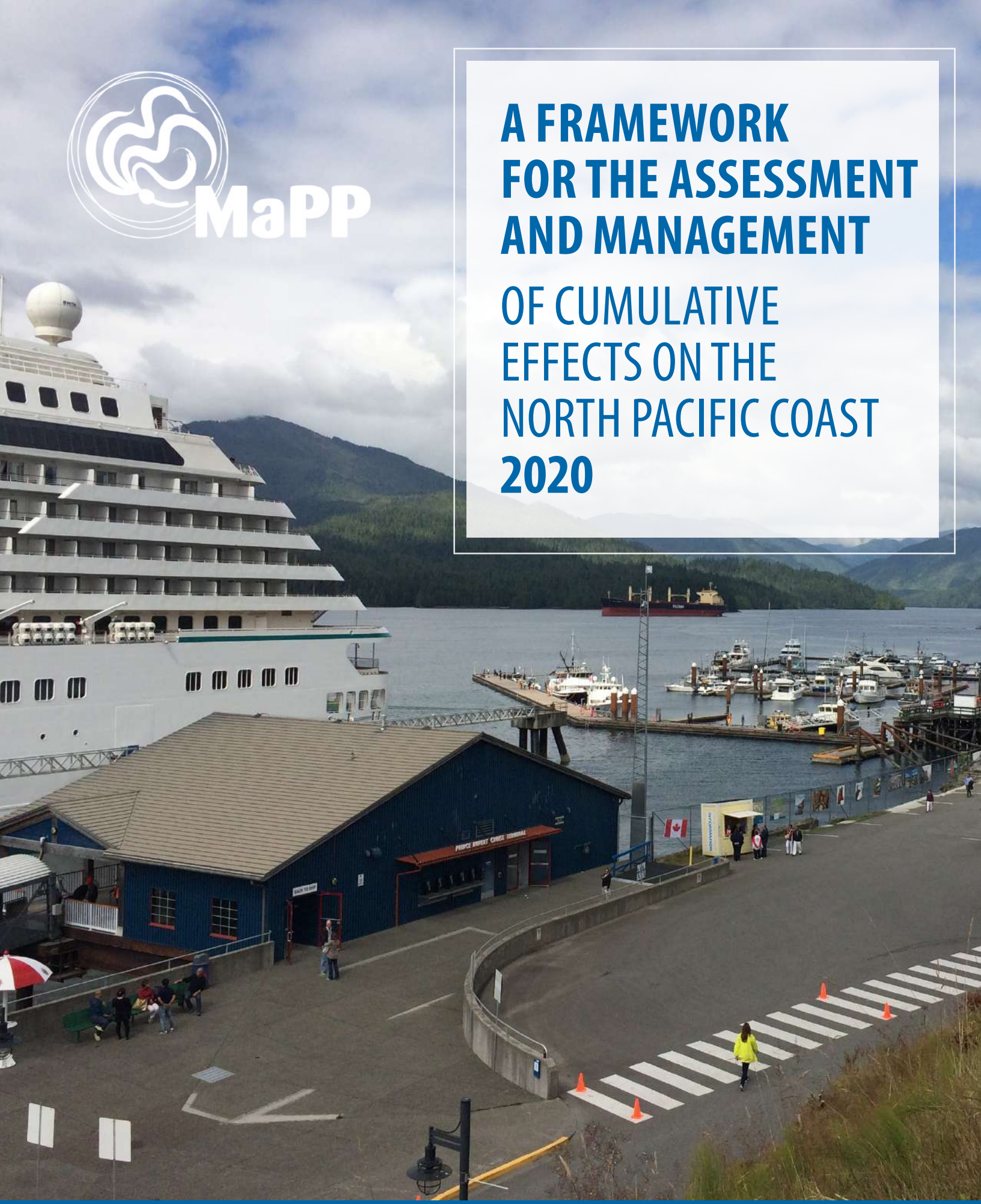
MaPP

A FRAMEWORK FOR THE ASSESSMENT AND MANAGEMENT OF CUMULATIVE EFFECTS ON THE NORTH PACIFIC COAST 2020



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PREPARED BY:

Steven F. Wilson, Ph.D., R.P.Bio.
EcoLogic Research
302-99 Chapel Street Nanaimo, BC V9R 5H3
steven.wilson@ecologicresearch.ca

PREPARED FOR:

Marine Plan Partnership for the North Pacific Coast (MaPP)

Cover photo by Maya Paul

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GLOSSARY OF TERMS

Assessment: A process to determine the condition of values in relation to objectives.

