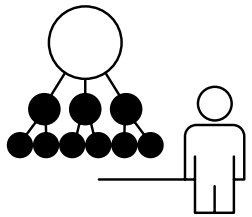
Managing the uncertainty of achieving policy objectives

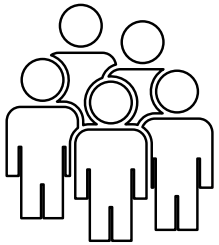
ROLAND CORMIER

NATIONAL CENTRE FOR EFFECTIVENESS, GULF REGION

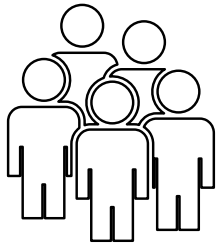
MARCH 28TH, 2023



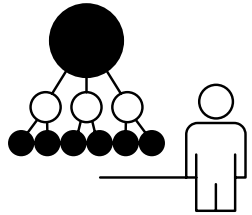
Departmental Policies



Science



Science and Programmes



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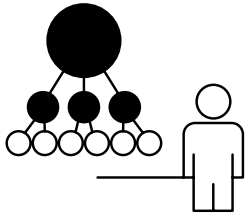

Operations

Policy Context	Risk Identification	Risk Analysis	Risk Evaluation	Risk Treatment
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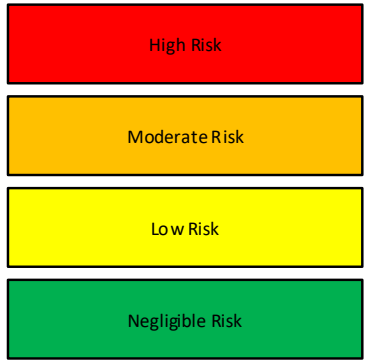

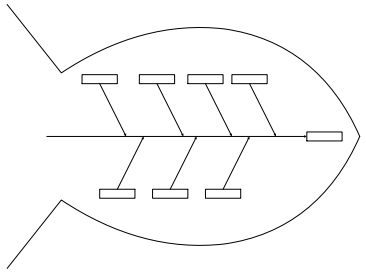

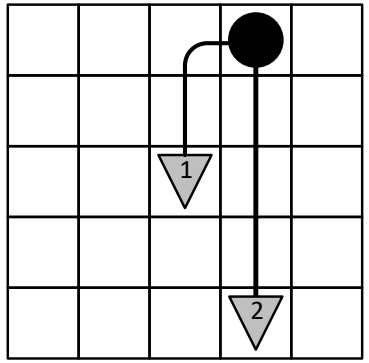

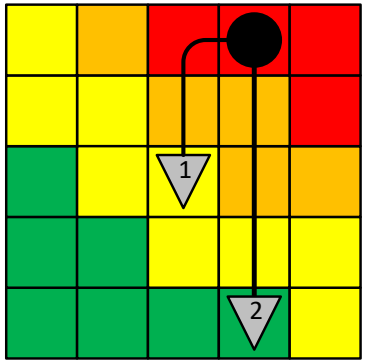

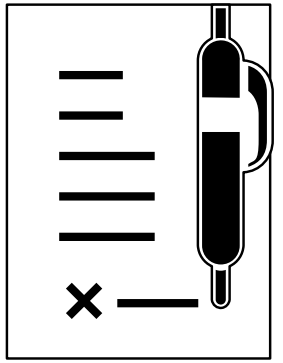

Risk assessment

Risk management process

Thematic structure of the seminar

- What are the roles of legislation, policies, programs and regulatory framework in risk management?
- Why should a risk management process scope the assessment of risk?
- What are the techniques used for analysing and evaluating effectiveness of management measures?
- Why use international risk management standards for Canadian government policy development and program delivery?

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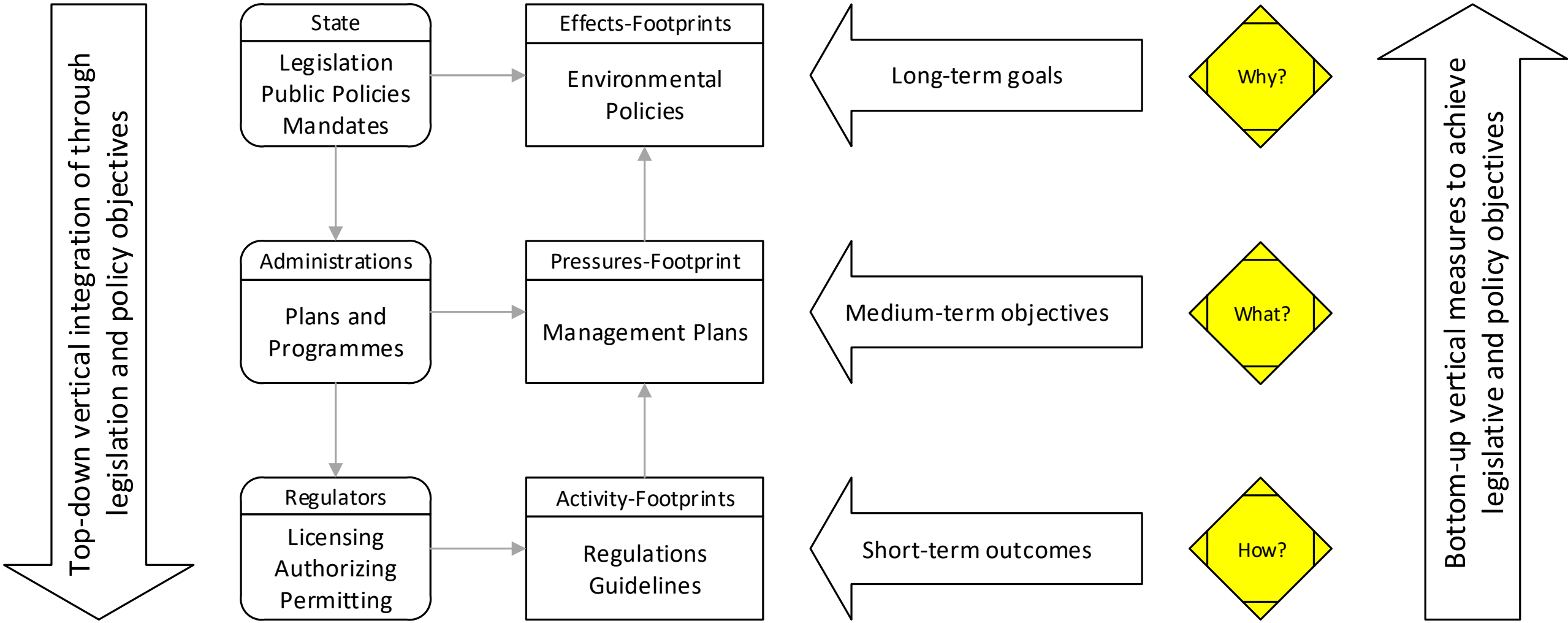
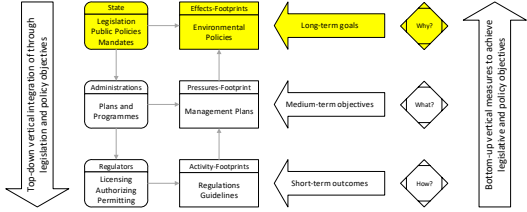


Adapted from: Cormier, R., Elliott, M. and Borja, Á. (2022) 'Managing Marine Resources Sustainably – The "Management Response-Footprint Pyramid" Covering Policy, Plans and Technical Measures', Frontiers in Marine Science, 9(May), pp. 1–15. doi: 10.3389/fmars.2022.869992.

Fisheries Act
Purpose of Act is to provide a framework



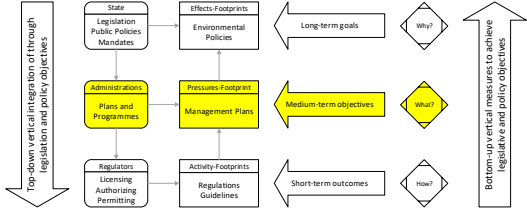
FISHERIES MANAGEMENT

- **Why?**
  - Proper management and control of fisheries
- **What?**
  - Fishery with respect to any fish, includes, any of its species, populations, assemblages and stocks, whether the fish is fished or not, any place where fishing may be carried on, any period during which fishing may be carried on, any method of fishing used, and any type of fishing gear or equipment or fishing vessel used
- **How?**
  - Prohibiting fishing of one or more species, populations, assemblages or stocks of fish
  - Prohibiting any type of fishing gear or equipment or fishing vessel from being used
  - Limiting the fishing of any specified size, weight or quantity of any species, populations, assemblages or stocks of fish
  - Imposing any requirements with respect to fishing

FISH AND FISH HABITAT PROTECTION

- **Why?**
  - Conservation and protection of fish and fish habitat, including by preventing pollution
- **What?**
  - Fish includes parts of fish, shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals
  - Fish habitat means water frequented by fish and any other areas on which fish depend directly or indirectly to carry out their life processes, including spawning grounds and nursery, rearing, food supply and migration areas
- **How?**
  - Prohibiting any works, undertaking or activities that could cause the death of fish or harmful alteration, disruption or destruction of fish habitat
  - Prescribing conditions through authorizations, regulations, standards and codes of practice to avoid the death of fish or to mitigate the extent of their death or offset their death, or to avoid, mitigate or offset the harmful alteration, disruption or destruction of fish habitat

Paraphrased from: Canada (2019) Fisheries Act (R.S.C., 1985, c. F-14). Canada. Available at: https://laws-lois.justice.gc.ca/eng/acts/f-14/.



Departmental policies and approaches

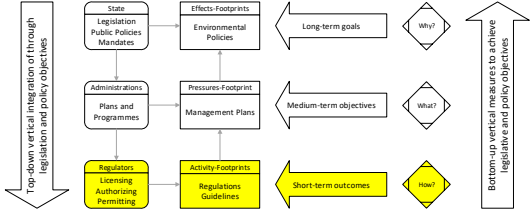
CANADA'S SUSTAINABLE FISHERIES

- Secure the future of our fisheries through sustainable and responsible fisheries management
  - Science based
  - Precautionary approach
  - Ecosystem considerations
  - Risk-based approach to managing resources

FISH AND FISH HABITAT PROTECTION POLICY STATEMENT, AUGUST 2019

- Conservation and protection of fish and fish habitat by
  - ensuring protection for fish and fish habitat and incorporating tools to accomplish this
  - providing certainty for industry, stakeholders, and Indigenous groups
  - promoting the long-term sustainability of aquatic resources
- Risk-based approach when evaluating the impacts of works, undertakings or activities where the death of fish is likely considering the relative contribution to the productivity of the relevant fisheries
- Risk-based approach when evaluating the impacts of works, undertakings or activities where any temporary or permanent change to fish habitat could cause direct or indirect impairment to the habitat's capacity to support one or more life processes of fish

Selected examples from: DFO (2019) Canada's sustainable fisheries. Available at: https://www.dfo-mpo.gc.ca/fisheries-peches/sustainable-durable/fisheries-peches/index-eng.html.
Selected examples from: DFO (2019) Fish and fish habitat protection policy statement, August 2019. Available at: http://www.dfo-mpo.gc.ca/pnw-ppe/policy-politique-eng.html..



Regulatory & non-regulatory instruments

FISHERIES MANAGEMENT PLANNING

- Biology and status of the fish stock
- Total amount of fish that can be caught to keep the stock healthy and viable
- Share of the total catch that can be caught by licence holders or the fishing fleet
- Setting goals for the fishery, and the management and enforcement approaches to be used
- Setting rules for the fishery, like when and where the fishing season can take place and what types of gear can be used

FISH AND FISH HABITAT PROTECTION

- Avoidance measures to prevent the harmful impacts to fish and fish habitat
- Mitigation measures reduce the spatial scale, duration, or intensity of harmful impacts to fish and fish habitat when such impacts cannot be avoided
- Offsetting measure counterbalances any residual harmful impacts to fish and fish habitat after efforts have been made to avoid and mitigate those impacts
- Standards and codes of practice are non-regulatory tools that specify procedures, minimum requirements, the potential harmful impacts to be managed

Selected examples from: DFO (2019) Canada's sustainable fisheries. Available at: https://www.dfo-mpo.gc.ca/fisheries-peches/sustainable-durable/fisheries-peches/index-eng.html.
Selected examples from: DFO (2019) Fish and fish habitat protection policy statement, August 2019. Available at: http://www.dfo-mpo.gc.ca/pnw-ppe/policy-politique-eng.html.

