FROM SCIENCE-BASED THRESHOLDS TO REGULATORY LIMITS: IMPLEMENTATION ISSUES FOR CUMULATIVE EFFECTS MANAGEMENT

Prepared for:

Environment Canada, Northern Division

By:

Steve Kennett
Canadian Institute of Resources Law

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1 Introduction

Implementation has received remarkably little attention in the published papers and consultants' reports dealing with the use of thresholds to assess and manage cumulative environmental effects. Without effective implementation, however, the best science in the world will not change the way we manage human uses of land and resources.

This paper focuses on implementation. The analysis builds on the excellent overview of the theory and practice of thresholds provided by Terry Antoniuk's background paper.[1] Terry shows that considerable work has already been accomplished in the NWT and elsewhere on the identification of indicators and thresholds for cumulative effects management. He also highlights some of the decision-making processes that are available for putting threshold-based approaches into practice. The record of success in moving from theory to practice is not, however, particularly impressive. An important theme running through several of the examples discussed in Terry's paper is that initiatives to develop and apply thresholds – particularly land-use thresholds – have tended to encounter obstacles at the implementation stage.

The objective here is to identify some of the key issues that should be confronted directly in order to implement a *threshold-based approach to cumulative effects management.* This way of framing the objective is important, because the challenge is not simply to implement thresholds once they have been identified. In fact, 'thresholds' as that term is often used cannot be implemented because they take the form of information, not decisions. Decision-makers use information, but they implement decisions. Bridging the gap between the generation of information about thresholds and the making and implementing of decisions regarding land and resource use requires a shift in both terminology and analysis. In particular, this paper suggests that implementation requires a serious analysis of *limits, trade-offs, and specific decision-making processes*. The following discussion focuses primarily on issues and options in these three areas.

The starting point is a summary of Terry's brief but significant comments about obstacles to implementing thresholds. The paper then focuses on challenges and opportunities for incorporating information about thresholds into actual decisions regarding the use of land and resources. This discussion is divided into three sections: (1) the acceptance of limits in principle; (2) the establishment of limits through planning; and (3) the implementation of limits in practice.

2 The Implementation Challenge

Terry's paper and extensive reference list show that the development of thresholds for environmental management has received considerable attention in recent years, especially in northern Canada. In particular, much effort has been and continues to be devoted to the science of thresholds – the identification of indicators and dose-response relationships in order to understand relationships between levels of human activity and environmental change. As Terry shows, many of the tools and decision-

[1] Salmo Consulting Inc. February 2006. "Developing and Implementing Thresholds in the Northwest Territories – A Discussion Paper", Prepared for Environment Canada, Northern Division [Salmo].

making processes needed to develop and implement a threshold-based approach to cumulative effects management are already in place or are under development in the NWT and elsewhere.[2] Furthermore, he suggests that there is a growing appreciation of the need to define thresholds that are "technically defensible, politically acceptable, and administratively efficient."[3] Satisfying these criteria, however, remains a challenge.

It is not surprising to observe a lag time between the emergence of an idea like threshold-based cumulative effects management and its implementation. Nonetheless, it is worth considering the types of issues that may, if they are not addressed, constitute significant obstacles to implementation. Terry's paper provides some hints about the types of obstacles that may arise. Here are a few examples.

Terry notes that although there have been numerous processes to identify desired environmental and social conditions in the NWT through statements of 'vision and objectives', only the Dehcho Land Use Plan has incorporated formal land management thresholds or targets.[4] As Terry points out, however, this process has generated some controversy. In particular, he identifies concerns that the tiered thresholds contained in the initial draft plan:[5]

- were too complex;
- would prevent further hydrocarbon exploration and development;
- did not reflect known problems with existing data;
- had unclear calculation rules; and
- created "implementation issues".

He also notes the suggestion that implementation of thresholds should be delayed pending further monitoring. Revisions to the draft plan incorporated a single threshold value for each indicator based on refined calculation rules. However, Terry states that comments on the draft plan are similar to those received on the original version.

A similar story unfolds for several of the other threshold initiatives referred to by Terry as they approach the implementation stage. He notes that research on cumulative effects management has been undertaken through the Environmental Studies Research Fund Beaufort Delta Project.[6] A report prepared for a multi-stakeholder technical advisory group included candidate limits of acceptable change or thresholds for key indicators and valued components. Results were presented at a workshop in Inuvik. Terry reports that participants were "generally supportive" of the overall framework and approach, but that they identified a need for further consultation on candidate limits or

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[2] For other useful discussion of the potential use of thresholds in northern processes for land and resource management, see: AXYS Environmental Consulting Ltd. March 2001. *Thresholds for Addressing Cumulative Effects on Terrestrial and Avian Wildlife in the Yukon*, Prepared for DIAND, Environmental Directorate and Environment Canada, Whitehorse Yukon; Macleod Institute. April 2002. *Carrying Capacity and Thresholds: Theory and Practice in Environmental Management*, Prepared for the Canadian Arctic Resources Committee. Other presentations at this workshop will also address this topic.

