Managing Risk Through Marine Spatial Planning

past, present, future

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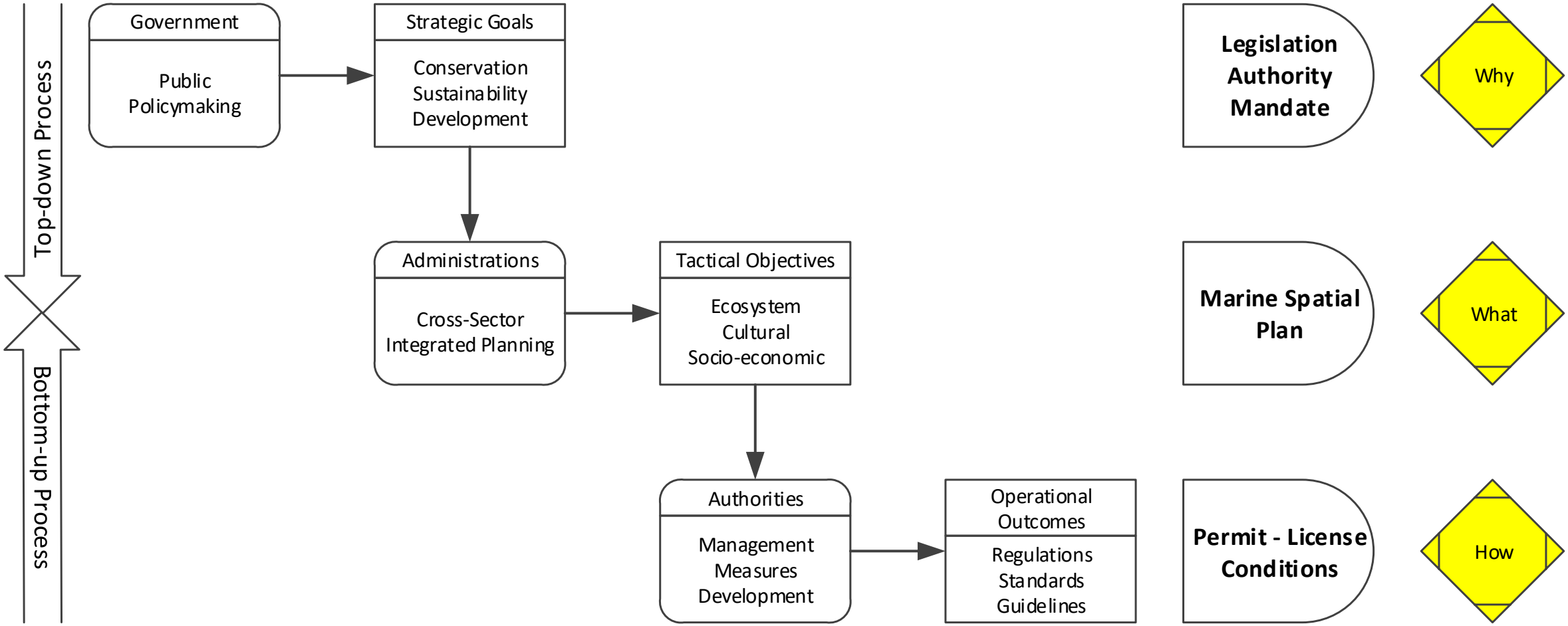
Ecosystem approach to managment

- **Why** something has to done?
- **What** needs to be done?
- **How** can it be done? 

Ecosystem approach to management Goals – Objectives - Outcomes



Cormier, R., Kelble, C.R., Anderson, M.R., Allen, J.I., Grehan, A., Gregersen, Ó., 2017. Moving from ecosystem-based policy objectives to operational implementation of ecosystem-based management measures. ICES J. Mar. Sci. 74, 406–413. https://doi.org/10.1093/icesjms/fsw181

Risk Management Process

- ISO 31000 Risk management process
  - Risk assessment is **scoped by the policy context** and the **effectiveness of the controls**
  - Risk is defined as the **effect of uncertainty on objectives**
  - Implement the **controls to reduce the uncertainties** of achieving the objectives
- Risk Management in regulatory frameworks
  - The coherent application of risk management to regulatory work is intended to develop a well-balanced system, as opposed to one that veers between two extremes:
  - (a) **Excessive or over-regulation**, i.e., regulations that are too stringent with respect to the risk they set out to address, and
  - (b) **Insufficient regulations**, which fail to address risk and unnecessarily or inordinately expose citizens and economic operators

UNECE. 2012. Risk management in regulatory frameworks: Towards a better management of risks. United Nations, Geneva. ECE/TRADE/390. http://www.unece.org/fileadmin/DAM/trade/Publications/WP6_ECE_TRADE_390.pdf