Seminar structure

- What are the roles of legislation, policies, programs and regulatory framework in risk management?
- Why should a risk management process scope the assessment of risk?
- What are the techniques used for analysing and evaluating effectiveness of management measures?
- Why use international risk management standards for Canadian government policy development and program delivery?

International Organization for Standardization

- ISO 31000 Risk Management
  - Principles of value and protection
  - Framework for continuous improvement
  - **Management process of risks to achieving objectives**
- IEC/ISO 31010 Risk Assessment Techniques
  - **Identify the risks that could undermine objectives**
  - **Analyse the effectiveness of the management measures to achieve objectives**
  - Evaluate management measures against risk tolerance criteria of the organization

ISO (2018) 'ISO 31000:2018(E) Risk management - Principles and guidelines', International Organization for Standardization. Geneva, Switzerland (Risk Management), p. 34.
IEC/ISO (2019) 'IEC 31010: 2019 Risk management - Risk assessment techniques', International Electrotechnical Commission. Geneva, Switzerland (Risk Management), IEC 31010, p. 105.

Risk management process

- Risk management
  - **Measures are used to reduce the effect of uncertainties in achieving policy objectives**
  - Risk includes the effects of any of the forms of uncertainty in achieving policy objectives
  - Scientific, management and operational uncertainty may lead to positive or negative consequences of a decision
  - **Scope the assessment to identify the sources of the risks, potential causes of events and their consequences that could undermine the policy objectives**
- Process
  - Provide structured information to support decisions and actions where there is uncertainty
  - Assist in defining realistic strategic and operational objectives
  - **Identify effective and efficient risk management measures and strategies**
  - Learn from failure and successes in order to improve the way risk is managed
  - **Demonstrate that regulatory and other requirements have been satisfied**

ISO (2018) 'ISO 31000:2018(E) Risk management - Principles and guidelines', International Organization for Standardization. Geneva, Switzerland (Risk Management), p. 34.
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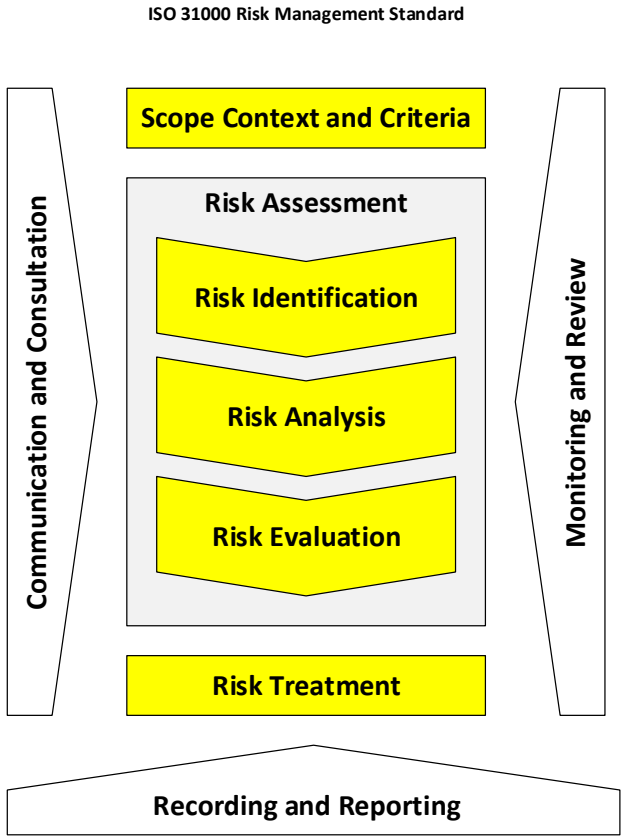
Risk management process

- Policy context to **scope** the risk assessment
- **Risk criteria** for the consequences that would undermine the policy objectives
- Based on the risk criteria, identify the likelihood of the **consequences** that would undermine the **objectives** as a result of the sources of the risk and their events
- Analyse the **effectiveness** of current and proposed management measures in reduce the **likelihood** and/or **magnitude** of the consequences
- Evaluate the measures analysed to select those measures that are considered **effective** and **feasible** to achieve objectives
- Implemented the selected measures



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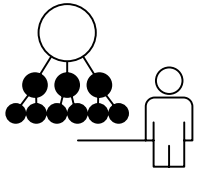
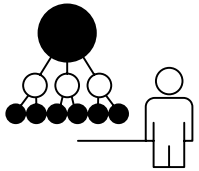
ISO 31000 Risk Management Standard

IEC/ISO 31010 Risk Assessment Techniques

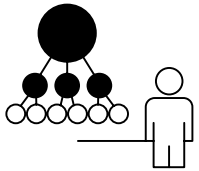


Departmental Policies

Science & Programs



Management



Operations

Communication and Consultation

Scope Context and Criteria

Risk Assessment

Risk Identification

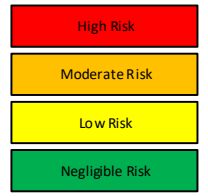
Risk Analysis

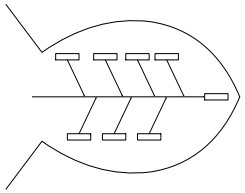
Risk Evaluation

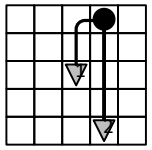
Risk Treatment

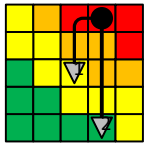
Monitoring and Review

Recording and Reporting









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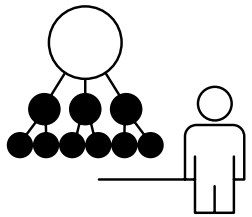
- What are the areas that risk management approaches are being used?



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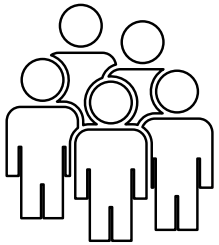

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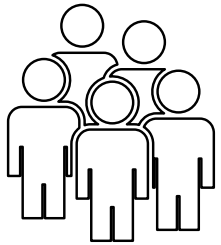
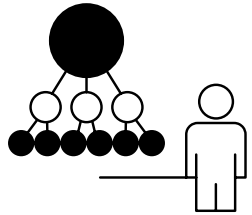


Science and Programmes



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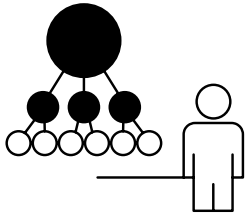

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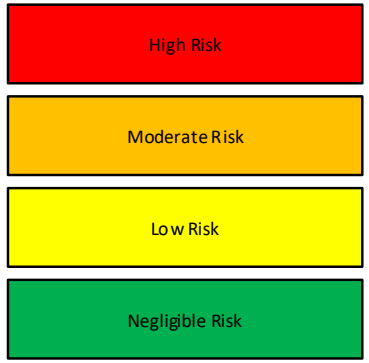
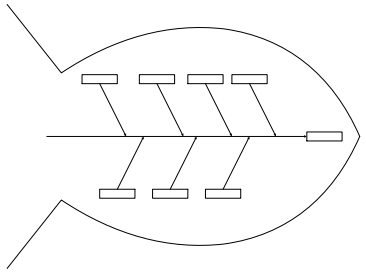
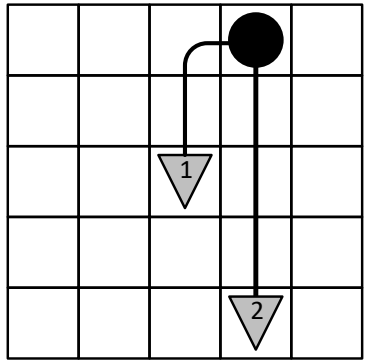
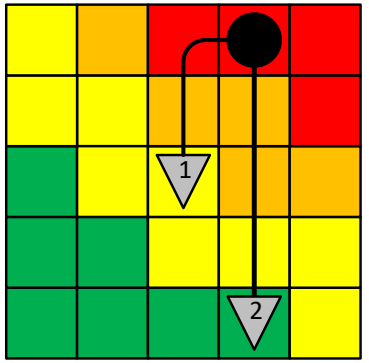
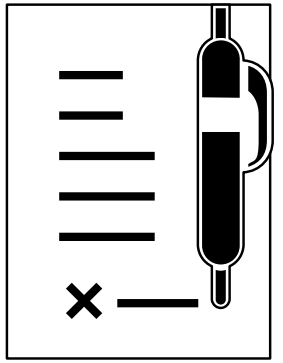




