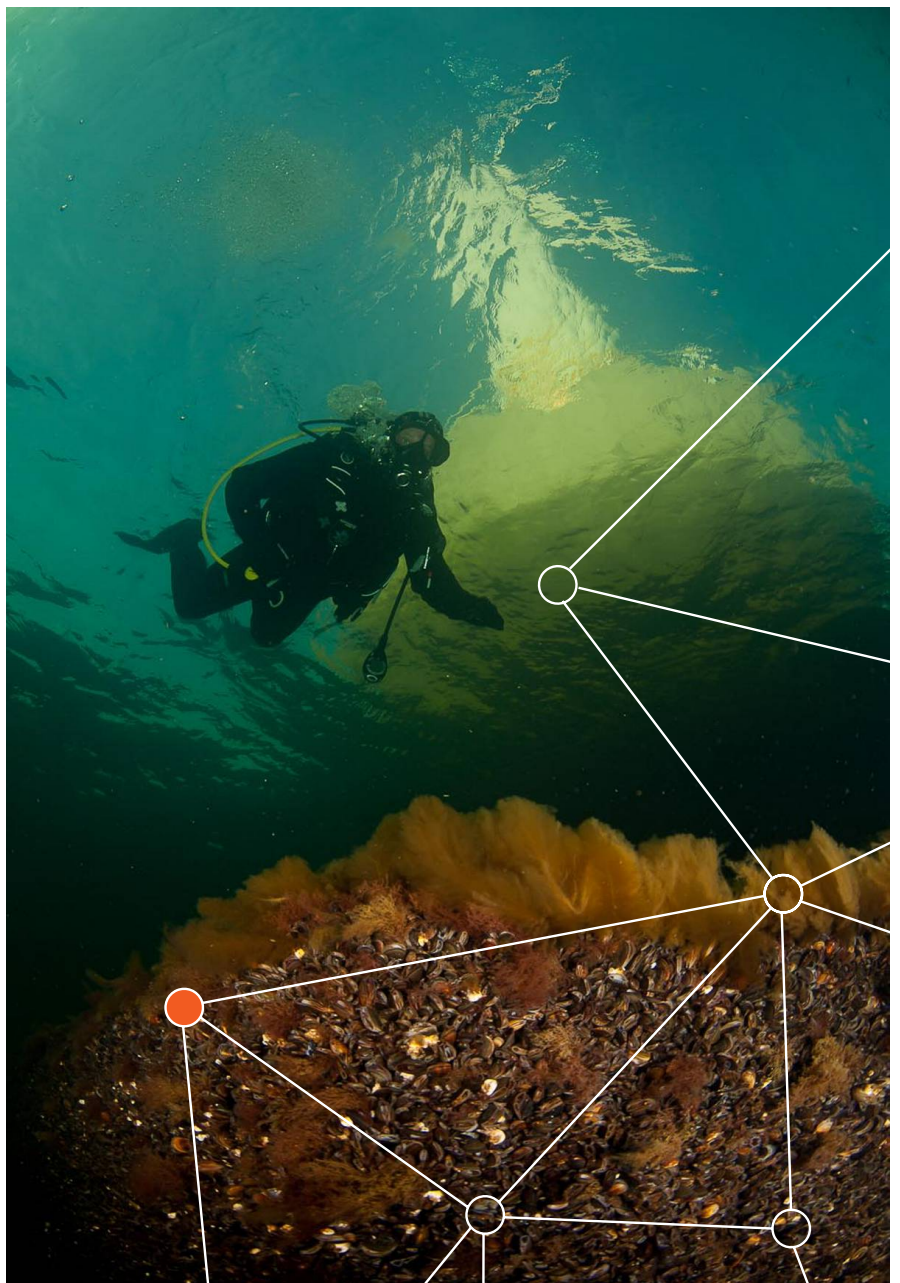


IEC/ISO Bowtie analysis of marine legislation: A case study of the Marine Strategy Framework Directive

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IEC/ISO Bowtie analysis of marine legislation: A case study of the Marine Strategy Framework Directive

Authors

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Foreword

ICES Working Group on Marine Planning and Coastal Zone Management (WGMPCZM) terms of reference are based on a long history of work and issues from the membership of the group. In 2003, ICES Study Group on Information Needs for Coastal Zone Management (ICES, 2003) recommended that decision-support systems, as applied in decision-making for the establishment of aquaculture farms, be applied more generally for the coastal zone. The following year, the study group recommended establishing a working group on coastal zone management to keep abreast of scientific developments in the coastal zone, in addition to requirements for sustainable uses and management of the coastal zone (ICES, 2004). Although progress was made in terms of information and management tools for integrated coastal zone management (ICZM), the newly formed Working Group on Integrated Coastal Zone Management (WGICZM) recognized the need for frameworks and processes to integrate and evaluate human impacts in the coastal zone in light of the EU Water Framework Directive (ICES, 2005). The need for such a framework carried through from that point onward with the addition of risk characterization as work was progressing on the development of indicators (ICES, 2006, 2007, 2008). In 2009, WGICZM started to examine risk-based, decision-making processes within the context of advancing integrated evaluation of human impacts and governance (ICES, 2009, 2010) within an ecosystem-based and ecosystem service context.

With the advent of marine spatial planning (ICES, 2011, 2012), the renamed Working Group on Marine Planning and Coastal Zone Management (WGMPCZM) began examining marine and coastal planning management practices and standards. Building on ICES guidance on the ecosystem-based approach to management (Rice *et al.*, 2005), two Cooperative Research Reports were produced that bridged ecosystem-based approaches to management with international risk management standards (Cormier *et al.*, 2013) and marine spatial planning with international quality management standards (Cormier *et al.*, 2015). The reports are policy and management-centric documents outlining management, decision-making, and stakeholder practices used in policy-making and implementation (Cormier *et al.*, 2017). They also contributed to broadening the focus of WGMPCZM's work (ICES, 2013a, 2014a) to include social-cultural dimensions of ecosystem services (ICES, 2013b; Gee *et al.*, 2017), cumulative-effects assessments (ICES, 2014b, 2015, 2017) and conflict management in planning (ICES, 2016).

Although seeking to advance scientific knowledge within the ICES community, WGMPCZM continues to research and develop management tools as an integrator of multidisciplinary scientific and technical knowledge with planning processes and decision-making. Our strategy is to produce Cooperative Research Reports that provide tools and guidance to managers, planners, and stakeholders involved in marine planning and coastal zone management while providing policy-making and management insights to the scientific community.

1 Introduction

Marine planning and coastal zone management require an understanding of the policy context (Cormier *et al.*, 2015) that addresses ecosystem, cultural, social, economic, and legal aspects (Barnard and Elliott, 2015). Policy includes a suite of agreements, legislation, and interpretations that are enabled by policy-making processes and public feedback (Ehler and Douvère, 2009), while being informed by scientific and technical knowledge. However, a plan requires the implementation of management measures to carry into effect the objectives set in the said plan (Elliott *et al.*, 2017). It is through legislation, regulations, standards, and guidelines that such measures are implemented within an operational context designed to meet expected outcomes to achieve the objectives of the plan and ultimately reach the goals of the policy (Cormier *et al.*, 2017).

Without a comprehensive suite of management measures to reduce the pressures that result from human activities, cumulative effects cannot be adequately prevented, leaving protection and conservation measures as the only option to mitigate the effects (Stelzenmüller *et al.*, 2018). Outside the changes resulting from continuously evolving natural processes, the premise, here, is that cumulative effects reflect the effectiveness management measures implemented across the relevant sectors of operation and jurisdictions. When cumulative effects and impacts are observed, it implies that the system of management measures and practices across the relevant sectors are not adequately managing the pressures generated by their respective activities (Elliott *et al.*, 2017). Given that cumulative-effects assessments are typically focused on the effects and their impacts, an assessment of the effectiveness of these measures and practices would also be required to get a better understanding of the root causes of such effects and impacts and to improve existing management strategies (de Jonge *et al.*, 2006). Such assessment must also include legislation, regulations, standards, and guidelines that are used to implement measures and guide the practices as these set the scope of the management approaches and objectives for each sector. The scope and objective of current measures and practices may not have considered broader ecosystem considerations at the time they were developed, resulting in cumulative effects and impacts.

In contrast to traditional ecosystem and risk-assessment approaches, risk-management processes (ISO, 2009a, 2009b) require that the effectiveness of the controls be assessed to better understand how the management system is addressing actual or potential impacts and consequences. In such a process, the effectiveness of the controls are assessed to determine if these are adequate to achieve objectives. As part of the International Organization for Standardization (ISO) suite of risk-management standards under ISO 31000 (ISO, 2009a, 2009b), the Bowtie analysis is one of the more than 31 risk-assessment techniques of IEC/ISO 31010 (IEC/ISO, 2009) and is designed to analyse the controls used to manage risks. The Bowtie analysis provides a structure to evaluate procedures, measures, and controls used to prevent and mitigate risk (Mostia, 2009; Markowski and Kotynia, 2011; Badreddine and Ben Amor, 2013). Recently, the Bowtie analysis has been adapted to the analysis of environmental legislation and policies (Cormier *et al.*, 2016; Creed *et al.*, 2016; Elliott *et al.*, 2017). This technique is also a valuable tool to help stakeholders characterize the risks with which they are concerned and understand how risks are being or could be managed (Chevreau *et al.*, 2006; Gerkenmeier and Ratter, 2016).

A series of ICES workshops regarding the qualitative and quantitative use of the Bowtie analysis in cumulative effects assessments (ICES, 2014b, 2015, 2016) recommended to elaborate a more detailed Bowtie of existing legislation and policies of a regional European sea integrating the EU Marine Strategy Framework Directive (MSFD) and

good environmental status criteria (EU, 2008). This report is a case study to demonstrate how the Bowtie analysis can be adapted to the analysis of legislation within a multijurisdictional context from a cumulative-effects assessment perspective. The analysis uses the programme of measures of the MSFD (Annex VI of MSFD) as the controls to be assessed to achieve and maintain good environmental status for each of the qualitative descriptors (Annex I of MSFD). Cited instruments under the MSFD are used, as an example, to demonstrate the relevant legislation and regulations involved in the management of the pressures for each relevant descriptor of good environmental status through the programme of measures.

This report is organized to provide guidance for managers and administrators involved in the analysis of legislation and policies. The report also provides valuable insight for the scientific community regarding the linkage between cumulative effects and management strategies to prevent effects and mitigate impacts. Readers of this report must understand that this is an example of a policy-analysis exercise. It is an analysis of the hierarchy of management strategies across the qualitative descriptors of good environmental status. It is not an ecosystem model of components, functions, and feedback mechanisms as is typically used to map ecosystem processes.

2 IEC/ISO 31010 Bowtie analysis

A Bowtie analysis depicts several pathways of risk based on multiple causes of an event in the presence of a source of the risk and multiple consequences as a result of that event (Figure 2.1; IEC/ISO, 2009; de Dianous and Fiévez, 2006). The analysis is used to identify the prevention controls (left side of the Bowtie) needed to reduce the likelihood of an event and the mitigation or recovery controls (right side of the Bowtie) needed to reduce the likelihood and magnitude of the consequences if and when such an event occurs (Ferdous *et al.*, 2013). Prevention controls are implemented for each cause that is linked to the source of the risk to reduce the likelihood or probability of the event. Prevention controls manage the causes and not the event. Mitigation and recovery controls are implemented to reduce the likelihood and magnitude of each consequence as a result of the event occurring. Mitigation and recovery controls manage the consequences and not the event. The event can occur in any given space and time as long as the source of the risk is present. An escalation factor is an external factor, outside the management strategy being analysed, that can undermine the effectiveness of a control. Once identified, additional escalation controls are added to reduce the likelihood of undermining the effectiveness of a control. In Figure 2.1, the escalation factors are shown as examples for only two of the controls. One or many escalation factors can be assigned to any prevention, mitigation, or recovery controls. As a risk-reduction strategy, removing the source of the risk completely eliminates the causes of the event and, thus, the likelihood of that event. As long as the source of the risk is present, the likelihood of the event depends on the effectiveness of the prevention controls implemented to manage each cause. Unless the prevention controls are 100% effective, the likelihood of the event occurring is never zero. Once the event has occurred, the likelihood and the magnitude of the consequences depend on the effectiveness of the mitigation controls implemented for each consequence. As with the prevention controls, the effectiveness of the mitigation controls is never 100% and, thus, the likelihood and the magnitude of the consequences occurring is also never zero. Generally, mitigation controls are used to reduce the spatial scale, duration, or intensity of the consequences. Recovery controls are used to restore the damage caused by the consequences as a result of the mitigation controls being ineffective in the face of the event. Recovery controls are technically the option of last resort when both prevention and mitigation controls are not effective or have failed.

The event can only be prevented by controlling the causes, and the consequences of the event can only be mitigated or recovered from by controlling the consequences. It is important to keep in mind that mitigation and recovery can only deal with the consequences of the event and can never return to the situation that existed before that event. Escalation factors can also be considered for prevention, mitigation, and recovery controls, where necessary. Escalation factors can either undermine the effectiveness of a control or can cause the control to fail. Generally, a Bowtie with a predominant number of prevention controls is indicative of a preventive management strategy, whereas a Bowtie with a predominant number of mitigation and recovery controls is indicative of a reactive management strategy (Cormier *et al.*, 2016).

In the Bowtie diagrams in this report, prevention controls are represented by a green flag, as they manage the causes of the event, while mitigation and recovery controls are flagged as yellow and red respectively, as they manage the consequences. Given the uncertainty of success, managing the consequences, after the fact, is considered a

larger risk than preventing the causes of the event in the first place. The escalation controls are yellow because they provide additional precautionary measures needed to ensure the effectiveness of the prevention, mitigation, and recovery controls.

It should be noted that the Bowtie diagrams presented in this report are produced with the BowTieXP software (CGE, 2017). Figure 2.1 is an adaptation of the IEC/ISO 31010 Bowtie diagram (IEC/ISO, 2009).

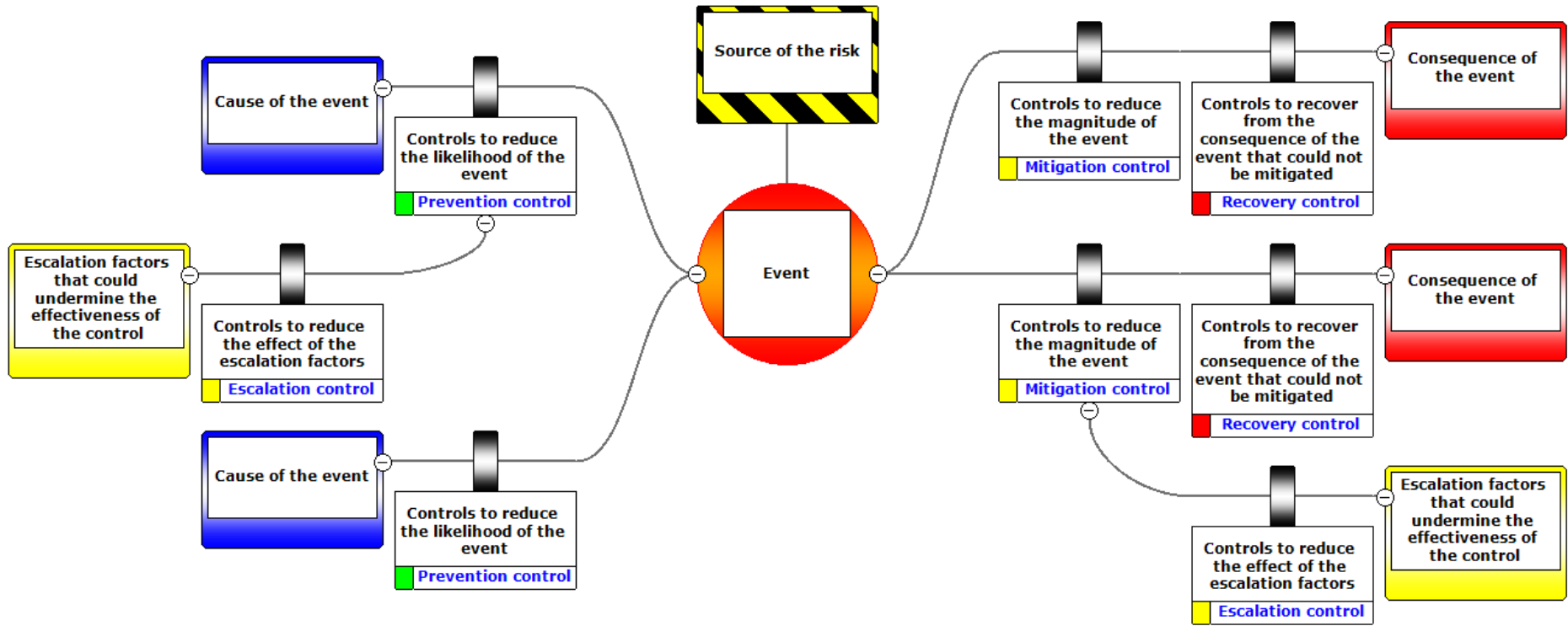


Figure 2.1. Structure of the Bowtie diagram (BowTieXP adaptation of IEC/ISO 31010).

3 Pathways of risk of a chain of events

As mentioned in Section 2, the Bowtie diagram structures the pathways of risk, from the causes to the event to the consequences, in the presence of a source of the risk (Figure 3.1). An important aspect to note is that the prevention, mitigation, and recovery controls represent the management system that is under the span of control of one management strategy or authority.

However, the lack or failure of one management system can cause a domino effect across a chain of events. At some point along the chain, events cannot be adequately controlled because of the cumulative effect of the consequences of the events occurring up the chain. In such a case, the only management strategy possible is a reactive approach: implementing mitigation and recovery controls. In risk management, it is important to understand the root causes of risk to ensure that these controls are adequately implemented to avoid a chain of events. Managing the root causes of such events is a preventive management strategy approach. There may also be a need to identify who has the authority to control root-cause events when these are outside the authority of a given management system. Therefore, a macro-level pathway of risk across several chained events starts with the root-cause event and ends with the endpoint event. Figures 3.2, 3.3, and 3.4 demonstrate how a chained Bowtie can show the progression of complexity in chained events. In this report, this technique is used to chain the management system of the descriptors of good environmental status and to demonstrate the domino effects that can accumulate across the descriptors.

In Figures 3.2 and 3.3, if Causes A and B are not adequately controlled within Events A and B's span of control, the consequences of Events A and B can cause Event C. Events A and B are the root cause of the chain of events that will result in Event C. Event C cannot occur if Events A and B are adequately managed by their respective prevention, mitigation, or recovery controls.

In Figure 3.4, the consequences of Events A and B are shown as causes of Event C. In such a case, prevention controls cannot be implemented within the span of control of the management system for Event C. Only mitigation and recovery controls can be implemented for Consequence C as a result of Event C.

In this example (Figure 3.4), Events A and B are the root causes of the chain of events, while Event C is considered as the endpoint event. Event C can only be prevented by the management systems of Events A and B. If these events are outside the authority or span of control of Event C, there may be a need for management coordination to ensure that the authority for Events A and B include Event C in the design of their management system.

It should be noted that Bowtie chains of events are produced as a function of the BowTieXP software (CGE, 2017) as an adaptation to root-cause analysis of IEC/ISO 31010 (IEC/ISO, 2009).