Controls assessment not assessed in Ecological Risk Assessments

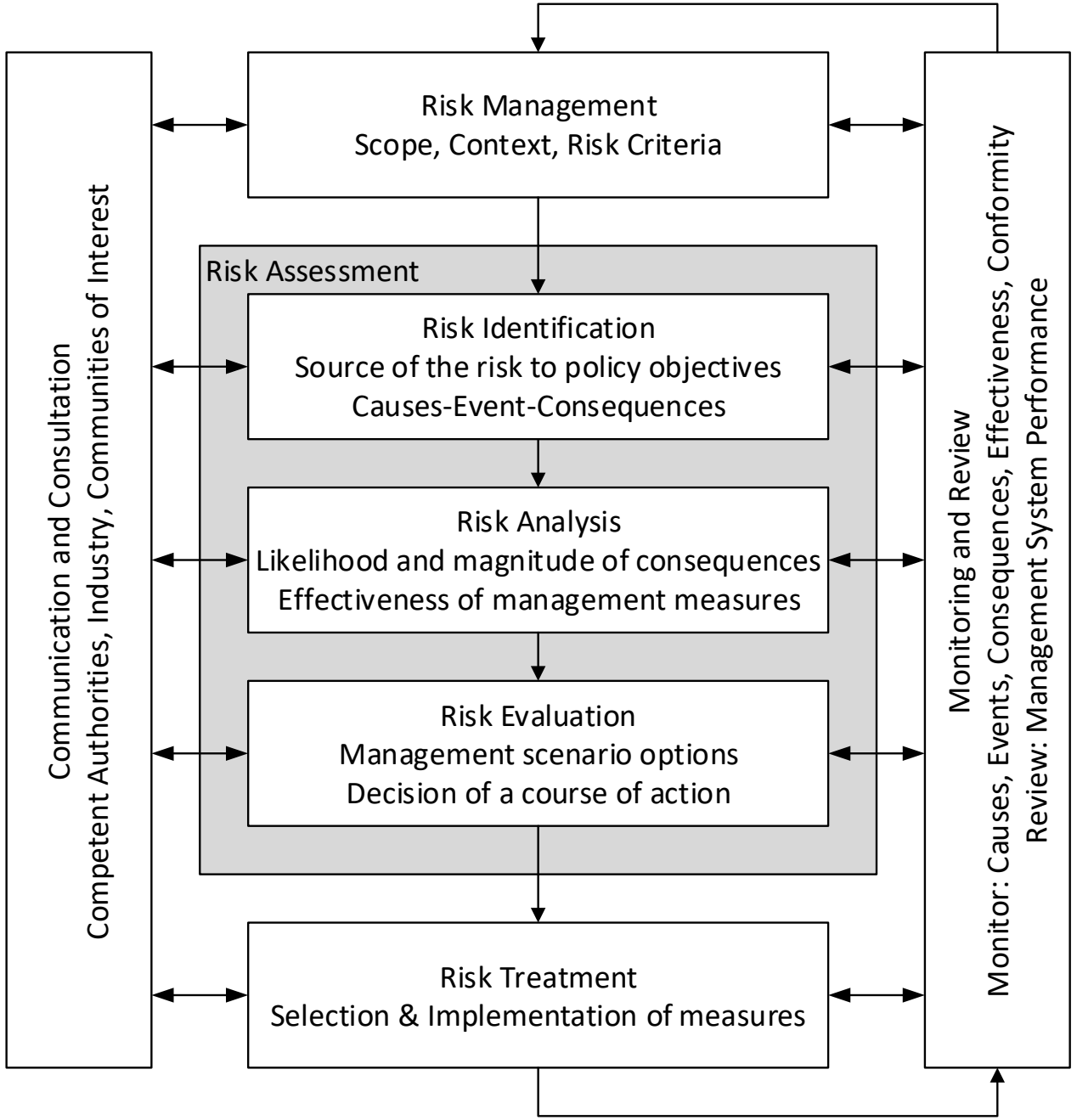
ERA Method Reference	Driver	Pressure	Biological Attributes	Management Control—Preventative	Undesirable Event	Management Control—Mitigative	Impact	Management Control—Recovery	Risk Estimation
[11]	-	E	V, P, EF	-	Ocean ecosystems impacted by multiple human activities	-	F, PI	-	Ranks threats affecting a species or system
[14,24]	Various	S	V, P	Various	Overfishing of ecosystem components	-	F, PI	-	Prioritises ecological components requiring action and degree of action required
[9] (Level 2)	-	S	V, P, EF	-	Relative abundance of ecological components is unsustainable	-	F, PI	-	Identifies which ecological components are at high risk from impacts of fishing
[27]	Various	-	V, P	-	Overfishing of multiple species	-	PI	-	Identifies if overfishing is occurring for which suite of species
[13] (Level 2)	-	E	V, P	-	Ecosystem components unacceptably impacted by human stressors	-	PI	-	Ranks stressors affecting an ecological component
[23]	-	E	V, P	BRD	Irreversible habitat damage	-	-	-	Identifies where and what habitat types are most intensely fished for management focus
[28]	-	E	V, P	-	Irreversible benthic habitat damage	-	F	-	Assesses benthic status of habitats to impacts of towed fishing gear
[29]	-	S, E	V, P	-	Irreversible habitat damage	-	-	-	Identifies where and what habitat types are most intensely fished for management focus
[25]	-	S	P	Selectivity fishing gear BRD	Overfishing of bycatch species	-	F	-	Assesses impact of fishing on bycatch species

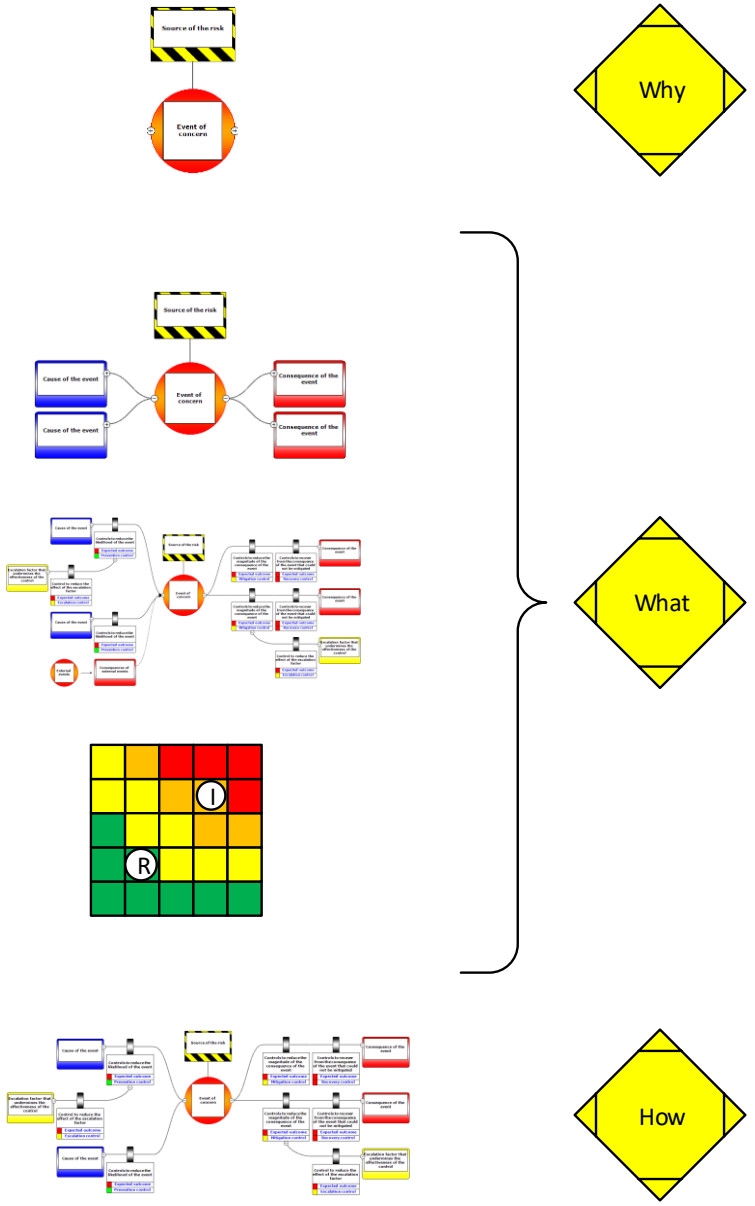
Astles, K., Cormier, R., 2018. Implementing Sustainably Managed Fisheries Using Ecological Risk Assessment and Bowtie Analysis. Sustainability 10, 3659. https://doi.org/10.3390/su10103659

EIC/ISO 31010: Bow-tie Analysis

- Developed in the early 1980's by the petrochemical industries to manage health and safety risks
- Widely-used by industry to analyze the connections between risk controls and the management system
- One of the more than 30 of IEC/ISO 31010 risk assessment techniques
- Combination of a Fault Tree and Event Tree analysis
- Incorporates multiple causes and consequences of a given event in the presence of a risk source
- Analyze existing and possible controls that are used to prevent the causes of the event and mitigate and recover from the consequences of the event

Cormier, R., Elliott, M., Rice, J., 2019. Putting on a bow-tie to sort out who does what and why in the complex arena of marine policy and management. Sci. Total Environ. 648, 293–305. https://doi.org/10.1016/j.scitotenv.2018.08.168

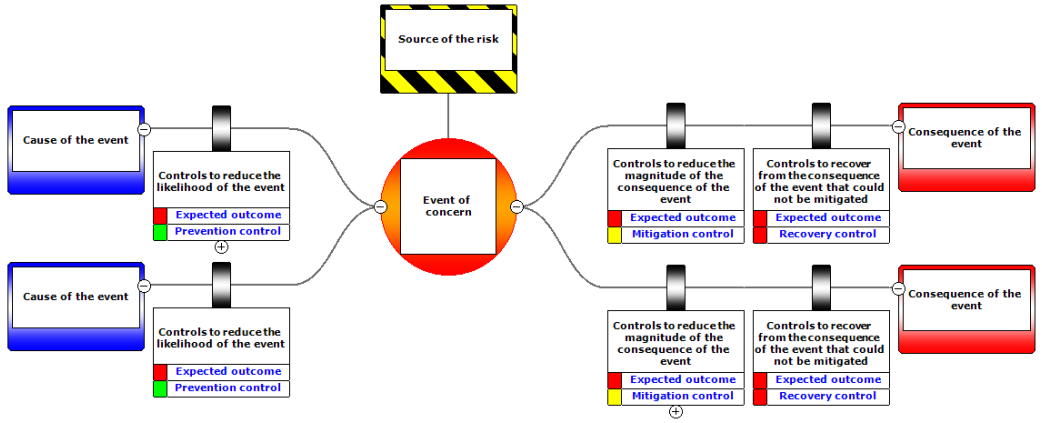




Cormier, R., Kannen, A., Elliott, M., and Hall. P. 2015. Marine Spatial Planning Quality Management System. ICES Cooperative Research Report No. 327. 106 pp.