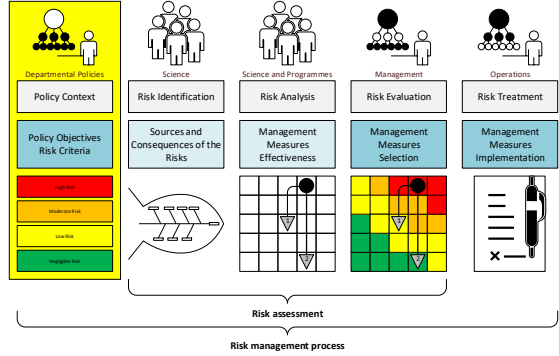






Risk assessment

Risk management process

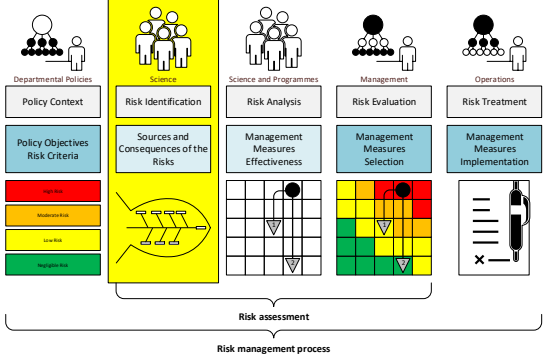


Example of Departmental Risk Criteria

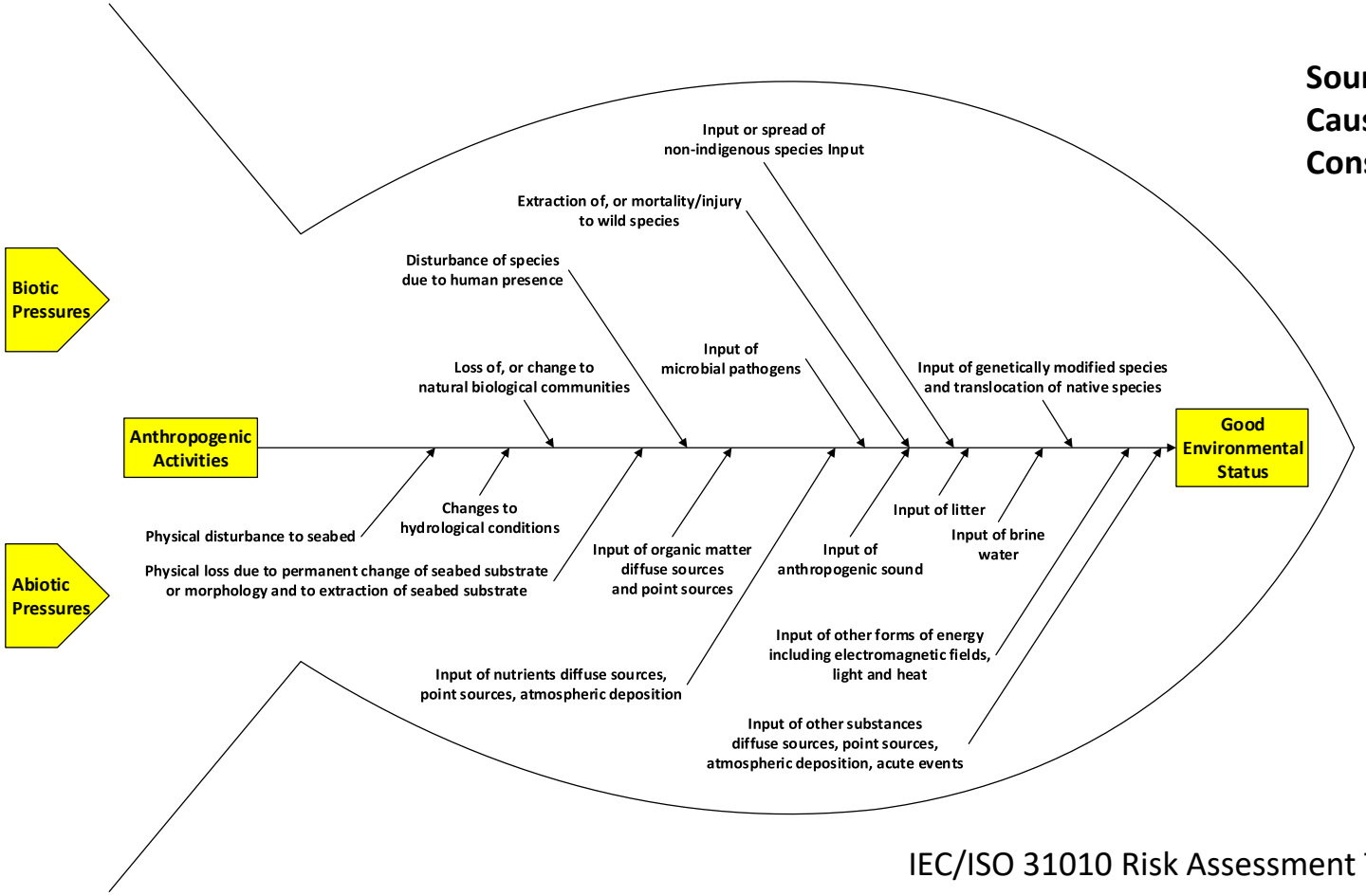
Vote	Level	Description				
4	High	A critical event that can be overcome with extraordinary management measures by the organization including external support. The consequences could lead to permanent or long-term damage to the organization's ability to achieve its objectives, possibly causing major problems for the public.				
		Liability/Cost of non-compliance • Financial impact: more than $1 million. • Long term financial obligations due to event.	**Magnitude of environmental impact** • Permanent environmental damage to a large area extending beyond the Department's property.	**Reputation / Image** • Public / media outcry to remove Minister or senior public servants. • A major regional crisis that was directly caused by the Department.	**Legal (regulatory exposure)** • Aspect subject to existing or new federal, provincial or municipal legislation or federal policy. • Legal issues with major long-term effects. • Potential litigation with a major impact.	**Impacts on Operations** • Major and long term operational disruptions.
3	Moderate	A significant event which can be managed under normal circumstances by the organization. The consequences could mean that the activity could be subject to significant review or changed ways of operation.				
		Liability/Cost of non-compliance • Financial impact: more than $100,000 but less than $1 million. • Mid-term financial obligations.	**Magnitude of environmental impact** • Recoverable environmental damage to a limited area that may extend beyond the Department's property.	**Reputation / Image** • Negative media attention, public criticism and loss of confidence in the Department.	**Legal (regulatory exposure)** • Aspect subject to federal, provincial or municipal guidelines or to Departmental policies or guidelines. • Legal issues with short term effects. • Potential litigation with a minor impact.	**Impacts on Operations** • Moderate and mid-term operational disruptions.
2	Low	An event, the consequences of which can be absorbed but management effort is required to minimize the impact. The consequences could threaten the efficiency or effectiveness of some aspects of the operation, but would be dealt with internally.				
		Liability/Cost of non-compliance • Financial impact: less than $100,000.	**Magnitude of environmental impact** • Minimal and recoverable environmental damage to a localized area.	**Reputation / Image** • Set-back in public trust.	**Legal (regulatory exposure)** • Aspect is subject to a code of practice or best management practices. • No legal issues.	**Impacts on Operations** • Minor and temporary disruption of operations.
1	Negligible	An event, the consequences of which can be absorbed through normal activity.				
		Liability/Cost of non-compliance • Financial impact: minor.	**Magnitude of environmental impact** • Limited or no environmental damage.	**Reputation / Image** • Minor and recoverable set-back in public trust.	**Legal (regulatory exposure)** • Aspect is not subject to any regulations, policies, guidelines, codes of practice or best management practices. • No legal issues.	**Impacts on Operations** • Limited or no disruption of operations.

IEC/ISO 31010 Risk Assessment Techniques - 6.1.6.3 Criteria for evaluating the significance of risk

DFO (2023) Environmental Impact and Probability Assessment Scale. Office of Environmental Coordination.



Risk Identification of the sources of the risk causes of undesired events and consequence of such events

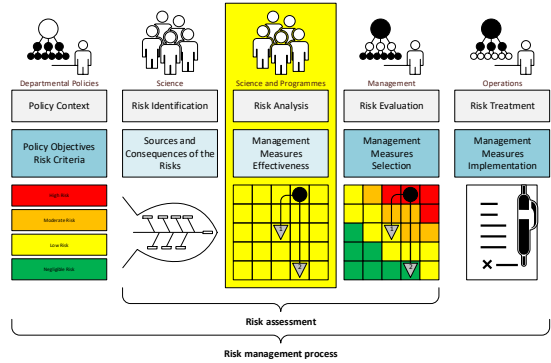


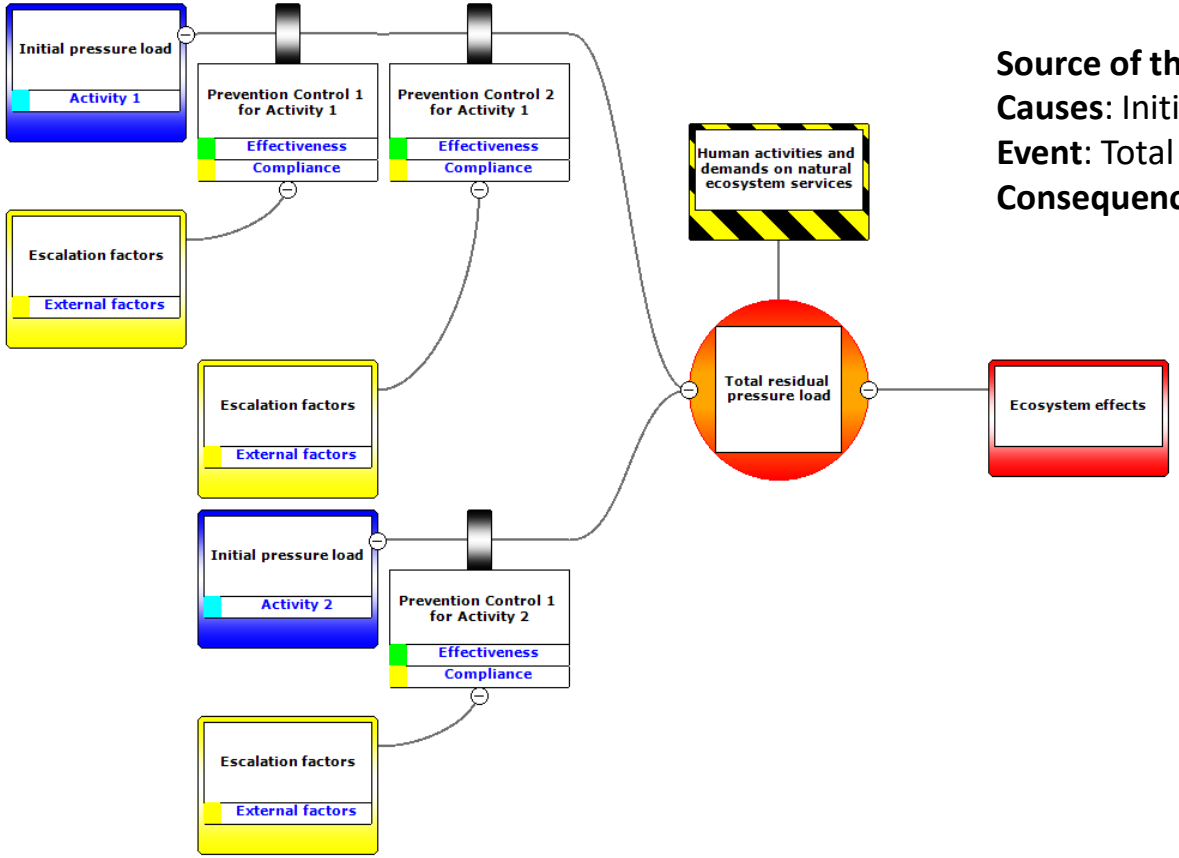
Source of the risk: Anthropogenic Activities
Causes: Abiotic and biotic pressures
Consequences: Good Environmental Status not achieved

IEC/ISO 31010 Risk Assessment Techniques - B.3.3 Ishikawa analysis (fishbone) method

Cormier, R., Elliott, M. and Kannen, A. (2018) 'IEC/ISO 31010 Bow-tie analysis of marine legislation: A case study of the Marine Strategy Framework Directive', ICES Cooperative Research Report, 342, p. 63. doi: 10.17895/ices.pub.4504.

Qualitative risk analysis of management measures used to controls the causes of an event



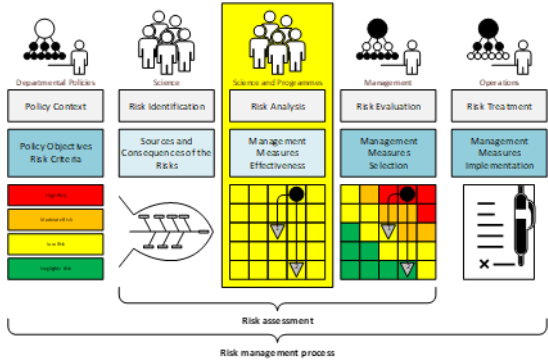


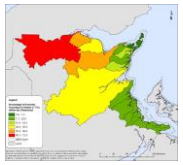
Source of the risk: Human activities and demands on natural ecosystem services
Causes: Initial pressure loads of activities 1 and 2
Event: Total residual pressure load
Consequences: Ecosystem effects

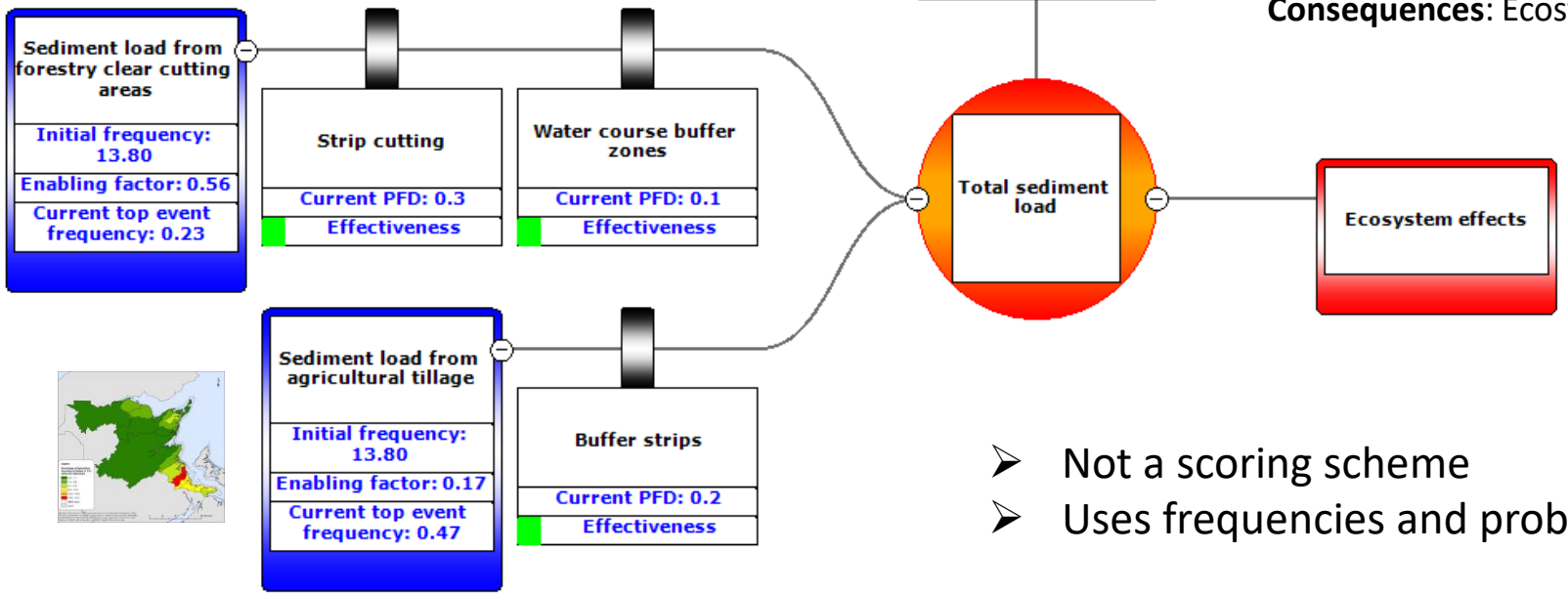
IEC/ISO 31010 Risk Assessment Techniques - B.4.2 Bow-tie analysis

Cormier, R. et al. (2018) 'The science-policy interface of risk-based freshwater and marine management systems: From concepts to practical tools', Journal of Environmental Management. Elsevier, 226(June), pp. 340–346. doi: 10.1016/j.jenvman.2018.08.053.