Causal pathway models: A representation of a system as a graph, with "nodes" representing input, output and intermediate factors, and "edges" between nodes representing relationships. "Directed" edges (i.e., arrows) are used to represent the hypothesized direction of a causal relationship.

Cumulative effects: "Changes in environmental, social, economic, health and cultural values as a result of the combined effect of present, past and reasonably foreseeable human actions or natural events" (Marine Plan Partnership Initiative 2016).

Ecosystem-based management (EBM): "An adaptive approach to managing human activities that seeks to ensure the coexistence of healthy, fully functioning ecosystems and human communities. The intent is to maintain those spatial and temporal characteristics of ecosystems such that component species and ecological processes can be sustained, and human well-being can be supported and improved." (Page 18, Marine Plan Partnership Initiative 2015c).

Effectiveness monitoring: Activities undertaken to determine whether managing to triggers is meeting objectives.

Factor: A random variable that serves as an input, output or intermediate node in a causal pathway model.

Indicators: Factors that are directly or indirectly related to a value through a causal pathway and that are used to measure the condition and/or trend of a value. Indicators for a value are usually a subset of the factors of a causal pathway model.

Indicator monitoring: Ongoing activities undertaken to determine the state of indicators in relation to triggers.

Limits: Used in some documents in a manner similar to triggers. Not used directly in this framework.

Management: Strategic, tactical or operational actions implemented with the intent to change a system, usually by acting on a factor that is causally related to an indicator.

Metric: Unit of measure that reflects the state of an indicator.

Objectives: Statements of future desired conditions associated with values. Objectives can be expressed either qualitatively or quantitatively (respectively "broad" or "specific" objectives in the BC provincial Cumulative Effects policy; Province of BC 2016).

Precautionary Principle: "When human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm" (Page 14; UNESCO 2005).

Targets: Used in some documents to describe reference points associated with indicators (e.g., Marine Plan Partnership Initiative 2015c). Not used directly in this framework.

Thresholds: "The point at which there is an abrupt change in an ecosystem quality, property or phenomenon, or where small changes in an environmental driver produce large responses in the ecosystem" (Page 1; Groffman et al. 2006). Not used directly in this framework.

Benchmarks: Reference points that support interpretation of the condition of an indicator (Province of BC 2016). Not used directly in this framework.

Triggers: The point at which a change in the state of an indicator should result in a change in management.

Values: Defined by Province of BC (2016) and used in this report to mean "the things that the people and government of British Columbia care about and see as important for assuring the integrity and well-being of the province's people and communities, economies and ecological systems, defined in policy, legislation or agreements with First Nations" (page 8).

Photo by Kyle Clifton

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NOTE: Additional information on the development of this framework can be found in Wilson 2017a, 2017b.

INTRODUCTION

Cumulative effects are defined as changes to environmental, social, economic, health and cultural values caused by the combined effects of present, past and reasonably foreseeable human actions or natural events (Marine Plan Partnership Initiative 2016). The consideration of cumulative effects was integral to the planning process for the North Pacific Coast and is integral to the implementation of sub-regional marine plans (Marine Plan Partnership 2015a, 2015b, 2015c, 2015d) and the Regional Action Framework (Marine Plan Partnership Initiative 2016).

PURPOSE

The goal of cumulative effects assessment and management is to improve the stewardship of marine ecosystems and resources, and the human well-being of coastal communities. The purpose of this report is to present a framework for a cumulative effects assessment and management for the MaPP plan area (hereafter MaPP CEF). As a framework, it presents strategic principles to guide ongoing development and iteration and components that comprise technical phases.

