond that, the criteria that they are founded on will be project specific and user dependent.

Table 9.3: Potential impacts on habitats and species due to marine aggregate dredging and extraction activities. Taken from Posford Duvivier Environment and M I Hill (2001).[99]

Qualifying feature	Potential impact					
	ReMoval of Substratum/Benthos	Increased Turbidity	Changes in Sediment Composition	Changes in Htydrodynamics/Sediment Transport	Water Chemistry Effects	Behavioural changes due to disturbance
Annex 1 Habitat						
Sublittoral sandbanks	M-L	S	M-L	M-L	S	
Estuaries	M-L	S	M-L	M-L	S	
Mudflats and sandflats	M-L	S	M-L	M-L	S	
Lagoons				M-L		
Large shallow inlets and bays	M-L	S	M-L	M-L	S	
Reefs		S	M-L		S	
Sea cliffs and shingle/stony banks				M-L		
Saltmarshes and salt meadows				M-L		
Coastal sand dunes				M-L		
Rocky habitats and caves		S		M-L	S	
Annex II Species						
Marine Mammals	S-M	S			S-L	S
Fish	S-M	S	M-L		S	S

KEY: S=Short-term impact M=Medium-term impact L=Long-term impact

The Regulations require the licensing authority to review the indicators when deciding to grant or refuse a license.[100] Arguably, this validates the operational utility and necessity of environmental indicators within the 2007 Regulations. Indicators can communicate current conditions in the environment, as well as provide a means to measure effects from the proposed activity. Consequently, indicators are important to ensure that the applicant(s) meets the requirements mandated within the legislation, which in turn will help them to obtain a license for their projected activity.

The 2007 Regulations relate to the securing of aggregate for land purposes and, therefore, do not apply to the disposal facets of dredging.[101] Instead, there exist other regulations and enforcement mechanisms which govern national aggregate dredging,

[99] Posford Duvivier Environment and M I Hill, "Guidelines on the Impact of Aggregate Extraction on European Marine Sites" [2001] 124p (p 13)
[100] The Environmental Impact Assessment and Natural Habitats Regulations 2007 *supra* note 74 (Para 13(5))
[101] D Carlin (2007) *Re: Important Question* (personal communication to E Bayer from D Carlin (Cefas)) Hull: email communication (sent 5 November 2007)

most notably the Marine and Coastal Access Act 2009. This will be discussed next. But before this, two example EIAs will be examined to determine the extent to which the indicators used meet the regulatory requirements noted above. These EIAs were produced for particular dredging permissions and utilize specific indicators to demonstrate potential impacts to the environment from the proposed activities and the measures necessary to reduce or eliminate these impacts.

9.3.3.1 Falmouth Marina Dredging EIA

A capital dredging project was proposed for the Falmouth Marina to remove the first 0.2m to 3.0m of contaminated sediment from the harbor, as well as the underlying clean sediment down to -2.2m, to allow for more effective operation of the marina and improve its long term viability.[102] An EIA was requested because the project was considered a marina development (under Annex II of the 2007 Regulations), which proposed potentially significant contamination risk.[103] Furthermore, the proposed project was located in close proximity to the Fal and Helford Special Area of Conservation (SAC), and could produce significant environmental effects.[104] This EIA was produced to determine the magnitude of impact and the value and sensitivity of the environment.[105]

Ecological information relating to this study sight was obtained from various indicators.[106] Additionally, inter-tidal and benthic surveys were undertaken, in order to biologically map the seabed within the study area and identify potential pressures that may occur on the biota as a result of the dredging.[107] The indicators selected included, among others, animal species and populations that were valued for their rarity, status and distribution, as well as habitats of importance.[108] Ecological receptors were used to determine the value of the particular species and habitat, as these were of nature conservation importance.[109] Additionally, the significance of effects was assessed based on a range of effects, which was determined by such

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102 Hyder Consulting, "Falmouth Marina Dredging – Environmental Impact Assessment: Environmental Statement Volume 1" [2010] 90pp (p 1)
103 Ibid, at p 2
104 Ibid, at p 2
105 Ibid, at p 6
106 Ibid, at p 21
107 Ibid, at p 22
108 Ibid, at p 23
109 Ibid, p 23

indicators as sign (i.e. positive or negative effects), probability of occurring, complexity, extent and context, magnitude, duration, *inter alia*.[110] Other indicators used within the EIA included currents, tides, wave climate, the bathymetry of the sedimentary regime, water quality and Tributyltin (TBT) concentrations.

The indicators used in the EIA meet the criteria required in Schedule 1 of the Regulations (i.e. the Minimum Requirements) in that they identified the habitats and species likely to be affected by the project, as well as their value to the environment. Furthermore, once the information was known, mitigation and enhancement measures were taken into account in the basic project design and dredging method to minimize any potential significant adverse impacts.[111] For example, the indicators revealed that the inter-tidal mudflats, the sheltered muddy gravels, the seagrass beds, the maerl beds, and the sub-tidal sands and gravels within the study area were priority habitats.[112] Additionally, the indicators determined the levels of nature conservation needed for fisheries, marine mammals and basking sharks, again in alignment with the requirements of the 2007 Regulations. Steps were undertaken to minimize potential effects to these habitats and species, to ensure their conservation during the proposed project.

Thus, the indicators employed in the Falmouth EIA were successful and operationally efficient. They were founded on the four core functions and appropriate criteria, including being policy relevant, scientifically valid, communicative, interpretable and tightly linked to human activities. Although these criteria were not mandated in the Regulations, having these as a foundation for the indicators allowed them to communicate the required information, which in turn, allowed the proposed project to meet the requirements of the 2007 Regulations. Thus, the user successfully developed and used these indicators, which was demonstrated in the EIA. Although the activities associated with the project were determined to likely have an impact on nature conservation, the indicators demonstrated that if proposed mitigation was implemented and followed, the project would not result in any significant effects on ecology and nature conservation.[113] Thus, with the inclusion of the conditions referred

[110] Hyder Consulting (2010) *supra* note 102 (p 24)
[111] Ibid, at p 31
[112] Ibid, p 26
[113] Ibid, at p 33, 42

to within the Consent Decision, it was determined that the marine elements of the project would not have a significant adverse effect on the environment and the license was granted.[114]

9.3.3.2 HMS Bristol Dredging Program, Portsmouth Harbor EIA

A capital dredging project was proposed by Portsmouth Commercial Port (PCP) to dredge an area around the current mooring position of the HMS Bristol in order to reposition the Bristol and create a vessel turning circle to increase navigation safety for all maritime users.[115] An EIA was requested because it was confirmed that the project fell under the 2007 Regulations, and it was noted that the EIA could provide supporting information for relevant consents, permission and licenses, as well as determine any potential effects of the proposed scheme on the hydrodynamics and sediment transport regime of the area.[116] Furthermore, the proposed project was located in close proximity to a number of nature conservation designations; thus, the assessment of the potential impacts that could be caused by the proposed projects formed the basis of the EIA.[117]

The indicators used in the EIA included tides, tidal current, bathymetry, wave generation, sediment distribution, water quality, benthic fauna and seahorse habitats, among others. Modeling was undertaken, using the data from many of these indicators, to enhance understanding of the potential changes associated with the proposed dredging project and to determine how these changes manifest on coastal processes.[118] These indicators meet the criteria required in Schedule 1 of the Regulations (i.e. the Minimum Requirements) in that they identified the parts of the environment likely to be affected by the project, as well as their value to the environment. Furthermore, once the information was known from both the indicators and the modeling, mitigation and enhancement measures were taken into account to minimize any potential significant adverse impacts.[119]

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114 Youell, "Environmental Impact Assessment Consent Decision: Proposal for the Dredging and Disposal of Material from the Falmouth Marina into Falmouth Bay" [2010] 10pp (p 9-10)

115 Lavender and Snowball, "HMS Bristol Dredging Programme Environmental Statement" [2010] 258pp (p i)

116 Ibid, at p i, 1

117 Ibid, at p i

118 Ibid, at p 39

119 MMO, *Environmental Impact Assessment Consent Decision* (2011) (p 4-5)

Thus, the indicators employed in the Bristol EIA were successful and operationally efficient. Similar to the Falmouth EIA, they were founded on the four core functions and appropriate criteria, including being communicative, policy relevant, scientifically valid, interpretable, unambiguous and tightly linked to human activities. As noted above, although these criteria were not mandated in the Regulations, having these as a foundation for the indicators allowed them to communicate the required information, which in turn, allowed the proposed project to meet the requirements of the 2007 Regulations. Thus, the user successfully developed and used these indicators, which was demonstrated in the EIA. And the indicators successfully demonstrated that with the modifications to the approach the project would have minimal adverse effects on the marine ecosystem.