Risk analysis of the existing controls

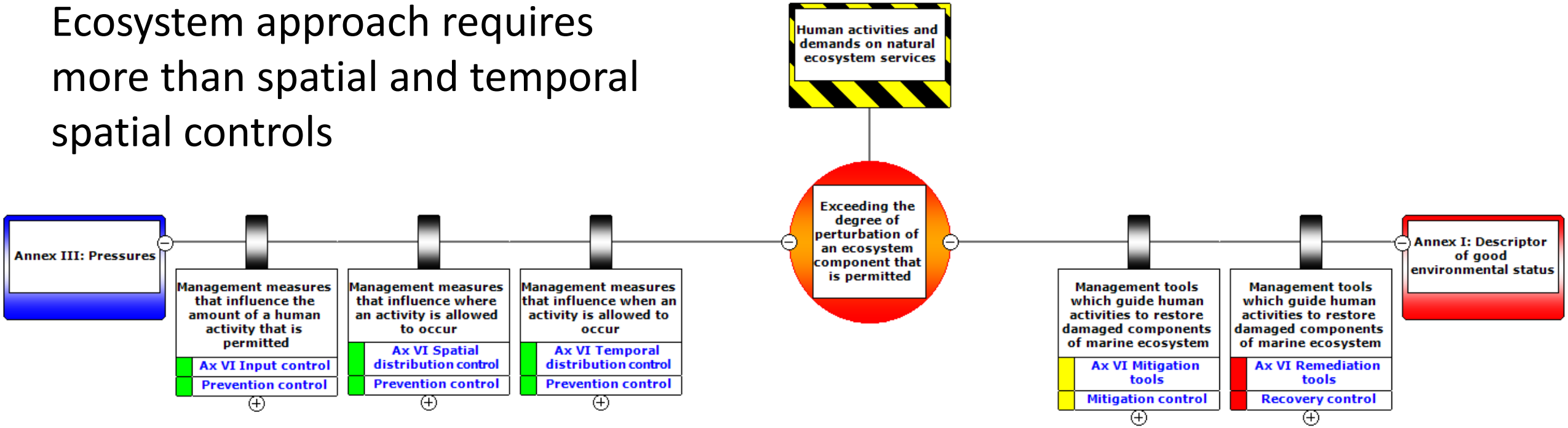
- **Prevention controls** are used to reduce the likelihood of the event by controlling the causes of the event
- **Mitigation controls** are used to reduce the magnitude of the consequence if and when the event occurs
- **Recovery controls** are used to recover from the consequence of the event that could not be mitigated
- Each control is implemented in sequence and is independent from one another



Cormier, R., Elliott, M., and Kannen, A. 2018. IEC/ISO Bow-tie analysis of marine legislation: A case study of the Marine Strategy Framework Directive. ICES Cooperative Re- search Report No. 342. 56 pp. https://doi.org/10.17895/ices.pub.4504

Ecosystem Approach to Management MSFD Programme of Measures

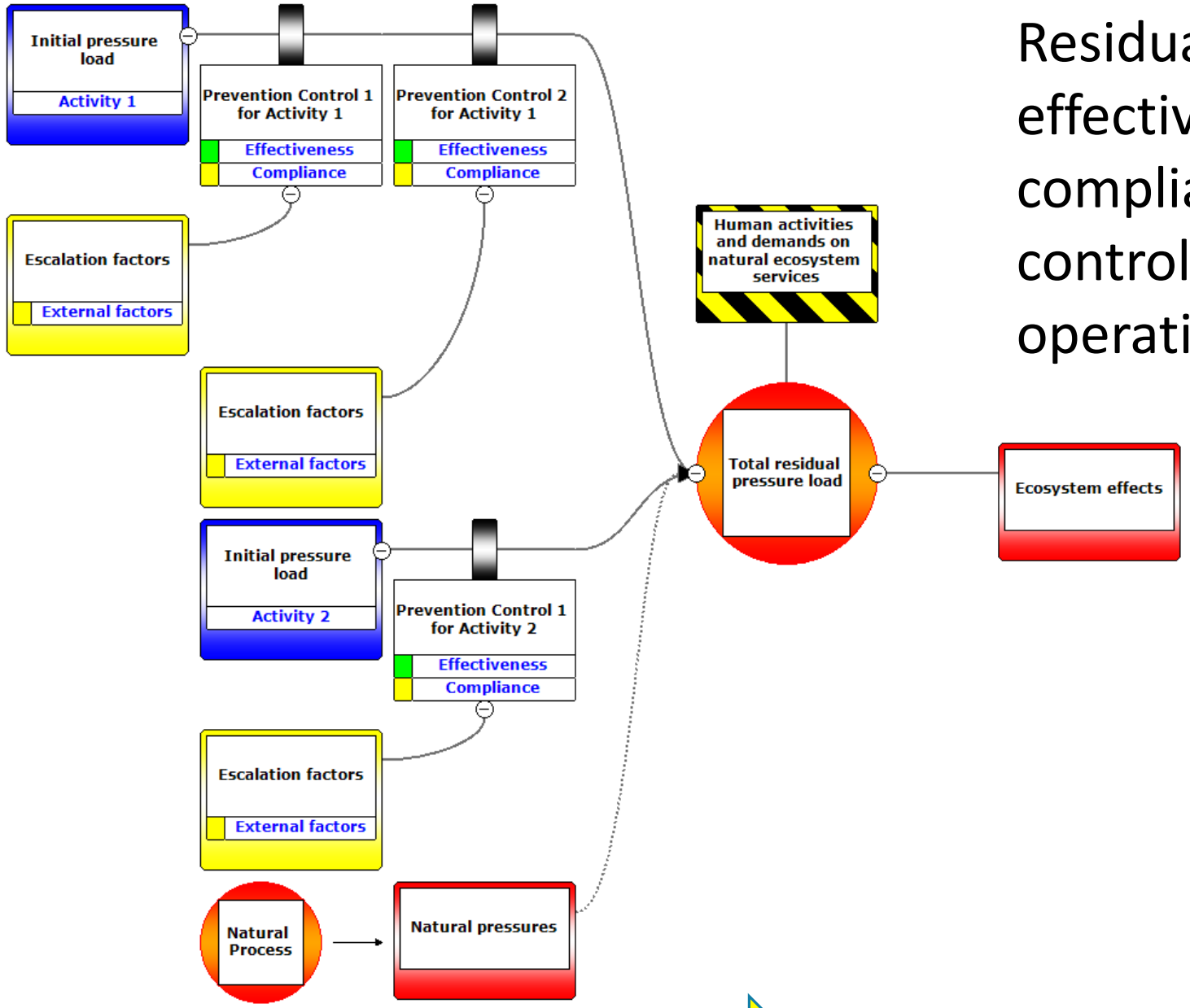
Ecosystem approach requires more than spatial and temporal spatial controls