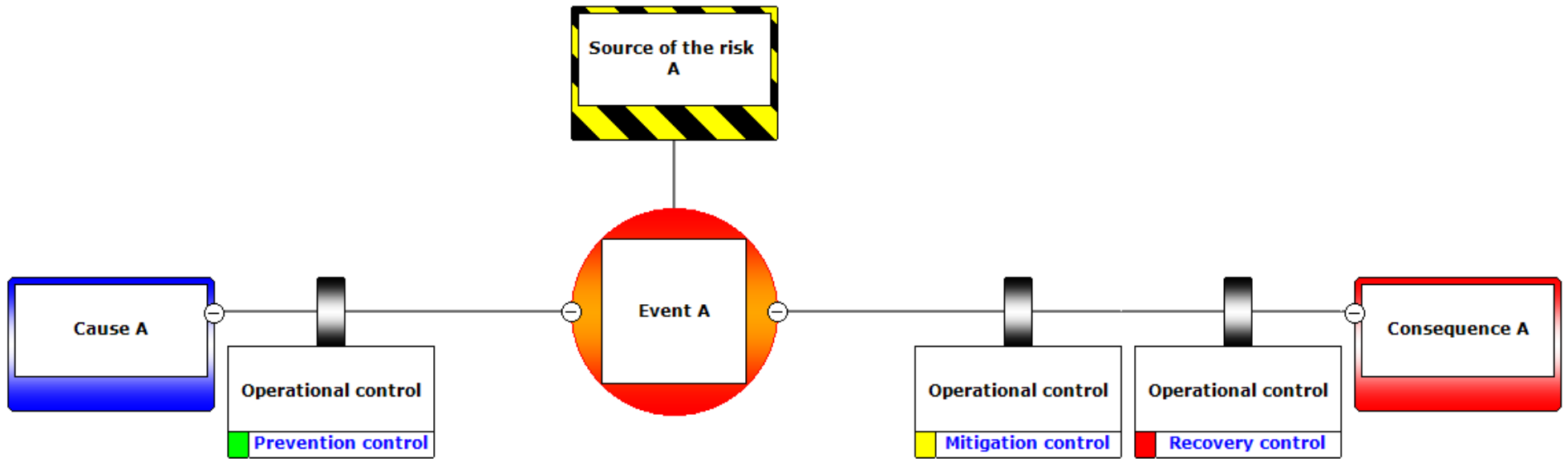


Figure 3.1. Bowtie diagram of a pathway of risk managed by one management system.

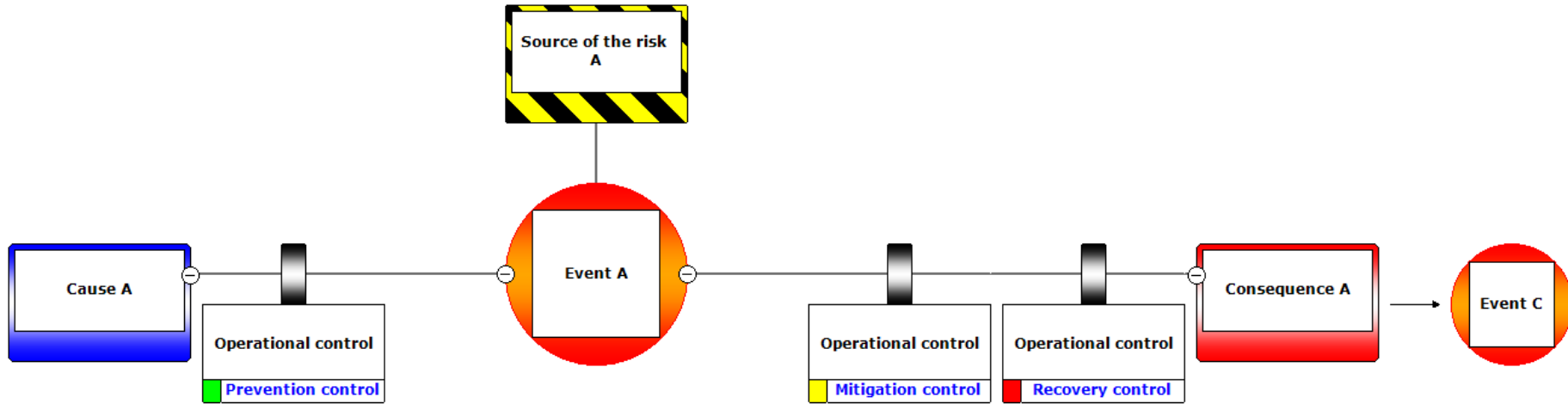


Figure 3.2. Bowtie diagram of pathway of risk across a chain of events where Event A can cause Event C.

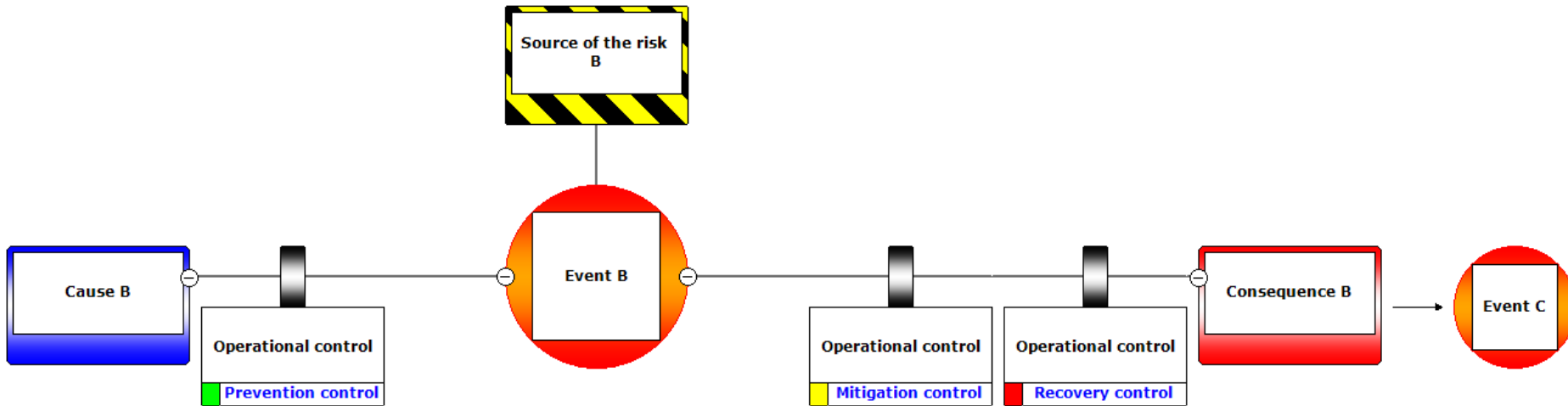


Figure 3.3. Bowtie diagram of pathway of risk across a chain of events where Event B can cause Event C.

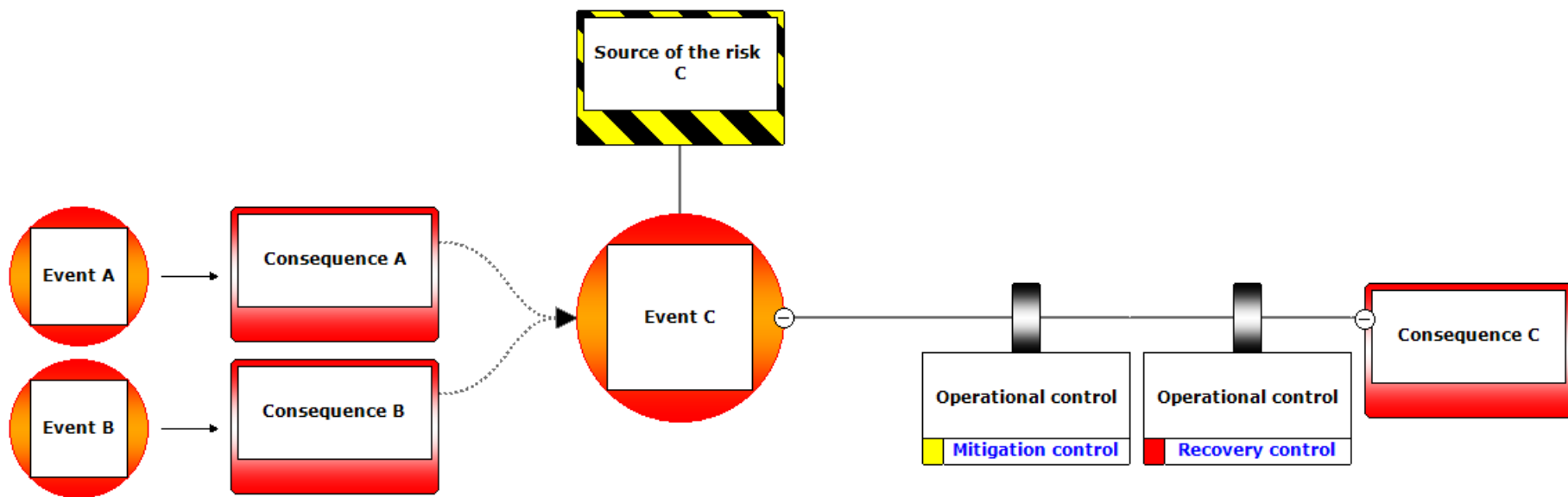


Figure 3.4. Bowtie diagram of pathway of risk showing the consequences of Event A and Event B causing Event C.

4 Understanding the management system of the MSFD

A management system is a framework of policies that includes management and operational control processes (Anthony and Dearden, 1980). Management control processes are used to manage an organization's resources to carry out its strategies effectively and efficiently, achieve objectives, and reach goals. Operational control processes are the implementation of specific tasks, procedures, and controls to meet expected outcomes effectively and efficiently. The management system relies significantly on operational controls to meet expected outcomes considered necessary to achieve the objectives set by management and to reach the goals set by the governance of the organization. Operational control, however, operates within a set of well-defined procedures, rules, and expected outcomes that are derived from the objectives. An operational control system is a rational system of rules, procedures, and tasks that are applied to a narrowly prescribed activity to control a specific input and to ensure that the output consistently meets an expected result or outcome. Operational control seldom, if ever, addresses all aspects of a given problem, issue, or risk. In this report's Bowtie diagrams, the prevention, mitigation, and recovery controls are operational controls.

Following through with the hierarchy of outcomes, objectives, and goals, the expected outcomes of the controls are defined in the programme of measures (Annex VI of MSFD), the objectives are listed as the qualitative descriptors of good environmental status (Annex I of MSFD), and the goals are set in the preamble of the Directive (Paragraph 4). Thus, the operational controls implemented across the sectors have to meet the expected outcomes of the programme of measures to achieve and maintain good environmental status as the objectives of the descriptors to reach the goals of promoting sustainable use of the seas and conserving marine ecosystems. However, the programme of measures includes management and operational control processes (Table 4.1). Operational controls are the prevention, mitigation, and recovery controls needed to manage the pressures and impacts resulting from human activities and the demands on natural ecosystem services. Management controls are the processes needed to ensure that the operational controls are implemented across relevant jurisdictions and sectors in consultation with stakeholders.

Table 4.1. Management system of the MSFD programme of measures (Annex VI of MSFD).

Programme of measures	Expected outcome	Application
Input controls	Management measures that influence the amount of a human activity that is permitted	Operational control process
Output controls	Management measures that influence the degree of perturbation of an ecosystem component that is permitted	Operational control process
Spatial and temporal distribution controls	Management measures that influence where and when an activity is allowed to occur	Operational control process
Management coordination measures	Tools to ensure that management is coordinated	Management control process
Measures to improve the traceability	Improve the traceability, where feasible, of marine pollution	Management control process
Economic incentives	Management measures which make it in the economic interest of those using the marine ecosystems to act in ways which help to achieve the good environmental status objective	Management control process
Mitigation and remediation tools	Management tools which guide human activities to restore damaged components of marine ecosystems	Operational control process
Communication	Stakeholder involvement and raising public awareness	Management control process

5 Bowtie diagram structure of the MSFD

Transferred to a Bowtie diagram (Figure 5.1), input controls and spatial and temporal distribution controls play the role of prevention controls in reducing the likelihood of exceeding the degree of perturbation of an ecosystem component permitted (event) as a result of pressures (causes) generated by human activities and demands for natural ecosystem services (source of the risk). As the central event to avoid, output control sets the degree of perturbation permitted for all cross-sectoral pressures. In this report, exceeding the level of perturbation permitted corresponds to cumulative effects that would undermine a qualitative Descriptor of good environmental status (Annex I of MSFD). Therefore, the effectiveness of input controls and spatial and temporal distribution controls, which are implemented in the operational activities of each sector, need to reduce the collective pressures to the level established by the output control. Mitigation and remediation tools play the role of mitigation and recovery controls in reducing the likelihood and magnitude of the impacts of not achieving or maintaining good environmental status for each descriptor. Here, we use the EU criteria for good environmental status (EU, 2010) to provide a set of ecosystem components impacts that would be observed as a consequence of not achieving or maintaining good environmental status for specific descriptors, although it is no longer in force and was replaced in June 2017 (EU, 2017).

As escalation factors, transboundary effects, and impacts can undermine the effectiveness of the operational controls needed to manage pressures and impacts. Management coordination measures, measures to improve traceability, economic incentives, communication, and stakeholder involvement are the escalation controls needed to ensure the effectiveness of operational controls implemented within each respective jurisdiction. Given the uncertainties related to the effectiveness of any operational control, monitoring (Annex V of MSFD) and environmental targets (Annex IV of MSFD) are shown as the management control processes needed to verify effectiveness and inform management and stakeholders as to the performance of the entire management strategy.

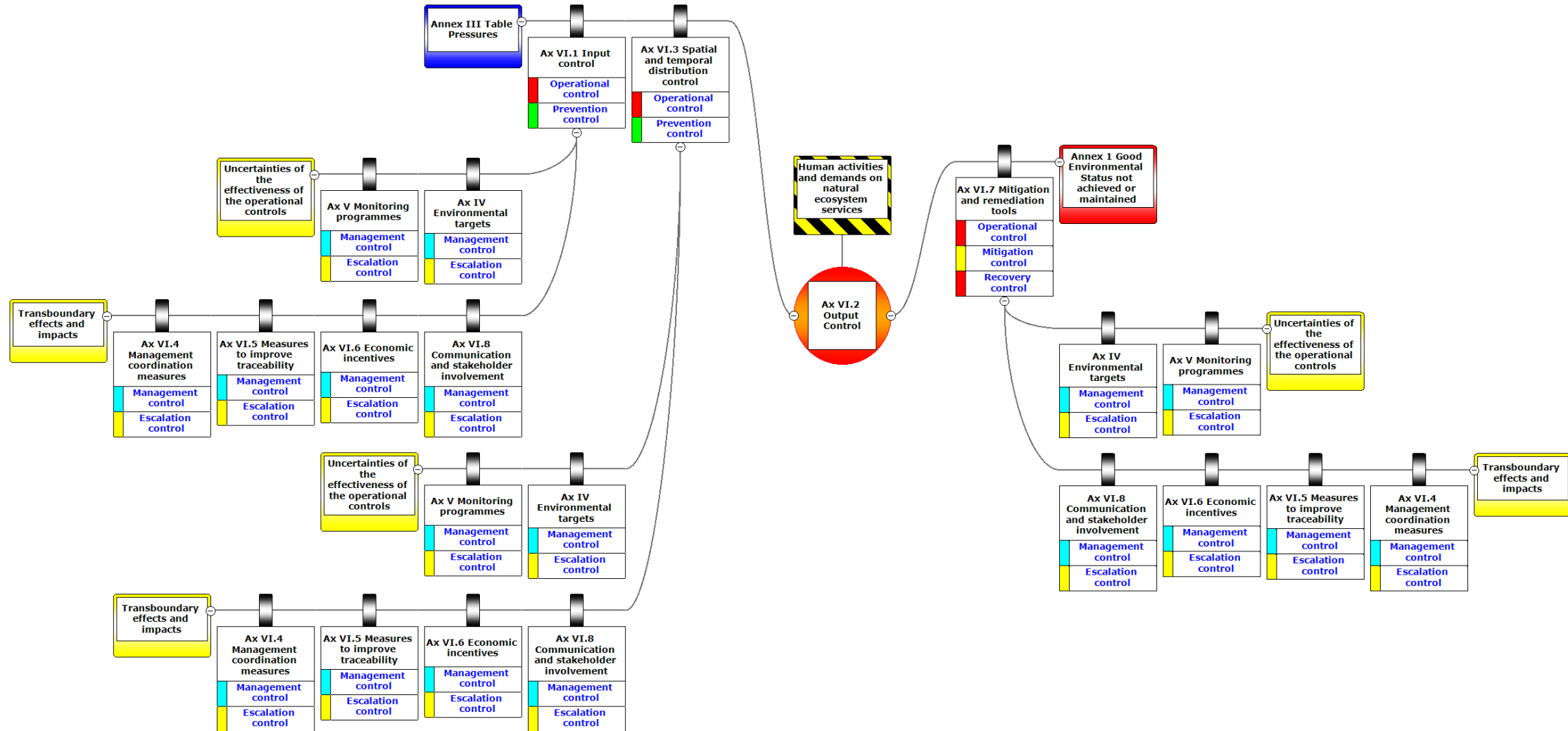


Figure 5.1. Bowtie diagram of the MSFD programme of measures (Annex VI of MSFD).

6 Bowtie analysis of the MSFD qualitative descriptor for good environmental status

In this section, a Bowtie diagram is generated for each qualitative descriptor of good environmental status (Annex I of MSFD). Given that an event is exceeding the level of perturbation permitted by an output control, each descriptor is reworded into a negative statement to reflect the consequences of exceeding such a level. From a total of 2715 “cited instruments” listed for the MSFD, 491 directives and regulations are used as examples of the legislation and regulations for each of the operational controls defined in Table 4.1. The former criteria for methodological standards on good environmental status of marine waters (EU, 2010) are used as a roster of ecosystem impacts as a consequence of not achieving or maintaining good environmental status of a descriptor. The impacts are listed under each consequence and form the basis for indicators that would be monitored and assessed.

As discussed in Section 3, the chain of events is used to link and describe the interdependencies of risk among the qualitative descriptors of good environmental status. This approach helps to understand the legislation and competent authorities that are accountable for implementing the necessary controls along the pathways of risk from the root causes of a chain of events leading to broader ecosystem effects and impacts. It also provides an overview of how the collective pressures can combine into cumulative effects and impacts across the qualitative descriptors of good environmental status.

The following sections presents a Bowtie analysis for each descriptor of good environmental status and the directives and regulations (e.g. cited instruments) as examples of the legislation that is linked to each operational and management control.

6.1 Descriptor 1: Biological diversity is maintained

Event: Biological diversity is not maintained as a consequence of exceeding the permitted degree of perturbation of an ecosystem component

Biological diversity is among the endpoints of the pathways of risk (Figure 6.1) in the chain of events. The degree of perturbation of ecosystem components related to biological diversity is caused by the consequences of abnormal abundance and diversity of marine foodwebs (Descriptor 4). Given that there are no pressures (Annex III) that can directly influence the degree of perturbation, there are no input controls or spatial and temporal distribution controls possible to reduce the perturbation. Mitigation and recovery tools are the only options to reduce the impacts of not maintaining biodiversity. However, the consequences of not maintaining biodiversity can also influence, in return, the normal abundance and diversity of marine foodwebs (Descriptor 4). These two Bowties reflect the ecosystem feedback mechanisms between biological diversity and the marine foodwebs.

The following examples are the relevant cited instruments for the controls of the programme of measures.