Semi-Qualitative risk analysis of management measures used to controls the causes of an event







Source of the risk: Erodible soils on slopes > 3%
Causes: Sediment load generated from forestry and agriculture
Event: Total sediment load
Consequences: Ecosystem effects

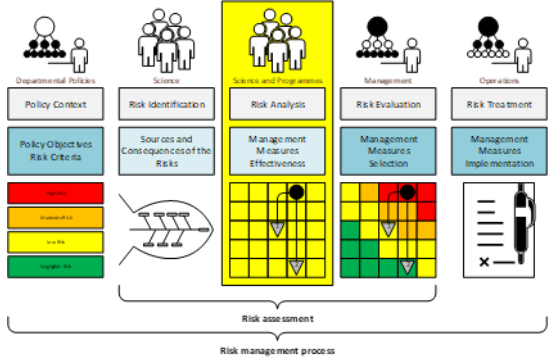
- Not a scoring scheme
- Uses frequencies and probabilities to calculate potential risks

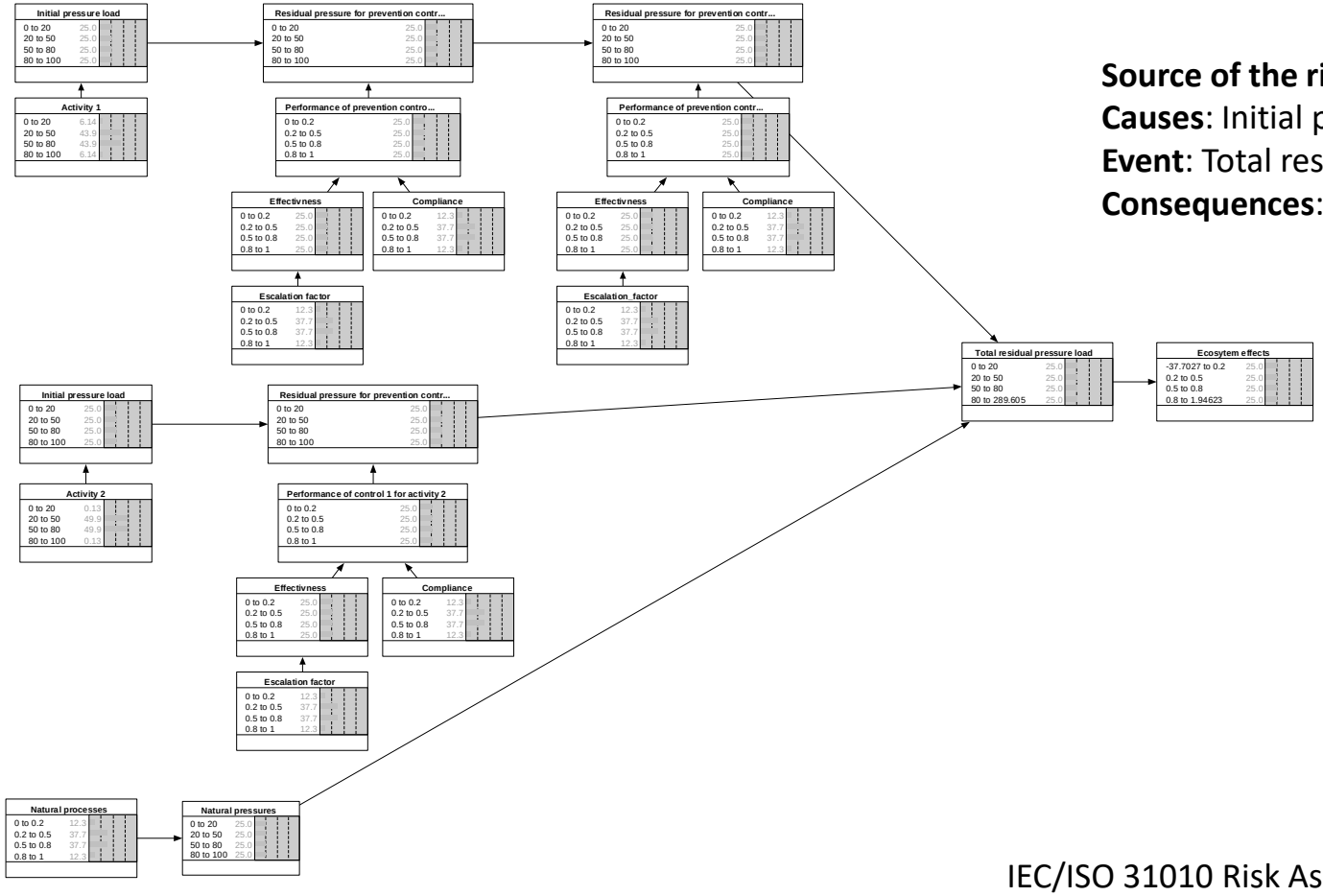
Simulated case study

IEC/ISO 31010 Risk Assessment Techniques - B.4.4 Layers of protection analysis (LOPA)

ICES (2020) 'Working group on cumulative effects assessment approaches in management (WGCEAM)', ICES Scientific Reports
ICES (2021) 'Working group on cumulative effects assessment approaches in management (WGCEAM)', ICES Scientific Reports

Quantitative analysis of management measures used to controls the causes of an event



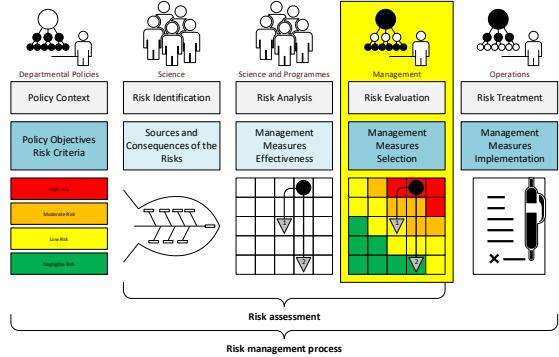


Source of the risk: Human activities and demands on natural ecosystem services
Causes: Initial pressure loads of activities 1 and 2
Event: Total residual pressure load
Consequences: Ecosystem effects

IEC/ISO 31010 Risk Assessment Techniques - B.5.3 Bayesian networks and influence diagrams

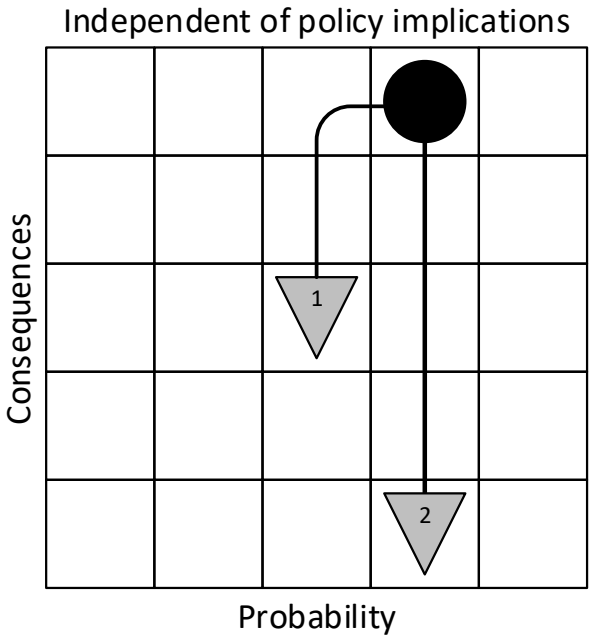
Cormier, R. et al. (2018) 'The science-policy interface of risk-based freshwater and marine management systems: From concepts to practical tools', Journal of Environmental Management. Elsevier, 226(June), pp. 340–346. doi: 10.1016/j.jenvman.2018.08.053.

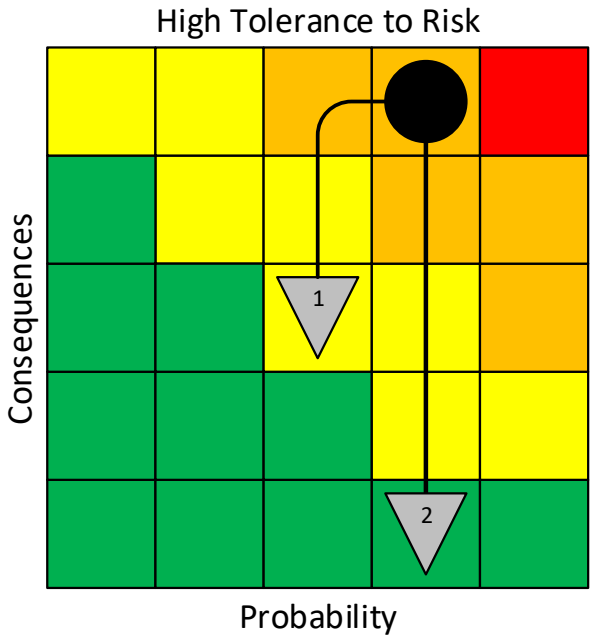
Risk evaluation of the outcomes as a result of the management measures analysed

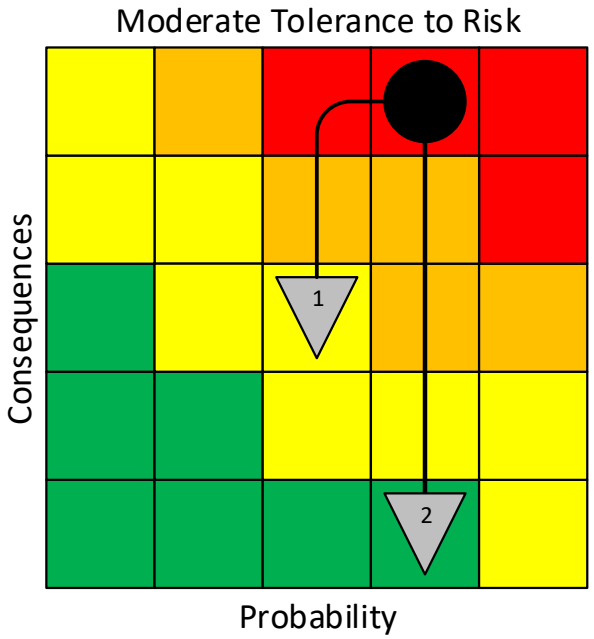


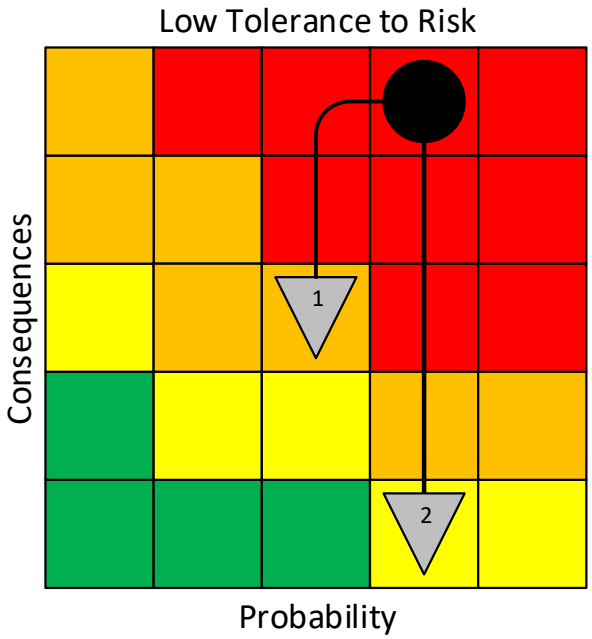
Risk Analysis: Outcomes of measures

Risk Evaluation: Policy context risk criteria









IEC/ISO 31010 Risk Assessment Techniques - B.10.3 Consequence/likelihood matrix (risk matrix or heat map)

Stelzenmüller, V. et al. (2020) 'Operationalizing risk-based cumulative effect assessments in the marine environment', Science of The Total Environment. Elsevier, 724, p. 138118. doi: 10.1016/j.scitotenv.2020.138118.