Operational controls for the sector activity

Restoration management activities

Cormier, R., Elliott, M., and Kannen, A. 2018. IEC/ISO Bow-tie analysis of marine legislation: A case study of the Marine Strategy Framework Directive. ICES Cooperative Re- search Report No. 342. 56 pp. https://doi.org/10.17895/ices.pub.4504



Residual pressures is a result of effectiveness, conformity, compliance and reliability of the controls implemented in daily operational activities

Operational controls for the sector activity

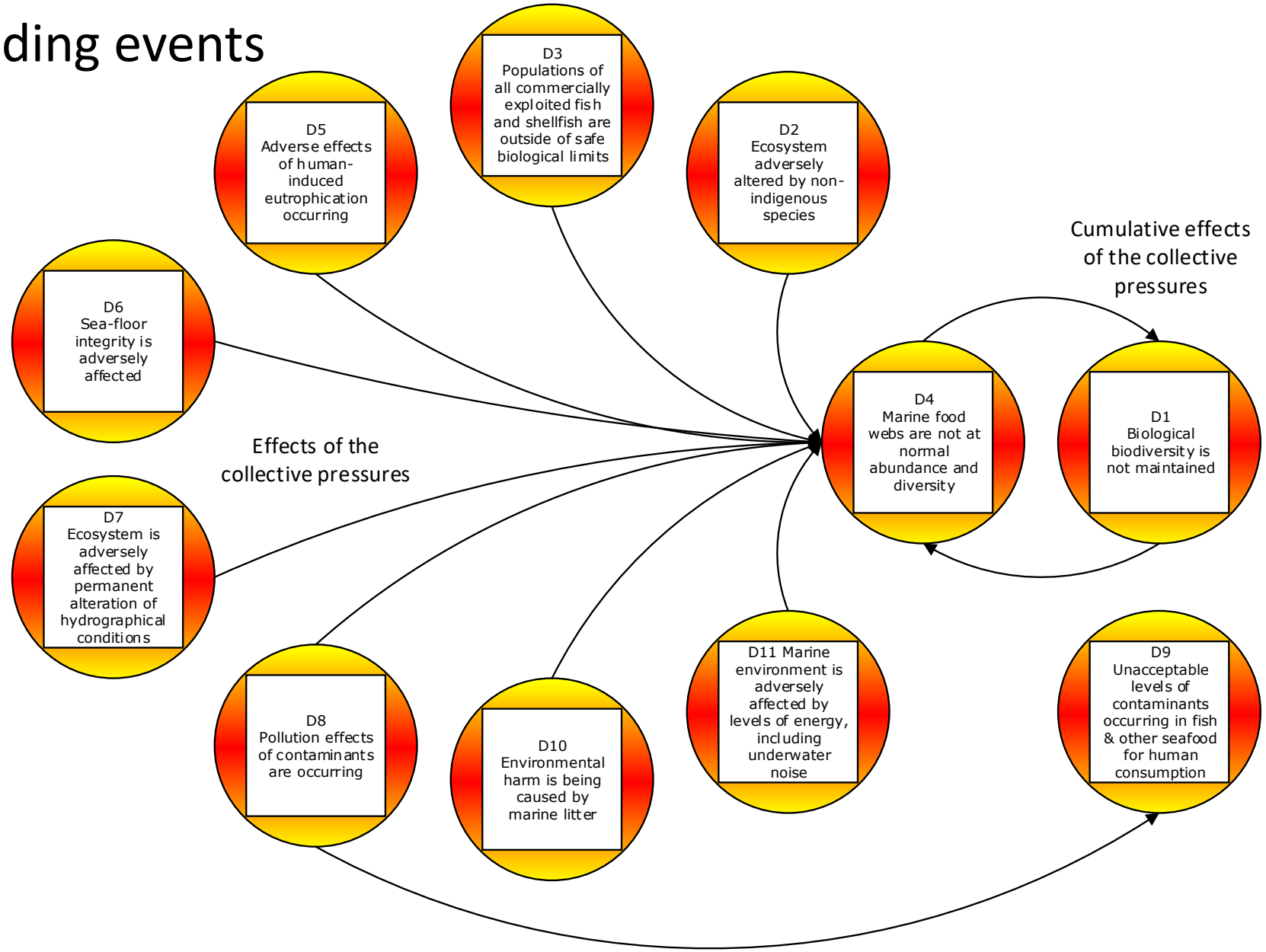
Protection and conservation management activities

Cormier, R., Stelzenmüller, V., Creed, I.F., Igras, J., Rambo, H., Callies, U., Johnson, L.B., 2018. The science-policy interface of risk-based freshwater and marine management systems: From concepts to practical tools. J. Environ. Manage. 226, 340–346. https://doi.org/10.1016/j.jenvman.2018.08.053

Cumulative risks from cascading events

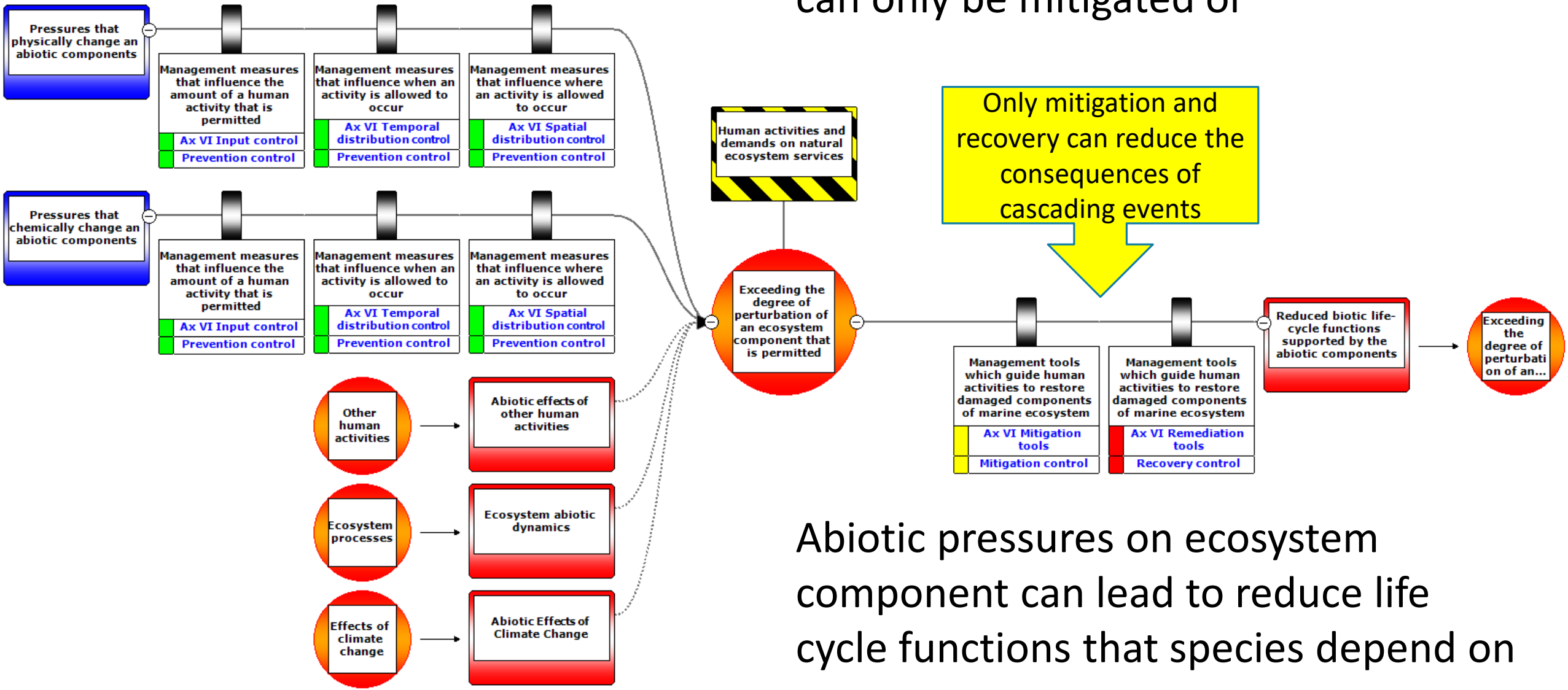
Events can cause other events in a cascade along pathways of cumulative risks