Mitigation and remediation tools

- CELEX:31978L0659 Council Directive 78/659/EEC of 18 July 1978 on the quality of freshwaters needing protection or improvement in order to support fish life
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31978L0659>

- CELEX:1979L040 Council Directive 79/409/EEC of 2 April 1979 on the conservation of wild birds
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31979L0409>
- CELEX:31982D0072 82/72/EEC: Council Decision of 3 December 1981 concerning the conclusion of the Convention on the conservation of European wildlife and natural habitats
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31982D0072>
- CELEX:31982R3626 Council Regulation (EEC) No 3626/82 of 3 December 1982 on the implementation in the Community of the Convention on international trade in endangered species of wild fauna and flora
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31982R3626>
- CELEX:31992L0043 Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora (OJ L 206, 22.7.1992, p. 7)
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31992L0043>
- CELEX:31993D0626 93/626/EEC: Council Decision of 25 October 1993 concerning the conclusion of the Convention on Biological Diversity
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31993D0626>
- CELEX:32000D0340 2000/340/EC: Council Decision of 8 May 2000 concerning the approval, on behalf of the Community, of the new Annex V to the Convention for the Protection of the Marine Environment of the North-East Atlantic on the protection and conservation of the ecosystems and biological diversity of the maritime area and the corresponding Appendix 3
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000D0340>
- CELEX:32009L0147 Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32009L0147>

Management coordination measures

- CELEX:31973Y1220(01) Programme d'action des Communautés européennes en matière d'environnement
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31973Y1220\(01\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31973Y1220(01))
- CELEX:31985L0337 Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31985L0337>
- CELEX:31987R2242 Council Regulation (EEC) No 2242/87 of 23 July 1987 on action by the Community relating to the environment
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31987R2242>
- CELEX:31987Y0107(02) Council Resolution of 16 December 1986 on the strengthening of Community action in favour of the environment
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31987Y0107\(02\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31987Y0107(02))
- CELEX:31990L0656 Council Directive 90/656/EEC of 4 December 1990 on the transitional measures applicable in Germany with regard to certain Community provisions relating to the protection of the environment
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31990L0656>
- CELEX:31990L0667 Council Directive 90/667/EEC of 27 November 1990 laying down the veterinary rules for the disposal and processing of animal waste, for its placing on the market, and for the prevention of pathogens in

- feedstuffs of animal or fish origin and amending Directive 90/425/EEC
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31990L0667>
- CELEX:31991Y0208(02) Council Resolution of 28 January 1991 on the Green Paper on the urban environment
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31991Y0208\(02\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31991Y0208(02))
 - CELEX:31993D0626 93/626/EEC: Council Decision of 25 October 1993 concerning the conclusion of the Convention on Biological Diversity
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31993D0626>
 - CELEX:31994D0157 94/157/EC: Council Decision of 21 February 1994 on the conclusion, on behalf of the Community, of the Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention as revised in 1992)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31994D0157>
 - CELEX:31994Y1231(07) Special report No 4/94 on the urban environment together with the Commission's replies
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31994Y1231\(07\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31994Y1231(07))
 - CELEX:31998D2179 Decision No 2179/98/EC of the European Parliament and of the Council of 24 September 1998 on the review of the European Community programme of policy and action in relation to the environment and sustainable development "Towards sustainability"
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998D2179>
 - CELEX:32000D0340 2000/340/EC: Council Decision of 8 May 2000 concerning the approval, on behalf of the Community, of the new Annex V to the Convention for the Protection of the Marine Environment of the North-East Atlantic on the protection and conservation of the ecosystems and biological diversity of the maritime area and the corresponding Appendix 3
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000D0340>
 - CELEX:32001L0042 Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:32001L0042>
 - CELEX:32002D1600 Decision No 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environment Action Programme
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32002D1600>
 - CELEX:32013D1386 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' Text with EEA relevance
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013D1386>

Measures to improve the traceability

- CELEX:31982H0472 82/472/EEC: Council Recommendation of 30 June 1982 concerning the registration of work involving recombinant deoxyribonucleic acid (DNA)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31982H0472>
- CELEX:31997Y1022(01) Council Resolution of 7 October 1997 on the drafting, implementation, and enforcement of Community environmental law

[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31997Y1022\(01\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31997Y1022(01))

Economic incentives

- CELEX:31992R1973 Council Regulation (EEC) No 1973/92 of 21 May 1992 establishing a financial instrument for the environment (LIFE)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992R1973>
- CELEX:32000R1655 Regulation (EC) No 1655/2000 of the European Parliament and of the Council of 17 July 2000 concerning the Financial Instrument for the Environment (LIFE)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:32000R1655>

Communication, stakeholder involvement, and raising public awareness

- CELEX:31990L0313 Council Directive 90/313/EEC of 7 June 1990 on the freedom of access to information on the environment
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31990L0313>
- CELEX:31991L0692 Council Directive 91/692/EEC of 23 December 1991 standardizing and rationalizing reports on the implementation of certain Directives relating to the environment
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31991L0692>
- CELEX:32001R0761 Regulation (EC) No 761/2001 of the European Parliament and of the Council of 19 March 2001 allowing voluntary participation by organizations in a Community eco-management and audit scheme (EMAS)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:32001R0761>

Monitoring programmes

- CELEX:31973D0126 Council Decision of 14 May 1973 adopting a research programme for the European Economic Community on the protection of the environment
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31973D0126>
- CELEX:31973D0127 Council Decision of 14 May 1973 adopting a research programme for the European Economic Community in the field of tele-detection of earth resources
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31973D0127>
- CELEX:31973D0174 Council Decision of 18 June 1973 adopting a research programme for the European Economic Community on the protection of the environment (direct project)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31973D0174>
- CELEX:31973D0180 Council Decision of 18 June 1973 adopting a European Economic Community research programme for the protection of the environment (indirect project)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31973D0180>
- CELEX:31985D0338 85/338/EEC: Council Decision of 27 June 1985 on the adoption of the Commission work programme concerning an experimental project for gathering, coordinating and ensuring the consistency of information on the state of the environment and natural resources in the Community
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31985D0338>
- CELEX:31990R1210 Council Regulation (EEC) No 1210/90 of 7 May 1990 on the establishment of the European Environment Agency and the European

Environment Information and Observation Network

<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31990R1210>

- CELEX:32003R2152 Regulation (EC) No 2152/2003 of the European Parliament and of the Council of 17 November 2003 concerning monitoring of forests and environmental interactions in the Community (Forest Focus)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:32003R2152>

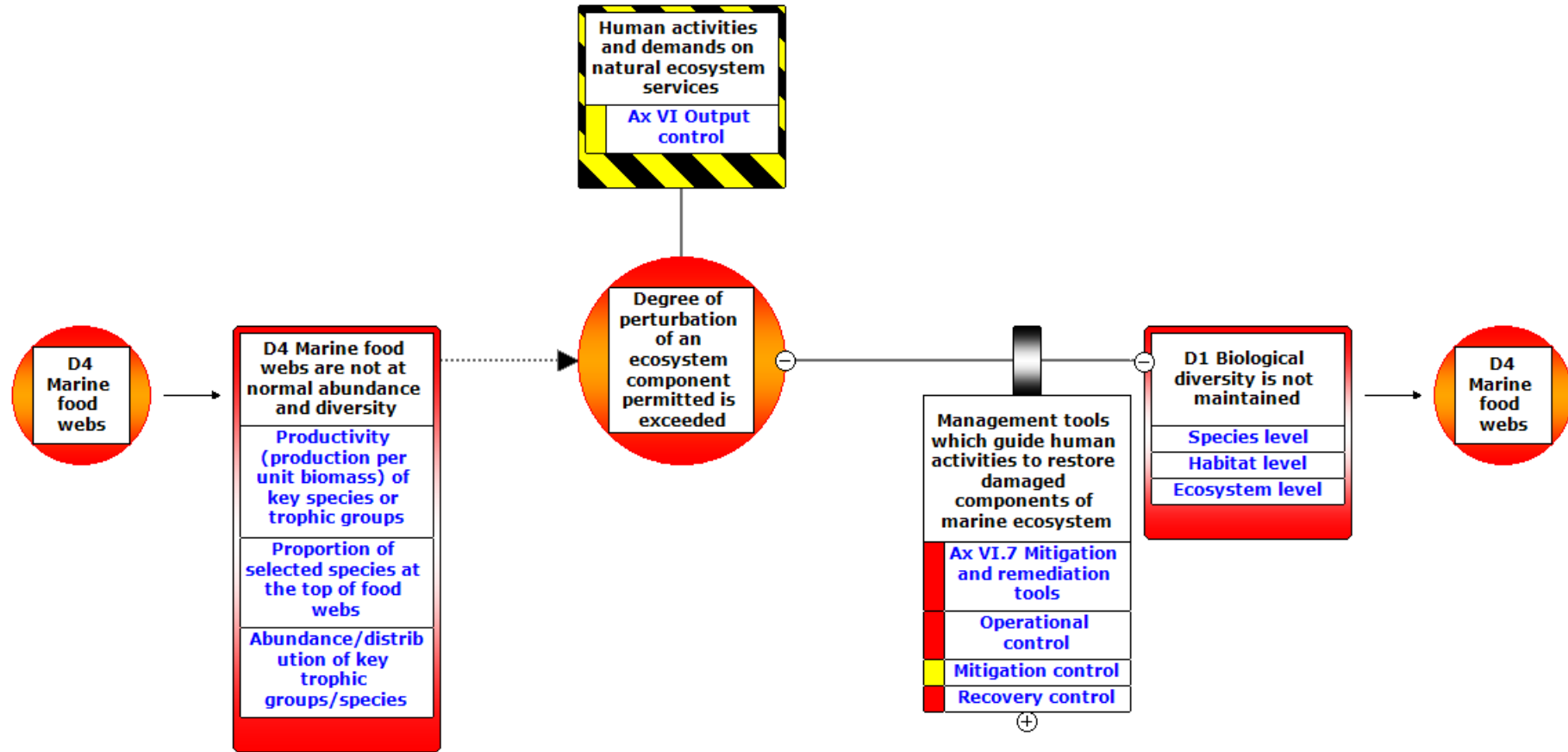


Figure 6.1. Bowtie analysis of MSFD Descriptor 1: Biological diversity is not maintained.

6.2 Descriptor 2: Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems

Event: Non-indigenous species introduced by human activities are at levels that adversely alter the ecosystem as a consequence of exceeding the permitted degree of perturbation of an ecosystem component.

The introduction of non-indigenous species is among the root causes of the pathways of risk (Figure 6.2) in the chain of events. The degree of perturbation of ecosystem components is caused by pressures related to the introduction of non-indigenous species and their translocation. Input controls or spatial and temporal distribution controls can be used to reduce or eliminate the perturbations. Mitigation and recovery tools can be used to reduce the impacts of adverse alteration of ecosystems due to non-indigenous species. However, the consequences can also influence, in return, the normal abundance and diversity of marine foodwebs (Descriptor 4). Non-indigenous species can cause biological disturbances to indigenous species and have an effect on marine foodwebs.

The following examples are the relevant cited instruments for the controls of the programme of measures.

Input controls

- CELEX:31990L0219 Council Directive 90/219/EEC of 23 April 1990 on the contained use of genetically modified microorganisms
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31990L0219>
- CELEX:32013R0576 Regulation (EU) No 576/2013 of the European Parliament and of the Council of 12 June 2013 on the non-commercial movement of pet animals and repealing Regulation (EC) No 998/2003 Text with EEA relevance
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013R0576>
- CELEX:32014R1143 Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014R1143>

Output controls

- CELEX:32014R1143 Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014R1143>
- CELEX:31990L0220 Council Directive 90/220/EEC of 23 April 1990 on the deliberate release into the environment of genetically modified organisms
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31990L0220>

Mitigation and remediation tools

- CELEX:32014R1143 Regulation (EU) No 1143/2014 of the European Parliament and of the Council of 22 October 2014 on the prevention and management of the introduction and spread of invasive alien species
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32014R1143>

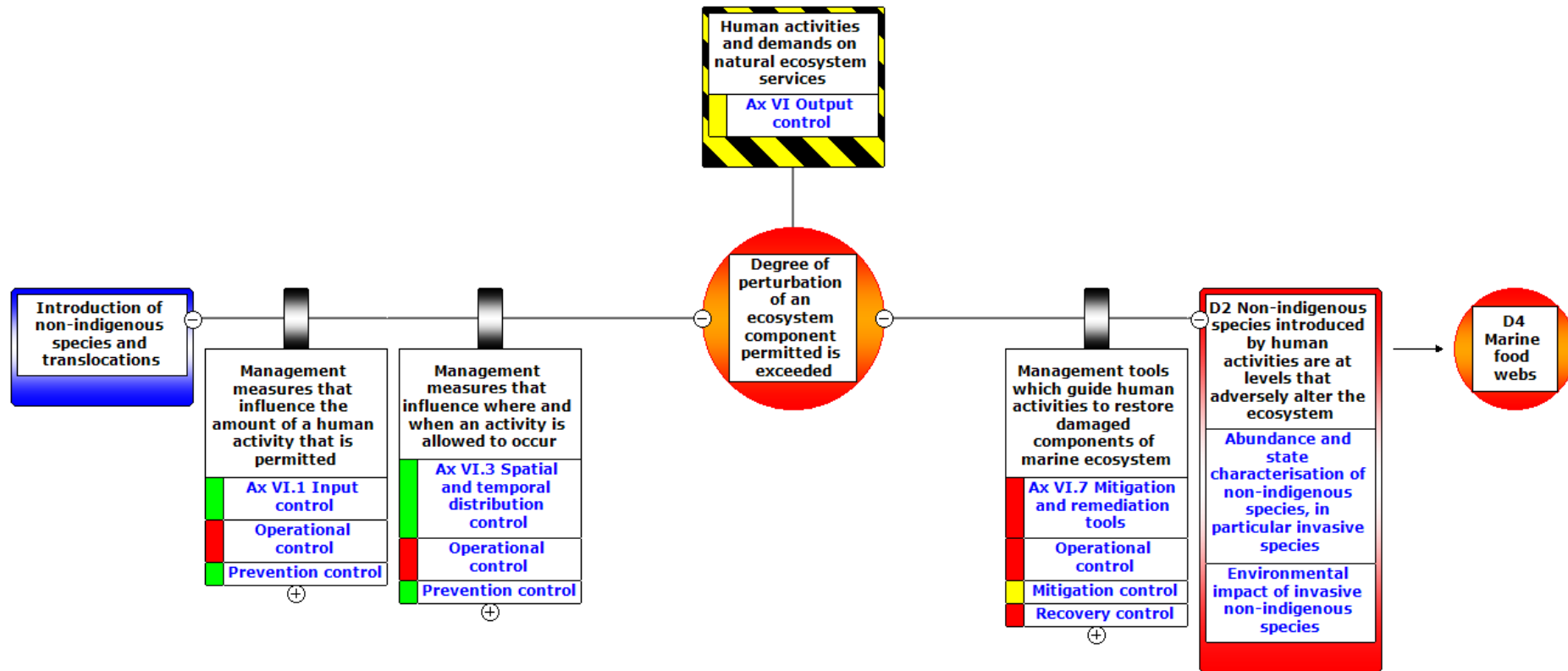


Figure 6.2. Bowtie analysis of MSFD Descriptor 2: Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystems.

6.3 **Descriptor 3: Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock**

Event: Populations of all commercially exploited fish and shellfish are outside safe biological limits as a consequence of exceeding the permitted degree of perturbation of an ecosystem component.

Commercially exploited fish and shellfish are among the root causes of the pathways of risk (Figure 6.3) in the chain of events. The degree of perturbation of ecosystem components is caused by pressures related to the selective extraction of species. Input controls or spatial and temporal distribution controls can be used to reduce or eliminate the perturbations. Mitigation and recovery tools can be used to reduce the impacts to recover fish and shellfish that are outside safe biological limits. However, the consequences can also influence, in return, the normal abundance and diversity of marine foodwebs (Descriptor 4). The selective extraction of species can cause biological disturbances to species and have an effect on marine foodwebs.

The following examples are the relevant cited instruments for the controls of the programme of measures.

Input controls

- CELEX:31978R1852 Council Regulation (EEC) No 1852/78 of 25 July 1978 on an interim common measure for restructuring the inshore fishing industry
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31978R1852>
- CELEX:31983L0515 Council Directive 83/515/EEC of 4 October 1983 concerning certain measures to adjust capacity in the fisheries sector
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31983L0515>
- CELEX:31983R0031 Council Regulation (EEC) No 31/83 of 21 December 1982 on an interim common measure for restructuring the inshore fishing industry and aquaculture
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31983R0031>
- CELEX:31985D0279 85/279/EEC: Commission Decision of 24 April 1985 on the multiannual guidance programme in respect of the fishing fleet submitted by Denmark pursuant to Council Regulation (EEC) No 2908/83
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31985D0279>
- CELEX:31985D0281 85/281/EEC: Commission Decision of 24 April 1985 on the multiannual guidance programme in respect of the fishing fleet submitted by France pursuant to Council Regulation (EEC) No 2908/83
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31985D0281>
- CELEX:31985D0283 85/283/EEC: Commission Decision of 24 April 1985 on the multiannual guidance programme in respect of the fishing fleet submitted by Greece pursuant to Council Regulation (EEC) No 2908/83
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31985D0283>
- CELEX:31985D0285 85/285/EEC: Commission Decision of 24 April 1985 on the multiannual guidance programme in respect of the fishing fleet submitted by Ireland pursuant to Council Regulation (EEC) No 2908/83
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31985D0285>
- CELEX:31985D0287 85/287/EEC: Commission Decision of 24 April 1985 on the multiannual guidance programme in respect of the fishing fleet submitted by Italy pursuant to Council Regulation (EEC) No 2908/83
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31985D0287>

- CELEX:31985D0291 85/291/EEC: Commission Decision of 24 April 1985 on the multiannual guidance programme in respect of the fishing fleet submitted by the United Kingdom Government pursuant to Council Regulation (EEC) No 2908/83
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31985D0291>
- CELEX:31986D0351 86/351/EEC: Commission Decision of 4 July 1986 on the guidance programme for the fishing fleet submitted by Portugal for 1986 in accordance with Council Regulation (EEC) No 2908/83 (Only the Portuguese text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31986D0351>
- CELEX:31986D0471 86/471/EEC: Commission Decision of 5 September 1986 on the guidance programme in respect of the fishing fleet submitted by Spain for 1986 pursuant to Regulation (EEC) No 2908/83 (Only the Spanish text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31986D0471>
- CELEX:31986R2930 Council Regulation (EEC) No 2930/86 of 22 September 1986 defining characteristics for fishing vessels
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31986R2930>
- CELEX:31987D0038 87/38/EEC: Commission Decision of 15 December 1986 on the extension of the multiannual guidance programme for 1986 in respect of the fishing fleet submitted by Belgium pursuant to Council Regulation (EEC) No 2908/83 (Only the French and Dutch texts are authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31987D0038>
- CELEX:31988D0121 88/121/EEC: Commission Decision of 11 December 1987 on the multiannual guidance programme for the fishing fleet (1987 to 1991) forwarded by France pursuant to Regulation (EEC) No 4028/86 (Only the French text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988D0121>
- CELEX:31988D0122 88/122/EEC: Commission Decision of 11 December 1987 on the multiannual guidance programme for the fishing fleet (1987 to 1991) forwarded by Belgium pursuant to Regulation (EEC) No 4028/86 (Only the French and Dutch texts are authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988D0122>
- CELEX:31988D0123 88/123/EEC: Commission Decision of 11 December 1987 on the multiannual guidance programme for the fishing fleet (1987 to 1991) forwarded by the Netherlands pursuant to Regulation (EEC) No 4028/86 (Only the Dutch text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988D0123>
- CELEX:31988D0140 88/140/EEC: Commission Decision of 11 December 1987 on the multiannual guidance programme for the fishing fleet (1987 to 1991) forwarded by Italy pursuant to Regulation (EEC) No 4028/86 (Only the Italian text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988D0140>
- CELEX:31988D0141 88/141/EEC: Commission Decision of 11 December 1987 on the multiannual guidance programme for the fishing fleet (1987 to 1991) forwarded by the United Kingdom pursuant to Regulation (EEC) No 4028/86 (Only the English text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988D0141>
- CELEX:31988D0142 88/142/EEC: Commission Decision of 11 December 1987 on the multiannual guidance programme for the fishing fleet (1987 to 1991) forwarded by Ireland pursuant to Regulation (EEC) No 4028/86

(Only the English text is authentic)