[3] Salmo, p. 11.

[4] Salmo, p. 5.

[5] Salmo, p. 18.

[6] Salmo, pp. 18-19.

thresholds. Participants "were understandably concerned about the impacts of threshold and limit implementation, and wanted to ensure that these management tools provide an appropriate balance between desired economic development, social conditions, and environmental protection."[7]

Another NWT example cited by Terry is the recommendation by the Mackenzie Valley Environmental Impact Review Board of a linear corridor threshold to manage the cumulative effects on woodland caribou of proposed development in the Cameron Hills area near the Alberta border. He comments that this recommendation "generated controversy and extensive discussion during the 'consult-to-modify' process" but that it was in fact accepted by responsible federal ministers as an interim land disturbance target for use by the Board and regulatory authorities.[8]

Thresholds have also been considered in the Yukon, but here again we see obstacles at the implementation stage. Terry notes that a proposed land use threshold for woodland caribou winter range in the southeast Yukon "apparently created controversy because of its perceived potential to affect forestry activities and has not been implemented."[9] He states that the absence of a clear regional management vision appeared to be the primary implementation barrier. He also observes that while the Kaska Forest Resources Stewardship Council has a long-term objective of establishing a management framework that incorporates limits of acceptable change or management targets, the forest management plan "will likely include cumulative effects indicators to be considered, but recommended limits or management targets for these indicators may not be provided."[10]

Northeast British Columbia is the only northern example where land use thresholds have been legally implemented. Terry's paper describes the use of thresholds in Muskwa-Kechika pre-tenure plans for oil and gas activities,[11] but he also includes a note of caution. Tiered thresholds have been proposed as part of a broader cumulative impact management framework for northeastern British Columbia that was endorsed by regional regulators and resource managers in May 2003 but has not yet been formally implemented. According to Terry: "Implementation barriers included a change in provincial policy that favours intensive resource development in the region, and the need to build aboriginal support for regional management initiatives."[12]

The pattern evident from these examples is also illustrated by an example not covered in Terry's paper: the fate of a recent proposal to examine implementation issues as part of a larger research project that focuses primarily on the science of thresholds. The proposal framed the issues as follows:

> "The principal impediment to the implementation of thresholds is the reluctance by decision-makers, whether regulatory, political or

[7] Salmo, p. 19.
[8] Salmo, p. 20.
[9] Salmo, p. 21
[10] Salmo, pp. 20-21.
[11] Salmo, pp. 21-22. See also: R. McManus Consulting Ltd. and Salmo Consulting Inc. 2004. *Conserving Canada's Natural Capital: The Boreal Forest, Muskwa-Kechika Case Study*, Prepared for the National Round Table on the Environment and the Economy, Ottawa, available at www.nrtee-trnee.ca.
[12] Salmo, p. 23.

> administrative, to assign limits of acceptable change in geographic areas with economically recoverable resources. Thresholds are typically perceived as onerous restrictions on development, particularly right-of-entry, as opposed to a mechanism to manage environmental change with a higher level of confidence and certainty. The significance of [the proposed] work is to overcome these limitations and demonstrate options that recognize a balance amongst current tenure based resource asset allocation, industry interest, political intent for development and common interest with publics in sustainable development."[13]

Funding for this work – which would have amounted to only a small proportion of the total project budget – was not approved, although the science components of the project are continuing.

While a number of factors may have contributed to the decision not to proceed with this work, the brief explanation transmitted to the individuals who submitted the proposal included the following "cautionary remarks":[14]

- the scope of the proposed work "could affect sensitivities related to thresholds among different agencies and in different areas";
- "we need to better communicate the opportunities and value associated with the [thresholds research project as a whole] so that it is not viewed as a threat"; and
- "we need to get buy-in from planners, regulators and land-owners before we start talking about options for implementing thresholds."