THE FRAMEWORK

PRINCIPLES

The MaPP CEF is based on the following principles:

1. Management of cumulative effects requires all users of coastal and marine resources to manage to a common set of values and objectives.
2. Decision-making and management should recognize the authority of provincial, federal and First Nations governments.
3. Assessment and management should inform decision-making for both major projects and for smaller permits and authorizations across multiple spatial scales.
4. To be feasible, assessments need to focus on a limited set of values that are at risk from cumulative effects.
5. The foundation of values, indicators and triggers should be developed based on best available information, including traditional knowledge and the results of ongoing monitoring.
6. The state of values should be monitored over time to support decision-making, improve our understanding of marine ecology and related socio-economic-cultural systems, and to determine whether objectives are being achieved.
7. Consistent with the precautionary principle, scientific uncertainty should not prevent the development and implementation of management actions to mitigate unintended impacts.
8. Management should be designed to allow iteration and adaptation as knowledge evolves.
9. Assessment and management of cumulative effects should be proactive rather than reactive, anticipating and addressing unintended impacts before they occur.
10. The framework should accommodate sub regional priorities but provide a consistent structure throughout the MaPP region.

COMPONENTS

The MaPP CEF comprises nine components organized into four phases (Figure 1). These phases generally follow those proposed by Gunn and Noble (2009), Wilson (2014), Province of BC (2016) and Zeeg et al. (2017) and constitute a comprehensive cumulative effects assessment and management program. While there is a sequencing to the four phases, the framework is intended to be iterative, and completion of all the components within a phase is not necessarily required before moving to the next

phase. For example, it can be insightful to conduct a current condition assessment before finalizing the values foundation.

Foundation

The values foundation establishes the technical scope of the assessment, management, and monitoring phases.

1. Values

Cumulative effects assessments are generally focused on a limited set of "valued ecosystem components" (e.g., Ross 1998, Canadian Council of Ministers of the Environment 2009; alternatively, "valued components" [BC Environmental Assessment Office 2013] or simply "values" [BC Ministry of Forests, Lands and Natural Resource Operations 2012]). Values are defined in the interim provincial cumulative effects policy as "the things that the people and government of British Columbia care about and see as important for assuring the integrity and well-being of the province's people and communities, economies and ecological systems, defined in policy, legislation or agreements with First Nations" (Page 8; Province of BC 2016).

Cumulative effects assessments are closely aligned with concepts common to ecosystem- based management, in that both approaches are values-based (e.g., Leslie and McLeod 2007). The ecosystem-based management approach implemented for terrestrial regions of the central and north coast of BC developed suites of values, indicators and triggers that align closely with the logic used in cumulative effects assessments in BC and elsewhere (Central Coast LRMP Completion Table 2004, BC Ministry of Sustainable Resource Management 2005, BC Environmental Assessment Office 2013).

Values can be defined for components of both the natural and human environment and are developed according to different methods, depending on the regulatory context. In provincial environmental assessments, values are defined by project proponents, the public, First Nations, technical experts and government agencies, based on an assessment of scientific, ecological, economic, social, cultural, archaeological, historical, or other importance (BC Environmental Assessment Office 2013). As a result, the values considered vary on a project- by-project basis.