9.3.4 MCAA

The Marine and Coastal Access Act was drafted to consolidate and modernize the FEPA and the CPA.[120] It aims to simplify regulations governing the national marine aggregate dredging and extraction industries.[121] It takes into account scientific evidence, including indicators, to ensure that appropriate decisions are made regarding aggregate dredging and extraction projects.[122]

Yet, the MCAA does not explicitly mandate the use of indicators. Similar to the legislation discussed above, they are implied as a means to communicate potential environmental impacts from the proposed projects. Consequently, such indicators as water quality, species assemblages, population densities, numbers of individuals, toxicity tests on fish for human consumption, and bacterial quantities in bathing waters can be used to ensure protection of human health and the environment. Indicators are also important within the required environmental statements as they can communicate whether the proposed activity is likely to have a significant effect on a European site. Similar to the 2007 Regulations and the CPA, these indicators include water quality, temperature, water clarity, number of taxa, bioassays, action levels, sediment type and size, and potential emissions from the proposed project. When successful and

[120] Marine and Coastal Access Act 2009 *supra* note 75
[121] Ibid
[122] Defra, *Guidance on Marine Licensing under Part 4 of the Marine and Coastal Access Act 2009* (2011) (at p 8) – i.e. any Marine Policy Statement that is in effect and any Marine Plan that is in place for the area or areas related to the decision

operationally efficient, indicators are important to help regulators make informed decisions regarding proposed marine dredging or extraction activities.

It is important to note that similar to the previous regulations discussed in this section, the MCAA does not require explicit criteria to ensure the success of the indicators. It is up to the user to verify that the indicators are founded on the four core functions and appropriate criteria so that they can be successful and operationally efficient. Because indicators are most prevalent in the ES, arguably, they should be communicative, scientifically valid and tightly linked to human activity. Beyond that, the criteria that they are founded on will be project specific and user dependent. Arguably, the MCAA is flexible in its approach to the development and use of indicators, to ensure that the regulations are fit for purpose and can be appropriately applied to every marine dredging and extraction project. Plus, it puts the onus to ensure the success of the indicators on the applicant.

Consequently, the importance of indicators is cemented within the national marine aggregate dredging and extraction industry and corresponding regulations. Although not explicit on the use of indicators, the regulations imply their development and use to gather data, communicate impacts to human health and the environment, and ultimately meet the set objectives of the legislation. Regulators must possess as much information as possible about a proposed activity to make an appropriate decision on granting a license. When successful and operationally efficient, indicators can provide such information.

9.4 Interactions between Policy/Legislation and Science

The Regulations discussed above are not explicit on indicators nor on the criteria that they should be founded upon. They are flexible in their approaches to the application of indicators, but leave the direction (and ultimately the success and operational efficiency) to the applicant. The applicant is therefore, able to use any indicators they believe can communicate the required information. But as a consequence, the success and effectiveness of these indicators is user dependent and, depending on how they are presented, their interpretation can vary. Thus, an assessment of the indicators which can be used to meet the objectives of the four Regulations discussed in Section 9.3 will now be undertaken. The success and operational efficiency of these indicators will be analyzed to gauge the depth to which interfacing has occurred between the disciplines (science, policy and law) and to determine if indicators used within this industry are policy driven, or based upon scientific findings.

Two univariate indicators which are representative of the data required by the four Regulations discussed above are sediment/substrata structure and total abundance of benthic micro/macro faunal assemblages.[123] But are these indicators successful and operationally efficient? To answer this question, we must look at the criteria upon which they are founded. For example, soil structure and species abundance are scientifically valid indicators. They are relatively simplistic and, therefore, easy to communicate. Both have the ability to show spatial/temporal trends. They are capable of communicating environmental change, although they are not as sensitive to early warning effects as some derived multivariate indicators. They are also cost-effective to measure. Successful indicators should be founded on the four core functions, appropriate criteria and be flexible in their implementation. With flexibility, these two indicators can detect change in one environment and yet, when used in a different ecosystem, still detect change. These two univariate indicators have been developed to address a particular management objective (i.e. impacts due to the proposed dredging/extraction activities). They have been designed to link the impacts from the proposed projects to the potential degradation of benthic assemblages, as well as potential changes to the structural integrity of the benthos. Consequently, they represent instantaneous measures of ecosystem structure.[124] Furthermore, these two indicators are activity specific – their response to changes in the surrounding environment is directly related to the activity at hand. Arguably, these two indicators are successful and operationally efficient. They demonstrate a successful integration between science, policy and law as they are used for the intended scientific rationale in which they were developed.

The problem lies, however, in the complex nature of the marine environment. Many of the requirements of the legislation can only be achieved through the use of multivariate indicators. These indicators can be much more challenging to understand, communicate, and even measure. For example, the Regulations require the applicant to communicate cumulating effects of their activity in combination with other projects,

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[123] These are measures listed in paragraph 3 of Schedule 1 of the 2007 Regulations.
[124] H L Rees *et al* (2006) *supra* note 2 (p 497)

the relative regenerative capacity of the natural resources in the area in which the activity is set to occur, and the absorption capacity of the natural environment.[125] Some of these indicators are based upon assumptions and predictive models. Arguably, they are not as solid or scientifically valid, as the true effects are unknown and may not become apparent until long after the cessation of the project. Thus great flexibility is needed when using such indicators. There are benefits and holistic representation derived from multivariate/suites of indicators. Such measurements are more sensitive to ecosystem change, provide a more complete representation of the environment and effects at hand, and adequately reflect the complexities of actual situations.[126]

The four Regulations discussed above do not explicitly mandate or require any specific indicators. Rather, the application of indicators (be they univariate or multivariate in nature) is determined by the applicant, most notably when they are producing the environmental statements. The regulations allow them latitude as to which indicators to use to communicate the information. Thus, these four regulations are arguably successful legal frameworks in terms of indicator applications, in that they permit such flexibility. This allows the applicants to develop and use indicators that are scientifically driven and fit for purpose when applying for their license to dredge or extract. Consequently, the national marine aggregate dredging and extraction industry appears to favor the use of indicators and provides the necessary legislative platforms for indicator success, which helps to ensure the protection of human health and the environment.

9.5 Concluding Remarks

Indicators are important with the contemporary marine management and regulation frameworks that guide the aggregate dredging and extraction industry of the UK. Although the term indicator is not explicit in the legislation, it is implied as a means to communicate the statutory information. Indicators can bridge environmental, economic and social goals, which in turn influence indicator development. Specifically, the current 2007 Regulations and the MCAA demonstrate legal frameworks that are flexible in their approach to the management of marine aggregate

[125] Seen in Schedule 2 of the 2007 Regulations & Schedule 2 of the Harbor Works Regulations 1999.
[126] H L Rees *et al* (2006) *supra* note 2 (p 500)

dredging and extraction activities, which allow for successful and operationally efficient indicators.

This chapter reviewed specific case studies to determine if the indicators being used within this industry are truly successful and operationally efficient. What it found was that, in general, the indicators being used to meet the requirements of the legislation do show success, but that this will be user dependent. Since no specific criteria or indicators are required by the main national legislation of this industry, the onus falls on the user to ensure that the indicators are communicative (i.e. are based on the four core functions) and are able to ensure that impacts to human health and the environment are minimal to nil. Protection of human health is one of the main driving forces of this industry, along with economic growth and development. Indicators must be able to communicate pertinent information on aggregate dredging and extraction projects, to ensure that these objectives are met.