Along the pathways, an effect can be immediate or latent



Cormier, R., Elliott, M., Kannen, A., 2018. IEC/ISO 31010 Bow-tie analysis of marine legislation: A case study of the Marine Strategy Framework Directive. ICES Coop. Res. Rep. 324, 63. https://doi.org/https://doi.org/10.17895/ices.pub.4504

Cumulative risks from cascading events can only be mitigated or



Abiotic pressures on ecosystem component can lead to reduce life cycle functions that species depend on

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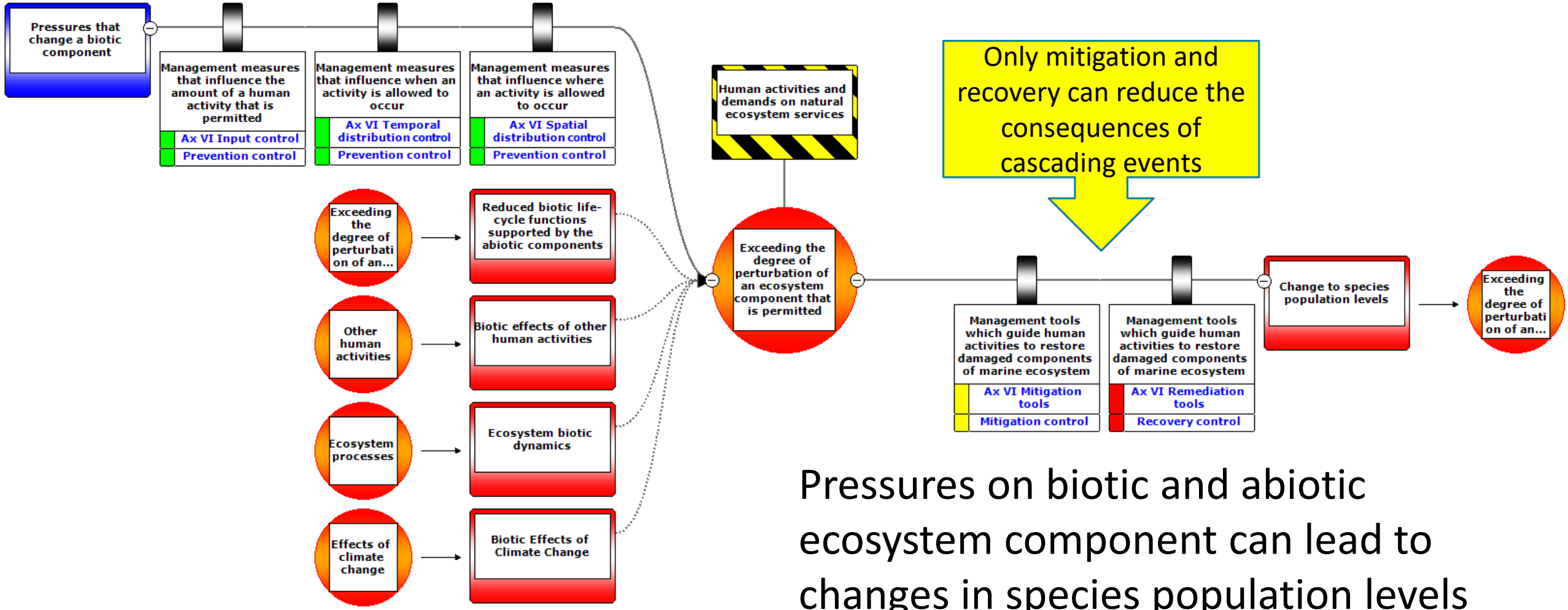

Pressures on biotic and abiotic ecosystem component can lead to changes in species population levels