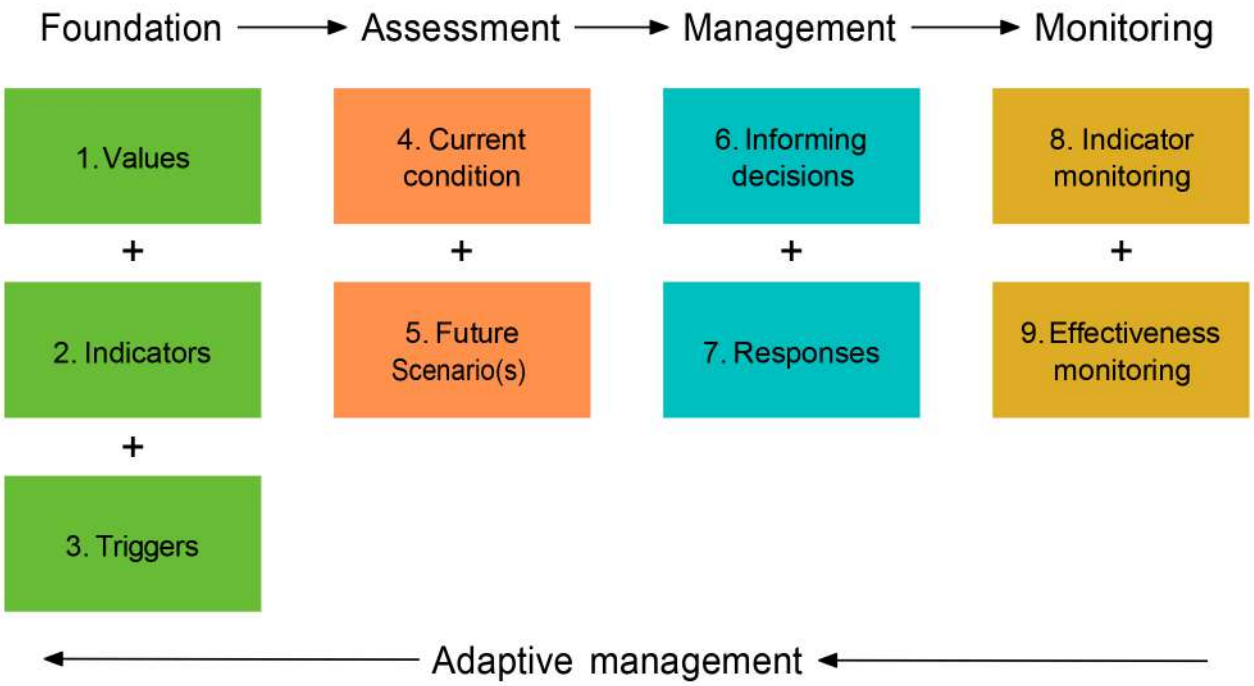

Figure 1. Components of the MaPP Cumulative Effects Framework. Four phases are identified and results are iteratively updated via formal adaptive management.

Environmental Assessment Office (2013) provides guidance on selection of values in the context of major projects, but their criteria apply well in the context of developing a comprehensive cumulative effects values foundation for the MaPP CEF. Modifying for the MaPP context, values should be:

- **Relevant** to the environmental, social, economic, health or cultural interests of First Nations and stakeholders;[1]
- **Comprehensive**, so that taken together, the values should enable a full understanding of the combined effects of present, past and reasonably foreseeable human actions or natural events;
- **Representative** of the important features of the natural and human environment likely to be affected by cumulative effects;
- **Responsive** to the potential effects of human-related developments and/or natural events; and,
- **Concise**, so that the nature of the value-stressor interactions and the resulting causal pathways can be clearly articulated and understood, and redundant analysis is avoided.

When defining values, it is important to identify existing, or to draft new objective statements. An objective is a statement of future desired conditions associated with values. A well-defined objective is critical to support the identification of appropriate indicators, inform triggers, and to provide a basis for effectiveness monitoring. Without clear and well-considered objectives, there can be no assessment and management of cumulative effects because unintended impacts are undefined.

Objectives typically include: 1) a measurable result; and 2) a standard. For example, an objective for a harvested species might be to "maintain sufficient populations in areas of community interest [the result] to meet community needs [the standard].

Optionally, time frames can be added for objectives that imply a directional improvement, e.g., instead of "maintain," the objective could be to "restore by 2027."

Objective statements help frame indicators and triggers and provide a basis for subsequent effectiveness monitoring (see below).

Ideally, values and their objectives should be non-competing, in the sense that objectives for all values should be achievable simultaneously. However, this might not be possible in all circumstances. For example, sea otter recovery and extensive shellfish aquaculture are unlikely to be compatible in the same area at the same time. Competing objectives can be separated in space or time, or can be ranked to allow trade-offs and optimization.

While there is no theoretical limit on the number of values that can be considered, complexity can quickly overwhelm attempts to build out causal pathway models and other components for a large number of values (Tamburello et al. 2017). For conservation planning projects in general, current advice recommends eight or fewer values, with the use of coarser values for larger projects (Conservation Measures Partnership 2013).[2] Finer-scale values can also be "nested" under broader values where they co-occur, share common ecological processes and/or threats, and can be expected to respond similarly to development pressures and management (World Wildlife Fund 2005). Nested values are considered partly or fully protected if the broader value is adequately protected. Nesting helps to maintain a manageable set of values to track and assess, and is useful for managing poorly understood species if their requirements can be addressed at broader scales.