IEC/ISO 31010 Risk management Risk assessment techniques

- More than 30 qualitative, semi-quantitative and quantitative techniques aligned to each of the ISO 31000 risk management process
- Many of the techniques are currently being used in ecosystem science and environmental impact assessments
- Challenge lies in the manipulation of existing data to use these techniques

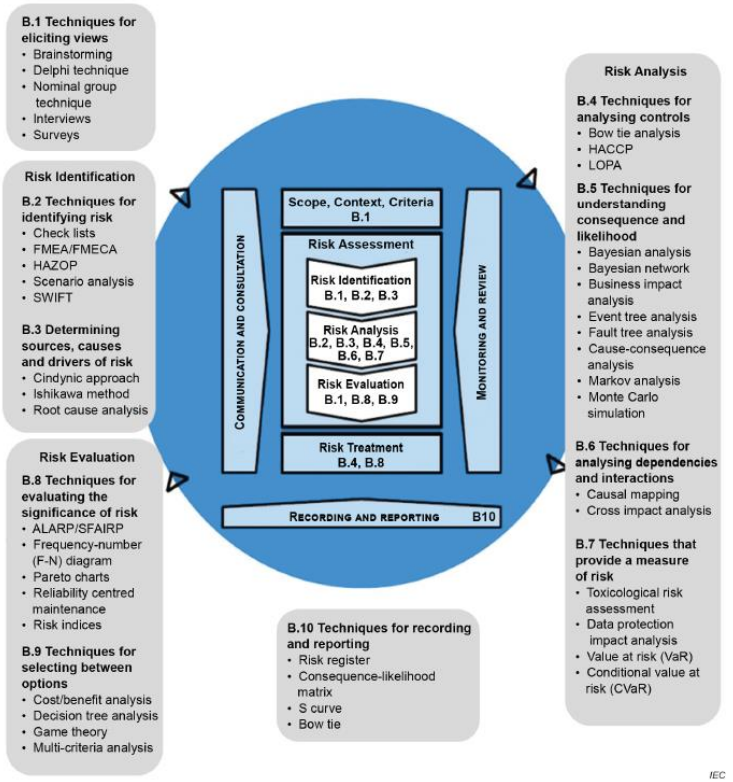
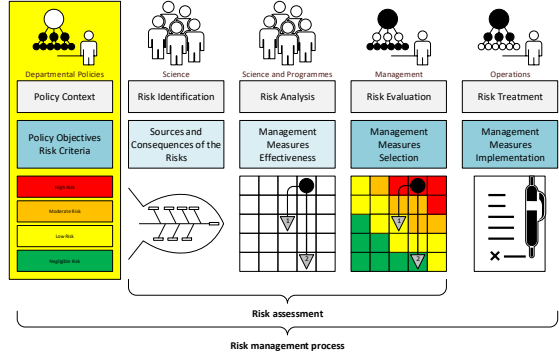


Figure A.1 – Application of techniques in the ISO 31000 risk management process [3]

ISO (2018) 'ISO 31000:2018(E) Risk management - Principles and guidelines', International Organization for Standardization. Geneva, Switzerland (Risk Management), p. 34.
IEC/ISO (2019) 'IEC 31010: 2019 Risk management - Risk assessment techniques', International Electrotechnical Commission. Geneva, Switzerland (Risk Management), IEC 31010, p. 105.

Scoping the assessment within the policy in two different context



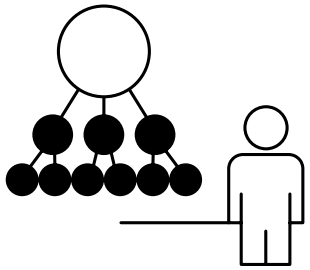
COD FISHERIES MANAGEMENT

- Policy Context
  - Sustainable fisheries mean harvesting and farming fish stocks in a way that meets our present needs without compromising the ability to meet our future needs
- Planning
  - the total amount of fish that can be caught to keep the stock healthy and viable

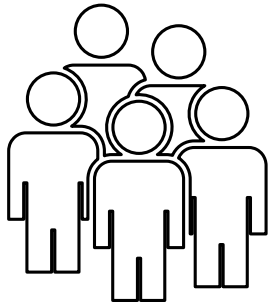
FISH AND FISH HABITAT PROTECTION

- Policy Context
  - Mitigation measures reduce the spatial scale, duration, or intensity of any temporary changes to habitat that could directly or indirectly impairs the habitat's capacity to support one or more life processes of fish
- Mitigation measures
  - Sediment and erosion controls implemented to reduce duration and intensity of worksite sediment laden water being released into the water body

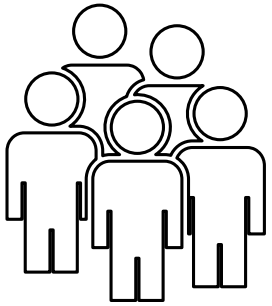
Selected examples from: DFO (2019) Canada's sustainable fisheries. Available at: https://www.dfo-mpo.gc.ca/fisheries-peches/sustainable-durable/fisheries-peches/index-eng.html.
Selected examples from: DFO (2019) Fish and fish habitat protection policy statement, August 2019. Available at: http://www.dfo-mpo.gc.ca/pnw-ppe/policy-politique-eng.html.



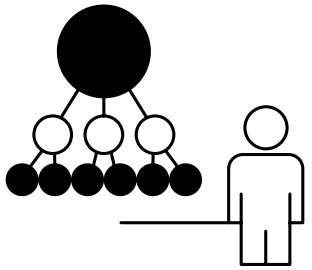
Departmental Policies



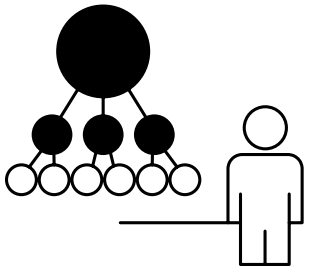
Science



Science and Programmes



Management



Operations

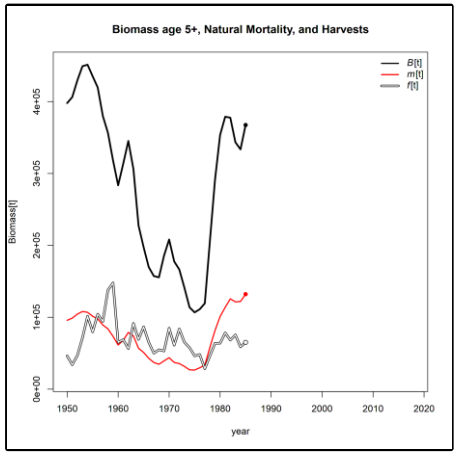
Policy Context	Risk Identification	Risk Analysis	Risk Evaluation	Risk Treatment
Risk criteria for expected timeframe to sustain the fishery	Biomass 5+ Stock Status	Expected time frame of sustained fishery for different harvest levels	Harvest levels implications for sustained fishery	Fisheries management plan

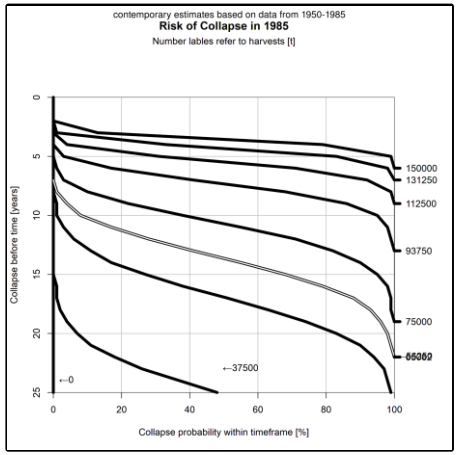
Extreme: Expected timeframe to sustain the fishery not achievable

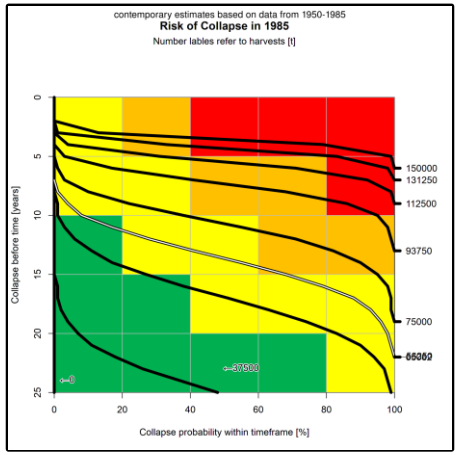
Moderate: Expected timeframe to sustain the fishery may not be achievable without precautions

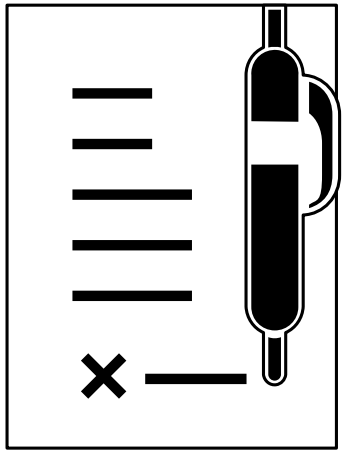
Low: Expected timeframe to sustain the fishery may be achievable with continuous improvements

Negligible: Expected timeframe to sustain the fishery achievable with current fisheries management strategy





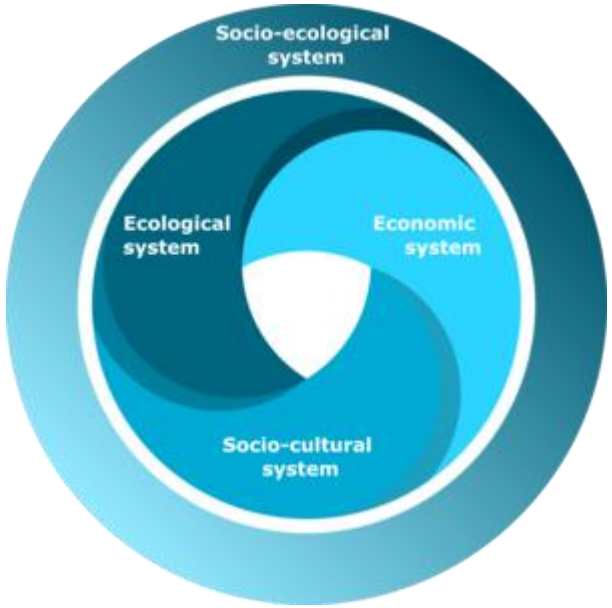




Blanz, B., Cormier, R., Swain, D., and Held, H. (2023) 'The implication of risk of (in)stability of stable states on fisheries sustainable policy: A cod case study'. For submission to Fisheries Research.