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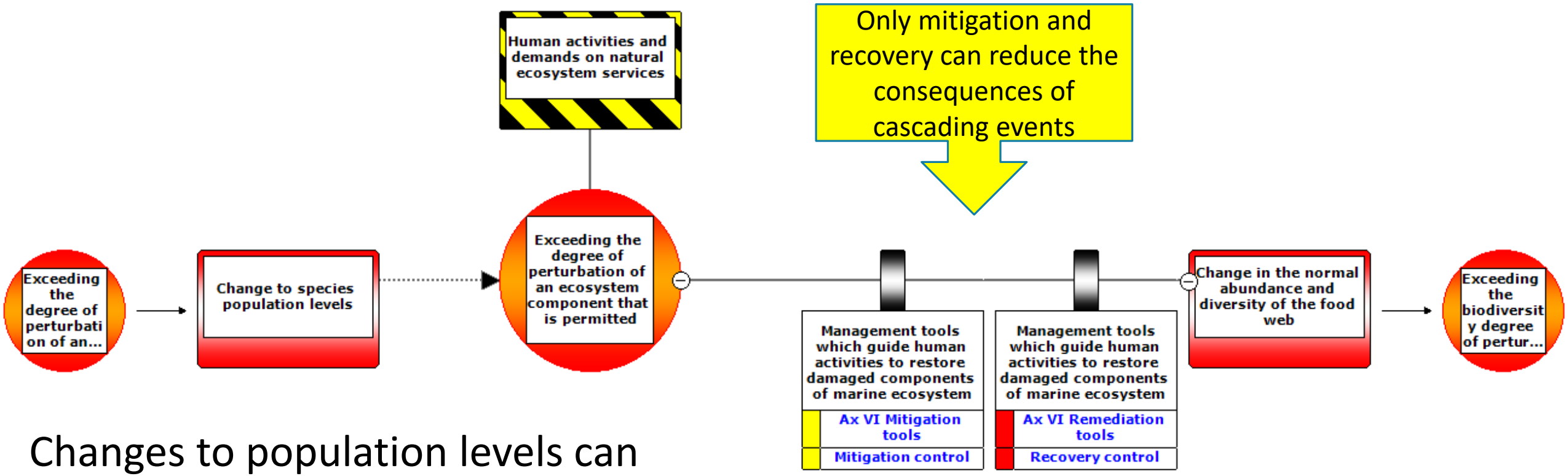
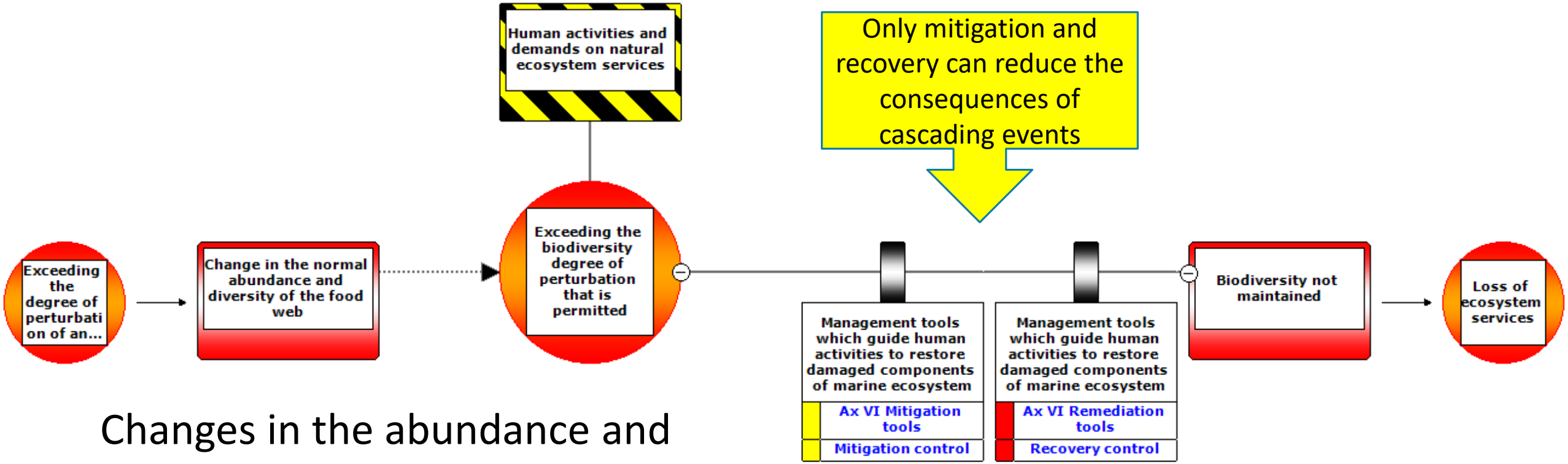
Cumulative risks from cascading events



Changes to population levels can subsequently lead to changes in the abundance and diversity of the food web

Cormier, R., Elliott, M., and Kannen, A. 2018. IEC/ISO Bow-tie analysis of marine legislation: A case study of the Marine Strategy Framework Directive. ICES Cooperative Re- search Report No. 342. 56 pp. https://doi.org/10.17895/ices.pub.4504

Cumulative risks from cascading events



Changes in the abundance and diversity of the food web will undermine biodiversity

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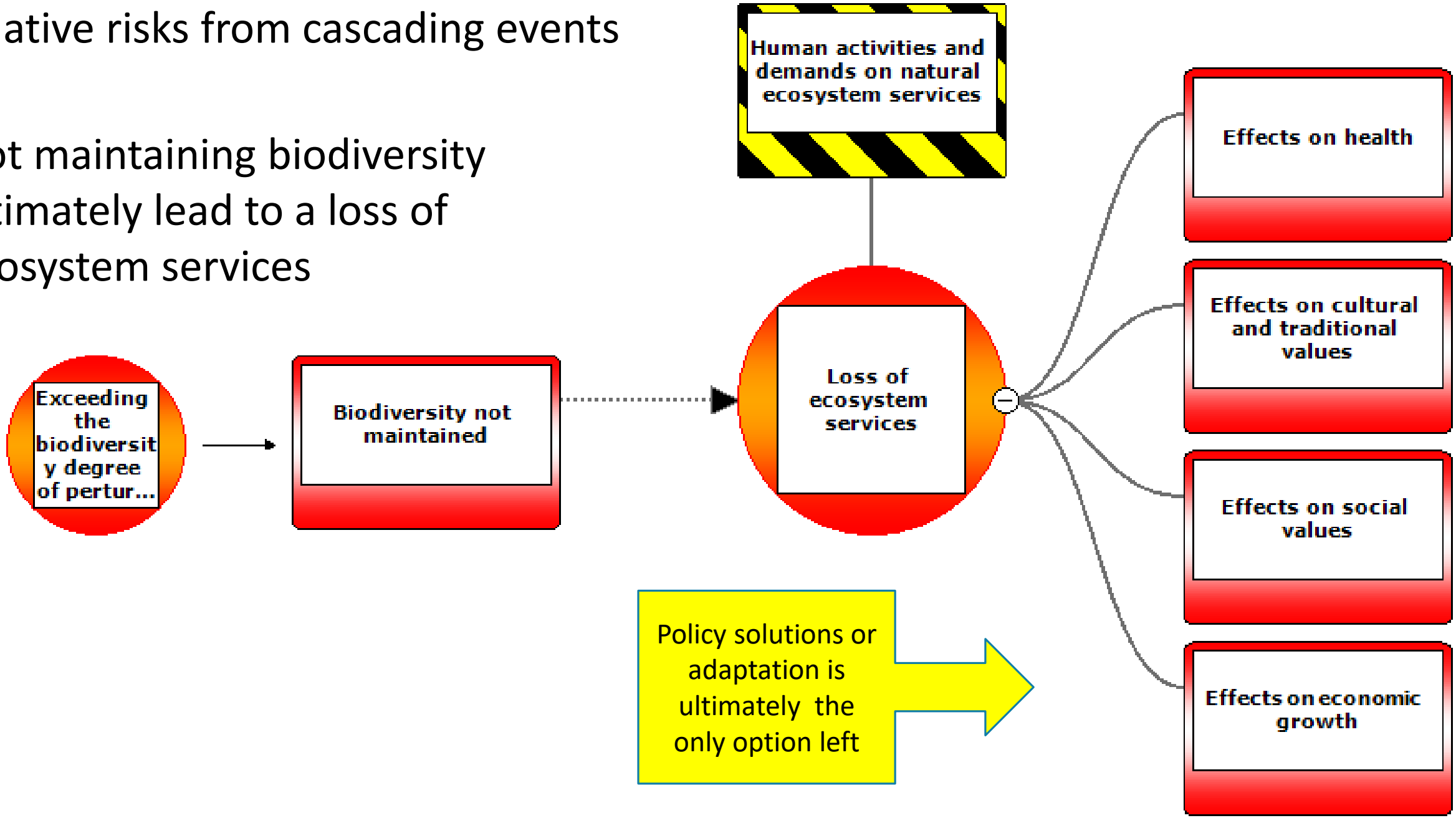
Cumulative risks from cascading events

Not maintaining biodiversity ultimately lead to a loss of ecosystem services



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Risk evaluation and risk criteria

Risk evaluation is the key step in decision-making regarding risk

Management and stakeholder decide to reduce or not to reduce risk through the selection and implementation of controls that are considered adequate to reduce the uncertainties of achieving the objectives

Risk criteria established at the beginning of the risk management process is used to compare option during the evaluation

Risk criteria link the likelihood and consequences from the risk analysis step with the policy repercussions

PS: Data, models, risk criteria and risk matrices do not make decisions. They are used to generate knowledge about the risks of not achieving policy objectives.