The comments concluded with the somewhat ambiguous observation that the agencies reviewing the proposal support the overall thresholds research project "and recognize the need to consider implementation options, but felt and agreed *it's too early to begin talking about thresholds implementation*."[15]

These examples suggest, at the very least, reason for concern that certain barriers to implementation may not have been fully appreciated and addressed in some of the recent initiatives to identify thresholds and incorporate them into cumulative effects management. Whatever the appeal of thresholds in theory, the resistance of key decision-makers and stakeholders to follow through with implementation may be explained by issues that may not simply be resolved over time by improved science. Some of these issues are highlighted in Terry's very useful summary of "lessons learned" from the theory and practice reviewed in his paper. These lessons include the following key points:[16]

- Thresholds cannot be based only on science; they must take into account social values, public policy, and traditional and local knowledge.

[13] Project proposal, on file with the author.
[14] E-mail correspondence, on file with the author.
[15] E-mail correspondence, on file with the author (emphasis added).
[16] Salmo, p. 16 (emphasis added).

- Thresholds work best when they are developed and used to manage negative effects of human activities, not stop resource development.
- Thresholds work best when they are part of a cumulative effects assessment and management framework.
- "Technically defensible': thresholds must be agreed to reflect the best available local and traditional knowledge and science. *Until recently, threshold development has been stalled at this first stage because the use of thresholds generates much technical debate and controversy.*
- 'Politically acceptable': thresholds must be socially acceptable and appropriate. This does not happen on its own and generally requires: a clear management vision; involvement and support of all residents, managers, and resource users; a clear understanding of likely benefits and costs; political and community support; and adequate time and resources. *Land use planning processes are the most effective way to achieve this*.
- 'Administratively efficient': implementation requirements must be directly evaluated and addressed when developing thresholds. *This includes: existing legal requirements; administrative processes and procedures; project-specific impact management tools; decision rules; and monitoring, enforcement and reporting requirements.*

This list captures many of the key implementation issues that must be confronted directly by decision-makers, stakeholders and society at large if threshold-based approaches to cumulative effects management are to make the transition from theory to practice. The rest of this paper examines several of the most important of these issues, beginning with the fundamental question of principle: are we prepared to accept limits and associated trade-offs in order to manage cumulative effects?

3 Limits in Principle

The term 'threshold' contains potential ambiguity when applied to the management or regulatory context. As a scientific term, it invites discussion about the 'correct' numerical value for any given threshold. Given the uncertainty inherent in much of the science of thresholds,[17] there is scope for virtually endless scientific discussion prior to any decision about implementation – a topic returned to below in the section on planning. From a management or regulatory perspective, thresholds may be interpreted as indicators or benchmarks, useful for assessing the likely impacts of human activities on ecological and social values, but not intended to act as a meaningful constraint on those activities. To take Terry's speed limit analogy, a threshold might provide an indication of the suggested speed to achieve a certain balance between safety, fuel efficiency and driver convenience, without creating a clear and enforceable speed limit.

Limits are, however, the logical and inevitable outcome of a serious commitment to the threshold-based approach to cumulative effects management. The following

[17] Peter N. Duinker and Lorne A. Greig. 2006. "The Impotence of Cumulative Effects Assessment in Canada: Ailments and Ideas for Redeployment" *Environmental Management*, Vol. 37, No. 2, p. 156.

sections summarize the reasons for framing the implementation discussion in terms of regulatory limits and then consider what it means to accept limits in principle.

3.1 Distinguishing thresholds from limits

As noted above, the discussion of thresholds in relation to cumulative effects management often focuses on the generation of information. In some cases, this information may be purely scientific. For example, some thresholds may describe relationships – sometimes referred to as dose-response relationships – between characteristics of the environment that are influenced by human activities and changes in valued components of the environment. Levels of dissolved oxygen below a certain threshold may result in significant fish mortality. Linear disturbance density above a certain threshold may result in adverse effects on caribou.

Thresholds may also take the form of information that incorporates explicit value judgments. For example, Terry's paper defines management thresholds as "technically or socially-based standards that identify the point at which an indicator changes to an unacceptable condition."[18]

Information of this type can and should be used when making decisions about land and resource management. Even when they incorporate value judgments, however, thresholds are not themselves decisions that can be implemented. Implementation requires incorporating information about thresholds into specific planning and regulatory decisions about land and resource use. For this reason, implementation of a threshold-based approach to cumulative effects management is defined for purposes of this paper as the establishment and enforcement of regulatory *limits* on specified human activities that contribute to cumulative environmental effects. As a practical matter, implementation of threshold-based approaches may be facilitated by an open and honest discussion, at the outset, about the need for and use of limits to manage cumulative effects.