The current national marine dredging and aggregate extraction industry promotes more efficient communication, improved transparency and dissemination of new information. This more efficient approach fosters integration between science, policy and law, as well as minimizes unnecessary regulatory burden. Furthermore, embedding science within regulatory frameworks will ensure that even if indicator selections are a political choice, they are still linked to a scientific foundation. Thus, policy-makers and legislators will be able to understand specific features of the marine environment in a less complex, but still scientifically accurate manner. In conclusion, although user dependent, indicators allow for effective communication and provide the opportunity to gauge the success of current marine management techniques within the marine dredging and extraction industry.

Conclusion

10.1 Final Comments

The research shows that indicators are an important tool in modern environmental and marine policy and law. They illustrate changes that occur in the marine environment and communicate them in a non-technical manner. Furthermore, they help explain the ways that law, policy and science interface in the context of marine regulations. When founded upon the four core functions (communication, simplification, quantification and standardization) and appropriate criteria (discussed in Chapter 2), indicators create dialogue, bridge communication gaps and measure progress towards meeting established goals. This is especially important as governments world-wide are beginning to take a more holistic, ecosystem based approach to marine management. Currently, many environmental legislation and policies have been developed internationally, regionally and nationally to monitor, conserve and protect the marine environment. These policies and legislation have evolved over time in their requirements to use indicators to assess the current state of the environment, the extent of human impacts and to meet overall political aims and objectives.

This thesis questioned the extent to which science is used in the development of marine policies and legislation through the use and application of indicators. While it aimed to provide a broad ranging review and detailed, critical analysis of significant marine policies and legislation, it could not exhaustively describe the totality of all regimes that exist (international, regional and domestic). Instead, the emphasis was placed on the techniques and approaches used to accommodate environmental (and specifically marine) indicators in policies and legislation operative as of 2011 (both the creation and application of law and policy). It assessed the criteria upon which indicators are developed to determine the foundation for successful and operationally efficient indicator.

The study also examined various indicators utilized within the environmental management of the UK marine aggregate-extraction industry. This included the principal regulatory and policy frameworks governing marine activities in this industry. This case study was prompted by Defra, but also provided an opportunity to test the interface between law and science in a regime influenced by local, regional and international law and policy. This thesis also evaluated the application of indicators within case law and determined the domestic courts' stance on the utilization of evidence and expert testimony. It used historical and contemporary literature to assess the effectiveness of indicators. It also analyzed their foundation within science (i.e. whether they are scientifically or politically driven) and ultimately provided an examination of the operational efficiency of environmental and marine indicators to determine if current marine policy and legislation are effectively employing indicators. The key research questions that the thesis addressed were:

1. Can indicators used in marine contexts achieve operational utility?
2. What is a successful indicator?
3. How does the use of marine environmental indicators vary in terms of the scale they are used at (e.g. international, European, national)?
4. How does the use of marine environmental indicators vary between law and policy (at different scales)?
5. Are indicators efficiently used in both law and policy at the international, European and national scales?
6. What are the instances of success and failure in marine environmental indicator development and application?
7. Does law influence policy or policy influence law in the development and application of marine environmental indicators (e.g. is there a top-down or bottom-up influence)?
8. What evidence is there that indicators have made a difference in successfully managing resources?

10.2 Operational utility & indicator success (Questions 1 and 2)

Indicators are not always explicitly identified in policy and legislative texts, yet they are nonetheless found in both. They can measure the impact that legislative initiatives have had on the quality of the environment, and the social and economic circumstances surrounding political and legal initiatives. They are as much influenced by policy and social outcome, as they are by science. But what makes an indicator successful and operationally efficient? The answers to research questions 1 and 2 are complex, as many purposes exists for indicators and, as Chapter 2 demonstrated, there is a wide-range of important attributes for successful and operationally efficient environmental indicators. This work argues that communication is the most important function of an indicator. With this being the case, the research found that often, the criteria that indicators are based on will be user dependent. And because the development and application of indicators is user-dependent, there is arguably no real way to categorize the essential criteria for an indicator, apart from the four core functions. The users themselves can evaluate the indicators they use against the criteria required in specific legislation or policies, but this will need to be done on a case by case basis.

For example, Chapter 3 found that the use of indicators is implied in the UNCLOS, but that the success and operational efficiency of these indicators will be user dependent, and no specific direction is given on successful indicator attributes.[1] The Marine Strategy Framework Directive (discussed in Chapter 4), on the other hand, is explicit on the use of indicators and provides specific attributes that they should be based on (policy-relevant, easily measurable, etc.), although no specific indicators are mandated within the legislation.[2] And the research demonstrated that the UNCSD promotes indicators developed on the four core functions and appropriate criteria, as they advocate an integrated ecosystem approach to protect the ocean and coastal areas.[3] But it leaves the decision on which indicators to apply to the States Parties, thereby demonstrating that the success of the indicators will be user dependent.

In reviewing the case law research, it becomes apparent that the role of procedures and evidence used in litigation is becoming more prevalent and that this evidence must be factual, scientific and grounded. For example, in the *Southern Bluefin Tuna Cases* (Chapter 3), the ICJ demonstrated the importance of successful and operationally efficient indicators. They validated the need for indicators to be subject to scrutiny and noted that it is their responsibility to evaluate the evidence in its entirety and draw appropriate conclusions in accordance with the rules of international law. They found, based on the presented evidence and their understanding of it, that Uruguayan indicators were more successful and operationally efficient than Argentinian indicators, and thus, they ruled in favor of Uruguay.[4] Similarly, in the *Commission v Germany* (Case C-298/95; Chapter 5), the ECJ found that the data (indicators) provided by Germany did not properly convey the

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[1] See pg. 45-50
[2] See pg. 148-151
[3] See pg. 100-104
[4] See pg. 72-76

requirements of the higher directives, and thus, were not applicable to be used as evidence in their case.[5] In other words, the indicators were not successful and operationally efficient because the indicators used were not founded on the four core functions or appropriate criteria and thus, failed to convey the message they were intended to communicate. The indicators themselves were not necessarily flawed, however. Rather, the method in which they were used and the management system responsible for their application was at fault.

These examples demonstrate the importance of interpreting environmental indicators, and ensuring that they are founded on the core functions and appropriate criteria, to make sure they are successful and operational efficient. The OECD is responsible for developing the majority of criteria discussed in Chapter 2, as they found that these criteria resulted in the most successful and operationally efficient indicators. But they also noted that it is necessary to continue to improve the quality and comparability of existing indicators.[6] Additionally, the case law review found additional factors, beyond the criteria discussed in Chapter 2, which are necessary and which affect indicators in court cases.[7]

Thus, can indicators used in marine contexts achieve operational utility? (research question 1)? Yes, they can be, but their success will be user dependent. They must be founded on the four core functions and appropriate criteria relevant to the purpose they were designed for (fit for purpose). What makes a successful indicator (research question 2)? The ability to communicate the information they are designed to measure (which is the main function of an indicator). But as this research has shown, indicators must be driven by science, to ensure that they are not derived on value-laden concepts that are politically driven and drafted in open textured terms with no relevance to the main objectives. Embedding science within regulatory frameworks will ensure that even if indicators are a political choice, they will still be linked to a scientific foundation. In conclusion, although the success and operational efficiency of indicators is more often than not user dependent, they still have the ability to provide effective communication and can gauge the success of current marine management techniques. However, if indicators are not developed on the core

[5] See pg. 157-161
[6] See pg. 111-119
[7] See pg. 228-229

functions, and if they are not formed on a strong evidentiary base to support them, the indicators will not be successful (as was seen in the Southern Bluefin Tuna and the Pulp Mills case of Chapter 3, all of the European cases in Chapter 5 and the Ikarian Reefer and the Murdoch cases of Chapter 7).[8]