Cormier, R., Lonsdale, J., 2019. Risk assessment for deep sea mining: An overview of risk. Mar. Policy. https://doi.org/10.1016/J.MARPOL.2019.02.056

Ecological and Biological Significance of Ecosystem Components

		Uniqueness	Aggregation	Fitness Consequences	Resilience	Naturalness
Spawning / Breeding	High	Only one suitable spawning site known to exist for a species; Site used for spawning by many species	High percentage of total population use the area; Noteworthy percentage of many species use the area	Semelparous, so loss of one spawning event poses risk of loss of lineage; or a single site's quality or quantity of breeding habitat greatly affects the productivity of the population.		
	Low	Suitable spawning sites are widespread over a large number of at least partially disjunct areas	Only a small portion of the population(s) is present at any given time.	Continuous reproduction throughout the year, over many years. Reproduction occurs at many sites. A single site's quality or quantity of breeding habitat has little effect on the productivity of the population		
Nursery / Rearing	High	Only a single nursery/ rearing area exists for the species	Larvae/juveniles are found in high concentrations in an area or a number of species use the area as nursery grounds/rearing	Larvae/juveniles have increased survivorship/fitness compared to other areas, especially if for reasons which can be tied to characteristics of the site.		
	Low	Multiple nursery/rearing sites for the species	Larvae/juveniles widespread or found evenly over a large area or single species uses area for nursery/rearing purposes	Larvae/juveniles fitness is comparable to adjacent habitats		

DFO, 2004. Identification of Ecologically and Biologically Significant Areas. DFO Can. Sci. Advis. Sec. Ecosystem Status Rep. 2004/006.

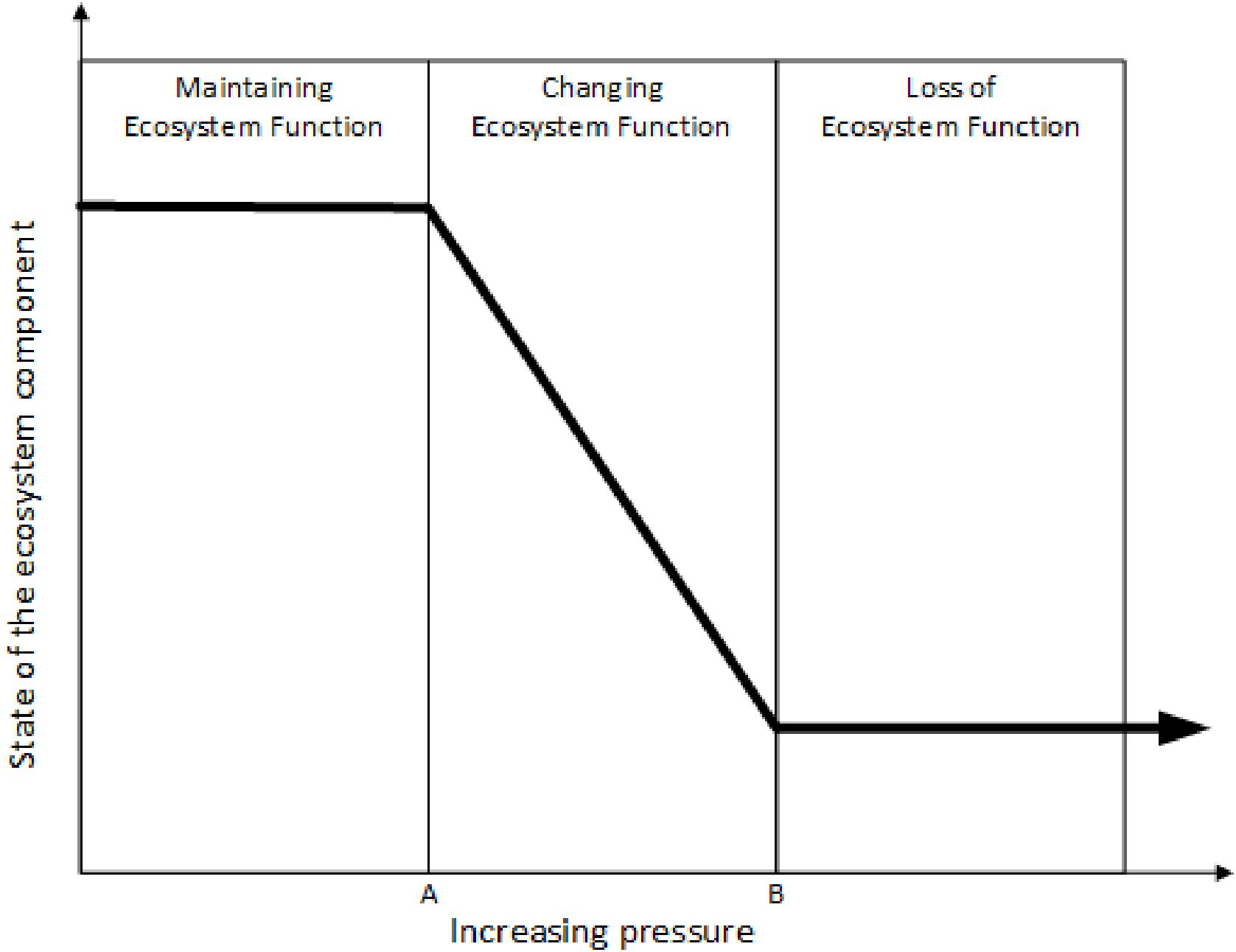
Ecologically and Biologically Significant Areas and Species

- "Significance" refers to the role of a species, habitat feature, community attribute, area, etc. in the ecosystem, and is used in a relative sense. All species, habitat features, areas etc. have some ecological function.
- However, to identify an area or species as "significant" is to conclude that if the area or species were perturbed severely, the ecological consequences (in space, in time, or outward through the foodweb) would be greater than an equal perturbation of most other areas or species, although the nature of those consequences could differ greatly among specific cases.
- The term "value" is used to refer to the special utility or importance of a species, habitat feature or area to humans. This is not a major consideration in identifying an area as biologically or ecologically significant.
- Valued ecosystem components depends on the maintenance of the ecologically and biologically significant areas and species through vertical and horizontal integration of measures

DFO, 2004. Identification of Ecologically and Biologically Significant Areas. DFO Can. Sci. Advis. Sec. Ecosystem Status Rep. 2004/006.