3.2 Acceptance of the need for limits

The existence of limits on the ability of species and ecosystems to maintain themselves in the face of increasing levels of human activity is obvious. The cumulative effects of over-hunting on passenger pigeons and over-fishing on the north Atlantic cod stock provide two striking examples of what can happen when the limits of sustainable use are exceeded. The steady retreat of woodland caribou populations in Alberta and grizzly bears throughout much of their historic range in North America are two among many ongoing examples of the ability of cumulative pressures to transform ecosystems and alter the distribution of species. Climate change, with its potential to disrupt weather patterns and ocean currents, is perhaps the most dramatic illustration of how cumulative effects can transform the world around us.

There is thus undeniable evidence that the cumulative effects of human activities can bring about profound changes in landscapes, ecosystems and even the Earth's climate. If levels of human activity and impacts are increasing and valued components of the environment are vulnerable to the resulting stresses, we have essentially two options: (1) impose limits on cumulative human activity before significant environmental change

[18] Salmo, p. 2.

occurs; or (2) wait, watch and try to adapt as these natural systems undergo either gradual or dramatic change.

At the most fundamental level, then, implementation of threshold-based approaches to cumulative effects management will depend on society's willingness to accept limits on certain human activities in order to preserve natural capital, reduce the risk of unintended and potentially catastrophic environmental change, protect a range of environmental, economic, social and cultural values, and reconcile competing land and resource uses. Implementing limits in practice requires recognition of the need for limits in principle – something that many of us appear reluctant to accept at both personal and societal levels.

As the NWT and other areas of Canada's north confront the opportunities and risks associated with increasing resource development and its many spin-offs, there will clearly be pressures and temptations to avoid an explicit debate about the need for limits. Immediately to the south of the NWT, the province of Alberta is pursuing a policy of massive resource development without cumulative limits for most terrestrial impacts. The pace, intensity and location of oil and gas development are essentially determined by market forces, subject in some areas to restrictions established through local land-use designations such as some types of protected areas. Alberta's rights issuance and regulatory regimes are intended to maximize short-term industrial activity and revenue. The oil and gas regime is difficult to reconcile with land-use planning and results in complex patterns of overlapping resource tenures, further complicating the task of managing cumulative effects. This model has generated considerable wealth – and there is increasing evidence that it will also transform landscapes across the province in significant ways.[19] The experience in Alberta shows that the acceptance of limits in principle is not inevitable, and certainly should not be taken for granted.

3.3 Limits and trade-offs

If societies are willing to accept the need for limits in principle, they will rapidly be confronted with the challenge of managing trade-offs. As with the cumulative impacts and costs of land and resource use, trade-offs are inevitable at some point as human activities increase in scope and intensity. Traditional decision-making, however, often ignores trade-offs, letting the costs fall where they may. Once limits are imposed and activity or disturbance levels approach these limits, trade-offs become unavoidable. The relationship between limits and trade-offs is therefore another issue that should be confronted directly when considering implementation of a threshold-based approach to cumulative effects management.

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[19] See, for example: Daniel Farr, Steve Kennett, Monique M. Ross, Brad Stelfox and Marian Weber. 2004. *Conserving Canada's Natural Capital: The Boreal Forest, Al-Pac Case Study Report*, Prepared for the National Round Table on the Environment and the Economy, Ottawa, available at www.nrtee-trnee.ca; Richard R. Schneider, J. Brad Stelfox, Stan Boutin, and Shawn Wasel. 2003. "Managing the Cumulative Impact of Land-uses in the Western Canadian Sedimentary Basin: A Modeling Approach" *Conservation Ecology*, Vol. 7, Issue 1, Article 8; Kevin Timoney and Peter Lee. 2001. "Environmental management in resource-rich Alberta, Canada: first world jurisdiction, third world analogue?" *Journal of Environmental Management*, vol. 63, pp. 387-405.

The use of regulatory limits to manage cumulative effects results in two broad types of trade-offs: (1) trade-offs when setting the limit – between the activities that are limited and the values that the collective or cumulative limit is intended to protect; and (2) trade-offs between activities that compete for space within the limit. Making these trade-offs involves planning and regulatory decision-making, both of which are examined later in this paper.

Terry's paper points out that regulatory limits are analogous to firm and enforceable speed limits.[20] He also notes that thresholds work best when used to manage negative effects, not stop development.[21] These two points are central to the relationship between limits and trade-offs.

Setting limits for cumulative effects management need not imply a rigid cap on development. When considering the acceptability of limits in principle, it is important to recognize that these limits apply to the human activities that produce impacts which contribute to cumulative environmental effects. These activities, it should be remembered, are generally means to achieve certain ends. Limiting the specific means does not necessarily prevent the attainment of the ends, although it may impose some significant constraints.