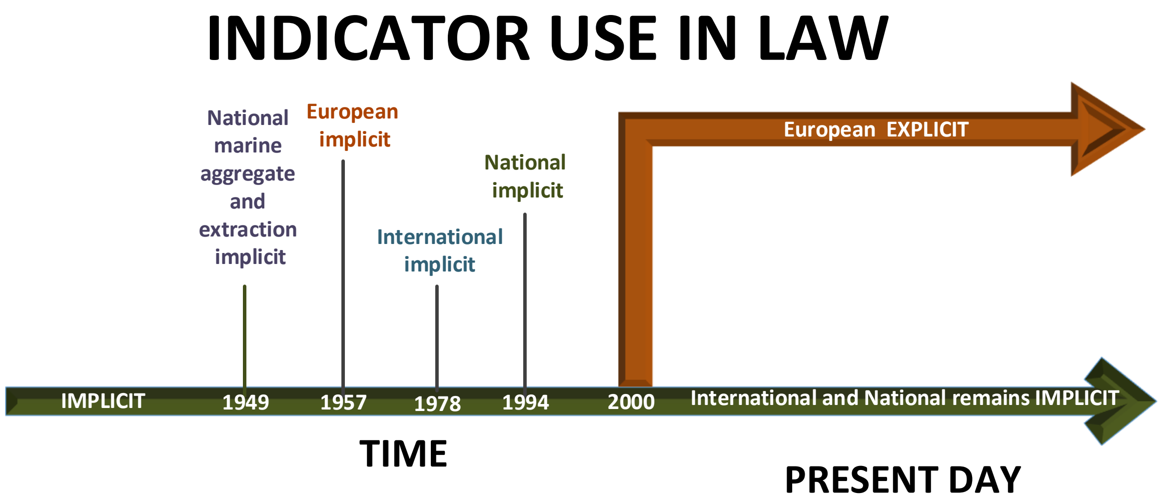

Figure 10.1: Illustration depicting the progression of indicator use overtime within international, regional and national environmental law. As can be seen in the figure, initially, the legislation is implicit on the requirements and use of indicators. However, by the 21st century, we see that indicators have become explicitly mandated within some environmental legislation. It would be interesting to see (with future research) if international and English law have become more explicit on indicator use and whether European law has remained explicit. International and national law (including national marine aggregate and extraction legislation) remains implicit on the requirements for indicators to present day. This answers research questions 3, 4 and 5.

10.3 Marine indicator use in terms of scale (Question 3)

This research also demonstrated that the use of marine environmental indicators varies in terms of the scale they are used at (e.g. international, European and national) and that an interesting pattern is prevalent across the three scales (research question 3). Figure 10.1 depicts the progression of indicator use over time within international, regional and national law. As can be seen in this figure, initially, the legislation for all three regimes is implicit on the requirements and use of indicators. For example, UNCLOS is general in its approach to indicator development and application and provides little direct relevance to indicators other than promoting best available science.[9] And MARPOL implies indicators, but has little to say about the qualities that these indicators should be based on.[10] It relies on domestic implementation, since

[8] See Tables 3.4, 5.4 and Table 7.2
[9] See pg. 45-50
[10] See pg. 63-69

States Parties are sovereign nations who govern themselves. The EC Treaty and early environmental directives were also implicit on a requirement to use indicators. No specific types of indicators were mandated, no specific criteria referenced. The word indicator was not even used in the legislation.

However, by the 21st century, European law had split from international and national (English) law. It explicitly required indicators within European environmental legislation. In 2000, the Water Framework Directive openly mandated the application of indicators, although it did not require specific indicators or attributes for those indicators.[11] Furthermore, no concrete definition of an indicator was provided. Arguably, indicators are implemented within the WFD, because it concerned human health and had a direct impact on quality of life (this was seen with the Bathing Water Quality Directive as well[12]). Furthermore, the EU left the WFD broad in regards to indicator application to give Member States the freedom to develop and use indicators within their national strategies that are best suited for their objectives. This is further supported by the Marine Strategy Framework Directive, which called upon the deployment of indicators to monitor the marine environment, but did not mandate specific indicators to achieve this goal.[13] The MSFD recognized the differences that occur both in the marine environment and across the national strategies of the Member States and provided the flexibility for the Member States to develop the indicators that are best suited to help them meet the requirements of the Directive locally.

Unlike international environmental law, which is more generic in its application, EU environmental law is much more precise and strict in its application, especially when human health is at risk. It must be strictly transposed at the Member State level. The case law demonstrated that the Commission requires a strict application of the law, purposive interpretation and a degree of precision to meet the objectives of the directives.[14] There is more jurisprudence on the use of environmental indicators in EU environmental law than under international environmental law, as a result of the greater range of EU regulations that specifically mandated indicators and

[11] See pg. 141-144
[12] See pg. 145-148
[13] See pg. 148-151
[14] See pg. 153-171

their attributes. The EU struggles with the tension between flexibility in legislation and certainty in application, especially in regards to indicators. But, it has now recognized the importance of indicators as tools to bridge science, policy and law to achieve their environmental objectives and thus, explicitly mandates them within legislation.

International and national law (including national marine aggregate and extraction legislation), on the other hand, remain implicit on the requirements for indicators to present day. This research surmises that this phenomenon occurs at the international level, because most agreements establish only general obligations of conduct and leave the technical details to be developed at the regional or national levels. [15] Thus, indicators are implied in international treaties, but in general terms, due to the broad framework of the agreements.

In national (English) environmental law, indicators are not explicitly required, but are implied as tools to monitor progress towards national objectives. The choice to deploy indicators is left to the regulating agency, and sometimes this includes the selection of attributes that they should be founded on. Even when the higher directive is explicit on the development and use of indicators (such as the Bathing Water Directive), the corresponding national regulations do not mention the term indicator (as seen in the 2013 Bathing Waters Regulations).[16] National legislation is subject to EU law, and thus, strictly adheres to the spirit and requirements of the EU directive driving them, although the application of indicators differs. Even more interesting, some of the national regulations are specific on the criteria that the indicators should be developed on, even though they do not explicitly call for the use of indicators. This is further demonstrated by the marine industry reviewed (Chapter 9 - national marine aggregate dredging and extraction). Consequently, although not mandated, the importance of indicators is cemented within national environmental regulations.

In comparing international legislation to EU and national regulations, indicators appear to be more explicitly used and enforced at an EU level. This does trickle down to the national level, as a strict adherence to the directive is a requirement of the EC Treaty, but interestingly, in an implicit manner. Arguably, the indicator

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[15] See pg. 88-90
[16] See pg. 213-216

concept is still being developed and understood at a national level, so the regulations reflect a cautious approach until this tool is better understood. It would be interesting to see how indicator application has developed in national law since 2011 (as this thesis only covered material up to that time).

Figure 10.2 depicts the progression of indicator use overtime within international, region and national policy. This research has shown that at the international level, environmental policies were initially implicit on the requirements and use of indicators, but gradually became explicit over time. Historically, economic preservation has been the main driving force for international environmental policy, followed by an emphasis on social justice.[17] Considered a profit-people-planet mentality, this shaped the initial direction of environmental policies at the international level and impacted the types of indicators that were developed and applied within these policies. Thus, early international environmental indicators often adopted a sectoral approach, with a large focus on economic improvements and human health. Suitable candidate indicators for oceans and the coastal zone were not always readily available or supported by commonly accepted goals at the international level either. Consequently, large gaps often occurred within the policy approaches, which were themselves driven by the social and economic standings of the States Parties. Around the early 1990s, however, a switch occurred, and indicators became explicitly defined and required within international environmental policies. But these were still more sectoral in nature and focused on the "profit" or economic benefits of the environment, with little focus on the marine sector. Eventually, global issues came to the forefront (such as climate change, decline of fisheries) and the international regime began to move beyond economic and social concerns. Thus, indicators began to take a more "people" or society focus, which then moved to a "planet" or more environmental focus.