2. Indicators

Indicators are metrics used to measure and report on the condition and trend of values. Indicators are an aspect of a value important to its integrity and can be used to understand and evaluate the potential effects

[1] In contrast with provincial CEF values, which are defined in policy, legislation, or agreements with First Nations (Province of BC 2016).

[2] Values are equivalent to "conservation targets" in the open standards process (Conservation Measures Partnership 2013).

of projects or other stressors. Adapting again from Environmental Assessment Office (2013), indicators should be:

- **Relevant**, by either directly or indirectly measuring the condition of a value;
- **Practical** to evaluate, using existing or feasible-to-collect data, predictive causal pathway models, or other means;
- **Measurable**, such that they can generate useful data that will improve our understanding of potential impacts on a value;
- **Responsive** to the potential effects of human-related developments and/or natural events;
- **Accurate** in reflecting changes to the value; and,
- **Predictable**, in terms of responsiveness to development or natural events.

Selection of suitable indicators should be supported by development of causal models that illustrate as pathways the relationships among a value, its potential indicators and stressors. Other projects that have developed models of similar structure include Pickard et al. (2015), Pacific Salmon Foundation (2016) and Zeeg et al. (2017). Models are also a foundational element of the provincial CEF.

Models can take different forms and are known by different names (e.g., "conceptual models [Province of BC 2016]," "means-ends networks" [Gregory et al. 2012]), but the goal is to formalize our understanding of a system, how values are likely to be affected, and how those changes can be measured (Figure 2). Models illustrate input and output factors as "nodes" and relationships as "edges," which are usually illustrated as arrows indicating an assumed causal direction (e.g., the stressor s_2 is assumed to cause changes in indicator i_1 in Figure 2). There can also be intermediate factors that may or may not be observed (indicated by the grey node in Figure 2). Ideally, indicators that are selected to monitor the state of a value have a direct causal relationship with the value.

Models can be extended from simply illustrating pathways to mathematically representing the relationships among factors. Fully parameterized models can identify the most important drivers of systems through various statistical techniques and can therefore be used to inform the development of triggers and to support forecasts of future condition and the estimated effectiveness of management actions. Rarely are all the causal relationships fully understood, but models can capture current understanding, including traditional and other expert knowledge, and can accommodate expressions of uncertainty by specifying probability distributions.

3. Triggers

Triggers are the levels of an indicator at which management should change. The relationship

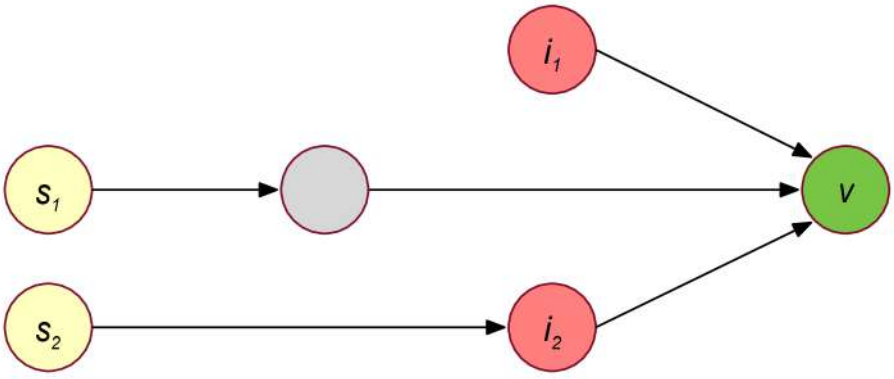

Figure 2. Template structure of a causal model where stressors or other inputs(s) act directly or indirectly on indicators (i) to estimate the condition of a value (v). Arrows indicate the direction of a causal relationship. A causal model provides the basis for proposing and testing hypotheses about the current and future condition of a value and how and where in a system management interventions can be made to mitigate unintended impacts.

between a value, as measured by an indicator, and triggers, can be represented by a diagram illustrating zones of management concern and possible trajectories of indicators as development or other changes proceed (Figure 3). More than one indicator can be used to characterize a value, and more than one trigger can be established to indicate different response requirements. For example, in addition to a trigger that indicates an unacceptable condition, a "precautionary trigger" could provide an earlier change point where "routine" management is altered to modify the trajectory of an indicator.