An important consideration when setting regulatory limits is therefore to facilitate and promote opportunities for achieving desired ends in ways that do not violate these limits. To some extent, setting limits will itself create powerful incentives to find new ways of achieving objectives for land and resource use. For example, limits on total forest clearing, the creation of public access routes, or linear disturbance density will encourage the development of techniques, such as low-impact or no-impact seismic, which allow activities such as geophysical exploration to continue without crossing these limits. Where no-impact alternatives are not available, options such as sharing infrastructure or making room for new disturbances by reclaiming old ones will become more attractive.

The key point is that accepting limits in principle does not imply simply imposing caps on the existing suite of human activities. Rather, it should be viewed as altering incentive structures and regulatory processes in ways that will both encourage and accommodate new ways of doing business – permitting valued economic activity to continue within prescribed limits.

Accepting limits in principle can therefore invite innovation, not stagnation. The design and implementation of limits should be directed to accommodating a broad range of possibilities for accommodating different land and resource uses in practice. Trade-offs will be inevitable when compared with a world where cumulative impacts are unconstrained, but the use of limits for cumulative effects management should promote maximum flexibility to achieve important objectives for land and resource use by other means.

[20] Salmo, p. 3
[21] Salmo, p. 16.

3.4 Collective versus individual limits

While the acceptance of limits in principle need not imply a rigid cap on society's ability to achieve a broad range of economic and other objectives, it will have important implications for land and resource users. These implications should be acknowledged when seeking societal consensus on the acceptance of limits in principle.

In particular, imposing collective limits in order to manage cumulative effects will change the regulatory regime in important ways from the perspective of project proponents. Where limits (or standards) apply only to individual projects or activities and where assessment and regulation occur on a project-by-project or activity-by-activity basis, the challenge for each proponent is essentially to carry out the proposed activity in a way that meets the regulatory requirement. Where that requirement is based on best available technology, doing your best is often enough to ensure approval.

Once cumulative limits are imposed, however, approval may be contingent not only on what the proponent is doing, but also on other activities that are happening, or have happened, and that affect overall compliance with the prescribed limit. This change may be seen as threatening because it implies a loss of control – doing your best or meeting project-specific standards of performance may not be enough, at least when they do not bring the impact within the collective limit.

3.5 Rationing 'free' goods

Limits may also be contentious when they impose new costs on users of land and resources by forcing them to pay for things that were previously treated as free. These costs arise because limits create scarcity where none existed before. For example, limits on total land disturbance in an area will eventually make it impossible for land users to ignore the cumulative ecological and social costs of creating roads, seismic lines, pipeline rights-of-way, forest clear cuts and other disturbances associated with industrial activities. Similarly, limits on total pollution discharges or water withdrawals will take a previously 'free' good and make it costly as its scarcity increases. Economists refer to this process as the internalization of externalities (or external costs).

Land and resource users that have benefited from the ability to use 'free' land and resources without internalizing the cumulative ecological and social costs of their activities may resist the imposition of limits that create new costs. It is worth remembering, however, that the failure to impose limits does not eliminate the costs; it simply ignores them in the short term and transfers them to other land and resource users and to society as a whole over the longer term as adverse cumulative effects become evident.

3.6 Implementation through a cumulative effects framework

The final key point regarding the acceptance of limits in principle is that managing cumulative effects requires attention to the broader legal, institutional and policy context. Cumulative effects are a problem because the decision-making processes

governing land and resource use are unable to set and achieve landscape-scale objectives. The reasons for this deficiency typically include:[22]

- The absence of an adequate policy and planning framework for decision-making on individual projects and activities – as noted in Terry's paper, this framework should set out a broad vision for land and resource use and identify a series of specific objectives and indicators that enable decision-makers to align project-specific decision-making with landscape-scale outcomes;
- Entrenched incrementalism and fragmentation in decision-making – cumulative effects management is frustrated because decisions on land and resource uses are typically made one at a time and by decision-makers who consider only one sector or type of activity (i.e., institutional 'silos'); and
- An unwillingness or inability to confront trade-offs when making decisions on land and resource use.

These interrelated problems must be addressed in order to meet the challenge of cumulative effects management.