SeaUseTip Project
Socio-ecological vulnerability to tipping points

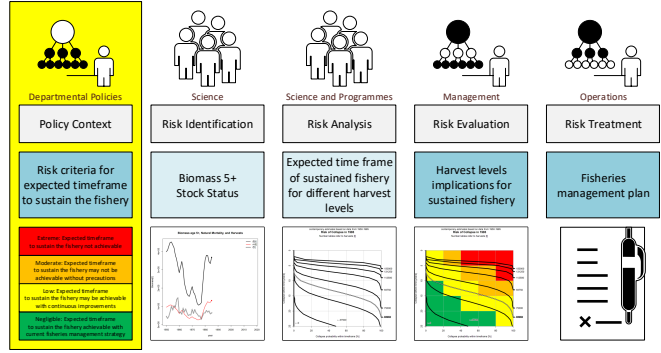
- Project aims
  - How vulnerable is the socio-ecological system (SES) of the North Sea to tipping points?
  - And which solutions and measures can be found to counteract unwanted changes?
- Project work
  - Identify mechanisms leading to tipping points in the composition of the fish community
  - Uncover ecological feedbacks that stabilize different ecosystem regimes
  - Identify and quantify the consequences of ecological tipping points for the economic and socio-cultural subsystems
  - Identify and quantify links and feedbacks between ecological, economic and socio-cultural subsystems that determine the vulnerability of the North Sea SES to tipping points
  - Develop operational measures for ecosystem-based management that reduce vulnerabilities and have the potential to counteract unwanted changes in the ecosystem



SeaUseTip: Publications

- Lauerburg, R. A. M. et al. (2020) 'Socio-ecological vulnerability to tipping points: A review of empirical approaches and their use for marine management', Science of The Total Environment. Elsevier B.V, 705, p. 135838. doi: 10.1016/j.scitotenv.2019.135838.
- Möllmann, C. et al. (2021) 'Tipping point realized in cod fishery', Scientific Reports, 11(1), p. 14259. doi: 10.1038/s41598-021-93843-z.
- Sguotti, C. et al. (2022) 'Irreversibility of regime shifts in the North Sea', Frontiers in Marine Science, 9(September), pp. 1–13. doi: 10.3389/fmars.2022.945204.
- Blöcker, A. M. et al. (2023) 'Regime shift dynamics , tipping points and the success of fisheries management', Scientific Reports. Nature Publishing Group UK, 13(289), pp. 1–11. doi: 10.1038/s41598-022-27104-y.
- Letschert, J. et al. (2023) 'Socio-ecological drivers of demersal fishing activity in the North Sea: The case of three German fleets', Ocean & Coastal Management, 238(October 2021), p. 106543. doi: 10.1016/j.ocecoaman.2023.106543.
- Stelzenmüller, V. et al. (2023) 'Fostering the capacity of a fisheries social-ecological system to adapt to global change', Global Environmental Change, (Under Review).

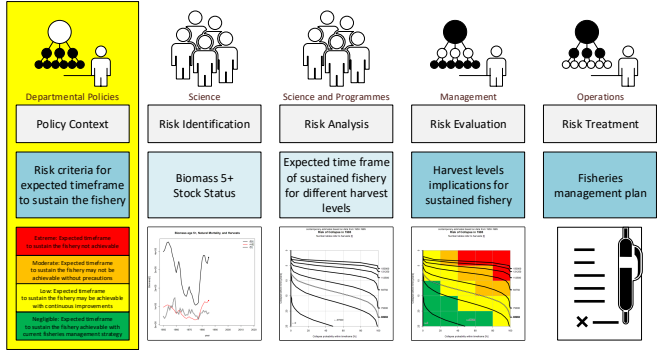
Scoping the assessment within the policy of sustained a fishery activity

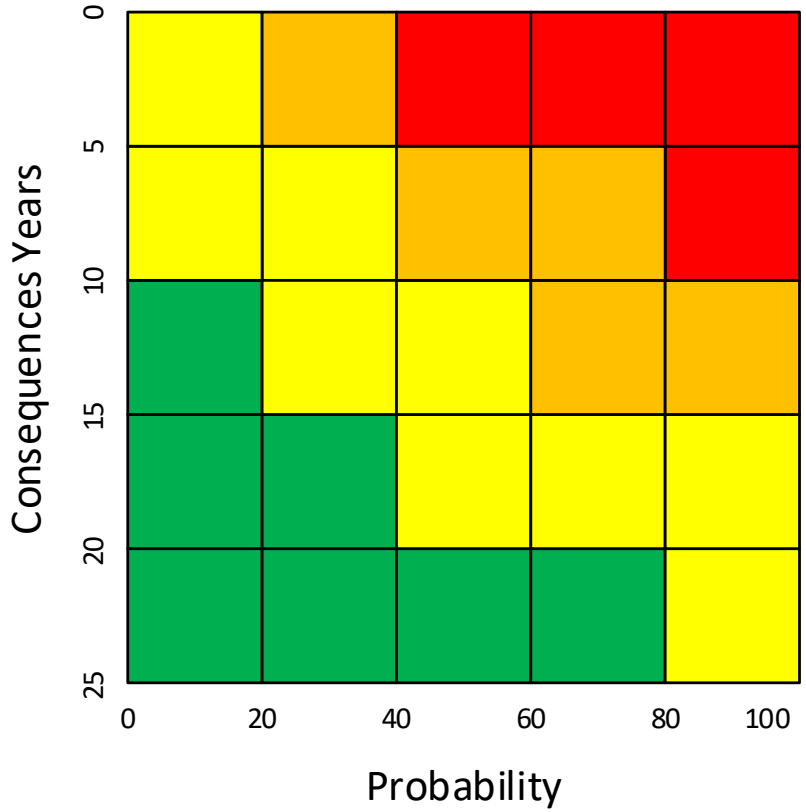


- Policy Context[1]
  - Sustainable fisheries mean **harvesting and farming fish stocks** in a way that meets our **present** needs without **compromising** the ability to meet our **future needs**
- Planning
  - the total amount of fish that can be caught to keep the **stock healthy** and **viable**
- From the stock assessment
  - **How much** fish can you have?
- To adding
  - **How long** to do you want to fish to sustain your livelihood?

[1]Selected examples from: DFO (2019) Canada's sustainable fisheries. Available at: https://www.dfo-mpo.gc.ca/fisheries-peches/sustainable-durable/fisheries-peches/index-eng.html.

Policy risk centric[1] Consequences/Probability combinations





Extreme
Expected timeframe to sustain the fishery not achievable

Moderate
Expected timeframe to sustain the fishery may not be achievable without precautions

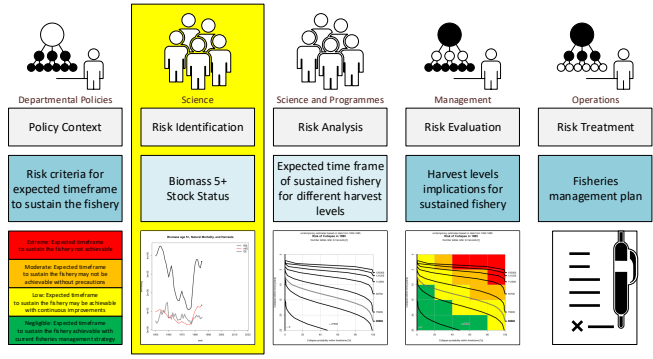
Low
Expected timeframe to sustain the fishery may be achievable with continuous improvements

Negligible
Expected timeframe to sustain the fishery achievable with current fisheries management strategy

[1]For proof of concept purposes

Blanz, B., Cormier, R., Swain, D., and Held, H. (2023) 'The implication of risk of (in)stability of stable states on fisheries sustainable policy: A cod case study'. For submission to Fisheries Research.

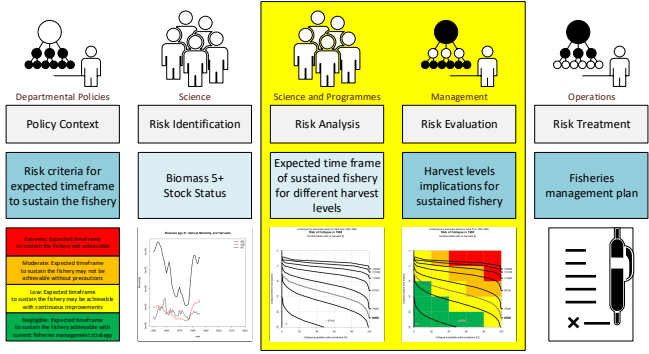
Analytical approach for risk identification



- Probabilistic assessment of risk to determine the distribution of collapse times running simulations of a dynamic stochastic model of stock change
- Age-structured population model of the southern Gulf of St. Lawrence cod population for years 1950 to 2018 and ages 2 to 12+ (i.e., 12 years and older)
- Biomass growth is described by a Ricker type function with random per period shocks
- Escape time distribution is determined from 20,000 simulations of the stock dynamics for each of the 3125 states of the world
- Simulations are performed for ten harvests levels between 0 and 150 thousand tonnes, in addition to the historical harvest levels of each year
- Calibration to available observations are performed for each year between 1975 and 2017 (43 years) resulting in roughly 29 billion simulation runs
- Vectorized simulations iterating all 20,000 runs of a given states of the world and harvest level simultaneously reduced the number of runs to roughly 1.5 million

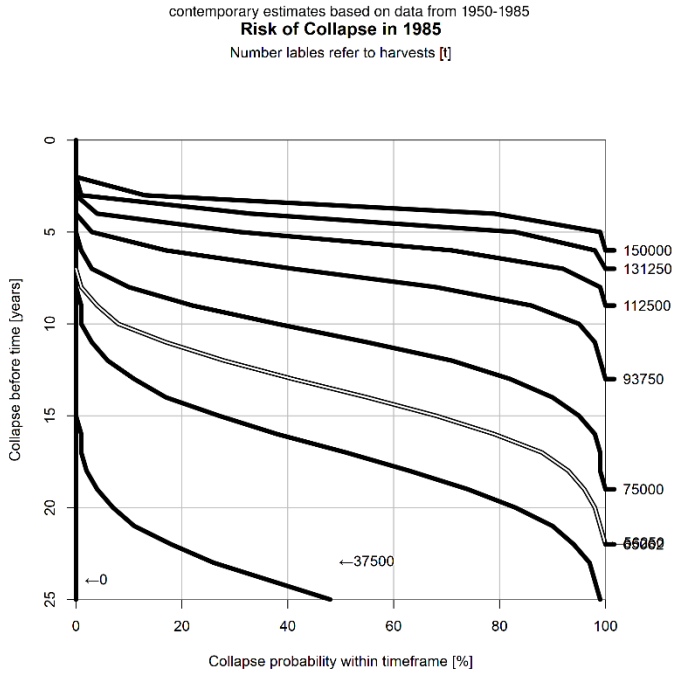
Blanz, B., Cormier, R., Swain, D., and Held, H. (2023) 'The implication of risk of (in)stability of stable states on fisheries sustainable policy: A cod case study'. For submission to Fisheries Research.

Policy centric risk criteria risk analysis and evaluation



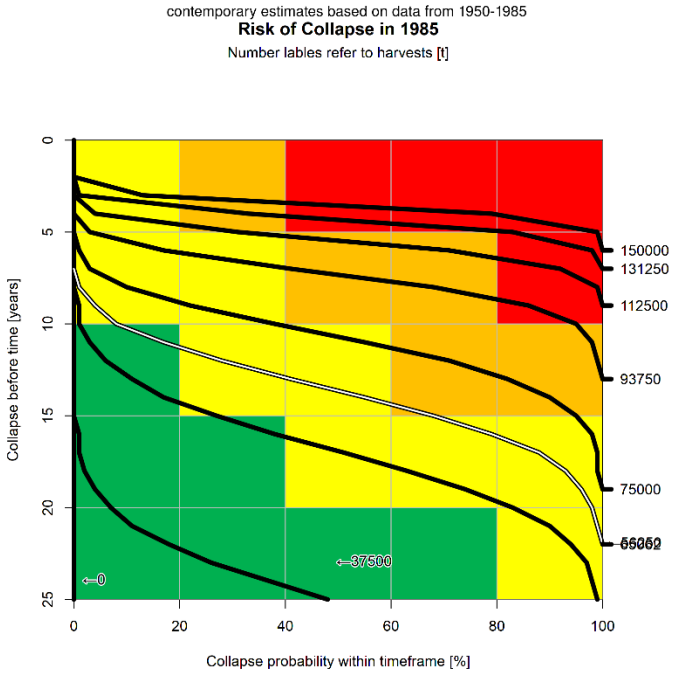
RISK ANALYSIS

CONSEQUENCE/PROBABILITY MATRIX

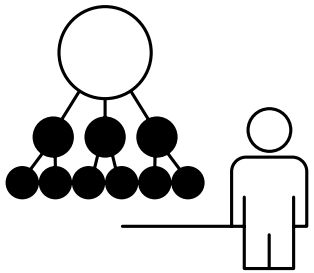


RISK EVALUATION

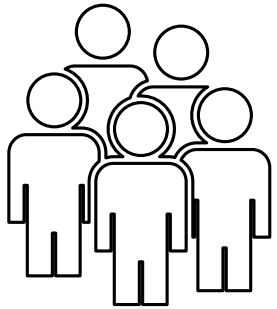
RISK MATRIX



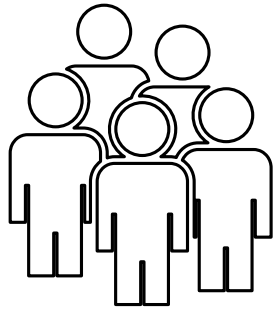
Blanz, B., Cormier, R., Swain, D., and Held, H. (2023) 'The implication of risk of (in)stability of stable states on fisheries sustainable policy: A cod case study'. For submission to Fisheries Research.