<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988D0142>

- CELEX:31988D0147 88/147/EEC: Commission Decision of 11 December 1987 on the multiannual guidance programme for the fishing fleet (1987 to 1991) forwarded by Denmark pursuant to Regulation (EEC) No 4028/86 (Only the Danish text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988D0147>
- CELEX:31988D0148 88/148/EEC: Commission Decision of 11 December 1987 on the multiannual guidance programme for the fishing fleet (1987 to 1991) forwarded by Greece pursuant to Regulation (EEC) No 4028/86 (Only the Greek text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988D0148>
- CELEX:31988D0149 88/149/EEC: Commission Decision of 11 December 1987 on the multiannual guidance programme for the fishing fleet (1987 to 1991) forwarded by Spain pursuant to Regulation (EEC) No 4028/86 (Only the Spanish text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988D0149>
- CELEX:31988D0150 88/150/EEC: Commission Decision of 11 December 1987 on the multiannual guidance programme for the fishing fleet (1987 to 1991) forwarded by Portugal pursuant to Regulation (EEC) No 4028/86 (Only the Portuguese text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988D0150>
- CELEX:31989R0163 Commission Regulation (EEC) No 163/89 of 24 January 1989 concerning the fishing vessel register of the Community
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31989R0163>
- CELEX:31992D0358 92/358/EEC: Commission Decision of 29 April 1992 on a transitional guidance programme for the fishing fleet (1992) of France pursuant to Council Regulation (EEC) No 4028/86 (Only the French text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0358>
- CELEX:31992D0359 92/359/EEC: Commission Decision of 29 April 1992 on a transitional guidance programme for the fishing fleet (1992) of Belgium pursuant to Council Regulation (EEC) No 4028/86 (Only the Dutch and the French texts are authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0359>
- CELEX:31992D0360 92/360/EEC Commission Decision of 29 April 1992 on a transitional guidance programme for the fishing fleet (1992) of the Netherlands pursuant to Council Regulation (EEC) No 4028/86 (Only the Dutch text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0360>
- CELEX:31992D0361 Commission Decision of 29 April 1992 on a transitional guidance programme for the fishing fleet (1992) of Germany pursuant to Council Regulation (EEC) No 4028/86 (Only the German text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0361>
- CELEX:31992D0362 92/362/EEC: Commission Decision of 29 April 1992 on a transitional guidance programme for the fishing fleet (1992) of Italy pursuant to Council Regulation (EEC) No 4028/86 (Only the Italian text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0362>

- CELEX:31992D0363 92/363/EEC: Commission Decision of 29 April 1992 on a transitional guidance programme for the fishing fleet (1992) of the United Kingdom pursuant to Council Regulation (EEC) No 4028/86 (Only the English text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0363>
- CELEX:31992D0364 92/364/EEC: Commission Decision of 29 April 1992 on a transitional guidance programme for the fishing fleet (1992) of Ireland pursuant to Council Regulation (EEC) No 4028/86 (Only the English text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0364>
- CELEX:31992D0365 92/365/EEC: Commission Decision of 29 April 1992 on a transitional guidance programme for the fishing fleet (1992) of Denmark pursuant to Council Regulation (EEC) No 4028/86 (Only the Danish text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0365>
- CELEX:31992D0366 92/366/EEC: Commission Decision of 29 April 1992 on a transitional guidance programme for the fishing fleet (1992) of Greece pursuant to Council Regulation (EEC) No 4028/86 (Only the Greek text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0366>
- CELEX:31992D0367 92/367/EEC: Commission Decision of 29 April 1992 on a transitional guidance programme for the fishing fleet (1992) of Spain pursuant to Council Regulation (EEC) No 4028/86 (Only the Spanish text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0367>
- CELEX:31992D0368 92/368/EEC: Commission Decision of 29 April 1992 on a transitional guidance programme for the fishing fleet (1992) of Portugal pursuant to Council Regulation (EEC) No 4028/86 (Only the Portuguese text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0368>
- CELEX:31992D0588 92/588/EEC: Commission Decision of 21 December 1992 on a multiannual guidance programme for the fishing fleet of France for the period 1993 to 1996 pursuant to Council Regulation (EEC) No 4028/86 (Only the French text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0588>
- CELEX:31992D0589 92/589/EEC: Commission Decision of 21 December 1992 on a multiannual guidance programme for the fishing fleet of Belgium for the period 1993 to 1996 pursuant to Council Regulation (EEC) No 4028/86 (Only the French and Dutch texts are authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0589>
- CELEX:31992D0590 92/590/EEC: Commission Decision of 21 December 1992 on a multiannual guidance programme for the fishing fleet of the Netherlands for the period 1993 to 1996 pursuant to Council Regulation (EEC) No 4028/86 (Only the Dutch text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0590>
- CELEX:31992D0591 92/591/EEC: Commission Decision of 21 December 1992 on a multiannual guidance programme for the fishing fleet of Germany for the period 1993 to 1996 pursuant to Council Regulation (EEC) No 4028/86 (Only the German text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0591>

- CELEX:31992D0592 92/592/EEC: Commission Decision of 21 December 1992 on a multiannual guidance programme for the fishing fleet of Italy for the period 1993 to 1996 pursuant to Council Regulation (EEC) No 4028/86 (Only the Italian text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0592>
- CELEX:31992D0593 92/593/EEC: Commission Decision of 21 December 1992 on a multiannual guidance programme for the fishing fleet of the United Kingdom for the period 1993 to 1996 pursuant to Council Regulation (EEC) No 4028/86 (Only the English text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0593>
- CELEX:31992D0594 92/594/EEC: Commission Decision of 21 December 1992 on a multiannual guidance programme for the fishing fleet of Ireland for the period 1993 to 1996 pursuant to Council Regulation (EEC) No 4028/86 (Only the English text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0594>
- CELEX:31992D0595 92/595/EEC: Commission Decision of 21 December 1992 on a multiannual guidance programme for the fishing fleet of Denmark for the period 1993 to 1996 pursuant to Council Regulation (EEC) No 4028/86 (Only the Danish text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0595>
- CELEX:31992D0596 92/596/EEC: Commission Decision of 21 December 1992 on a multiannual guidance programme for the fishing fleet of Greece for the period 1993 to 1996 pursuant to Council Regulation (EEC) No 4028/86 (Only the Greek text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0596>
- CELEX:31992D0597 92/597/EEC: Commission Decision of 21 December 1992 on a multiannual guidance programme for the fishing fleet of Spain for the period 1993 to 1996 pursuant to Council Regulation (EEC) No 4028/86 (Only the Spanish text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0597>
- CELEX:31992D0598 92/598/EEC: Commission Decision of 21 December 1992 on a multiannual guidance programme for the fishing fleet of Portugal for the period 1993 to 1996 pursuant to Council Regulation (EEC) No 4028/86 (Only the Portuguese text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992D0598>
- CELEX:31993R2847 Council Regulation (EEC) No 2847/93 of 12 October 1993 establishing a control system applicable to the common fisheries policy
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31993R2847>
- CELEX:31993R3682 Council Regulation (EC) No 3682/93 of 20 December 1993 laying down for 1994 certain measures for the conservation and management of fishery resources applicable to vessels flying the flag of Sweden
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31993R3682>
- CELEX:31994R3259 Council Regulation (EC) No 3259/94 of 22 December 1994 amending Regulation (EEC) No 2930/86 defining the characteristics of fishing vessels
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31994R3259>
- CELEX:31995D0084 95/84/EC: Commission Decision of 20 March 1995 concerning the implementation of the Annex to Council Regulation (EEC) No 2930/86 defining the characteristics of fishing vessels
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31995D0084>

- CELEX:31997D0413 97/413/EC: Council Decision of 26 June 1997 concerning the objectives and detailed rules for restructuring the Community fisheries sector for the period from 1 January 1997 to 31 December 2001 with a view to achieving a balance on a sustainable basis between resources and their exploitation
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31997D0413>
- CELEX:31998D0119 98/119/EC: Commission Decision of 16 December 1997 approving the multiannual guidance programme for the fishing fleet of France for the period from 1 January 1997 to 31 December 2001 (Only the French text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998D0119>
- CELEX:31998D0120 98/120/EC: Commission Decision of 16 December 1997 approving the multiannual guidance programme for the fishing fleet of Belgium for the period from 1 January 1997 to 31 December 2001 (Only the French and Dutch texts are authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998D0120>
- CELEX:31998D0121 98/121/EC: Commission Decision of 16 December 1997 approving the multiannual guidance programme for the fishing fleet of the Netherlands for the period from 1 January 1997 to 31 December 2001 (Only the Dutch text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998D0121>
- CELEX:31998D0122 98/122/EC: Commission Decision of 16 December 1997 approving the multiannual guidance programme for the fishing fleet of Germany for the period from 1 January 1997 to 31 December 2001 (Only the German text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998D0122>
- CELEX:31998D0123 98/123/EC: Commission Decision of 16 December 1997 approving the multiannual guidance programme for the fishing fleet of Italy for the period from 1 January 1997 to 31 December 2001 (Only the Italian text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998D0123>
- CELEX:31998D0124 98/124/EC: Commission Decision of 16 December 1997 approving the multiannual guidance programme for the fishing fleet of the United Kingdom for the period from 1 January 1997 to 31 December 2001 (Only the English text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998D0124>
- CELEX:31998D0125 98/125/EC: Commission Decision of 16 December 1997 approving the multiannual guidance programme for the fishing fleet of Ireland for the period from 1 January 1997 to 31 December 2001 (Only the English text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998D0125>
- CELEX:31998D0126 98/126/EC: Commission Decision of 16 December 1997 approving the multiannual guidance programme for the fishing fleet of Denmark for the period from 1 January 1997 to 31 December 2001 (Only the Danish text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998D0126>
- CELEX:31998D0127 98/127/EC: Commission Decision of 16 December 1997 approving the multiannual guidance programme for the fishing fleet of Greece for the period from 1 January 1997 to 31 December 2001 (Only the Greek text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998D0127>

- CELEX:31998D0128 98/128/EC: Commission Decision of 16 December 1997 approving the multiannual guidance programme for the fishing fleet of Spain for the period from 1 January 1997 to 31 December 2001 (Only the Spanish text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998D0128>
- CELEX:31998D0129 98/129/EC: Commission Decision of 16 December 1997 approving the multiannual guidance programme for the fishing fleet of Portugal for the period from 1 January 1997 to 31 December 2001 (Only the Portuguese text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998D0129>
- CELEX:31998D0130 98/130/EC: Commission Decision of 16 December 1997 approving the multiannual guidance programme for the fishing fleet of Finland for the period from 1 January 1997 to 31 December 2001 (Only the Finnish text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998D0130>
- CELEX:31998D0131 98/131/EC: Commission Decision of 16 December 1997 approving the multiannual guidance programme for the fishing fleet of Sweden for the period from 1 January 1997 to 31 December 2001 (Only the Swedish text is authentic)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998D0131>

Spatial and temporal distribution controls

- CELEX:31981Y0507(01) Council Resolution of 3 November 1976 on certain external aspects of the creation of a 200-mile fishing zone in the Community with effect from 1 January 1977
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31981Y0507\(01\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31981Y0507(01))
- CELEX:31995R0685 Council Regulation (EC) No 685/95 of 27 March 1995 on the management of the fishing effort relating to certain Community fishing areas and resources
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31995R0685>
- CELEX:31998R2092 Commission Regulation (EC) No 2092/98 of 30 September 1998 concerning the declaration of fishing effort relating to certain Community fishing areas and resources
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998R2092>

Output controls

- CELEX:31983R0170 Council Regulation (EEC) No 170/83 of 25 January 1983 establishing a Community system for the conservation and management of fishery resources
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31983R0170>
- CELEX:31997R0779 Council Regulation (EC) No 779/97 of 24 April 1997 introducing arrangements for the management of fishing effort in the Baltic Sea
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31997R0779>
- CELEX:31998R2091 Commission Regulation (EC) No 2091/98 of 30 September 1998 concerning the segmentation of the Community fishing fleet and fishing effort in relation to the multiannual guidance programmes
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998R2091>
- CELEX:32002R2371 Council Regulation (EC) No 2371/2002 of 20 December 2002 on the conservation and sustainable exploitation of fisheries resources

under the Common Fisheries Policy (OJ L 358, 31.12.2002, p. 59).

<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32002R2371>

Mitigation and remediation tools

- CELEX:31986R3094 Council Regulation (EEC) No 3094/86 of 7 October 1986 laying down certain technical measures for the conservation of fishery resources
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31986R3094>

Management coordination measures

- CELEX:31976R0101 Council Regulation (EEC) No 101/76 of 19 January 1976 laying down a common structural policy for the fishing industry
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31976R0101>
- CELEX:31978R3179 Council Regulation (EEC) No 3179/78 of 28 December 1978 concerning the conclusion by the European Economic Community of the Convention on Future Multilateral Cooperation in the Northwest Atlantic Fisheries
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31978R3179>
- CELEX:31983R2908 Council Regulation (EEC) No 2908/83 of 4 October 1983 on a common measure for restructuring, modernizing, and developing the fishing industry and for developing aquaculture
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31983R2908>
- CELEX:31986R4028 Council Regulation (EEC) No 4028/86 of 18 December 1986 on Community measures to improve and adapt structures in the fisheries and aquaculture sector
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31986R4028>
- CELEX:31989R4042 Council Regulation (EEC) No 4042/89 of 19 December 1989 on the improvement of the conditions under which fishery and aquaculture products are processed and marketed
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31989R4042>
- CELEX:31990R2060 Council Regulation (EEC) No 2060/90 of 16 July 1990 on transitional measures concerning trade with the German Democratic Republic in the agriculture and fisheries sector
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31990R2060>
- CELEX:31992R3759 Council Regulation (EEC) No 3759/92 of 17 December 1992 on the common organization of the market in fishery and aquaculture products
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992R3759>
- CELEX:31992R3760 Council Regulation (EEC) No 3760/92 of 20 December 1992 establishing a Community system for fisheries and aquaculture
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992R3760>
- CELEX:31994R1275 Council Regulation (EC) No 1275/94 of 30 May 1994 on adjustments to the arrangements in the fisheries chapters of the Act of Accession of Spain and Portugal
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31994R1275>
- CELEX:31999R1447 Council Regulation (EC) No 1447/1999 of 24 June 1999 establishing a list of types of behaviour which seriously infringe the rules of the common fisheries policy
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31999R1447>

Measures to improve the traceability

- CELEX:31982R2057 Council Regulation (EEC) No 2057/82 of 29 June 1982 establishing certain control measures for fishing activities by vessels of the Member States
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31982R2057>
- CELEX:31983R2807 Commission Regulation (EEC) No 2807/83 of 22 September 1983 laying down detailed rules for recording information on Member States' catches of fish
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31983R2807>
- CELEX:31985Y1224(01) Communication from the Commission on the description of certain FAO areas, subareas, and divisions used for the purpose of fishery statistics and regulations
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31985Y1224\(01\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31985Y1224(01))
- CELEX:31987R1381 Commission Regulation (EEC) No 1381/87 of 20 May 1987 establishing detailed rules concerning the marking and documentation of fishing vessels
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31987R1381>
- CELEX:31989R0163 Commission Regulation (EEC) No 163/89 of 24 January 1989 concerning the fishing vessel register of the Community
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31989R0163>
- CELEX:31993R3690 Council Regulation (EC) No 3690/93 of 20 December 1993 establishing a Community system laying down rules for the minimum information to be contained in fishing licences
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31993R3690>
- CELEX:31994R0109 Commission Regulation (EC) No 109/94 of 19 January 1994 concerning the fishing vessel register of the Community
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31994R0109>
- CELEX:31994R1627 Council Regulation (EC) No 1627/94 of 27 June 1994 laying down general provisions concerning special fishing permits
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31994R1627>
- CELEX:31998R2090 Commission Regulation (EC) No 2090/98 of 30 September 1998 concerning the fishing vessel register of the Community
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998R2090>

Economic incentives

- CELEX:31972R0272 Regulation (EEC) No 272/72 of the Council of 7 February 1972 on the financing of intervention expenditure in respect of the market in fishery products
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31972R0272>
- CELEX:31976R0100 Council Regulation (EEC) No 100/76 of 19 January 1976 on the common organization of the market in fishery products
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31976R0100>
- CELEX:31980R1898 Commission Regulation (EEC) No 1898/80 of 9 July 1980 amending Regulation (EEC) No 2572/78 on applications for aid from the Guidance Section of the European Agricultural Guidance and Guarantee Fund for projects in the inshore fishing industry as envisaged in Regulation (EEC) No 1852/78
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31980R1898>

- CELEX:31981R3796 Council Regulation (EEC) No 3796/81 of 29 December 1981 on the common organization of the market in fishery products
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31981R3796>
- CELEX:31983R2909 Council Regulation (EEC) No 2909/83 of 4 October 1983 on measures to encourage exploratory fishing and cooperation through joint ventures in the fishing sector
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31983R2909>
- CELEX:31985R3733 Council Regulation (EEC) No 3733/85 of 20 December 1985 amending Regulation (EEC) No 2908/83 on a common measure for restructuring, modernizing, and developing the fishing industry and for developing aquaculture
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31985R3733>
- CELEX:31991L0493 Council Directive 91/493/EEC of 22 July 1991 laying down the health conditions for the production and the placing on the market of fishery products
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31991L0493>
- CELEX:31993R2080 Council Regulation (EEC) No 2080/93 of 20 July 1993 laying down provisions for implementing Regulation (EEC) No 2052/88 as regards the financial instrument of fisheries guidance
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31993R2080>
- CELEX:31993R3699 Council Regulation (EC) No 3699/93 of 21 December 1993 laying down the criteria and arrangements regarding Community structural assistance in the fisheries and aquaculture sector and the processing and marketing of its products
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31993R3699>
- CELEX:31995R1796 Commission Regulation (EC) No 1796/95 of 25 July 1995 laying down detailed rules for the implementation of assistance granted by the Financial Instrument for Fisheries Guidance (FIFG) for schemes defined by Regulation (EC) No 3699/93
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31995R1796>
- CELEX:31998R2468 Council Regulation (EC) No 2468/98 of 3 November 1998 laying down the criteria and arrangements regarding Community structural assistance in the fisheries and aquaculture sector and the processing and marketing of its products
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998R2468>
- CELEX:31999R1263 Council Regulation (EC) No 1263/1999 of 21 June 1999 on the Financial Instrument for Fisheries Guidance
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31999R1263>
- CELEX:31999R2792 Council Regulation (EC) No 2792/1999 of 17 December 1999 laying down the detailed rules and arrangements regarding Community structural assistance in the fisheries sector
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31999R2792>

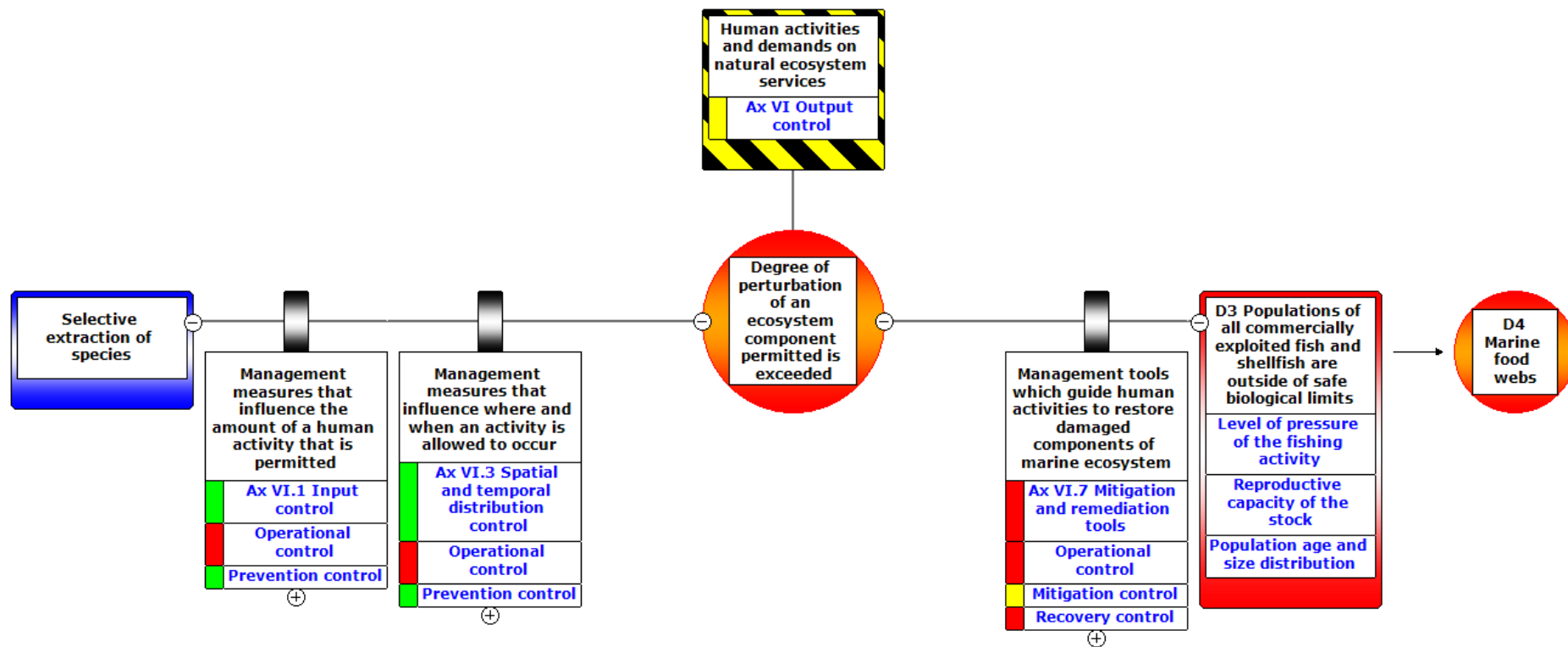


Figure 6.3. Bowtie analysis of MSFD Descriptor 3: Populations of all commercially exploited fish and shellfish are within safe biological limits, exhibiting a population age and size distribution that is indicative of a healthy stock.