Translating information about thresholds into regulatory limits can be a powerful tool for managing cumulative effects, but it is not a shortcut for addressing these structural problems. The solution lies in a fundamental shift from blind incrementalism and fragmented decision-making to an integrated system for managing land and resource use. In operational terms, integrated resource (or landscape) management requires a legal, institutional and policy framework that achieves three types of integration:[23]

- Integration across sectors and land uses – recognizing that all significant land and resource uses must be coordinated in order to achieve landscape-scale objectives;
- Integration among stages of decision-making – from broad land-use policy and planning, through the issuance of resource rights (e.g., mineral or forestry rights) to project-specific review and regulation; and
- Integration over spatial and temporal scales that are meaningful in terms of ecological and social objectives.

A cumulative effects assessment and management (CEAM) framework provides the basis for moving towards this type of integrated decision-making process.

The NWT is well positioned to achieve this type of integration. A CEAM Strategy and Framework has been developed, building on the significant degree of integration established by the *Mackenzie Valley Resource Management Act* and through the planning

[22] Steven A. Kennett. 1999. *Towards a New Paradigm for Cumulative Effects Management*, CIRL Occasional Paper #8 (Calgary: Canadian Institute of Resources Law).
[23] Steven A. Kennett. 1998. "New Directions for Public Land Law" *Journal of Environmental Law and Practice*, Vol. 8, pp. 1-46.

and resource management institutions established in the Inuvialuit Settlement Region.[24] Nonetheless, the CEAM Blueprint identifies the need for significant progress in a number of areas in order to fully implement the CEAM Strategy and Framework.[25] The contribution to cumulative effects management of a threshold-based approach to setting regulatory limits is an integral part of the overall initiative to achieve more integrated decision-making.

4 Establishing Limits through Planning

Cumulative effects management is the process of setting and achieving landscape-scale objectives in the context of multiple activities and competing values, interests and priorities. Setting objectives is achieved primarily through the policy and planning components, as illustrated by the NWT's CEAM Strategy and Framework. In particular, incorporating information on thresholds into decisions that result in collective regulatory limits is a planning function. Implementing a threshold-based approach to cumulative effects management requires attention to several fundamental issues related to planning.

4.1 The role of planning in cumulative effects management

A well designed planning process is central to cumulative effects management because it is an antidote to blind incrementalism and fragmented decision-making. In theory:[26]

- Planning is a mechanism for generating decisions on land and resource use through a process that considers relevant information, values and interests.
- Planning is an integrative mechanism because it adopts a landscape-scale perspective that, ideally, considers the full range of land uses over a large area and long time frame.
- Planning provides an opportunity to consider trade-offs among objectives for land and resource use.
- Planning includes feed-back mechanisms so that decisions regarding land and resource use can be revisited in a systematic manner, reflecting new information and changing values and objectives.

Implementation of a threshold-based approach to cumulative effects management therefore starts with an understanding of these key aspects of planning and a commitment to achieving them in practice.

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[24] See: www.ceamf.ca.

[25] NWT CEAM Steering Committee. July 2004 (revised). *A Blueprint for Implementing the Cumulative Effects Assessment and Management Strategy and Framework in the NWT and its Regions*, available at www.ceamf.ca. Specific action 7.3 (p. 12) of the Blueprint calls for "Research on carrying capacity, thresholds, and limits of acceptable change, and ways to implement these concepts in predictive tools/models and decision-making."

[26] See Kennett, *supra* notes 22 and 23.

4.2 Science and social choice

Planning is an exercise in social choice that is intended to yield decisions regarding land and resource use. These decisions should incorporate a range of information as inputs – including scientific information about thresholds – but these inputs should not be confused with the decision itself.

Since the concept of thresholds has a strong scientific pedigree, there may be a tendency to think that science is the principal driver of implementation decisions once overall objectives for land and resource use have been established. In other words, once broad objectives have been set, science can identify the corresponding thresholds that translate directly into regulatory limits. Science is obviously essential to understanding the relationships between human activities, environmental change and the sustainability of valued ecosystem components. It may also offer the prospect of rigour in identifying thresholds and setting limits, a potentially attractive alternative to the messy compromises of conventional planning and political decision-making.

This view of the role of science may, however, be a double-edged sword from the perspective of implementing threshold-based approaches to cumulative effects management. Placing science in the driver's seat raises two significant risks. First, limitations in the ability of science to define thresholds with precision – notably due to deficiencies in data and modeling – may stall the implementation process. Second, the advantages of rigour and insulation from political compromises may be lost at the implementation stage if science-based decision-making yields results that are politically unacceptable, fail to reflect important values and interests, or simply are not well understood by politicians, stakeholders and the public at large.