The management objective is generally to maintain a trajectory similar to trajectory A in Figure 3, where the condition of the value remains below trigger 1. This represents a condition consistent with the value's objective. Trigger 1 is a "precautionary trigger" that signals that a change in management is required to ensure that the condition does not deteriorate to the point that it is exceeded (trajectory B), at which point some remedial action will be required to return the condition below Trigger 1. An unacceptable condition results when Trigger 2 is exceeded and more intensive management is required to return the indicator to a condition consistent with the objective (trajectories C). If management does not change, unintended cumulative effects can result in a worsening condition of the value (trajectory D).

Management decisions can alter the levels of both Triggers. For example, Trigger 1 can be lowered to signal a change in management sooner and reduce the risk that Trigger 2 is exceeded. Alternatively, trade-off decisions that favour other values could move Trigger 2 higher on the graph.

The term "trigger" is used in this framework rather than "target" or "threshold" because "trigger" implies a call to action, rather than something to be achieved ("target") or an inflection point ("threshold") that may or may not exist.

The interim provincial cumulative effects policy (Province of BC 2016) uses the term "triggers" similarly to this framework, but only where quantifiable objectives are available in policy or legislation (e.g., old growth forest retention targets). The interim policy uses ecologically derived "benchmarks" to inform decision-making when only broad, qualitative objectives are available (e.g., land

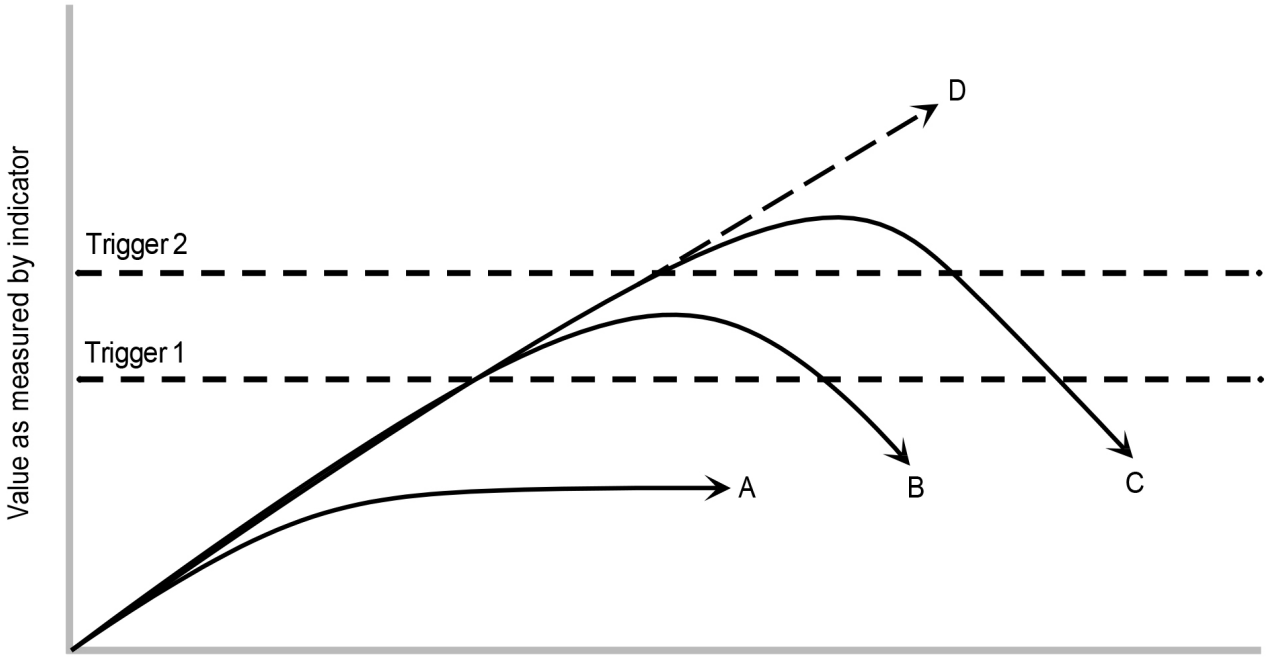

Figure 3. Conceptual relationship between a value, as measured by an indicator, and triggers. More than one trigger may be used to identify points where management should change. Generally, the goal is to maintain (A) or return (B and C) conditions below the lowest trigger, which indicate a condition consistent with an objective for a value.

use plan direction). The MaPP CEF does not require the development of formal benchmarks but assumes that triggers will be informed by best available science and traditional knowledge for all types of values.