European and national environmental policy, on the other hand, are clearly explicit on the use of indicators from early on. As early as the 1970s (arguably the beginning of the global environmental movement), indicators are used in EU environmental policy (seen in the 1st EAP).[18] The research of this thesis demonstrated

[17] See pg. 93-96
[18] See Figure 6.1 and pg. 187-188

that indicators are used by the EU at a policy level to achieve environmental protection targets. The EU recognized that the environment and indicators are important ingredients of their economic strategy and better regulation agenda.[19] Consequently, they fully endorsed indicators on a policy level and used the DPSIR model specifically to communicate progress towards environmental policy goals. This is different than the pattern that was seen at the international environmental policy level. Arguably, this trend in EU policy and indicators occurred because of a stronger focus on pollution prevention, protection of natural resources and other objectives that recognized the connections between the environment, human health and the economy at the EU level.

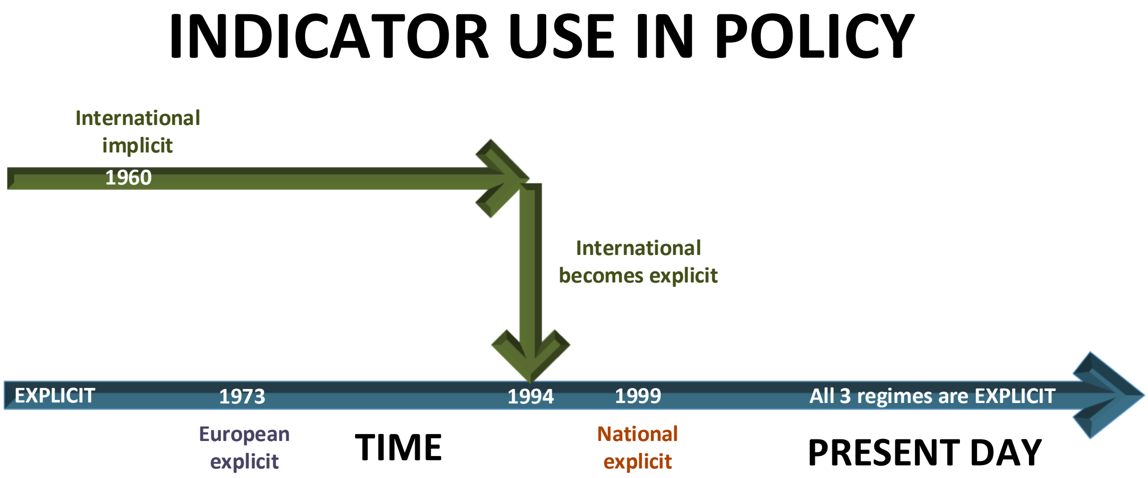

Figure 10.2: Illustration depicting the progression of indicator use overtime within international, regional and national environmental policy. As can be seen in the figure, initially, international policy is implicit on the requirements and use of indicators. However, by the early 90's all three regimes are explicit on the development and use of indicators in environmental policy. It would be interesting to see (with future research) whether all three have remained explicit in more current policy documents. This answers research questions 3, 4 and 5.

Similarly, national environmental policy has been explicit on the development and use of environmental indicators in all pertinent environmental documents. Besides being explicit on indicator use, national policies tend to be specific on the criteria that the indicators should be developed on and even the types of indicators that should be used. Arguably, these policies and their corresponding indicators are successful and operationally efficient because of this specificity. It tends to focus on resource protection, biodiversity, economic stability and the protection of human health (all of which are major objectives of sustainable development). But because the economy plays such a large role in national environmental policies, the UK

[19] See pg. 199-200

remains a strong player in the global pursuit for successful and operationally efficient environmental and marine indicators.

How does the use of marine environmental indicators vary in terms of the scales they are used (research question 3)? Table 10.1 summarizes the findings discussed above. Essentially, indicator development and use remained implicit in international and national environmental law as of 2011. However, as of 2000, European law had moved to explicitly mandate indicators within EU environmental directives. With regards to environmental policy, however, indicator use and development was initially implicit at the international level. In 1992, a change was seen through Agenda 21, where indicators were explicitly mentioned for the first time in international environmental policy. On the other hand, European and national environmental policy were explicit on indicator use from the start and remain so as of 2011.

10.4 Indicator variations between law and policy (Question 4)

How does the use of marine environmental indicators vary between law and policy at the different scales (research question 4)? As summarized in Table 10.1, this research found that legislation is supported by policy. At the international level, the research identified that indicators remain implicit in law, but have become explicit in contemporary environmental policy. Thus, international environmental law favors a more open-ended and flexible approach to science and indicators because it must be applicable across multiple borders and ecosystems. Furthermore, suitable candidate indicators for oceans and the coastal zone may not always be readily available or supported by commonly accepted goals at the international law level. At the policy level, the research shows that although the application of environmental indicators should in no way be prescriptive, it is still imperative to provide guidance on the development and deployment of these tools. Science plays a role in the formation and implementation of international environmental policy because it provides the evidence basis for decisions, while remaining politically neutral.

Both international environmental law and policy have shown to be successful in developing and using environmental indicators, but often the success and operational efficiency of the indicators will be user dependent. In addition, international environmental law exhibits a top-down approach to indicator development, whereas international environmental policy uses both a top-down and bottom-up approach. Lastly, the objectives for indicator use within international environmental law and policy are generally the same, with a few exceptions. Indicators in international environmental policy tend to be focused on sustainable development, protection of the ocean and its resources, and communication – these indicators look to improve scientific understanding, including marine ecosystem assessment and management (i.e. indicators at the international policy level tend to focus beyond economic and social concerns). Within law, these indicators tend to focus more on regulating ocean activities and measuring environmental problems. They tend to be generated to show that negative human impacts tend to have repercussions on the global economy.

Regardless of these differences, past work on international environmental indicators has arguably adopted a more sectoral approach. This sectoral approach to indicators has occurred because the main driving forces behind the development of indicators has varied greatly within international organizations and regulations, as well as from country to country. Regardless of how indicators are progressing in international law and policy, the point is, they are progressing. International environmental law and policy are helping to shape and guide the development and application of successful and operationally efficient marine environmental indicators. What needs to occur next is greater coherence amount countries and international harmonization, to ensure that the data and corresponding indicators remain meaningful to both decision-making and regulation compliance.

At the European level, the research identified that indicators are initially implicit in law, but do become explicit by the early 21st century. And in contemporary European environmental policy, indicators are generally explicit from as early as 1973 and the 1st EAP. This is note-worthy, as most legal and policy documents made no mention of indicators until the late 1990’s and early 2000’s. Arguably, this is because the EAPs were specifically designed to measure environmental impacts to aid in the achievement of sustainable development and a strong economy for Europe. Perhaps these fundamental objectives are responsible for an early recognition of the need for indicators to communicate progress towards these goals.

In general, the indicators developed and applied to meet the objectives of European legislation are successful, but similar to international environmental law and policy, it's user dependent. Some specific criteria and indicator attributes are identified within European environmental law, but this is rare and does not become prevalent until more recently developed directives (such as the BWD and the MSFD). Within European environmental policy, however, indicators are successful and operationally efficient, but only when the specific indicators and corresponding criteria recommended by the policies are used. Specific indicators are not required in every European environmental policy (some policies require indicators, but do not mention specific ones, others require types of indicators as opposed to any one specific indicator). Regardless, the environmental indicators deployed at the European policy level must be appropriate to support the framework they are designed for and to measure the objectives for which they were created.

Both European environmental law and policy exhibit a top-down and bottom-up approach to indicator development and application. Lastly, the objectives for indicators is starkly different between European environmental law and policy. Within law, it is evident that indicators are deployed to measure environmental quality, pollution, human impacts, natural resources and to overall protect human health. In EU environmental policy, the emphasis seems to be more on the economy and society. There are similar objectives to those seen in law (e.g. monitoring for pollution and environmental quality), but the majority of objectives appear to point towards sustainability: how can the European Union protect its strong economic base by protecting the environment? Despite this difference, it can be surmised that within the EU, environmental indicators are important tools to guide policy-makers and regulators in achieving environmental targets.