The tendency of discussions about cumulative effects management to bog down in technical discussion about the science of thresholds is commonly observed phenomenon. While efforts to improve the scientific basis for decision-making should obviously be encouraged, scientific uncertainty is sometimes used as a reason for refusing to set any limits at all. From the perspective of cumulative effects management, this situation may be an example of the old adage that 'the best is the enemy of the good.' In purely strategic terms, however, endless debates about scientific uncertainty serve the interests of those whose ability to carry on business as usual may be compromised by the establishment of regulatory limits to manage cumulative effects.

Putting the role of science in perspective requires an understanding of the structure of social decision-making on limits, the subject of the next section. The point here is that the argument that scientific uncertainty regarding thresholds is a reason for delay in setting limits can itself cut both ways. Consider the following two questions:

- Given the clear evidence that cumulative effects can transform landscapes and ecosystems in unintended and often undesirable ways, what is the scientific basis for a decision to allow significant incremental human activity to proceed in the absence of any collective limits?
- Should the onus of scientific proof when identifying thresholds and setting limits be on those advocating limits for cumulative effects management or on those whose activities contribute to cumulative effects?

These questions highlight the challenge of dealing with scientific uncertainty in resource management.

Advocates of the precautionary principle maintain that uncertainty should not be a reason for delaying action to avoid potentially significant risks. They also suggest that the burden of proof should be shifted – those who create environmental risks should be required to prove that they are reasonable, as opposed to putting the burden on regulators and potentially affected parties to show that these risks are excessive. From the development perspective, the argument is made that too much caution in approving activities and an excessive burden of proof to demonstrate that risks are well understood and acceptable will unduly restrict economic development. Resolving this debate is a matter of social choice, informed but not resolved by science.

4.3 The planning process – an analogy with the parents' dilemma

Establishing limits through planning is likely to be a complex process, particularly once it is recognized that the science of thresholds cannot provide a 'silver bullet' solution. Understanding how this process might work in the context of scientific uncertainty and conflicting priorities and values among regulators, stakeholders and the public at large is important for implementation. It may therefore be useful to describe this process through a simple and familiar analogy – the parents' dilemma when setting limits in the form of bedtimes for small children. While this example of limit setting appears at first glance to have little to do with the subject of this paper, it illustrates several important lessons about the nature of the decision-making (i.e., planning) process.

Many people come to the conclusion relatively early in their experience with parenting that life without limits is a recipe for disaster. One area where limits may be required is in setting an appropriate bedtime for children. The tendency of children to want to stay up late and the consequences of sleep deprivation the next day are well known to most parents. The problem arises because behavioural tendencies encounter biological limits – much like the problem of cumulative environmental effects. Furthermore, setting limits provides an attractive alternative to purely *ad hoc* management, involving ongoing negotiations to contain continual pressure to push bedtimes later.

Once parents accept the need for limits (i.e., a fixed bedtime) in principle, the next challenge is to determine where the limit should be set. As noted above, a child's need for sleep is essentially a biological requirement. One might expect, therefore, that science will have something to say about setting bedtimes. Most parents would probably agree, however, that science alone will not resolve the issue. The process of setting limits can involve the consideration of at least the following five factors.

First, the parents may consult reference material that provides scientific information on the sleep requirements of children of the appropriate ages. This information is likely to provide general guidance, indicating that young children need significantly more sleep than adults – perhaps 9 or 10 hours per night – in order to avoid sleep deprivation. As with adults, however, the amount of sleep that individual children will need is likely to vary according factors such as personal characteristics, level of

physical and mental activity, stresses of daily living, seasonal biorhythms, etc. Furthermore, different scientists may provide different estimates of the amount of sleep required – confronting the parental decision-makers with scientific uncertainty that they are ill equipped to resolve. Most parents would not, however, treat these limitations of science as a reason to abandon the search for bedtime limits.

The second source of information that parents may turn to is traditional and community knowledge. Other relatives such as grandparents and other parents with experience raising children may provide first-time parents with useful 'rules of thumb' for setting bedtimes. While this information may not be grounded in the standard scientific method, it is often tried and tested, reflecting a common pool of practical wisdom that can be applied to setting limits.

The third component of limit setting is likely to be adaptive management. Parents may use experiments to test different bedtimes. Feedback loops are generally relatively short. Putting a child to bed too early may result in difficulty falling asleep or waking up at a socially unacceptable time. If the bedtime is too late, difficulty getting going in the morning and the signs of fatigue during the day will often become evident. Sensitivity to these types of feedback provides a practical way of determining the appropriateness of limits and making adjustments accordingly. Conversely, the absence of effective feedback loops may result in dysfunctional limit setting. Problems may arise, for instance, if parents set a late bedtime in order to maximize family time together in the evening, but leave daytime care to others who do not tell them about the consequences of sleep deprivation for their child's behaviour during the day.