Triggers should also be informed by more than just a technical understanding of a system. Concepts such as "unacceptable" and "acceptable" are normative terms that have no objective scientific definition, but have deep importance to resource users. Different groups will assign different levels of importance to resources and will have different risk tolerances and thus may want to apply different levels of precautionary management. As a result, triggers need to be set through facilitated, consultative processes rather than by technical experts alone (Selkoe et al. 2015).

Setting appropriate triggers requires consideration of the problem of "shifting baseline syndrome" (Pauly 1995), which, broadly speaking, is the phenomenon of generating increasingly worse management outcomes by accepting changes against a baseline condition that is itself deteriorating because of previous management decisions. The problem of shifting baselines can be addressed by avoiding objectives that express standards based on current or historical baselines, but instead set standards based on future desired conditions. There is no reason to assume that an historic baseline is ideal, natural, or even desirable. This is particularly clear for some social and economic indicators (e.g., health outcomes, education levels).

In practice, triggers may be difficult to set without the context provided by a current condition assessment that occurs in the second phase of the framework. That is, it can be difficult to frame what we want without knowing what we have. This underlines the importance of iteration in the implementation of the framework. Later phases will generate information that can be used to address gaps and uncertainties in earlier phases.

Assessment

Conducting an assessment is the analytical phase of a cumulative effects program. The principal output is a report on the condition of values, based on measured, estimated or forecasted indicator metrics in a specific area. Areas-of-interest will vary depending on the scope and scale of proposed developments or on the size of planning areas, as is case for regional strategic environmental assessments. Values themselves can be associated with one or more scales that are relevant to their management (e.g., community, traditional territory, species local population). Therefore, assessments are likely to report on areas for some values that extend beyond the footprint of the project or planning area.

Assessment results can be very sensitive to scales of analysis. Increasing the area-of-interest can reduce the apparent impacts of projects while reducing the size of the area can have the opposite effect. Therefore, areas-of-interest need to be considered carefully and rationalized, based on the ecological scale of values and potential effects that might occur beyond the direct physical footprint of project-related activities.

4. Current Condition

The assessment of current condition considers the effects of activities that have occurred in the past and are currently occurring. Activities and events that have not yet occurred but are in advanced stages of permitting or otherwise forecasted are considered "foreseeable" and the estimated effect of these activities and events on levels of indicators should be included in the assessment, if practicable. Further guidance on including foreseeable activities in assessments is provided in Hegmann et al. (1999).

Indicator metrics can be derived from direct measurements or can be estimated from causal pathway models. Then the levels of indicators in relation to their triggers are assessed to determine whether a change in management is required.

5. Future Scenarios

Most cumulative effects assessments also forecast the condition of values with the additive effects of a project (e.g., environmental assessment) or with the effects of contrasting regional development strategies (e.g., Regional Strategic Environmental Assessments; Canadian Council of Ministers of the Environment 2009, Noble 2010). To assess future scenarios the effects on indicators of the project or of regional

development strategies must be estimated. The change in the forecasted levels of indicators might alter the management concern (e.g., from trajectory A to trajectory C in Figure 3).

The catalogue of indicators and their levels of management concern provide the necessary information for informed decision making and designing management responses to mitigate cumulative effects.

Management

Management refers to the collection of responses to the results of a cumulative effects assessment. Because the values considered in assessments can be diverse, it is unlikely that only one agency will be responding to assessment results. Addressing these governance complexities is a required component of cumulative effects management and is addressed under Implementation below.

6. Informing Decisions

Cumulative effects assessments are usually conducted as part of a broader analysis to inform a decision regarding a proposed project or other change in resource management. Decision- making authority rests with relevant jurisdictions and normally requires consultation with affected parties. Statutory decision-making is bounded by the legal and policy context of the responsible agency, and the latitude of decision-makers to consider information and exercise discretion varies.