At the national level, the research identified that indicators remain implicit in law, but are explicit in contemporary environmental policy. At the policy level, the Government recognizes that more than just a single indicator is required to achieve successful environmental and marine management. Thus, although there are similarities in the indicator approach between the policy documents, indicators can be developed and applied in a variety of manners and still be successful and operationally efficient. No single indicator or its corresponding criteria is more important than the next, nor can a single indicator measure all national policy objectives. Ultimately, the development and application of national indictors, although influenced by and contributing to higher policies, will be dependent on the user and objective the policy is designed to meet.

In general, the indicators developed and applied to meet the objectives of national legislation are successful, but similar to international and European environmental law and international policy, it is user dependent. Some specific criteria and indicator attributes are identified within national environmental law, but indicators are not explicitly mentioned. Within national environmental policy, however, indicators are successful and operationally efficient, but only when the specific indicators and corresponding criteria recommended by the policies are used, which are provided in nearly every national environmental policy. National environmental policy tends to focus on resource protection, biodiversity, economic stability and the protection of human health. In addition, national environmental law exhibits a top-down approach to indicator development, whereas national environmental policy uses both a top-down and bottom-up approach. National policies influence and are influenced by policies and regulations that flow down from the EU and internationally. Thus, there is synergy between national environmental indicators used in policy and those which operate at the EU or international policy levels. This creates more effective management of the marine environment and points to a wider democratic function for indicators

Lastly, the objectives for indicator development and use generally mimic what was seen at the European level. In law, the indicators are mainly designed to measure environmental protection aspects (i.e. water quality biological diversity, human health). At the policy level, the emphasis is more on sustainable development and economic growth (measuring progress towards fiscal objectives related to the environment). Despite this difference, it can be construed that nationally, environmental indicators are important tools to guide policy-makers and regulators in achieving environmental targets and ensuring that the economy remains strong, efficient and stable.

Table 10.1: Summary of the findings which address research questions 3 (how indicator use varies in terms of scale), 4 (how indicator use varies between law and policy) and 5 (are indicators efficiently used in law and policy across the three scales).

	Indicators in Law				**Indicators in Policy**			
	Trends	Success/ Failure	Top-Down/ Bottom-Up	Objectives	Trends	Success/ Failure	Top-Down/ Bottom-Up	Objectives
International	Implicit	Successful – but dependent on the user. No specific criteria are provided.	Both	*Regulate ocean activities *To measure environmental problems *Conserve biological diversity *Monitor human impacts *Monitor environmental pollution *Monitor climate change	Implicit to Explicit	Successful – but dependent on the user. Specific criteria are provided.	Both	*Monitor human impacts *Sustainable development *Conserve biological diversity *To protect the ocean and its resources *To communicate and improve scientific understanding *Marine ecosystem assessment and management *To monitor climate change
European	Implicit to Explicit	Successful – but user dependent. Some specific criteria are given.	Both	*Preserve, protect and improve the quality of the environment *Monitor environmental pollution *Monitor environmental impacts *Protect human health *Protect European waters *Monitor pressures on natural resources	Generally explicit	Successful – but only when the specific indicators and criteria are applied.	Both	*Monitor the economic and social dimensions of sustainable development *Monitor environmental industries *Monitor environmental pollution *Measure environmental quality *Measure natural resources *Measure environmental policy *Sustainability

National	Implicit	Successful – but user dependent. Some specific criteria are given.	Top-Down	*Measure water quality *Measure biological diversity *Measure ocean resources *Measure biological, geological and physiographical features *Measure human health	Explicit	Successful – but only when the specific indicators and criteria are applied.	Both	*Measure quality of life *Sustainable development *Measure economic growth in relation to environmental impacts *Monitor the state of the marine environment *Measure progress towards fiscal and environmental objectives

10.5 Indicator efficiency in both law and policy (Question 5)

Are indicators efficiently used in both law and policy at the international, European and national scales (research question 5)? Table 10.1 and the above analysis demonstrates that the answer is yes, although this is often dependent on the user developing and applying the indicators. An example of an indicator used at an EU and international level is measurement of fish declines, which can be representative of global warming. Another indicator that is used at a national level and which is pertinent at an EU and international level is water quality. Water quality measurements can determine the amount of pollution from human activities. Still, other examples of pertinent indicators important nationally, regionally and internationally include trends in abundance and distribution of selected species and habitats, seabird population trends, and the density of opportunistic species. Based on the research, these indicators have proven successful and operationally efficient at a national, EU and international level.[20]

[20] See pg. 254

10.6 Instances of success and failure in indicators (Question 6)

But what are the instances of success and failure in marine environmental indicator development and application (research question 6)? As discussed above, success and operational efficiency is more often than not, user dependent. In instances where the user understands the meaning of the indicator and applies it appropriately, there is success. For example, in the *MOX Plant Case* (Chapter 3), the English indicators were successful because they disproved Ireland's claims and showed that exposure to radiative discharges from the MOX Plant was negligent and that it was safe to eat fish and shellfish from the Irish Sea and enjoy its amenities.[21] The UK argued that their evidence refuted Irish claims regarding the risk of pollution from the operation of the MOX Plant. Arguably this was because their indicators were founded on the core functions and based on appropriate indicator criteria to communicate the findings. The UK used both historical and current indicators to prove that no harm would occur to the marine environment. They asserted that Ireland had failed to supply such indicators and even when data was supplied, it could not successfully communicate the concerns that they were voicing. Arguably, Ireland's indicators were not based on the core functions, nor were they founded on appropriate criteria.

Similarly, the *Pulp Mills Case* (Chapter 3) contained indicators that were successful for Uruguay.[22] Argentina may have asserted that Uruguayan mills were polluting the aquatic environment, but their data did not support these claims. Uruguay used dissolved oxygen, phosphorus levels, algal blooms, dioxin and furan concentrations and biological diversity to communicate the fact that no patterns could be conclusively linked to the mill's operations. The Court's rulings in this case demonstrate the importance of correctly interpreting environmental indicators. Understanding the meaning of an indicator is essential to effectively using the indicator to measure for or argue a specific point. Furthermore, ensuring the indicators are founded on the core functions and appropriate criteria will ensure their success and operational efficiency. Although they are meant to communicate and simplify complex situations, if indicators are not successful and operationally efficient, they

[21] See pg. 76-81
[22] See pg. 81-88

can obscure an already complex situation by providing approximations and imprecise data.

At the European level, the WFD has been cited as both a success and failure in its mandates to develop and apply environmental indicators.[23] This thesis argues that, according to the indicator timeline (Figure 5.1), this is the first directive that has explicitly mandated indicators within the text of the regulation. Being one of the first directives to require indicators, it had no precedent on indicator definitions, indicator qualities, criteria, etc. Perhaps, because this Directive has a direct impact on human health, the regulators wanted indicators mandated within the text of the legislation (setting it apart from previous directives). But maybe, the use of imprecise qualitative statements is a form of compromise. It is a way of mediating the economic/political consequences of the Directive. In contrast, the BWD mandated specific indicators with precise levels of measurement.[24] Arguably, because of their precision, and their foundation on the four core functions and appropriate criteria relevant for the purposes they were designed (to monitor for human health concerns), these indicators have proven successful in European environmental legislation.

A definite distinction exists between directives drafted in precise terms for precise purposes (such as the Bathing Waters Directive) and other that are more open (the Water Framework Directive). From the analysis, it seems that the more ambiguous the directive, the more flexible the implementing mechanisms and the more flexibility that is afforded to the Member Sate. Yet, this creates uncertainty in the use of the indicators.[25] This can be directly tied to the core functions of an indicator, as well as the criteria for successful indicators. The Water Framework Directive provides an example of what happens when indicators are denied the ability to carry out their core function of communicating information. When an indicator does not have appropriate criteria underlying its foundation then it becomes politically driven, not scientifically founded (i.e. it may not be successful and operationally efficient). This then, in turn, can create an issue with compliance; if a Member State

[23] See pg. 141-144
[24] See pg. 145-148
[25] See Borja, A., Elliott, M., Uyarra, M. C., Carstensen, J., Mea, M., (Eds.) "Bridging the gap between policy and science in assessing the health status of marine ecosystems" [2016] Lausanne: Frontiers Media, doi: 10.3389/978-2-88945-004-6; pp293; Elliott, M, "Marine science and management means tackling exogenic unmanaged pressures and endogenic managed pressures – a numbered guide" [2011] Marine Pollution Bulletin, 62: 651-655

fails to implement the ambiguous directive correctly, then infraction proceedings can result, where the meaning of uncertain terms or obligations will be determined (which can impact the true spirit of the legislation).