Ecological Risk

The influence of pressures on ecosystem components and their functions



DFO. 2015. A science-based approach to assessing the impact of human activities on ecosystem components and function. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/020. http://waves-vagues.dfo-mpo.gc.ca/Library/364604.pdf

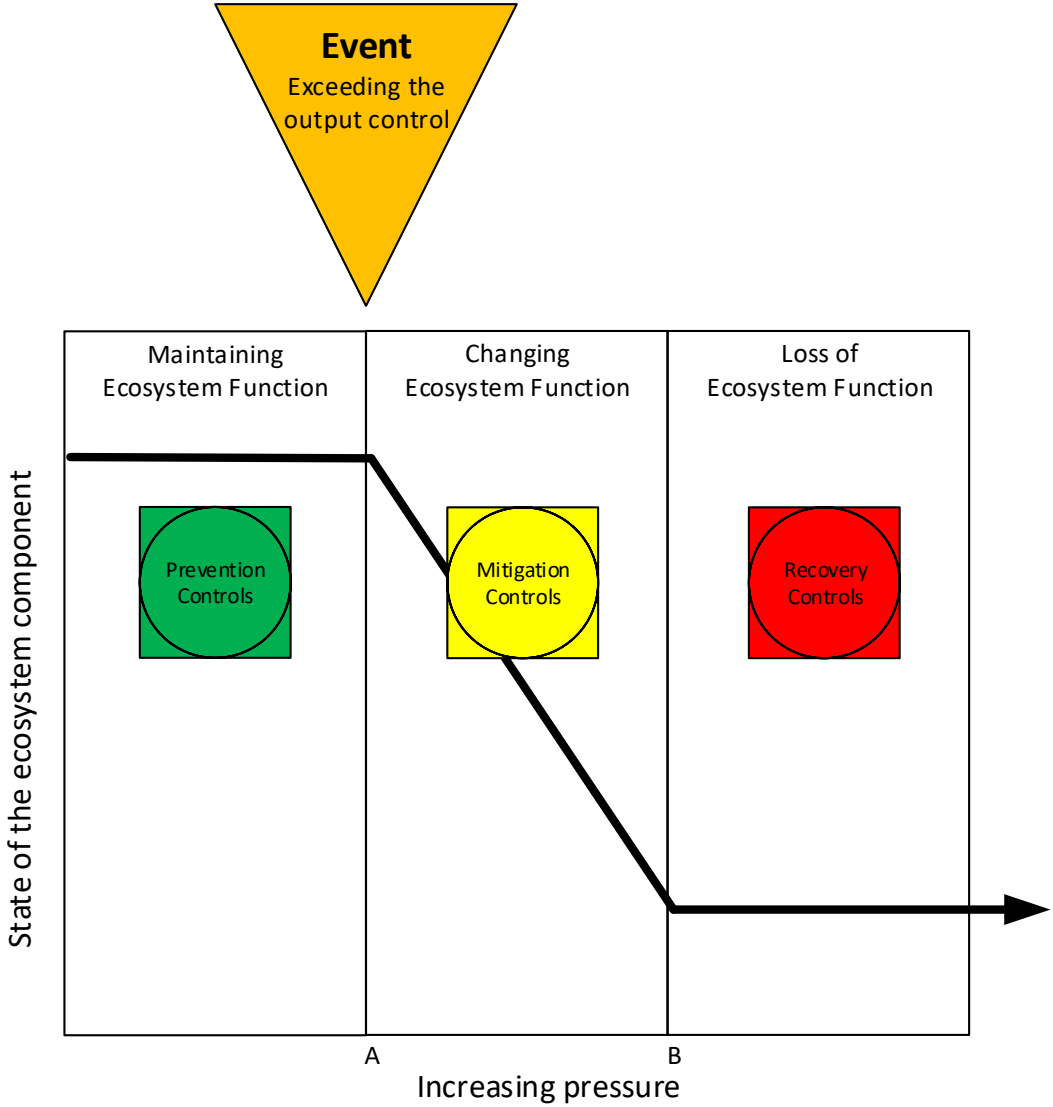
Ecological Policy Risks

Maintaining Function	Changing Function	Loss of Function
Ecosystem function is maintained although there may be changes in the status of the ecosystem component	Ecosystem function systematically changes as the ecosystem component changes in the face of perturbation	Ecosystem function can no longer be supported by the ecosystem component
The ecosystem component resists or rapidly compensates in the face of perturbation so that it can be inferred that the ecosystem function it supports is maintained	The ecosystem component changes with perturbation, and is in states where decreases in function are generally likely to occur. Recovery of the ecosystem component is expected to be secure, but a period of altered status of the component is expected	The ecosystem component has reached a status where evidence indicates that the function can no longer be provided; OR The ecosystem component has been degraded to a status where recovery is no longer secure; even if the pressure is removed the loss of function will continue to accumulate

DFO. 2015. A science-based approach to assessing the impact of human activities on ecosystem components and function. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/020. http://waves-vagues.dfo-mpo.gc.ca/Library/364604.pdf

MSFD Programme of Measures

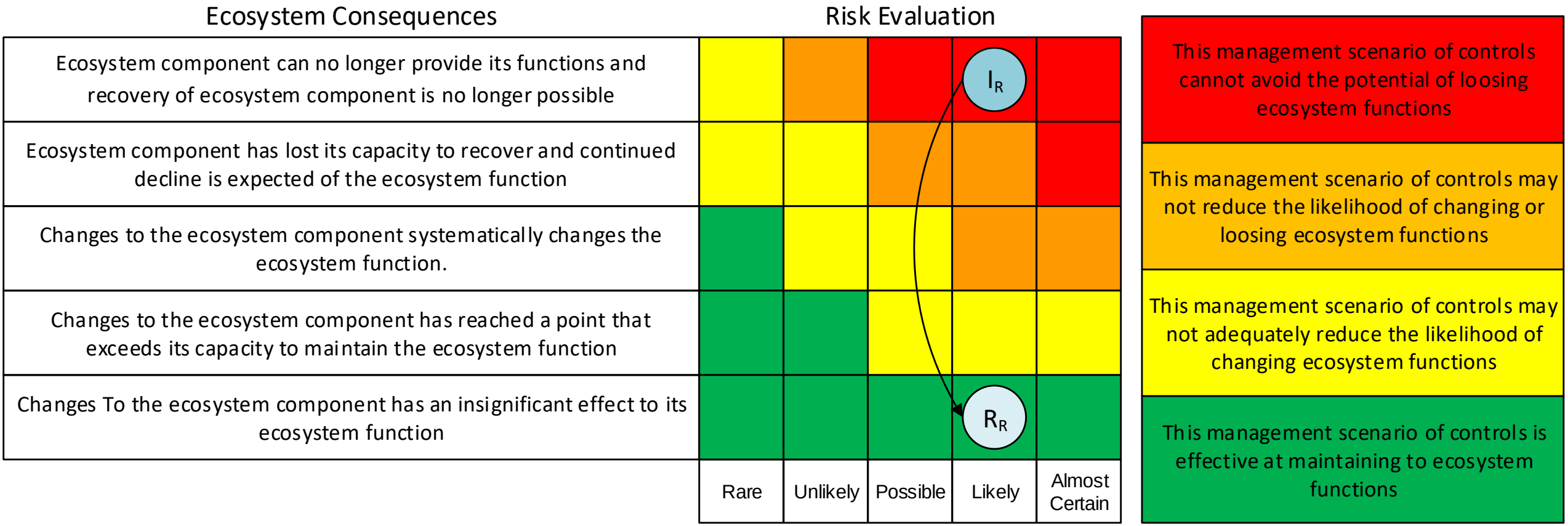
- The input controls, and the spatial and temporal distribution controls are equivalent to the prevention controls of the Bow-tie analysis
- The mitigation and remediation tools are equivalent to the mitigation and recovery controls of the Bow-tie analysis
- The transition point A is equivalent to the output control



Prevention Controls	Mitigation Controls	Recovery Controls
Input controls Spatial and temporal distribution controls	Mitigation tools	Remediation tools

DFO. 2015. A science-based approach to assessing the impact of human activities on ecosystem components and function. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/020. http://waves-vagues.dfo-mpo.gc.ca/Library/364604.pdf

Policy Repercussions of Ecosystem Risks



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Thank you!

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