Assessment results aid decision-makers by providing information on the current and forecasted state of values. The completeness, validity and veracity of the values foundation will have a direct effect on the quality of decisions and the likelihood of mitigating unintended cumulative effects.

Ensuring that statutory decision-makers consider assessment results generated through implementation of MaPP strategies and actions requires agreements related to both process and governance. These issues are addressed under Implementation below.

7. Responses

Often associated with permitting decisions is the requirement for mitigations to limit or compensate for the negative impacts of a project. Mitigation is defined by the BC government's mitigation policy as:

"Any actions taken to avoid, minimize, rectify, reduce, eliminate, compensate or offset potential adverse environmental effects during the planning, design, construction, operation, and decommissioning phases of development projects, activities, works and undertakings. It also includes remediation or restoration of habitats disturbed, damaged, or destroyed by the development or activity" (Page 20, BC Ministry of Environment 2010, page 29)

The hierarchy of mitigation measures are applied in a manner that reflects increasing cost: from avoid and minimize impacts, to restoring values and finally financial offsetting, which compensates for an irreparable loss (ten Kate et al. 2004). Mitigations are often the responsibility of the proponent to implement, or in some cases resources are provided to third parties to implement.

The environmental mitigation policy of the BC government (BC Ministry of Environment 2014) is intended to apply to new or amended authorizations on lands where the province has statutory authority, although as a policy it does not convey legal authority. The provincial environmental mitigation policy is directly applicable to the coastal and marine context.

Because values can interact, mitigations to improve the condition of one value might negatively affect another. A table of proposed mitigations and their estimated impacts on values can help avoid unintended effects.

Mitigations are generally project-level responses undertaken by proponents, but other responses can also be appropriate to address some negative impacts. Responses can include strategic actions, such as setting new objectives or initiating new planning processes. Strategic responses are typically led by government. Tactical responses can be led by governments, stakeholders, proponents and/or First Nations and can include activities such as directing

research and monitoring, or requiring coordination among proponents or resource users (Province of BC 2016).

Monitoring

Monitoring is a critical component of any cumulative effects program because it provides information on the status and trend of values through the measurement of indicators. As valuable as causal pathway models can be for estimating current conditions, forecasting impacts and designing mitigations, they require validation and calibration through properly designed monitoring programs.

8. Indicator Monitoring

Indicator monitoring is defined as the routine collection of indicator data. This information can be used to calibrate and verify causal pathway models, thereby increasing the reliability of condition and trend estimates for values.

There are many benefits to having the communities most dependent on values involved in their monitoring. Deploying resources locally is cost-effective and builds a situational awareness that can provide important feedback for the continuous improvement of the values foundation and, hence, the cumulative effects program. This feedback can include recommendations for new or revised values or indicators, as well as information to inform the setting or revision of triggers.

9. Effectiveness Monitoring

Effectiveness monitoring refers to activities that aim to determine whether the overall cumulative effects program is successful; specifically, an effectiveness evaluation poses the following questions:

- Is the values foundation sufficiently complete and valid?
- Are decisions and management actions meeting stated objectives for values?
- Is the cumulative effects program achieving its stated goal?

Effectiveness monitoring has a much broader scope than indicator monitoring. It can involve the use of both formal and informal methods to address evaluation questions. In general, effectiveness evaluations should be conducted periodically and results should inform changes to the values foundation to improve alignment of technical components with desired outcomes.

Adaptive Management

Adaptive management is a formalized, iterative process of management decision-making and adjustment in the face of uncertainty, with the goal of reducing uncertainty over time through monitoring (Walters 1986). The phases and components of the cumulative effects program outlined above serve the adaptive management process by:

1. Formalizing our current knowledge of systems as testable models;
2. Developing forecasts of future conditions that provide management hypotheses; and,
3. Monitoring system inputs and outputs over time and using results to improve estimates of conditions and the reliability of forecasts.

These steps are necessary to provide the feedback required to make iterative improvements to the cumulative effects program.

SUMMARY

Where all components of the framework are implemented according to the principles presented, the result is a comprehensive cumulative effects assessment and management program. As the program expands to cover more values, and as adaptive management improves confidence in indicators and triggers, marine ecosystems and coastal communities will be benefit from improved stewardship.

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