In the EU case law review, this research uncovered a series of cases where indicators were unsuccessful.[26] Each Member State failed in their case because they misunderstood or misinterpreted the corresponding directive and thus, applied the wrong indicators (or failed to develop indicators at all). This was not a fault of the indicators – they were unsuccessful or did not meet the operation efficiency because they were not developed and applied correctly by the Member State. They were founded on the wrong criteria or simply the wrong indicators were used altogether (or no indicators were used at all). The Courts use indicators to determine failure in complying with the requirement of a Directive. If a regulator does not use the correct or appropriate indicators, then they will be unable to properly implement the legislation.

For example, in *Commission v. Germany* (Case C-298/95), the importance of indicators and how they are interpreted is evident.[27] Measures were in place which Germany felt were adequate to meet the requirements of the Directive. Furthermore, the indicators demonstrated conditions similar to those mandated within the legislation. Yet, the Courts interpretation was entirely different. The data that Germany provided to the Courts was obtained from indicators taken in a single area at a particular time. According to the Court they did not constitute evidence that the waters met the requirements of either Directive. In other words, the indicators were not successful and operationally efficient because the wrong indicators were used and those used were not based on the four core functions or the appropriate criteria. Thus the indicators were not flawed. Rather, the method in which they were used and the management system responsible for such application was found to be at fault.

Similarly, in *Commission v. Netherlands* (Case C-152/98), the Court's interpretation of the case, the Directive, and the corresponding quality objectives, limit values and indicators is interesting.[28] They understood that laying down limit values

[26] See pg. 153-172
[27] See pg. 155-157
[28] See pg. 165-167

and indicators would not necessarily eliminate water pollution. But these measures are of vital importance, as they are a step towards meeting the requirements of the Directive. To be effective, there must be fixed values for these substances that the indicators can measure for. Thus, the Court demonstrated an acute understanding of indicators and their role in marine management. The level at which the limit values are fixed will ultimately determine the success of eliminating the pollution. Consequently, even if limit values are unknown, Member States must still establish programs that aim to eliminate pollution using quality objectives and indicators that can measure progress towards such objectives. Thus, the indicators themselves did not fail; instead, the Netherlands was responsible as they did not develop indicators based on the four core functions or appropriate criteria to meet the requirements of the Directive.

At the national level, there were instances of both success and failure in the cases that were reviewed. For example, in *Bonnington Castings Ltd v Wardlaw*, an analysis of the research found that indicators are often successful where human health is concerned and even when they are lacking, a conservative approach will be taken. This particular case laid the foundation for how Courts assess evidence and expert testimony in legal proceedings. Limits exist in scientific knowledge, yet this has not prevented Courts from exercising their judicial functions and basing decisions on less than full proof. When the indicators lack a concrete foundation (in this case, no evidence could substantially demonstrate which dust or what amount caused the illness), the courts often use a 'common sense' approach to fill the gaps (i.e. they infer what the indicator is meant to communicate – in this particular case, the Court took a conservative approach). Thus, indicators applied in a court context must be at a minimum based on the four core functions to allow for a 'common sense' approach and to be considered successful and operationally efficient.

In *Murdoch v Glacier Metal Co. Ltd*, the indicators and the criteria they were measured against failed because they could not adequately prove that noise and glare from the factory disrupted the Murdoch's sleep. This was not necessarily the fault of the indicator, but of the user applying them (the Murdoch's expert). He could not justify the validity of his argument because his data was incomplete and was not sufficient enough to justify his claims. Arguably, the indicators were not successful and operationally efficient because they were not founded on the fundamental four core functions, nor on appropriate criteria. This resulted in the Court's interpretation of the indicators.

Thus, when no specific indicators or corresponding criteria are mandated in the legislation, the success of the indicators at case law level will be dependent on the user, their ability to communicate the facts, and the Court's interpretation of the data. Furthermore, where human health is concerned and the indicators are implied or inconclusive, the Courts will take a conservative approach, infer common sense and rule in favor of protection of human health. So, if the applicant's understanding of the indicator does not align with the interpretation of the Court, they will not be successful in their case. Consequently, although there is little direct scrutiny of indicators in formal domestic legal proceedings, the Courts have developed rules on the treatment of evidence and expert witnesses. Thus, these factors (along with the four core functions and pertinent criteria) must be accounted for in the design of indicators.

10.7 Law influence policy or policy influence law (Question 7)

Research question #7 asked whether law influences policy or policy influences law in the development of marine environmental indicators. According to Table 10.1, both occur across the three regimes, although there tends to be more of a top-down approach within environmental law at all three levels. At the international environmental law level, the research showed that a top-down approach exists, but one that allows the States Parties the ability to develop and deploy the indicators that best fit their national strategies. Across the conventions that were analyzed, it was found that the success and efficiency of the chosen indicators was dependent on the user developing them (which was discussed in detail above). The regulations influence marine environmental indicators in legislation and policy at the regional and national levels (as seen in the UNCLOS and the CBD). But, as time has evolved, the regulations have slowly begun to take both a top-down and bottom-up approach to indicator development and application (although as of 2011, this was still in its infancy). OSPAR, the UNFCCC and MARPOL demonstrated that the law is influencing policy (in terms of indicators), but also that regional and national instruments are beginning to influence international environmental law and statutory approaches as well.

Similarly, international environmental policy demonstrates both a top-down and bottom-up approach to indicator development and application. As discussed previously, environmental protection and conservation was not the original aims of international policy. Initially economic preservation was the main driving force, followed by an emphasis on social justice. Considered a profit – people – planet mentality this formed the initial foundation of sustainable development and ultimately impacted the type of indicators developed and applied in early international environmental policy. Yet, global issues (e.g. climate change, the decline of fisheries) prompted governments to cooperate for their mutual protection and to focus beyond economic and social concerns. This allowed nations to work together to perceive the common interests between the environment, society and the economy and, therefore, approach environmental issues through cooperative efforts.[29] These efforts included developing and applying operationally efficient environmental indicators aimed at protecting and preserving the environment (including marine ecosystems) for more than economic and social purposes. Due to the trans-boundary nature of the marine environment, action instigated at the international level has been and is still responsible for further action pursued at the national and regional levels. Arguably, this, combined with the global movement to protect the environment, has paved the way for an approach to indicator development that is influenced as much from the bottom-up as the top-down.

At the European environmental law level, both a top-down and bottom-up approach to indicator development is evident. Member States must strictly implement the minimum requirements of environmental directives in their national strategies, but they have the flexibility to adopt more stringent measures. Additionally, the directives must be implemented in accordance with other pertinent regulations and coordinated across Member States, so that data is shared and meaningful on a regional level. Thus, Member States can influence the corresponding application of the directives and the indicators implemented within them, so long as the minimum mandates are met. From the research, it seemed that there was both a top-down and bottom-up approach within the directives from an early date, arguably because the EU is composed of sovereign states and, thus, looks to them for guidance as much as it seems to guide them. An

[29] This can be seen in the UNEP Oceans and Coastal Areas Program, Agenda 21, the UNCLOS, and other international environmental organizations.

exception to this is where human health is concerned, as these directives have been much stricter and prescriptive in their interpretation, specifically as it related to indicator development and application (i.e. the BW+-D).