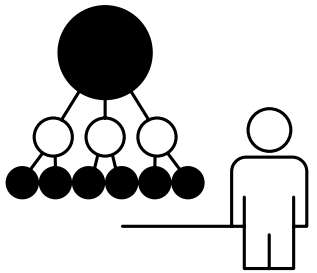
Departmental Policies



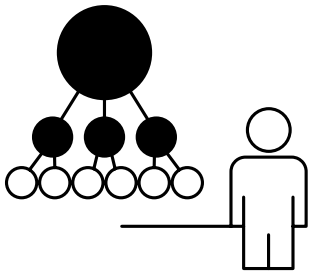
Science



Science and Programmes



Management



Operations

Policy Context	Risk Identification	Risk Analysis	Risk Evaluation	Risk Treatment
Total particulate matter guideline	Causes and consequences of sediment laden water	Mitigation Measures Effectiveness	Number times measures meet guideline	Implemented sediment and erosion controls

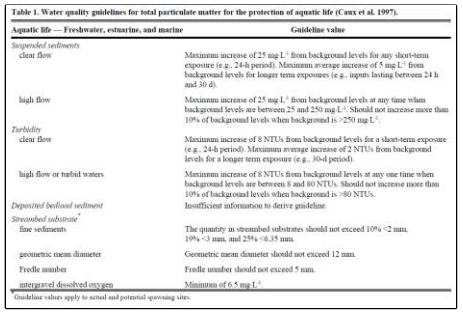
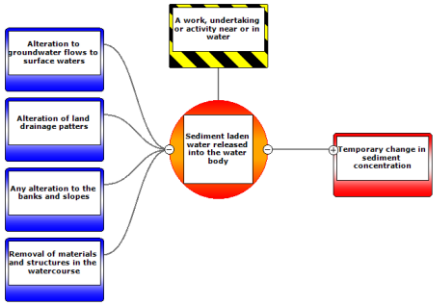
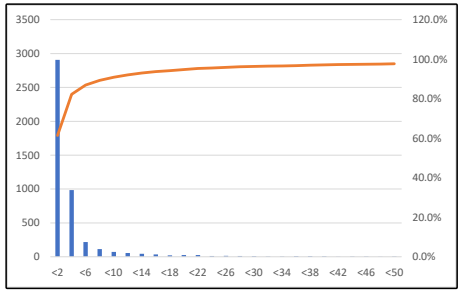


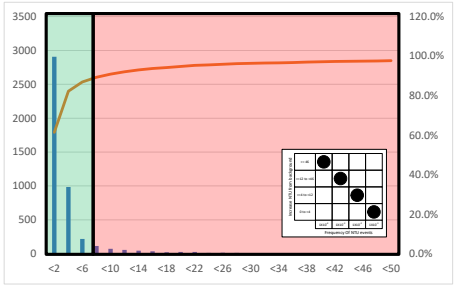
Table 1. Water quality guidelines for total particulate matter for the protection of aquatic life (Caux et al. 1997).

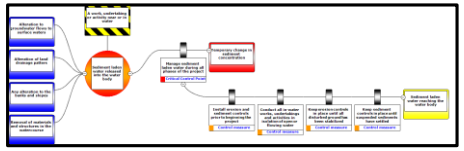
Aquatic life — Freshwater, estuarine, and marine	Guideline value
Suspended sediments	
clear flow	Maximum increase of 25 mg·L^{-1} from background levels for any short-term exposure (e.g., 24-h period). Maximum average increase of 5 mg·L^{-1} from background levels for longer term exposures (e.g., inputs lasting between 24 h and 30 d).
high flow	Maximum increase of 25 mg·L^{-1} from background levels at any time when background levels are between 25 and 250 mg·L^{-1}. Should not increase more than 10% of background levels when background is >250 mg·L^{-1}.
Turbidity	
clear flow	Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g., 24-h period). Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g., 30-d period).
high flow or turbid waters	Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs. Should not increase more than 10% of background levels when background is >80 NTUs.
Deposited bedload sediment	Insufficient information to derive guideline.
Streambed substrate[a]	
fine sediments	The quantity in streambed substrates should not exceed 10% <2 mm, 19% <3 mm, and 25% <6.35 mm.
geometric mean diameter	Geometric mean diameter should not exceed 12 mm.
Fredle number	Fredle number should not exceed 5 mm.
intergravel dissolved oxygen	Minimum of 6.5 mg·L^{-1}

[a]Guideline values apply to actual and potential spawning sites.









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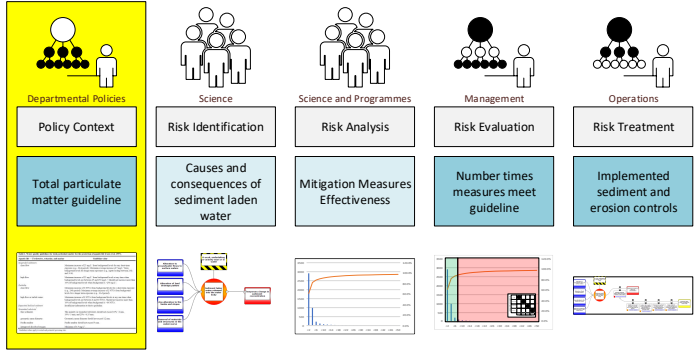
Scoping the assessment within the fish and fish habitat policy



- Policy Context[1]
  - Mitigation measures reduce the spatial scale, duration, or intensity of any temporary changes to habitat that could directly or indirectly impairs the habitat's capacity to support one or more life processes of fish
- Mitigation measures
  - Sediment and erosion controls implemented to reduce duration and intensity of worksite sediment laden water being released into the water body
- Assessment
  - What are the levels of sediment laden water released into the adjacent water body from sediment and erosion controls installed at a worksite?
  - Do the levels of released sediment meet the expected outcomes effectively and reliably during all phased of the project?

[1]Selected examples from: DFO (2019) Fish and fish habitat protection policy statement, August 2019. Available at: http://www.dfo-mpo.gc.ca/pnw-ppe/policy-politique-eng.html..

Expected outcome maximum increase for total particulate matter

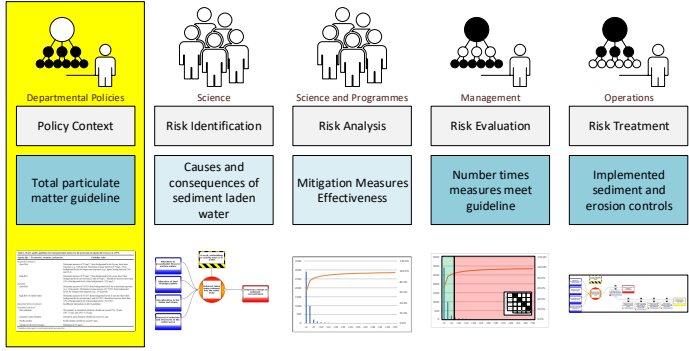


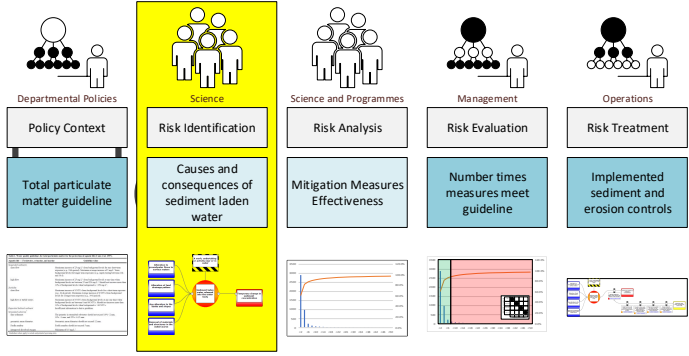
Table 1. Water quality guidelines for total particulate matter for the protection of aquatic life (Caux et al. 1997).

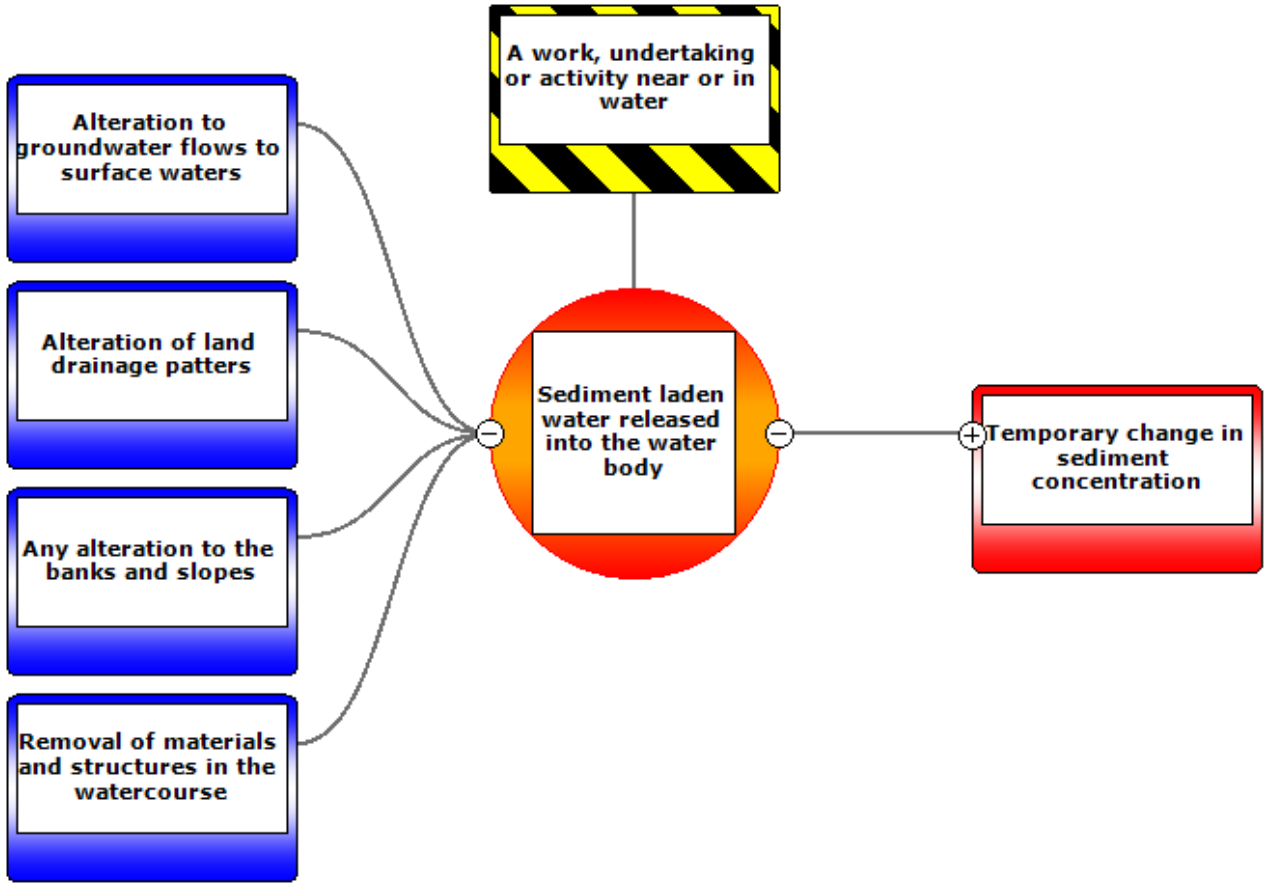
Aquatic life — Freshwater, estuarine, and marine	Guideline value
Suspended sediments	
clear flow	Maximum increase of 25 mg·L^{-1} from background levels for any short-term exposure (e.g., 24-h period). Maximum average increase of 5 mg·L^{-1} from background levels for longer term exposures (e.g., inputs lasting between 24 h and 30 d).
high flow	Maximum increase of 25 mg·L^{-1} from background levels at any time when background levels are between 25 and 250 mg·L^{-1}. Should not increase more than 10% of background levels when background is >250 mg·L^{-1}.
Turbidity	
clear flow	Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g., 24-h period). Maximum average increase of 2 NTUs from background levels for a longer term exposure (e.g., 30-d period).
high flow or turbid waters	Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs. Should not increase more than 10% of background levels when background is >80 NTUs.
Deposited bedload sediment	Insufficient information to derive guideline.
Streambed substrate[*]	
fine sediments	The quantity in streambed substrates should not exceed 10% <2 mm, 19% <3 mm, and 25% <6.35 mm.
geometric mean diameter	Geometric mean diameter should not exceed 12 mm.
Fredle number	Fredle number should not exceed 5 mm.
intergravel dissolved oxygen	Minimum of 6.5 mg·L^{-1}.