6.4 Descriptor 4: All elements of the marine foodwebs, to the extent that they are known, occur at normal abundance, diversity, and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity

Event: Marine foodwebs are not at normal abundance and diversity as a consequence of exceeding the permitted degree of perturbation of an ecosystem component.

The abnormal abundance and diversity of marine foodwebs are among the endpoints of the pathways of risk (Figure 6.4) in the chain of events. The degree of perturbation of ecosystem components is caused by the consequences of biological diversity not being maintained (Descriptor 1), adverse alteration of ecosystems due to non-indigenous species (Descriptor 2), populations of commercially important species being outside their safe biological limits (Descriptor 3), adverse effects of human-induced eutrophication (Descriptor 5), adversely affected seabed integrity (Descriptor 6), permanent alteration of hydrographical conditions (Descriptor 7), pollution effects of contaminants (Descriptor 8), harm caused by marine litter (Descriptor 10), and adverse effects of energy and noise (Descriptor 11). It is an important point of convergence among the majority of descriptors and biodiversity (Descriptor 1). Given that there are no pressures (Annex III of MSFD) that can directly influence the degree of perturbation, there are no input controls or spatial and temporal distribution controls possible to reduce the perturbation. Mitigation and recovery tools are the only options for reducing the impacts of abnormal abundance and diversity of marine foodwebs. However, the consequences can also influence, in return, the maintenance of biodiversity (Descriptor 1). Changes in the abundance and diversity of marine foodwebs are more likely to have direct effects on biological diversity.

The examples of relevant cited instruments for the controls of the programme of measures listed for biological diversity (Descriptor 1) would also apply to Descriptor 4, given that the same ecosystem components would need to be addressed.

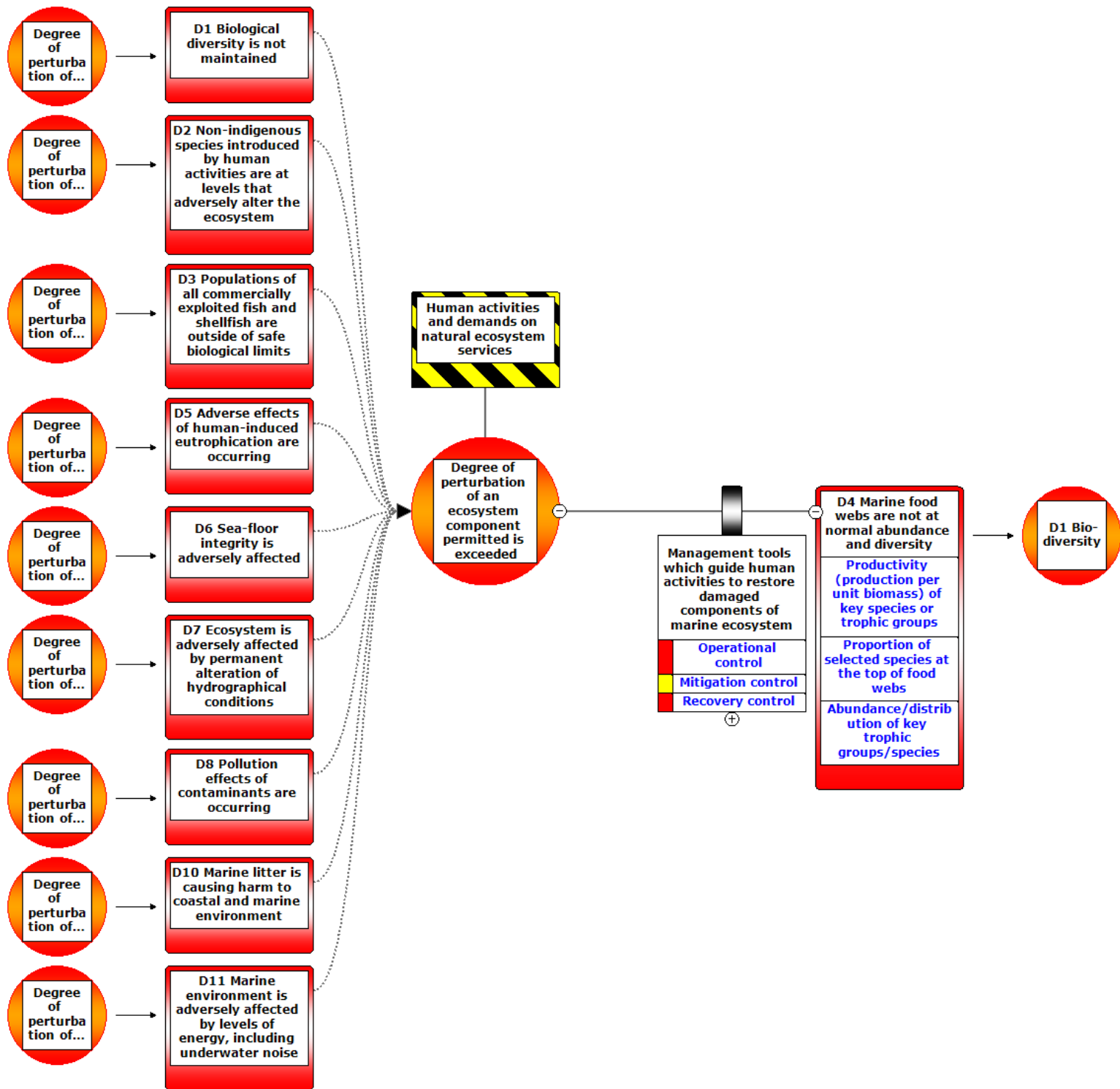


Figure 6.4. Bowtie analysis of MSFD Descriptor 4: All elements of the marine foodwebs, to the extent that they are known, occur at normal abundance and diversity.

6.5 Descriptor 5: Human-induced eutrophication is minimized, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms, and oxygen deficiency in bottom waters

Event: Adverse effects of human-induced eutrophication are occurring as a consequence of exceeding the permitted degree of perturbation of an ecosystem component.

The effects of human-induced eutrophication are among the root causes of the pathways of risk (Figure 6.5) of the chain of events. The degree of perturbation of ecosystem components is caused by pressures related to the inputs of fertilizers and other nitrogen and organic matter. Input controls or spatial and temporal distribution controls can be used to reduce or eliminate the perturbations. Mitigation and recovery tools can be used to reduce the impacts of eutrophication, and the same as for biological diversity (Descriptor 1). However, the consequences can also influence, in return, the normal abundance and diversity of marine foodwebs (Descriptor 4). Human-induced eutrophication is more likely to cause biological disturbances to species and have an effect on marine foodwebs.

The following examples are the relevant cited instruments for the controls of the programme of measures.

Input controls

- CELEX:31973L0404 Council Directive 73/404/EEC of 22 November 1973 on the approximation of the laws of the Member States relating to detergents <http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31973L0404>
- CELEX:31989R1610 Council Regulation (EEC) No 1610/89 of 29 May 1989 laying down provisions for implementing Regulation (EEC) No 4256/88 as regards the scheme to develop and optimally utilize woodlands in rural areas in the Community <http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31989R1610>
- CELEX:31992R2078 Council Regulation (EEC) No 2078/92 of 30 June 1992 on agricultural production methods compatible with the requirements of the protection of the environment and the maintenance of the countryside <http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992R2078>

Mitigation and remediation tools

- CELEX:31991L0676 Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources <http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31991L0676>

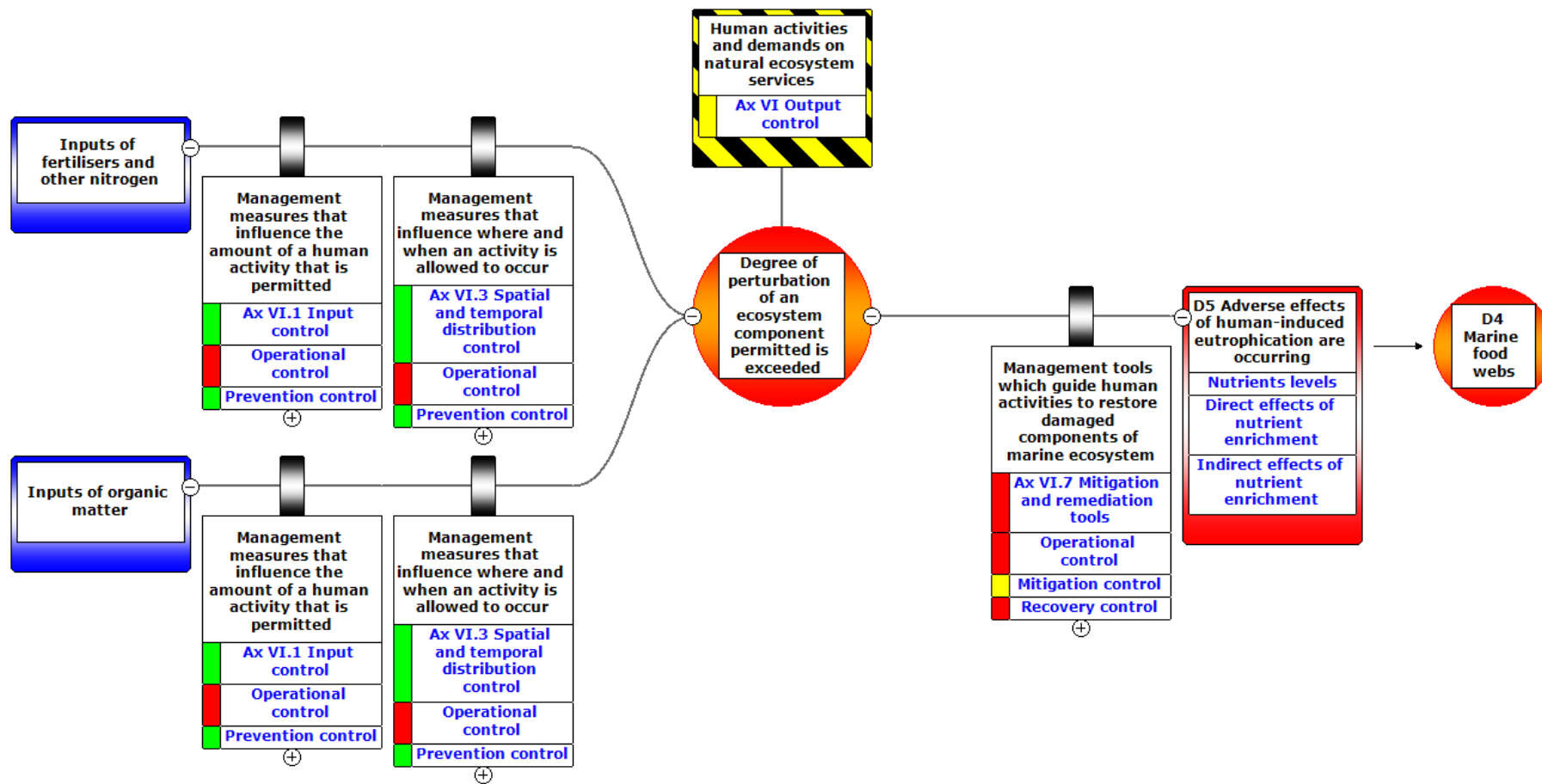


Figure 6.5. Bowtie analysis of MSFD Descriptor 5: Human-induced eutrophication is minimized, especially adverse effects thereof, such as losses in biodiversity, ecosystem degradation, harmful algae blooms, and oxygen deficiency in bottom waters.

6.6 Descriptor 6: Seabed integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected

Event: Seabed integrity is adversely affected as a consequence of exceeding the permitted degree of perturbation of an ecosystem component.

The adverse effects to seabed integrity are among the root causes of the pathways of risk (Figure 6.6) of the chain of events. The degree of perturbation of ecosystem components is caused by pressures due to smothering, sealing, changes in siltation, abrasion, and selective extraction of seabed and subsoil. Input controls or spatial and temporal distribution controls used to reduce the perturbations are identified as results of environmental impacts assessments used as management control processes. Mitigation and recovery tools are the same as the ones provided for biological diversity (Descriptor 1). The consequences can also influence, in return, the normal abundance and diversity of marine foodwebs (Descriptor 4). Changes to the integrity of the seabed can cause biological disturbances of species and have an effect on marine foodwebs.

The following examples are the relevant cited instruments for the controls of the programme of measures.

Management coordination measures

- CELEX:31973Y1220(01) Programme d'action des Communautés européennes en matière d'environnement
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31973Y1220\(01\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31973Y1220(01))
- CELEX:31985L0337 Council Directive 85/337/EEC of 27 June 1985 on the assessment of the effects of certain public and private projects on the environment
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31985L0337>
- CELEX:31987R2242 Council Regulation (EEC) No 2242/87 of 23 July 1987 on action by the Community relating to the environment
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31987R2242>
- CELEX:31987Y0107(02) Council Resolution of 16 December 1986 on the strengthening of Community action in favour of the environment
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31987Y0107\(02\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31987Y0107(02))
- CELEX:31988D0540 88/540/EEC: Council Decision of 14 October 1988 concerning the conclusion of the Vienna Convention for the protection of the ozone layer and the Montreal Protocol on substances that deplete the ozone layer
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988D0540>
- CELEX:31990L0667 Council Directive 90/667/EEC of 27 November 1990 laying down the veterinary rules for the disposal and processing of animal waste, for its placing on the market, and for the prevention of pathogens in feedstuffs of animal or fish origin and amending Directive 90/425/EEC
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31990L0667>
- CELEX:31991Y0208(02) Council Resolution of 28 January 1991 on the Green Paper on the urban environment
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31991Y0208\(02\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31991Y0208(02))

- CELEX:31993D0626 Council Decision of 25 October 1993 concerning the conclusion of the Convention on Biological Diversity (93/626/EEC)
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31993D0626>
- CELEX:31994D0157 94/157/EC: Council Decision of 21 February 1994 on the conclusion, on behalf of the Community, of the Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention as revised in 1992)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31994D0157>
- CELEX:31994Y1231(07) Special report No 4/94 on the urban environment together with the Commission's replies
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31994Y1231\(07\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31994Y1231(07))
- CELEX:31998D2179 Decision No 2179/98/EC of the European Parliament and of the Council of 24 September 1998 on the review of the European Community programme of policy and action in relation to the environment and sustainable development "Towards sustainability"
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998D2179>
- CELEX:32000D0340 2000/340/EC: Council Decision of 8 May 2000 concerning the approval, on behalf of the Community, of the new Annex V to the Convention for the Protection of the Marine Environment of the North-East Atlantic on the protection and conservation of the ecosystems and biological diversity of the maritime area and the corresponding Appendix 3
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000D0340>
- CELEX:32001L0042 Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:32001L0042>
- CELEX:32002D1600 Decision No 1600/2002/EC of the European Parliament and of the Council of 22 July 2002 laying down the Sixth Community Environment Action Programme
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32002D1600>
- CELEX:32008L0056 Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive) (Text with EEA relevance)
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0056>
- CELEX:32011L0092 Directive 2011/92/EU of the European Parliament and of the Council of 13 December 2011 on the assessment of the effects of certain public and private projects on the environment Text with EEA relevance
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32011L0092>
- CELEX:32013D1386 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' Text with EEA relevance
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013D1386>
- CELEX:32013L0030 Directive 2013/30/EU of the European Parliament and of the Council of 12 June 2013 on safety of offshore oil and gas operations and amending Directive 2004/35/EC Text with EEA relevance
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32013L0030>

- CELEX:31997Y1022(01) Council Resolution of 7 October 1997 on the drafting, implementation and enforcement of Community environmental law
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31997Y1022\(01\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31997Y1022(01))

Economic incentives

- CELEX:31992R1973 Council Regulation (EEC) No 1973/92 of 21 May 1992 establishing a financial instrument for the environment (LIFE)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992R1973>
- CELEX:32000R1655 Regulation (EC) No 1655/2000 of the European Parliament and of the Council of 17 July 2000 concerning the Financial Instrument for the Environment (LIFE)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:32000R1655>

Communication, stakeholder involvement, and raising public awareness

- CELEX:31990L0313 Council Directive 90/313/EEC of 7 June 1990 on the freedom of access to information on the environment
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31990L0313>
- CELEX:31991L0692 Council Directive 91/692/EEC of 23 December 1991 standardizing and rationalizing reports on the implementation of certain Directives relating to the environment
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31991L0692>
- CELEX:32001R0761 Regulation (EC) No 761/2001 of the European Parliament and of the Council of 19 March 2001 allowing voluntary participation by organizations in a Community eco-management and audit scheme (EMAS)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:32001R0761>

Monitoring programmes

- CELEX:31973D0126 Council Decision of 14 May 1973 adopting a research programme for the European Economic Community on the protection of the environment
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31973D0126>
- CELEX:31973D0127 Council Decision of 14 May 1973 adopting a research programme for the European Economic Community in the field of tele-detection of earth resources
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31973D0127>
- CELEX:31973D0174 Council Decision of 18 June 1973 adopting a research programme for the European Economic Community on the protection of the environment (direct project)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31973D0174>
- CELEX:31973D0180 Council Decision of 18 June 1973 adopting a European Economic Community research programme for the protection of the environment (indirect project)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31973D0180>
- CELEX:31985D0338 85/338/EEC: Council Decision of 27 June 1985 on the adoption of the Commission work programme concerning an experimental project for gathering, coordinating, and ensuring the consistency of information on the state of the environment and natural resources in the Community
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31985D0338>

- CELEX:31990R1210 Council Regulation (EEC) No 1210/90 of 7 May 1990 on the establishment of the European Environment Agency and the European Environment Information and Observation Network
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31990R1210>
- CELEX:32003R2152 Regulation (EC) No 2152/2003 of the European Parliament and of the Council of 17 November 2003 concerning monitoring of forests and environmental interactions in the Community (Forest Focus)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:32003R2152>