Similar to European environmental law, EU environmental policy has also taken both a top-down and bottom-up approach to indicator development. Although EU policy documents are often prescriptive on which type of indicators to use (such as the headline, lead and action indicators referenced in the EC Sustainable Development Strategy), the EC is flexible and works with Member States to continually refine these indicators and develop additional indicators.[30] Similarly, the 7th EAP looks to Member States to continue to promote a strong knowledge base and to develop successful and operationally efficient indicators to communicate the state of the environment and monitor progress towards existing environmental objectives (e.g. climate change, energy targets, biodiversity).[31] The EU looks to Member States for guidance in environmental indicator development and application to meet the objectives of its various environmental policy documents. Thus, environmental governance and indicator development is multi-leveled, with the EU influencing Member States and vice versa at the policy level. The research has found that the EU has worked closely with Member States to develop successful and operationally efficient indicators that integrate environmental policy approaches at every level, thereby creating a top-down and bottom-up approach to environmental indicator development and policy creation.

At the national environmental law level, a strictly top-down approach to indicator development and application is evident. This was seen in the Marine and Coastal Access Act, which was not explicit on the use of indicators, but which took a more top-down stance regarding the use of environmental indicators and the management of the national marine environment.[32] Similarly, the Bathing Water Regulations, although not explicit on the use of indicators (unlike the higher Directive) implies their use.[33] The indicators, and the regulatory provisions which they are intended to measure, are straight from the higher Directive, demonstrating a top-down

[30] See pg. 184-187
[31] See pg. 191-192
[32] See pg. 208-211
[33] See pg. 213-216

approach in both the legislation and corresponding indicators. For example, the Environmental Agency must establish a monitoring program for Intestinal enterococci and Escherichia coli, as well as cyanobacteria, macro-algae and marine phytoplankton. These indicators are identical to those found within the Directive. In other words, national legislation closely adheres to the spirit of the EU directive driving them. If the directive specifically mandates indicators or provides guidance on what indicators to use and the criteria to base them on, then the regulations reflect this. Thus, EU law drives national legislation and the resultant indicators that are used. England and the UK may have some influence over higher legislation, but there is clearly a top-down approach occurring, which directly influences indicator development and use.

National environmental policy, on the other hand, takes both a top-down and bottom-up approach to indicator development and application. Arguably, this is because EU and international economics influence national policies on sustainable development. So as much as the strategy is designed to promote national economic growth, social cohesion and protection of the environment, the Government looks to higher policies and legislation from the EU and internationally to help meet their intended objectives through the application of indicators. For example, *Safeguarding Our Seas* is a key national marine policy that has been influenced by higher policy and legislation from the EU and internationally.[34] Thus, the environmental indicators discussed are influenced by decisions made on a global scale. At the same time, this national policy works to influence and participate in EU and international policies that are important on a national scale (i.e. biodiversity, bathing water quality, sustainable tourism). As discussed above, nationally, the UK has been explicit on the development and use of environmental indicators in all pertinent environmental documents. Moreover, the research has uncovered a bottom-up and top-down approach to indicator development, demonstrating that as much as the UK is guided by the EU and international policies, it strongly influences these regimes. Because the economy plays such a large role in national environmental policies, the UK remains a strong player in the global pursuit for successful and operationally efficient indicators.

[34] See pg. 250-254

10.8 Indicators and resources (Question 8)

Lastly, research question #8 asked what evidence is there that indicators have made a difference in successfully managing resources. Examples of this were prevalent throughout the research, although it was much more evident at the EU and national levels, and not as much at the international levels. Arguably, this is because international environmental law and policy is more concerned with things that impact the global community (e.g. climate change, pollution control) than managing resources (which do not necessarily belong to any one particular States Party). The research found that resources tend to be more easily managed at a regional or national level vs. an international level. Thus, the thesis demonstrated a drive to protect natural resources within the EAPs of the EU[35] and the *Southern Bluefin Tuna* cases (where indicators were used to determine the amounts of Bluefin tuna taken by Japan under their experimental fishing programs. This case demonstrates the issues that arise when trying to use indicators to manage resources, such as fish, at an international level).[36] Resource management was also seen in international environmental law through the CBD.[37] As discussed above, although indicators were not explicitly mandated within the text, they are implied as a means to conserve biological diversity and manage resources. They appear explicitly in the national reports (such as those for the UK) and, therefore, have an impact on the development and use of indicators for resource management down to the domestic level. Thus, the CBD depends upon the national transposition of measures and the way in which local conditions and contexts are determined, since these will drive the specific indicators. Indicators can and are deployed to integrate the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programs and policies within a given State.

At the national level, chapter 9 demonstrated the importance of indicators in managing a valuable resource, such as marine aggregate extraction and dredging. There are many indicators of community structure used in the aggregate dredging and extraction industry. These aim to show the natural and human-induced changes to an area. They are sometimes based on an accepted paradigm (such as the Pearson &

[35] See pg. 187-192
[36] See pg. 72-76
[37] See pg. 50-55

Rosenberg model). They must also show inherent variability and then build this into a signal: noise ratio.

The indicators explored in chapter 9 are founded on science, but are often heavily influenced and driven by policy in both their development and use. As noted by Hague *et al*, when indicators are selected by regulators to meet policy agenda it is a political choice, not necessarily a scientific one, as these indicators are designed to meet specific policy objectives. This can create tension between scientists and regulators. Arguably, science can objectively evaluate indicators because it is driven by the data itself, and not political objectives. Consequently, the importance of indicators is cemented within the national marine aggregate dredging and extraction industry and corresponding regulations. Although not explicit on the use of indicators, the regulations imply their development and use to gather data, communicate impacts to human health and the environment, and ultimately manage this valuable and economically important resource. Regulators must possess as much information as possible about a proposed activity to make an appropriate decision on granting a license. The regulations analyzed in Chapter 9 are arguably successful legal frameworks in terms of indicator applications, in that they permit flexibility. This allows the applicants to develop and use indicators that are scientifically driven and fit for purpose when applying for their license to dredge or extract. Consequently, the national marine aggregate dredging and extraction industry appears to favor the use of indicators and provides the necessary legislative platforms for indicator success, which helps to ensure the protection of human health and the environment.

10.9 Next Steps

In recent years, a greater emphasis has been placed on employing indicators across all levels of policy and law. Thus, more conferences, symposiums and discussions on indicators are emerging. But are scientists and regulators adhering to the advice being provided through the literature? This thesis focused on regimes operative as of 2011 and successfully met the aims and objectives upon which it was designed. But this work is in no way finished. It could be further expanded (in future studies) to explore more current regimes (i.e. as of 2016) and to analyze more contemporary indicator use. How has the development and application of indicators in law and policy evolved since 2011? Have new criteria emerged? What trends in indicator development and application are prevalent today?

The literature review of Chapter 8 found that published lists of indicator criteria must be routinely evaluated. Further analysis and future work could be conducted to understand new indicator frameworks that have emerged since 2011 and to re-evaluate the lists of indicator criteria. Are these criteria still valid? Can they produce indicators that are fit for purpose? What new criteria are pertinent? Additionally, a similar study could be conducted for other maritime industries (such as fisheries). How has the employment of indicators influenced other national environmental marine industries and what is the trend that is emerging from the application of new regulatory and policy frameworks?

It was noted in this thesis that while it aimed to provide a broad ranging review and detailed critical analysis of significant marine policies and legislation, it could not exhaustively describe the totality of all regimes that exist. Thus, further work could be undertaken to determine how other policies, legislation and case law (not explored in this thesis) accommodate indicators.

Indicators can bridge environmental, economic and social goals, which in turn have influenced indicator development – a cyclic pattern has emerged. Embedding science within policy and regulatory frameworks ensures that even if indicator selections are a political choice, they are still linked to a scientific foundation. Thus, policy-makers and regulators can use indicators to understand specific features of the marine environment in a less complex, but still scientifically accurate manner. This thesis demonstrates that when founded upon the four core functions and successful criteria, indicators gauge the success of current marine management techniques within environmental law and policy at the international, European and national levels. Whether scientifically or politically driven, they are crucial to the successful development and implementation of environmental policies and legislation world-wide. They cross various disciplines and when properly understood and applied, can assess progress in achieving political and legal goals, thereby ensuring that the needs of humans and the environment are equally balanced.

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