[*] Guideline values apply to actual and potential spawning sites.

CCME (2002) 'Canadian Water Quality Guidelines for the Protection of Aquatic Life - Total Particulate Matter', Canadian Environmental Quality Guidelines, p. 13. Available at: https://ccme.ca/en/res/total-particulate-matter-en-canadian-water-quality-guidelines-for-the-protection-of-aquatic-life.pdf.

Causes and consequences of sediment water release into water body





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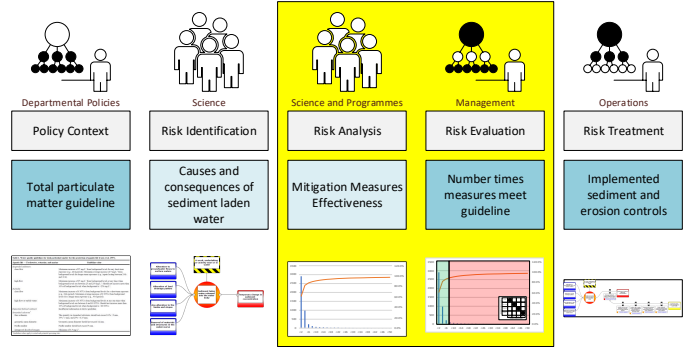
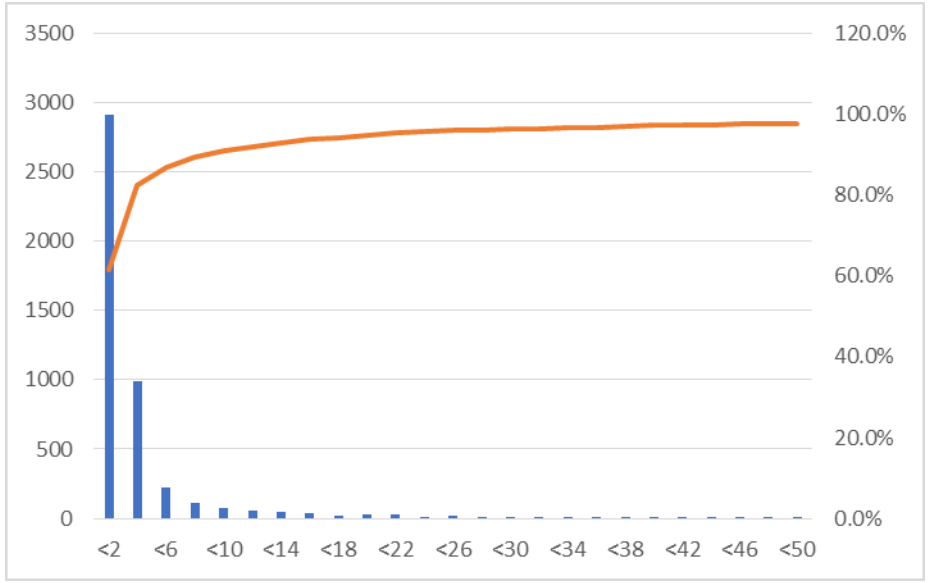
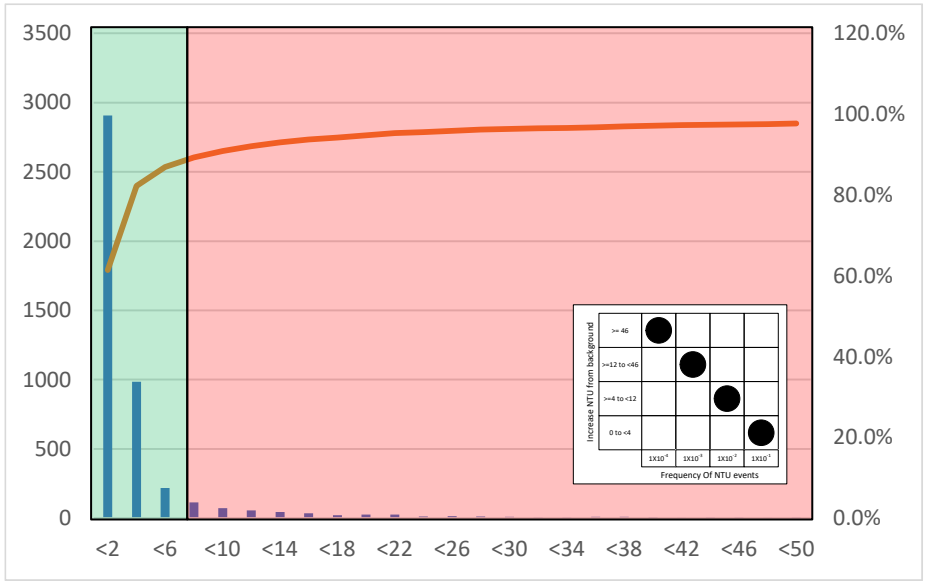
Frequency of nephelometric turbidity units (NTU) outcomes



RISK ANALYSIS OF MEASURES



RISK EVALUATION OF EFFECTIVENESS



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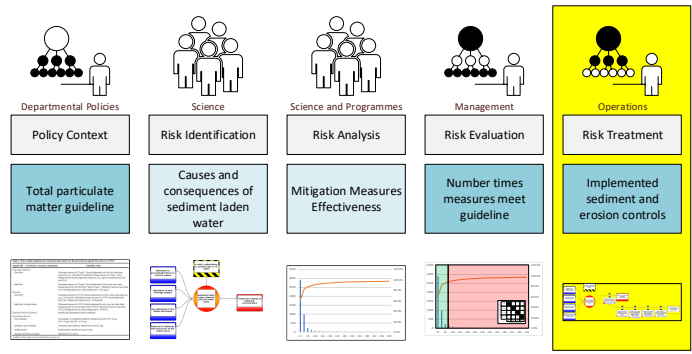
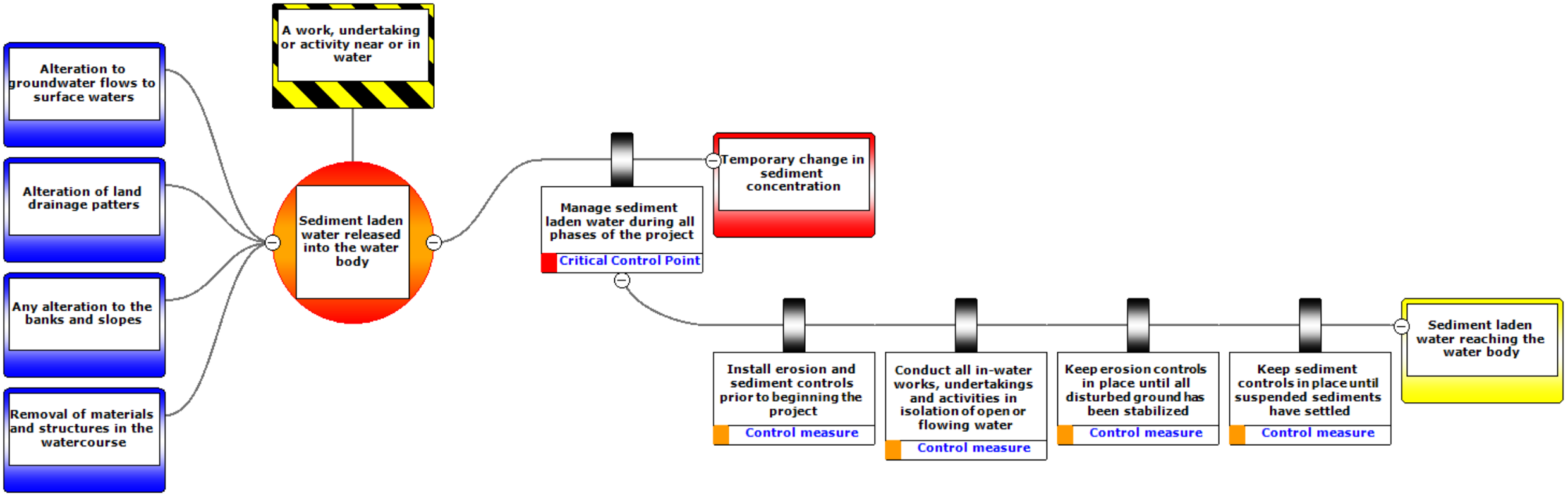
Standards and codes of practice





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Seminar structure

- What are the roles of legislation, policies, programs and regulatory framework in risk management?
- Why should a risk management process scope the assessment of risk?
- What are the techniques used for analysing and evaluating effectiveness of management measures?
- Why use international risk management standards for Canadian government policy development and program delivery?

Cabinet Directive on Regulation

- In accordance with the Government of Canada's Cabinet Directive on Regulatory Management, federal government departments and agencies are responsible for **assessing the effectiveness and appropriateness of regulatory and non-regulatory instruments for achieving public policy objectives**.
- As part of the process of considering how to best address a public policy issue, Canadian federal departments and agencies must:
  - Consider potential alternatives to regulation, including voluntary standards, information disclosure, and guidelines, and whether outcome or performance based approaches would be suitable
  - Make use of all or parts of relevant national or International Standards, guidelines, and recommendations as a basis for technical regulations and for conformity assessment procedures when they fulfill intended policy objectives
- **IEC and ISO International Standards** may be referenced in Canadian regulations without first being nationally adopted.

ISO/IEC (2015) 'Using and referencing ISO and IEC standards to support public policy', International Organization for Standardization and International Electrotechnical Commission (ISO/IEC), p. 53. Available at: https://www.iso.org/files/live/sites/isoorg/files/store/en/PUB100358.pdf.

Cabinet Directive on Regulation Regulatory Impact Analysis

- RIA is the systematic approach to the identification and critical assessment of the potential positive and negative effects and implications of a regulatory proposal for consideration by the public, stakeholders and the Cabinet.
- It is an important element of evidence-based decision-making.
- An assessment of environmental impacts involves examining the scope and nature of:
  - the likely environmental effects (positive or negative)
  - the need for mitigation to reduce or eliminate adverse effects or opportunities for enhancement
  - the likely importance of any adverse environmental effects, taking mitigation into account
- This helps inform the public that environmental factors have been appropriately considered when decisions are made.

Canada (2020) Cabinet Directive on Regulation. Ottawa. Available at: https://www.canada.ca/en/government/system/laws/developing-improving-federal-regulations/requirements-developing-managing-reviewing-regulations/guidelines-tools/cabinet-directive-regulation.html.

In conclusion
The importance of framing the science within the context of policy objectives and regulatory outcomes

- Risk management
  - **Measures are used to reduce the effect of uncertainties in achieving policy objectives**
  - Risk includes the effects of any of the forms of uncertainty in achieving policy objectives
  - Scientific, management and operational uncertainty may lead to positive or negative consequences of a decision
  - **Scope the assessment to identify the sources of the risks, potential causes of events and their consequences that could undermine the policy objectives**
- Process
  - Provide structured information to support decisions and actions where there is uncertainty
  - Assist in defining realistic strategic and operational objectives
  - **Identify effective and efficient risk management measures and strategies**
  - Learn from failure and successes in order to improve the way risk is managed
  - **Demonstrate that regulatory and other requirements have been satisfied**

Cormier, R., Tunney, T. D. and Mallet, M. (2022) 'Framing the science for technical measures used in regulatory frameworks to effectively implement government policy', Frontiers in Marine Science, 9(December), pp. 1–10. doi: 10.3389/fmars.2022.898010.

Thank you!!