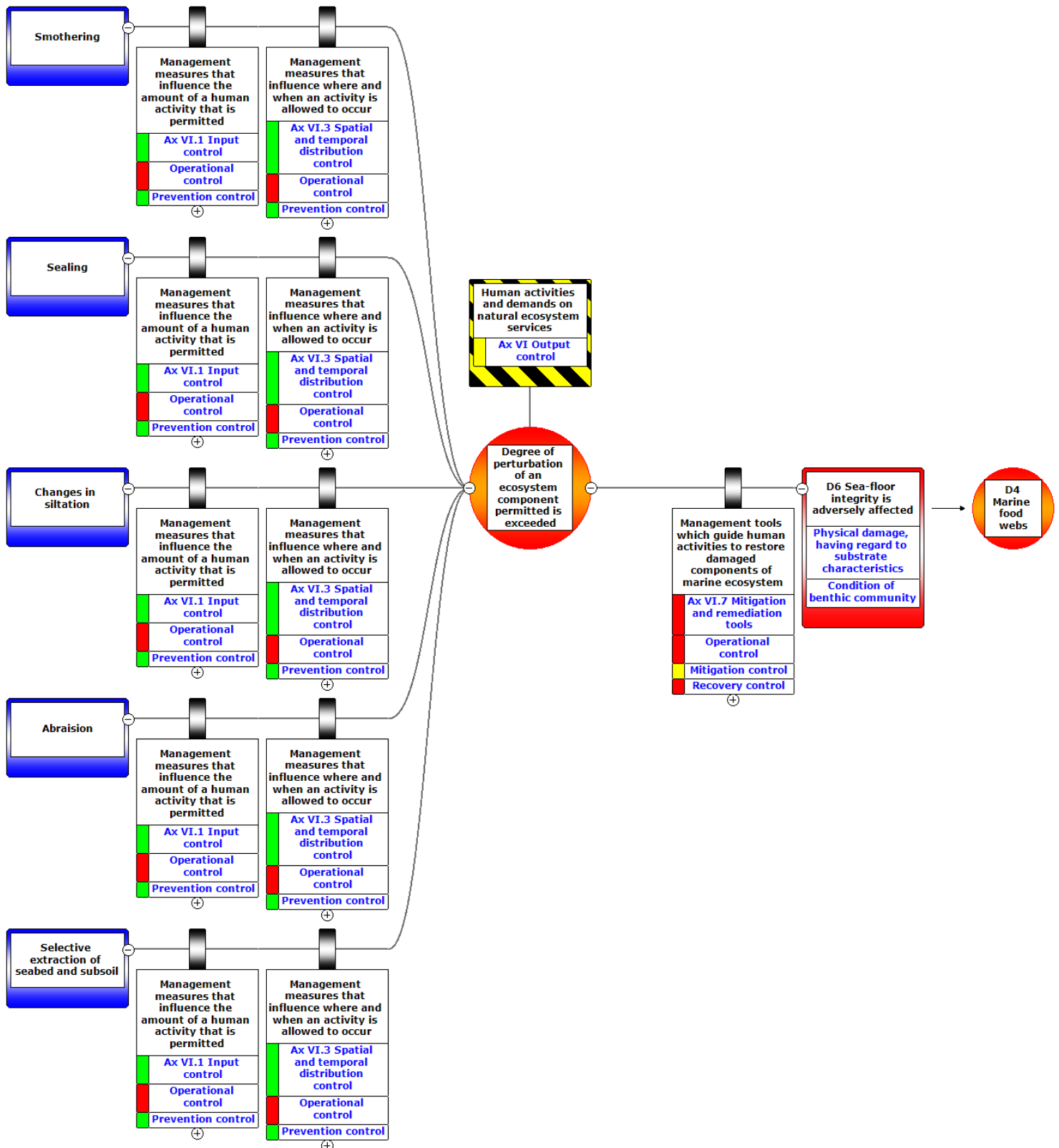


Figure 6.6. Bowtie analysis of MSFD Descriptor 6: Seabed integrity is at a level that ensures that the structure and functions of the ecosystems are safeguarded and benthic ecosystems, in particular, are not adversely affected.

6.7 Descriptor 7: Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems

Event: Ecosystem is adversely affected by permanent alteration of hydrographical conditions as a consequence of exceeding the permitted degree of perturbation of an ecosystem component.

The alteration of hydrographical conditions is among the root causes of the pathways of risk (Figure 6.7) of the chain of events. The degree of perturbation of ecosystem components is caused by pressures due to significant changes in thermal and salinity regimes. Input controls or spatial and temporal distribution controls for reducing the perturbations are identified as results of environmental impacts assessments used as management control processes. Mitigation and recovery tools are the same as those provided for biological diversity (Descriptor 1). The consequences can also influence, in return, the normal abundance and diversity of marine foodwebs (Descriptor 4). Alterations to hydrographical conditions are more likely to cause biological disturbances of species and have an effect on marine foodwebs.

The examples of relevant cited instruments for the controls of the programme of measures for Descriptor 7 are the same as for seabed integrity (Descriptor 6).

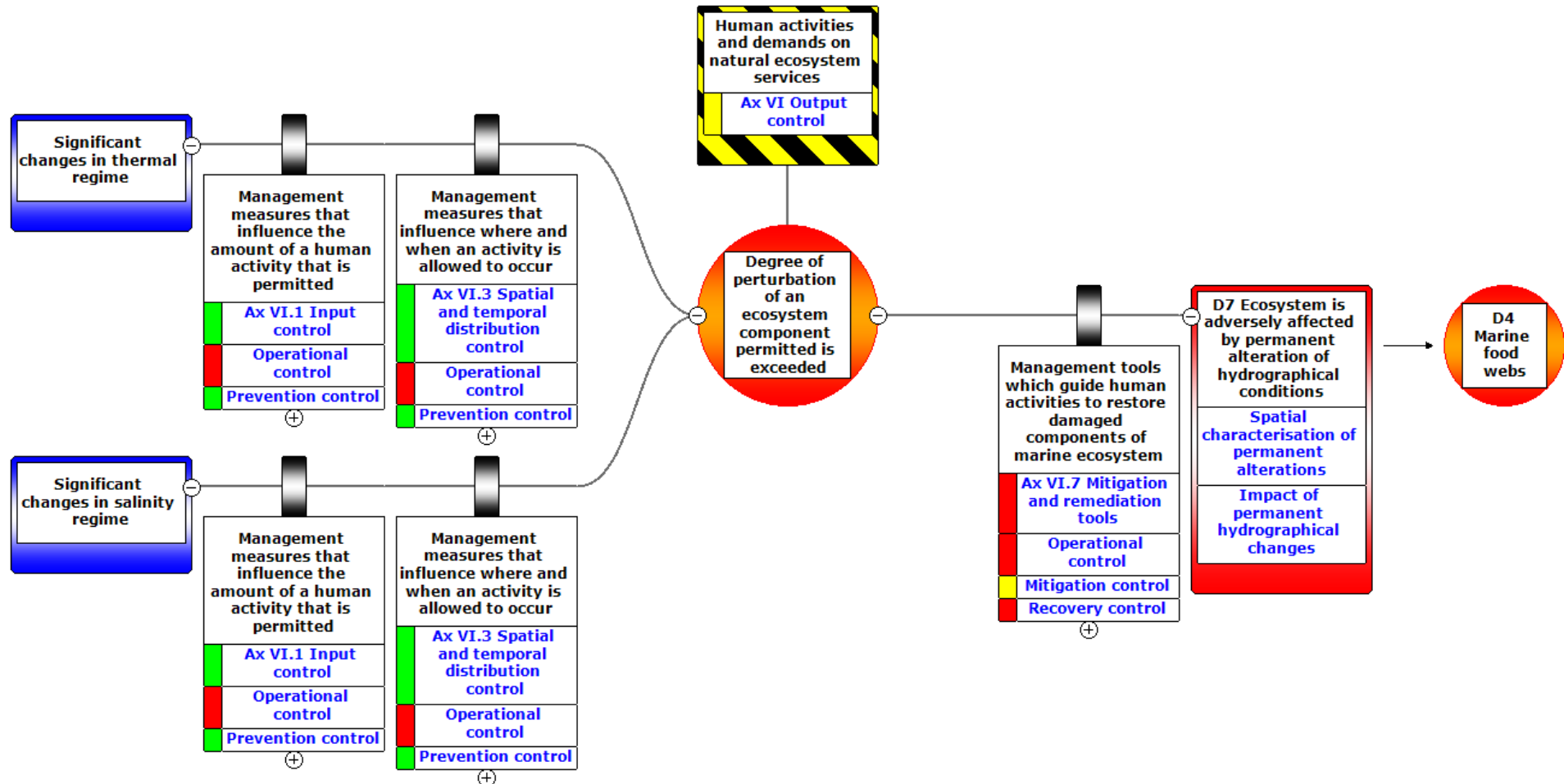


Figure 6.7. Bowtie analysis of MSFD Descriptor 7: Permanent alteration of hydrographical conditions does not adversely affect marine ecosystems.

6.8 Descriptor 8: Concentrations of contaminants are at levels not giving rise to pollution effects

Event: Pollution effects of contaminants are occurring as a consequence of exceeding the permitted degree of perturbation of an ecosystem component.

The pollution effects of contaminants are among the root causes of the pathways of risk (Figure 6.8) of the chain of events. The degree of perturbation of ecosystem components is caused by pressures due to introduction of synthetic compounds, non-synthetic substances and compounds, radionuclides, and other substances whether solid, liquid, or gas. Input controls or spatial and temporal distribution controls can be used to reduce or eliminate the perturbations. Mitigation and recovery are not available, with the exception of responses to spills and accidents. The consequences can also influence, in return, the normal abundance and diversity of marine foodwebs (Descriptor 4). The pollution effects of contaminants can cause chemical interferences in species and have an effect on marine foodwebs. However, the consequences can contribute to contaminants levels in fish and shellfish that exceed acceptable levels for human consumption (Descriptor 9) regardless of the degree of perturbation it may cause to ecosystem components.

The following examples are the relevant cited instruments for the controls of the programme of measures.

Input controls

- CELEX:31961Q0102(01) Règlement financier relatif aux modalités et à la procédure de la mise à la disposition de la Commission des contributions des États membres, visées à l'article 172, paragraphe 1, du Traité instituant la Communauté européenne de l'énergie atomique (article 183, b) du Traité)
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31961Q0102\(01\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31961Q0102(01))
- CELEX:31962Q0402 Règlement financier relatif aux modalités et à la procédure de la mise à la disposition de la Commission des contributions des États membres visées à l'article 172, paragraphe (2), du Traité instituant la Communauté européenne de l'énergie atomique (article 183, alinéa b) du Traité)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31962Q0402>
- CELEX:31966L0045 Council Directive 66/45/Euratom of 27 October 1966 amending the Directives laying down the basic standards for the protection of the health of workers and the general public against the dangers arising from ionising radiations
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31966L0045>
- CELEX:31970L0220 Council Directive 70/220/EEC of 20 March 1970 on the approximation of the laws of the Member States relating to measures to be taken against air pollution by gases from positive-ignition engines of motor vehicles
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31970L0220>
- CELEX:31972L0306 Council Directive 72/306/EEC of 2 August 1972 on the approximation of the laws of the Member States relating to the measures to be taken against the emission of pollutants from diesel engines for use in vehicles
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31972L0306>

- CELEX:31975L0439 Council Directive 75/439/EEC of 16 June 1975 on the disposal of waste oils
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31975L0439>
- CELEX:31976L0403 Council Directive 76/403/EEC of 6 April 1976 on the disposal of polychlorinated biphenyls and polychlorinated terphenyls
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31976L0403>
- CELEX:31976L0579 Council Directive 76/579/Euratom of 1 June 1976 laying down the revised basic safety standards for the health protection of the general public and workers against the dangers of ionizing radiation
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31976L0579>
- CELEX:31976L0769 Council Directive 76/769/EEC of 27 July 1976 on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31976L0769>
- CELEX:31976R3227 Commission Regulation (Euratom) No 3227/76 of 19 October 1976 concerning the application of the provisions on Euratom safeguards
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31976R3227>
- CELEX:31978L0176 Council Directive 78/176/EEC of 20 February 1978 on waste from the titanium dioxide industry
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31978L0176>
- CELEX:31978L0319 Council Directive 78/319/EEC of 20 March 1978 on toxic and dangerous waste
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31978L0319>
- CELEX:31978Y0607(01) Council Resolution of 30 May 1978 on fluorocarbons in the environment
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31978Y0607\(01\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31978Y0607(01))
- CELEX:31979L0117 Council Directive 79/117/EEC of 21 December 1978 prohibiting the placing on the market and use of plant protection products containing certain active substances
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31979L0117>
- CELEX:31980D0372 80/372/EEC: Council Decision of 26 March 1980 concerning chlorofluorocarbons in the environment
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31980D0372>
- CELEX:31980L0068 Council Directive 80/68/EEC of 17 December 1979 on the protection of groundwater against pollution caused by certain dangerous substances
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31980L0068>
- CELEX:31980L0777 Council Directive 80/777/EEC of 15 July 1980 on the approximation of the laws of the Member States relating to the exploitation and marketing of natural mineral waters
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31980L0777>
- CELEX:31980L0836 Council Directive 80/836/Euratom of 15 July 1980 amending the Directives laying down the basic safety standards for the health protection of the general public and workers against the dangers of ionizing radiation
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31980L0836>
- CELEX:31981L0602 Council Directive 81/602/EEC of 31 July 1981 concerning the prohibition of certain substances having a hormonal action and of

any substances having a thyrostatic action

<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31981L0602>

- CELEX:31981L0852 Council Directive 81/852/EEC of 28 September 1981 on the approximation of the laws of the Member States relating to analytical, pharmaco-toxicological, and clinical standards and protocols in respect of the testing of veterinary medicinal products
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31981L0852>
- CELEX:31982L0883 Council Directive 82/883/EEC of 3 December 1982 on procedures for the surveillance and monitoring of environments concerned by waste from the titanium dioxide industry
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31982L0883>
- CELEX:31983L0029 Council Directive 83/29/EEC of 24 January 1983 amending Directive 78/176/EEC on waste from the titanium dioxide industry
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31983L0029>
- CELEX:31984L0360 Council Directive 84/360/EEC of 28 June 1984 on the combating of air pollution from industrial plants
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31984L0360>
- CELEX:31984L0467 Council Directive 84/467/Euratom of 3 September 1984 amending Directive 80/836/Euratom as regards the basic safety standards for the health protection of the general public and workers against the dangers of ionizing radiation
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31984L0467>
- CELEX:31985L0358 Council Directive 85/358/EEC of 16 July 1985 supplementing Directive 81/602/EEC concerning the prohibition of certain substances having a hormonal action and of any substances having a thyrostatic action
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31985L0358>
- CELEX:31985L0649 Council Directive 85/649/EEC of 31 December 1985 prohibiting the use in livestock farming of certain substances having a hormonal action
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31985L0649>
- CELEX:31986L0280 Council Directive 86/280/EEC of 12 June 1986 on limit values and quality objectives for discharges of certain dangerous substances included in List I of the Annex to Directive 76/464/EEC
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31986L0280>
- CELEX:31987L0018 Council Directive 87/18/EEC of 18 December 1986 on the harmonization of laws, regulations and administrative provisions relating to the application of the principles of good laboratory practice and the verification of their applications for tests on chemical substances
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31987L0018>
- CELEX:31988L0077 Council Directive 88/77/EEC of 3 December 1987 on the approximation of the laws of the Member States relating to the measures to be taken against the emission of gaseous pollutants from diesel engines for use in vehicles
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988L0077>
- CELEX:31988L0146 Council Directive 88/146/EEC of 7 March 1988 prohibiting the use in livestock farming of certain substances having a hormonal action
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988L0146>

- CELEX:31988L0299 Council Directive 88/299/EEC of 17 May 1988 on trade in animals treated with certain substances having a hormonal action and their meat, as referred to in Article 7 of Directive 88/146/EEC
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988L0299>
- CELEX:31988L0609 Council Directive 88/609/EEC of 24 November 1988 on the limitation of emissions of certain pollutants into the air from large combustion plants
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988L0609>
- CELEX:31988R1734 Council Regulation (EEC) No 1734/88 of 16 June 1988 concerning export from and import into the Community of certain dangerous chemicals
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988R1734>
- CELEX:31988Y0629(01) Council Resolution of 16 June 1988 concerning export from and import into the Community of certain dangerous chemicals
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988Y0629\(01\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988Y0629(01))
- CELEX:31989L0677 Council Directive 89/677/EEC of 21 December 1989 amending for the eighth time Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the member states relating to restrictions on the marketing and use of certain dangerous substances and preparations
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31989L0677>
- CELEX:31993L0086 Commission Directive 93/86/EEC of 4 October 1993 adapting to technical progress Council Directive 91/157/EEC on batteries and accumulators containing certain dangerous substances
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31993L0086>
- CELEX:31995Y0228(01) Council Resolution of 20 February 1995 on ground-water protection
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31995Y0228\(01\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31995Y0228(01))
- CELEX:31996L0061 Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31996L0061>
- CELEX:31998L0008 Directive 98/8/EC of the European Parliament and of the Council of 16 February 1998 concerning the placing of biocidal products on the market
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31998L0008>
- CELEX:32008L0056 Directive 2008/56/EC of the European Parliament and of the Council of 17 June 2008 establishing a framework for community action in the field of marine environmental policy (Marine Strategy Framework Directive)
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0056>

Out controls

- CELEX:31975L0440 Council Directive 75/440/EEC of 16 June 1975 concerning the quality required of surface water intended for the abstraction of drinking water in the Member States
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31975L0440>
- CELEX:31976L0464 Council Directive 76/464/EEC of 4 May 1976 on pollution caused by certain dangerous substances discharged into the aquatic

environment of the Community

<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31976L0464>

- CELEX:31982D0795 82/795/EEC: Council Decision of 15 November 1982 on the consolidation of precautionary measures concerning chlorofluorocarbons in the environment
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31982D0795>
- CELEX:31986L0278 Council Directive 86/278/EEC of 12 June 1986 on the protection of the environment, and in particular of the soil, when sewage sludge is used in agriculture
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31986L0278>
- CELEX:31989Y1026(01) Council Resolution of 16 October 1989 on guidelines to reduce technological and natural hazards
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31989Y1026\(01\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31989Y1026(01))
- CELEX:31991L0271 Council Directive 91/271 /EEC of 21 May 1991 concerning urban waste water treatment
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31991L0271>
- CELEX:31994L0067 Council Directive 94/67/EC of 16 December 1994 on the incineration of hazardous waste
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31994L0067>

Mitigation and remediation tools

- CELEX:31975L0716 Council Directive 75/716/EEC of 24 November 1975 on the approximation of the laws of the Member States relating to the sulphur content of certain liquid fuels
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31975L0716>
- CELEX:31976L0160 Council Directive 76/160/EEC of 8 December 1975 concerning the quality of bathing water
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31976L0160>
- CELEX:31980L0778 Council Directive 80/778/EEC of 15 July 1980 relating to the quality of water intended for human consumption
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31980L0778>
- CELEX:31982L0501 Council Directive 82/501/EEC of 24 June 1982 on the major-accident hazards of certain industrial activities
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31982L0501>
- CELEX:31992R2157 Council Regulation (EEC) No 2157/92 of 23 July 1992 amending Regulation (EEC) No 3528/86 on the protection of the Community's forests against atmospheric pollution
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992R2157>
- CELEX:32006L0007 Directive 2006/7/EC of the European Parliament and of the Council of 15 February 2006 concerning the management of bathing water quality and repealing Directive 76/160/EEC
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:32006L0007>

Management coordination measures

- CELEX:31974R0165 Regulation (EEC, Euratom, ECSC) No 165/74 of the Council of 21 January 1974 determining the powers and obligations of officials appointed by the Commission pursuant to Article 14 (5) of Regulation (EEC, Euratom, ECSC) No 2/71
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31974R0165>

- CELEX:31992L0032 Council Directive 92/32/EEC of 30 April 1992 amending for the seventh time Directive 67/548/EEC on the approximation of the laws, regulations, and administrative provisions relating to the classification, packaging, and labelling of dangerous substances
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992L0032>
- CELEX:31992R2455 Council Regulation (EEC) No 2455/92 of 23 July 1992 concerning the export and import of certain dangerous chemicals
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992R2455>
- CELEX:31977D0585 77/585/EEC: Council Decision of 25 July 1977 concluding the Convention for the protection of the Mediterranean Sea against pollution and the Protocol for the prevention of the pollution of the Mediterranean Sea by dumping from ships and aircraft
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31977D0585>
- CELEX:31979H0003 79/3/EEC: Council Recommendation of 19 December 1978 to the Member States regarding methods of evaluating the cost of pollution control to industry
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31979H0003>
- CELEX:31981D0437 81/437/EEC: Commission Decision of 11 May 1981 laying down the criteria in accordance with which information relating to the inventory of chemical substances is supplied by the Member States to the Commission
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31981D0437>
- CELEX:31983D0101 83/101/EEC: Council Decision of 28 February 1983 concluding the Protocol for the protection of the Mediterranean Sea against pollution from land-based sources
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31983D0101>
- CELEX:31987D0516 87/516/Euratom, EEC: Council Decision of 28 September 1987 concerning the framework programme for Community activities in the field of research and technological development (1987 to 1991)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31987D0516>
- CELEX:31992Y0306(02) Council Resolution of 25 February 1992 on the future Community groundwater policy
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992Y0306\(02\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992Y0306(02))
- CELEX:31993R0793 Council Regulation (EEC) No 793/93 of 23 March 1993 on the evaluation and control of the risks of existing substances
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31993R0793>
- CELEX:31995D0308 95/308/EC: Council Decision of 24 July 1995 on the conclusion, on behalf of the Community, of the Convention on the protection and use of transboundary watercourses and international lakes
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31995D0308>
- CELEX:31999D0801 Council Decision of 22 October 1999 on accepting the amendments to the Protocol for the protection of the Mediterranean Sea against pollution from land-based sources (Barcelona Convention) (1999/801/EC)
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31999D0801>
- CELEX:31999D0802 1999/802/EC: Council Decision of 22 October 1999 on the acceptance of amendments to the Convention for the Protection of the Mediterranean Sea against Pollution and to the Protocol for the Prevention of Pollution by Dumping from Ships and Aircraft (Barcelona Convention)
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:31999D0802>

- CELEX:32000L0060 Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy (OJ L 327, 22.12.2000, p. 1).
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0060>

Measures to improve the traceability

- CELEX:31979L0831 Council Directive 79/831/EEC of 18 September 1979 amending for the sixth time Directive 67/548/EEC on the approximation of the laws, regulations, and administrative provisions relating to the classification, packaging, and labelling of dangerous substances
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31979L0831>
- CELEX:31982H0490 82/490/EEC: Commission Recommendation of 6 July 1982 relating to the certificates of conformity provided for in Council Directive 76/117/EEC on the approximation of the laws of the Member States concerning electrical equipment for use in potentially-explosive atmospheres
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31982H0490>
- CELEX:31984L0631 Council Directive 84/631/EEC of 6 December 1984 on the supervision and control within the European Community of the transfrontier shipment of hazardous waste
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31984L0631>
- CELEX:31987D0600 87/600/Euratom: Council Decision of 14 December 1987 on Community arrangements for the early exchange of information in the event of a radiological emergency
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31987D0600>
- CELEX:31988L0379 Council Directive 88/379/EEC of 7 June 1988 on the approximation of the laws, regulations, and administrative provisions of the Member States relating to the classification, packaging, and labelling of dangerous preparations
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31988L0379>
- CELEX:31989Y0112(01) Council Resolution of 21 December 1988 concerning transfrontier movements of hazardous waste to third countries
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31989Y0112\(01\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31989Y0112(01))
- CELEX:31990D0170 90/170/EEC: Council Decision of 2 April 1990 on the acceptance by the European Economic Community of an OECD Decision/recommendation on the control of transfrontier movements of hazardous wastes
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31990D0170>
- CELEX:31992L0003 Council Directive 92/3/Euratom of 3 February 1992 on the supervision and control of shipments of radioactive waste between Member States and into and out of the Community
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31992L0003>
- CELEX:31993D0098 93/98/EEC: Council Decision of 1 February 1993 on the conclusion, on behalf of the Community, of the Convention on the control of transboundary movements of hazardous wastes and their disposal (Basel Convention)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31993D0098>
- CELEX:32000D0479 2000/479/EC: Commission Decision of 17 July 2000 on the implementation of a European pollutant emission register (EPER) according to Article 15 of Council Directive 96/61/EC concerning integrated

pollution prevention and control (IPPC) (notified under document number C(2000) 2004) (Text with EEA relevance)

<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:32000D0479>

Economic incentives

- CELEX:31975H0436 75/436/Euratom, ECSC, EEC: Council Recommendation of 3 March 1975 regarding cost allocation and action by public authorities on environmental matters
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31975H0436>

Communication, stakeholder involvement, and raising public awareness

- CELEX:31967L0548 Council Directive 67/548/EEC of 27 June 1967 on the approximation of laws, regulations, and administrative provisions relating to the classification, packaging, and labelling of dangerous substances
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31967L0548>
- CELEX:31973L0146 Council Directive 73/146/EEC of 21 May 1973 amending the Directive of 27 June 1967 on the approximation of laws, regulations, and administrative provisions relating to the classification, packaging, and labelling of dangerous substances
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31973L0146>
- CELEX:31973L0173 Council Directive 73/173/EEC of 4 June 1973 on the approximation of Member States' laws, regulations and administrative provisions relating to the classification, packaging, and labelling of dangerous preparations (solvents)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31973L0173>
- CELEX:31978L0631 Council Directive 78/631/EEC of 26 June 1978 on the approximation of the laws of the Member States relating to the classification, packaging, and labelling of dangerous preparations (pesticides)
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31978L0631>
- CELEX:31978D0436 78/436/EEC: Commission Decision of 21 April 1978 establishing a Scientific Committee for Pesticides
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31978D0436>
- CELEX:31981D0462 81/462/EEC: Council Decision of 11 June 1981 on the conclusion of the Convention on long-range transboundary air pollution
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31981D0462>

Monitoring programmes

- CELEX:31978D0436 78/436/EEC: Commission Decision of 21 April 1978 establishing a Scientific Committee for Pesticides
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31978D0436>
- CELEX:31981D0462 81/462/EEC: Council Decision of 11 June 1981 on the conclusion of the Convention on long-range transboundary air pollution
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31981D0462>

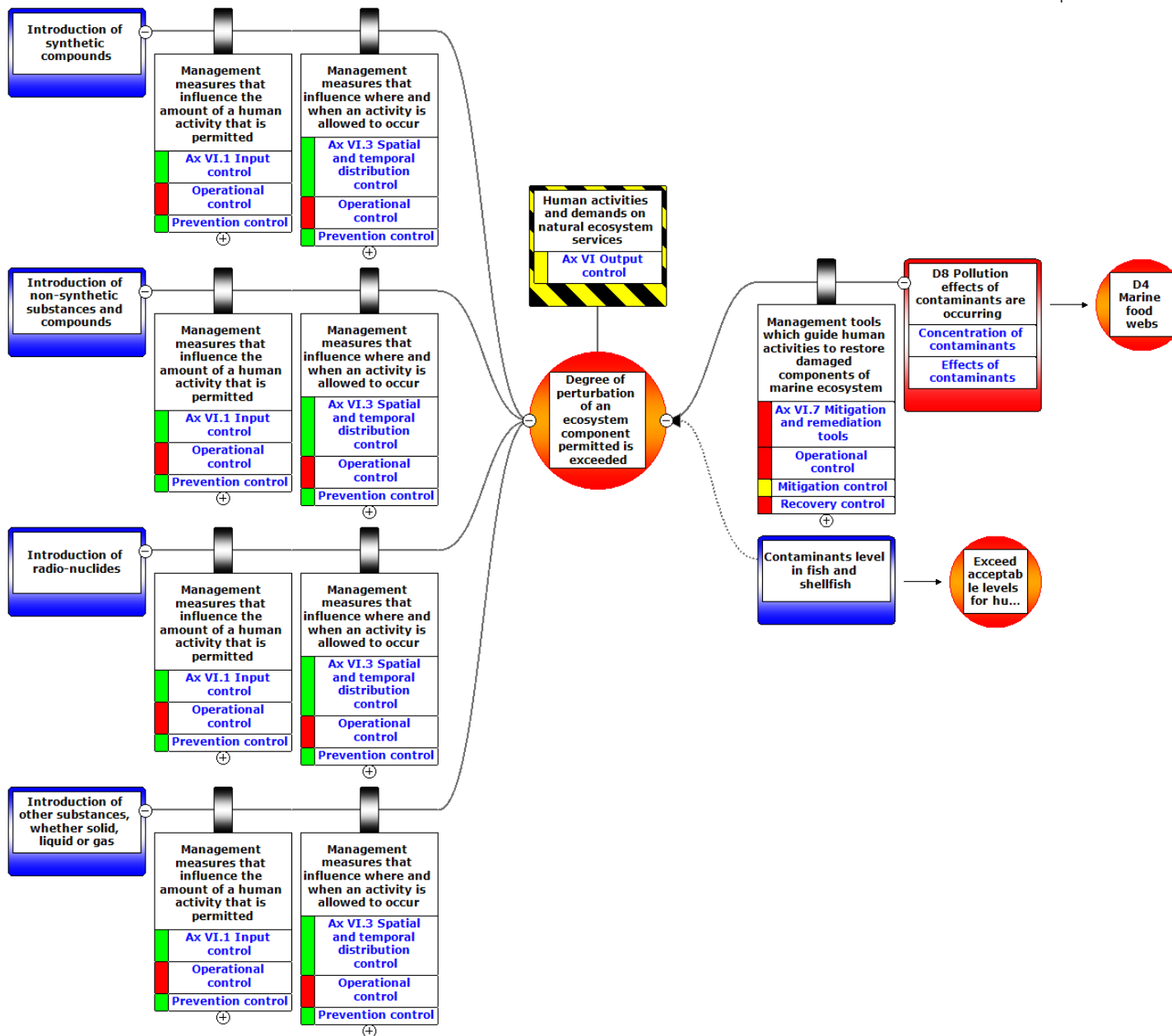


Figure 6.8. Bowtie analysis of MSFD Descriptor 8: Concentrations of contaminants are at levels not giving rise to pollution effects.

6.9 Descriptor 9: Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards

Event: Unacceptable levels of contaminants occurring in fish and other seafood for human consumption as a consequence of exceeding acceptable levels for human consumption.

The unacceptable levels of contaminants in fish and seafood are among the endpoints of the pathways of risk (Figure 6.9) of the chain of events. This descriptor does not depend on an output control related to the degree of perturbation of ecosystem components. It relies on the effectiveness of the input controls and the spatial and temporal distribution controls of contaminants (Descriptor 8) and any naturally occurring background contamination. Mitigation and recovery are based on public health and safety standards.

The following examples are the relevant public health and safety cited instruments.

Mitigation and remediation tools

- CELEX:31959L0221 Directives laying down the basic standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiations
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31959L0221>
- CELEX:31976L0403 Council Directive 76/403/EEC of 6 April 1976 on the disposal of polychlorinated biphenyls and polychlorinated terphenyls
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31976L0403>
- CELEX:31979L0923 Council Directive 79/923/EEC of 30 October 1979 on the quality required of shellfish waters
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31979L0923>
- CELEX:31991L0492 Council Directive 91/492/EEC of 15 July 1991 laying down the health conditions for the production and the placing on the market of live bivalve molluscs
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31991L0492>
- CELEX:31996L0023 Council Directive 96/23/EC of 29 April 1996 on measures to monitor certain substances and residues thereof in live animals and animal products and repealing Directives 85/358/EEC and 86/469/EEC and Decisions 89/187/EEC and 91/664/EEC
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31996L0023>
- CELEX:32004R0852 Regulation (EC) No 852/2004 of the European Parliament and of the Council of 29 April 2004 on the hygiene of foodstuffs
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32004R0852>
- CELEX:32004R0853 Regulation (EC) No 853/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific hygiene rules for food of animal origin
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32004R0853>
- CELEX:32005R0183 Regulation (EC) No 183/2005 of the European Parliament and of the Council of 12 January 2005 laying down requirements for feed hygiene (Text with EEA relevance)
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32005R0183>
- CELEX:32005R0396 Regulation (EC) No 396/2005 of the European Parliament and of the Council of 23 February 2005 on maximum residue levels of pesticides in or on food and feed of plant and animal origin and amending

Council Directive 91/414/EEC Text with EEA relevance.

<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32005R0396>

Monitoring programmes

- CELEX:32004R0854 Regulation (EC) No 854/2004 of the European Parliament and of the Council of 29 April 2004 laying down specific rules for the organization of official controls on products of animal origin intended for human consumption
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32004R0854>
- CELEX:32004R0882 Regulation (EC) No 882/2004 of the European Parliament and of the Council of 29 April 2004 on official controls performed to ensure the verification of compliance with feed and food law, animal health, and animal welfare rules
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32004R0882>

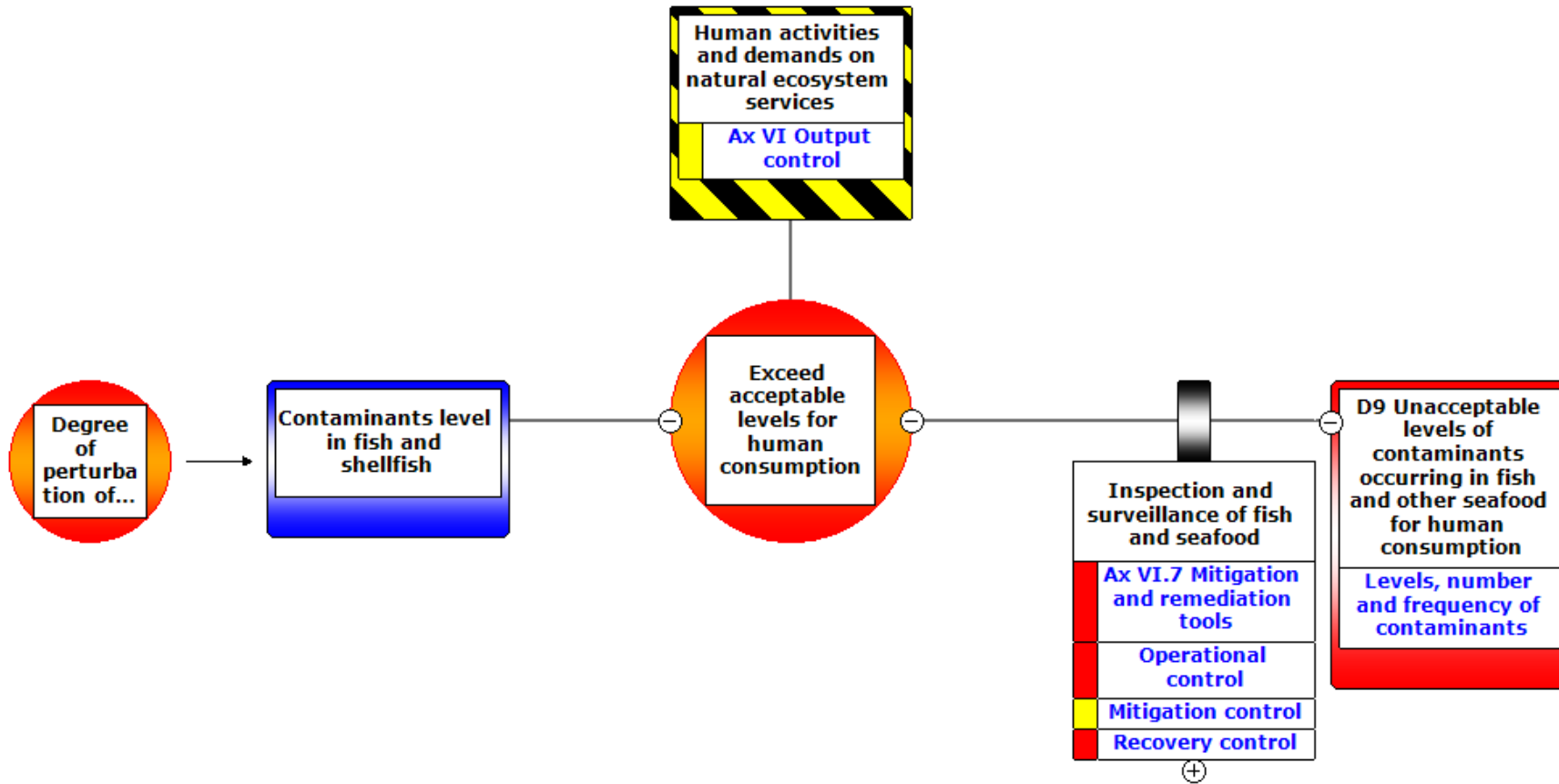


Figure 6.9. Bowtie analysis of MSFD Descriptor 9: Contaminants in fish and other seafood for human consumption do not exceed levels established by Community legislation or other relevant standards.

6.10 Descriptor 10: Properties and quantities of marine litter do not cause harm to the coastal and marine environment.

Risk event: As a consequence of exceeding the permitted degree of perturbation of an ecosystem component, marine litter contaminants are causing environmental harm.

The harm caused by marine litter is among the root causes of the pathways of risk (Figure 6.10) of the chain of events. The degree of perturbation of ecosystem components is caused by pressures due to the introduction of marine litter. Input controls or spatial and temporal distribution controls can be used to reduce or eliminate the perturbations. Mitigation and recovery tools can reduce or eliminate the impacts of marine litter. The consequences can also influence the normal abundance and diversity of marine foodwebs (Descriptor 4). Marine litter can cause biological disturbances to species and have an effect on marine foodwebs.

The following examples are the relevant cited instruments for the controls of the programme of measures.

Input controls

- CELEX:31975L0442 Council Directive 75/442/EEC of 15 July 1975 on waste
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31975L0442>
- CELEX:31990Y0518(01) Council Resolution of 7 May 1990 on waste policy
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31990Y0518\(01\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31990Y0518(01))
- CELEX:31991L0156 Council Directive 91/156/EEC of 18 March 1991 amending Directive 75/442/EEC on waste
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31991L0156>
- CELEX:31991L0689 Council Directive 91/689/EEC of 12 December 1991 on hazardous waste
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31991L0689>
- CELEX:31994L0062 European Parliament and Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31994L0062>
- CELEX:31997Y0311(01) Council Resolution of 24 February 1997 on a Community strategy for waste management
[http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31997Y0311\(01\)](http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31997Y0311(01))
- CELEX:31999L0031 Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31999L0031>
- CELEX:32008L0098 Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives (Text with EEA relevance)
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32008L0098>
- CELEX:31993R0259 Council Regulation (EEC) No 259/93 of 1 February 1993 on the supervision and control of shipments of waste within, into, and out of the European Community
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31993R0259>
- CELEX:31998D0392 98/392/EC: Council Decision of 23 March 1998 concerning the conclusion by the European Community of the United Nations Convention of 10 December 1982 on the Law of the Sea and the Agreement

of 28 July 1994 relating to the implementation of Part XI thereof

<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31998D0392>

- CELEX:32000L0059 Directive 2000/59/EC of the European Parliament and of the Council of 27 November 2000 on port reception facilities for ship-generated waste and cargo residues
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32000L0059>
- CELEX:32006R1013 Regulation (EC) No 1013/2006 of the European Parliament and of the Council of 14 June 2006 on shipments of waste
<http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32006R1013>

Management coordination measures

- CELEX:31993R0259 Council Regulation (EEC) No 259/93 of 1 February 1993 on the supervision and control of shipments of waste within, into and out of the European Community
<http://eur-lex.europa.eu/legal-content/EN/AUTO/?uri=CELEX:31993R0259>

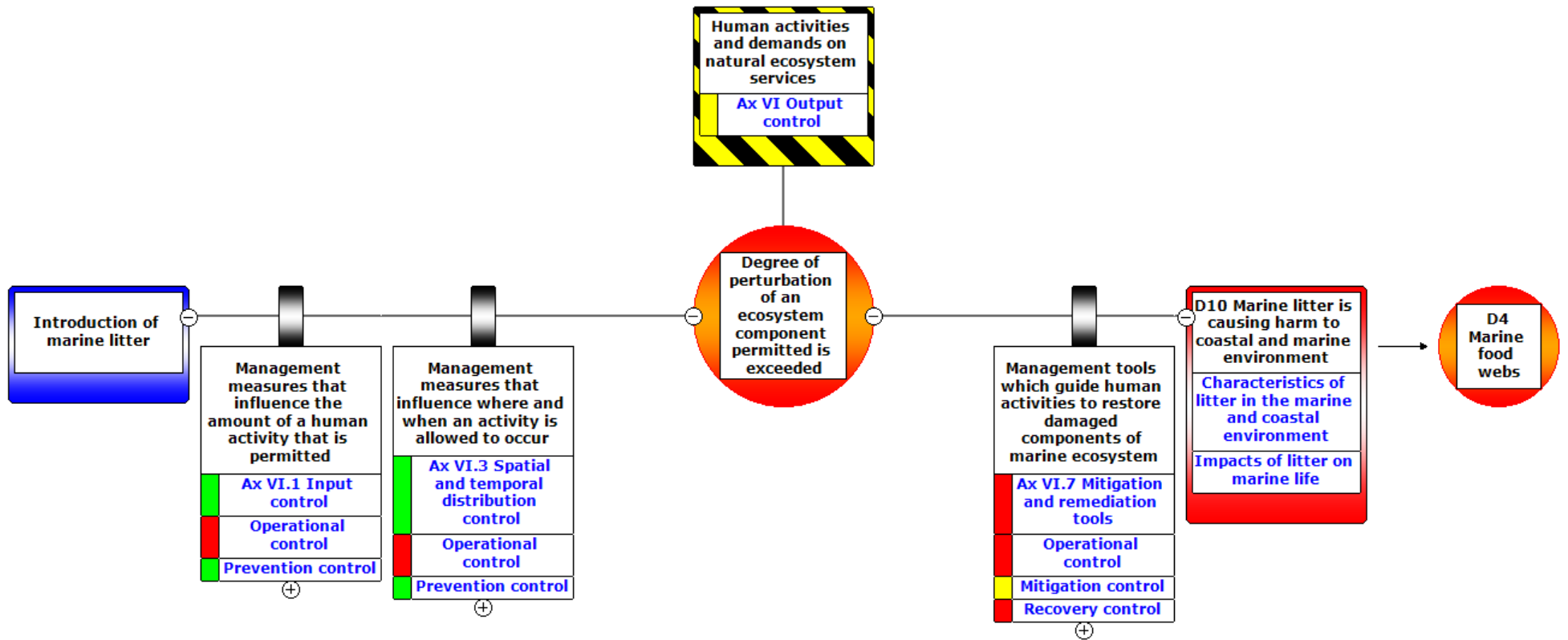


Figure 6.10. Bowtie analysis of MSFD Descriptor 10: Properties and quantities of marine litter do not cause harm to the coastal and marine environment.

6.11 Descriptor 11: Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment

Risk event: Marine environment is adversely affected by levels of energy, including underwater noise, as a consequence of exceeding the permitted degree of perturbation of an ecosystem component.

The adverse effects of energy and noise are among the root causes of the pathways of risk (Figure 6.11) of the chain of events. The degree of perturbation of ecosystem components is caused by pressures related to the introduction of underwater noise. Input controls or spatial and temporal distribution controls to reduce the perturbations are identified as results of environmental impacts assessments used as management control processes. Mitigation and recovery tools are the same as those provided for biological diversity (Descriptor 1). The consequences can also influence, in return, the normal abundance and diversity of marine foodwebs (Descriptor 4). The effects of energy and noise can cause biological disturbances of species and have an effect on marine foodwebs.

Examples of relevant cited instruments for the controls the programme of measures are similar to the ones for Descriptor 1 on biological diversity and Descriptor 6 on seabed integrity (see subsections 6.1 and 6.6 of this report).

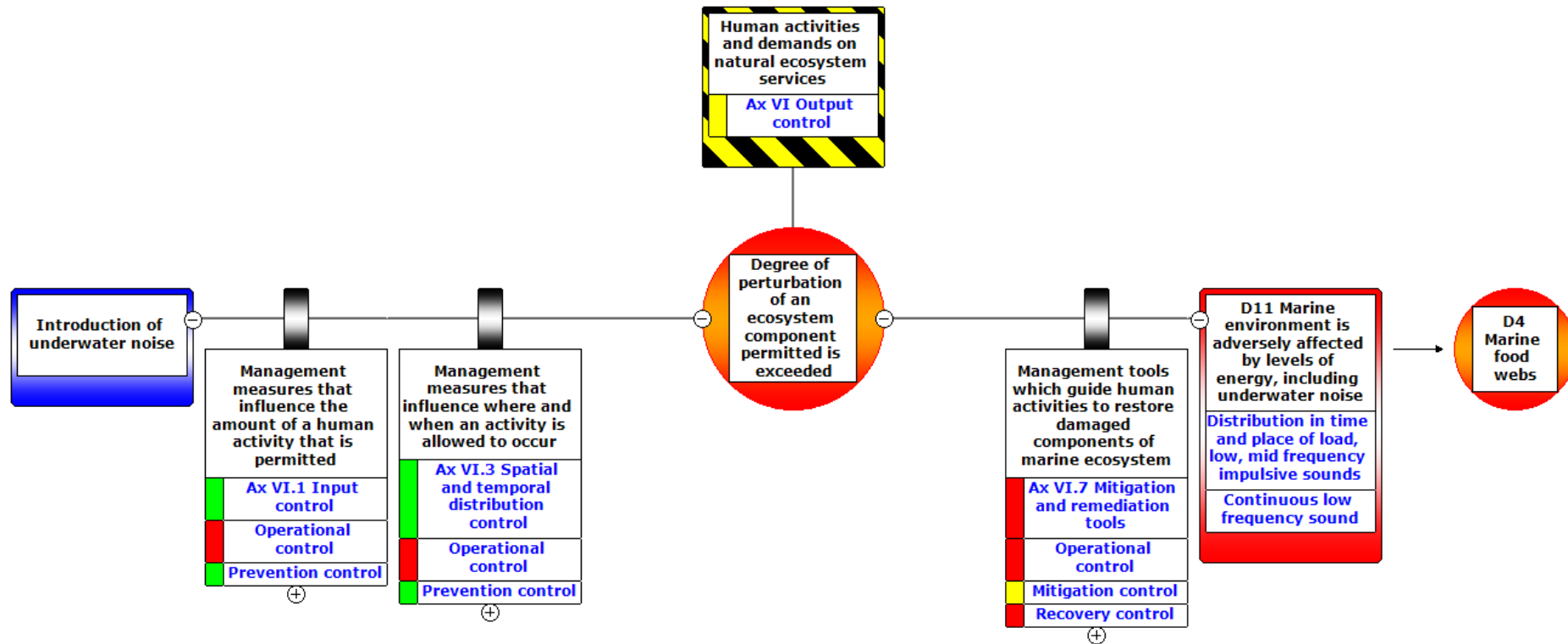


Figure 6.11. Bowtie analysis of MSFD Descriptor 11: Introduction of energy, including underwater noise, is at levels that do not adversely affect the marine environment.

7 General discussion

As a framework, the MSFD is well aligned to the Bowtie analysis structure of legislation and regulations. In addition to the goals set in the preamble of the directive, the qualitative descriptors of good environmental status (Annex I of MSFD), the list of pressures (Annex III of MSFD), and the programme of measures (Annex VI of MSFD) provide the necessary elements to identify the source of the risk, the causes of an event, the consequences of such event, and the management and operational controls needed to reduce the risks related to such an event. The definitions provided in the annexes of the MSFD can be considered as a comprehensive risk management framework that is also well aligned with the ISO risk management standards.

7.1 Analysis of the legislation to implement the MSFD

It is the programme of measures (Annex VI of MSFD) that carries into effect the goals and objectives of the MSFD. Legislation and regulations are among the key measures, in addition to voluntary measures and practices that may be found in codes of conducts, best practices, and guidelines. In this report, the Bowtie analysis of the EU legislation and regulations shows that pressures and impacts are managed by different competent authorities across national, regional, and transboundary jurisdictions. From a cumulative-effects perspective, this implies that the good environmental status of each descriptor depends on the effectiveness and implementation of EU legislation within the specific national legislation by their respective competent authorities. The competent authority under the MSFD only has the authority to use the descriptors as a broad set of ecosystem-scale objectives and to lead the necessary coordination to align the legislation for achieving and maintaining good environmental status.

However, management measures implemented under any legislative and regulatory framework are not always 100% effective. Thus, the resulting collective residual pressures are at the root cause of cumulative and synergistic effects in combination with changes generated by natural processes. In a Bowtie setting, this is expressed as a chain of events caused by the consequences of the residual pressures of another Bowtie event. In addition, the regulatory limits may have been established for very different objectives at the time the legislation was developed. For example, a regulatory limit may have been set for acute toxicity to fish within a limited perimeter from its sources instead of the collective effects at an ecosystem scale. An in-depth analysis of the actual legislation would be needed to determine if this is the case. This report provides an example of a macroanalysis by identifying the legislation that plays a role for each descriptor of good environmental status.

The macroanalysis, however, shows that the number of EU legislations used to manage pressures varies greatly across the descriptors and their pressures. For example, there is a large number of directives and regulations for fisheries (Descriptor 3) and pollution effects (Descriptor 8), which is likely due to the fact that these have a long history of management issues. In contrast, there are less, if any, directives and regulations found for non-indigenous species (Descriptor 2), marine litter (Descriptor 10), or underwater noise (Descriptor 11) as these issues are more recent. Compared to pollution effects (Descriptor 8), which is mostly based on regulatory limits and standards, other descriptors such seabed integrity (Descriptor 6) and alteration of hydrographical conditions (Descriptor 7) are primarily managed through environmental impact assessment projects which can lead to piecemeal management approaches. Furthermore, the EU regulations that manage pollution effects (Descriptor 8) apply to land-based and marine-based operations.

As a management control process, management coordination measures (Annex VI of MSFD) may need to play a more significant role in coordinating the development of input controls and spatial and temporal distribution controls across jurisdictions to ensure that they meet the output control requirements set for a regional sea. This analysis reveals that the output control may be the most important control as it sets the degree of perturbation of an ecosystem component that is permitted at a regional sea scale for the collective pressures. As the central event, the Bowtie analysis shows that a qualitative descriptor for good environmental status will not be achieved or maintained as a consequence of exceeding the level set by the output control. The output control could be used to evaluate older pieces of legislation and regulations to determine if their regulatory limits and standards can meet the degree of perturbation of an ecosystem component permitted at an ecosystem scale.

7.2 Risk management consideration to achieve and maintain good environmental status

In risk management, the risk is tied to the uncertainty of achieving objectives set by policy. Risks related to the likelihood of impacts identify and describe the potential for not achieving an objective if these risks are not managed. It is the implementation of operational controls that actually reduces the uncertainties of achieving objectives. Thus, it is the programme of measures that reduces the uncertainties of achieving and maintaining good environmental status. Specifically, it is the input controls, the spatial and temporal distribution controls, and the output controls that need to be implemented operationally. Figure 7.1 is a summary of the insights that a Bowtie analysis could provide.

In terms of the risk of not achieving or maintaining good environmental status, it is quite clear that biological diversity (Descriptor 1) and marine food webs (Descriptor 4) depend heavily on the effectiveness of EU directives and regulations that are implemented for the other descriptors. As expected, the analysis highlights current approaches to the protection and conservation of ecosystems components based on mitigation and remediation tools such as marine protected areas. Because of the structure of the Bowtie, mitigation and remediation approaches imply that their status is not being achieved as a consequence of exceeding the permitted level of the output control. Given that this is a reactive risk management strategy, current approaches can continue to mitigate and remediate the impacts until the level of collective pressures leaves nothing to mitigate and remediate outside the change resulting from continuously evolving natural processes (Cochrane *et al.*, 2016). These two descriptors depend on a comprehensive prevention strategy of the pressures for the other descriptors in order to achieve good environmental status.

The analysis also shows that there are few EU directives providing mitigation and remediation tools for the descriptors that are directly influenced by pressures, such as non-indigenous species (Descriptor 2), eutrophication (Descriptor 5), or pollution effects (Descriptor 8). This implies that achieving and maintaining good environmental status for these descriptors relies heavily on the effectiveness of the input controls and the spatial and temporal distribution controls. In cases where controls cannot reduce the pressures to levels below or at the permitted level set by the output controls, there is a greater risk of ever achieving or maintaining their status because of the lack of mitigation and remediation options.

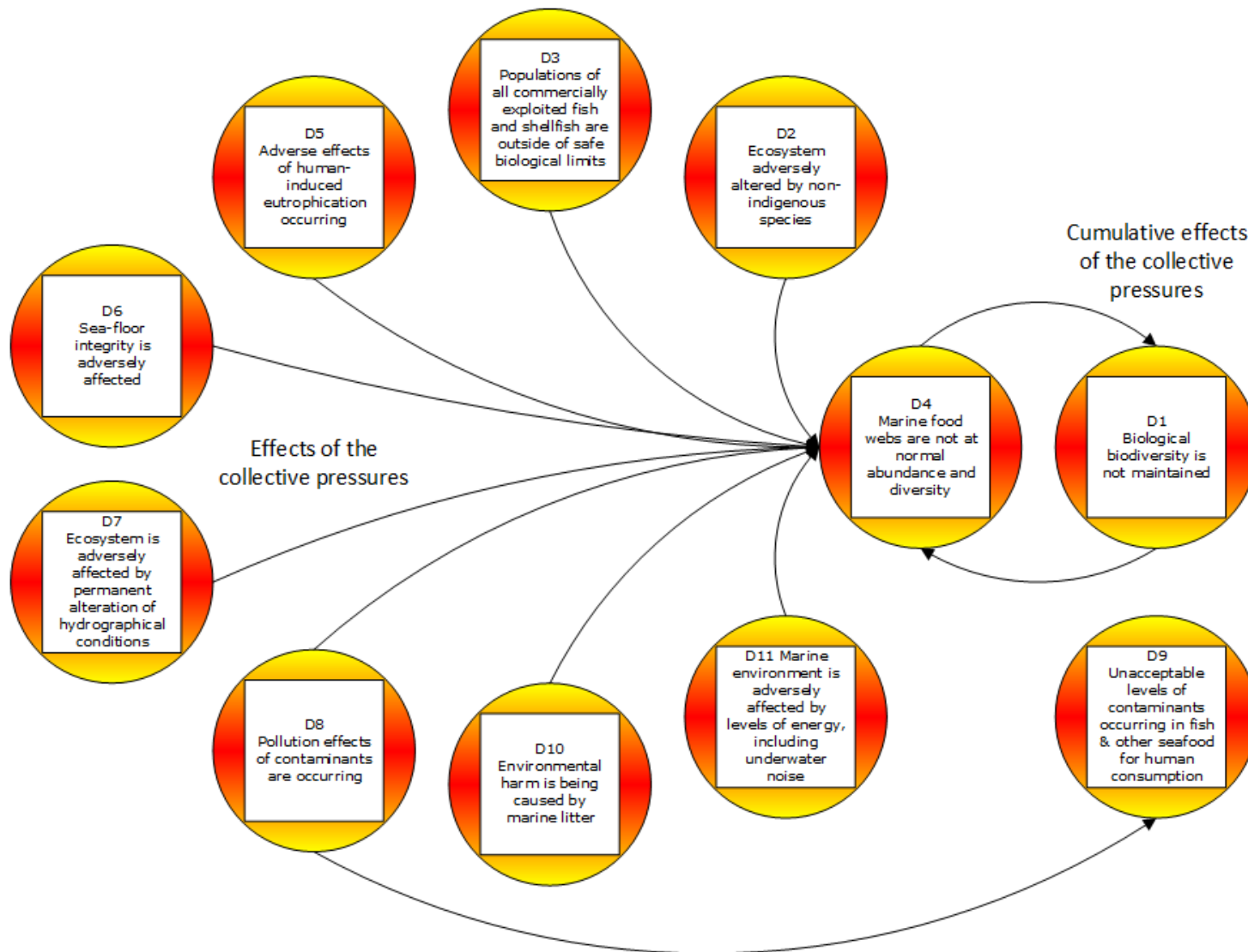


Figure 7.1. Chain of events of failing to meet the qualitative descriptors for good environmental status.

It should be noted that contaminants in fish and other seafood (Descriptor 9) rely heavily on the effectiveness of pollution effects (Descriptor 8). In this Bowtie, however, the event is not linked to an output control. The event is levels of contaminants that exceed acceptable levels for human consumption based on regulatory standards. It is not based on the degree of perturbation of an ecosystem component, as defined for an output control. The programme of measures would not apply here as inspection and surveillance of fish and seafood products would mitigate the risk from exposing consumers. Finally, contaminants can also occur as a result of natural background contamination that is outside the MSFD span of control.

From a management perspective, the Bowtie analysis provides important insights as to the risk involved in the various management strategies for each descriptor. In a well-balanced risk management strategy, there should be an effective prevention strategy of prevention controls paired with an effective reactive strategy of mitigation and recovery in the event that the prevention controls fail to avoid such an event. The Bowtie analysis of the MSFD and the cited instruments provide a valuable example of the types of issues that would be addressed through a more comprehensive integrated management approach.

7.3 Managing the collective pressure to reduce cumulative effects and impacts

Outside natural trends, this analysis considers that cumulative effects and impacts related to human activities reflect the effectiveness and, in some cases, the compliance of the operational control implemented through legislation, regulations, standards, and guidelines. Cumulative effects and impacts are most likely the result of a lack of effectiveness of controls for meeting expected outcomes, a lack of consistency in the expected outcomes for the controls, a lack of coherence between the outcomes and the objectives to be met, or a lack of policy setting the objectives and goals all together.

As mentioned in Article 1.3 of the MSFD, “Marine strategies shall apply an ecosystem-based approach to the management of human activities, ensuring that the collective pressure of such activities is kept within levels compatible with the achievement of good environmental status”. Given that the output control plays a key role in defining the event in this Bowtie analysis, it implies that the collective pressures would need to be managed to meet the permitted levels set by the output controls collectively across the jurisdictions. This does not imply that all jurisdictions have to use the same operational controls. It simply implies that the effectiveness of their individual controls must achieve the output controls set for a regional sea. This allows for regional and cultural differences in management strategies. Using a risk management approach for cumulative effects assessment would introduce the need to assess the effectiveness of existing operational controls in reducing the pressures and minimize effects at ecosystem scales.

8 Conclusion

This report demonstrates the value of adapting the Bowtie analysis to legislation and policies. Although environmental impacts assessments are used to inform management and stakeholders of environmental risks, the Bowtie analysis of the management and operational controls complement these assessments. The qualitative diagrammatic representation of the legislation and policies used to implement the controls are valuable inputs to identify needed improvements in existing or new management strategies necessary to achieve policy objectives. From a cumulative effects assessment context, a comprehensive Bowtie analysis can identify which pressures may be lacking the controls needed to reduce the collective pressures generated by human activities and demands for natural ecosystem services.

The Bowtie diagrams in this report provide a structured template for the analysis of national legislation relative to the MSFD. This report demonstrates how such analysis can be adapted to legislation and policy analysis within the context of the programme of measures of the MSFD.

9 Acknowledgements

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