Trade-off analysis is a fourth possible component of setting bedtime limits. The decision is not simply a matter of optimizing biological outcomes, although biological sleep requirements cannot be ignored beyond a certain point without serious consequences. The time available between school and bedtime may be used for doing homework, playing with friends, eating dinner, participating in organized after-school activities, reading, and interacting with parents and siblings. The value of these activities will generally be incorporated into any bedtime limit. If they are considered sufficiently important, parents may decide that trade-offs between biological requirements and other priorities should be made. For example, some sleep deprivation may be tolerated during the week in order to accommodate other activities. The balance may be restored on weekends, however, when a different set of constraints and trade-offs reduces time pressures in the evening and also allows both parents and children to compensate by sleeping in. Trade-offs may also be necessary to accommodate the needs of different members of the family. If equity requires putting two children to bed at the same time but they need different amounts of sleep, bedtime will be a compromise.

The fifth component of limit setting will likely by a systematic incorporation of flexibility mechanisms. As noted above, one advantage of limits as a management technique is that they avoid *ad hoc* negotiation on a daily basis. No system of bedtime limits is likely to be acceptable, however, if it is completely rigid. Implicit or explicit criteria will likely be set by the family for determining when it is acceptable to exceed normal limits – Christmas Eve or special dinners and evenings with family or friends might be examples. Furthermore, bedtime limits will likely be re-evaluated over time as children grow older and their needs and priorities change.

Taking into account all of these factors, parents are often able to come up with very precise bedtime limits. In fact, precise limits often work best as a practical matter, despite the multiple levels of uncertainty and subjective trade-offs that go into setting these limits.

There are obviously some important differences between setting bedtime limits and setting regulatory limits on land and resource use. Feedback loops with children are likely to be much shorter and more direct. Trade-off analysis is less complicated. Adaptive management is easier to implement. Nonetheless, the basic structure of decision-making is essentially the same. This structure highlights several important aspects of bedtime limit setting that contain important lessons for environmental and resource management – lessons that build on those set out in Terry's paper.

- While scientific information is a useful input to setting bedtime limits, the ultimate decision is made by parents, not scientists. Bedtime limits, like limits on land and resource use, are determined through a process of social choice.
- Scientific uncertainty is not a barrier to setting limits. Parents and other human beings are quite capable of setting very specific regulatory limits in circumstances where science does not provide precise information on thresholds.
- Traditional and community knowledge can provide very useful guidance when setting limits and should not be discounted simply because it is not supported by standard scientific methodology.
- While there is clearly a significant biological component in setting bedtime limits, trade-off analysis is also important. Furthermore, the more flexibility there is for accommodating different trade-offs, the more likely it is that limits will be consistent with achieving a range of objectives.
- Feedback and flexibility mechanisms are an important part of making limits work in practice. It is essential that these mechanisms be built into the decision-making process and that they work well.

All of these lessons from the parents' dilemma are applicable to the planners' dilemma of setting limits for cumulative effects management.

4.4 Intensity limits and trade-offs in planning

The planning component of threshold-based cumulative effects management is a significant advance over earlier versions of integrated planning because it includes intensity limits on activities in addition to spatial zoning. Planning has often reflected a 'multiple-use' approach to resource management that establishes land-use zones with associated lists of permitted or prohibited activities. One limitation of this approach is that it typically provides little or no guidance on the appropriate intensity of activity. In other words, it identifies what types of activities can occur where but does not incorporate limits on the amount of activity that is acceptable.

This type of planning is well illustrated by Alberta's integrated resource plans (IRPs).[27] Zoning indicates where certain types of activities are acceptable, but these plans generally provide little or no guidance to decision-makers faced with increasing intensity of multiple activities on the same land base. For example, IRPs tell decision-makers that oil and gas development is an accepted activity within a certain area, but not what well density is appropriate or how the oil and gas footprint should be coordinated with forestry and other activities on the land base in order to achieve landscape-scale objectives. Addressing these types of questions, however, is central to cumulative effects management.

4.5 Planning as a component of integrated resource management

The final point regarding the planning process is that the implementation of planning decisions requires linkages to subsequent stages of decision-making. These linkages ensure that limits set through planning are implemented at the rights issuance, project review and regulatory stages. Formal linkages are established through legal requirements that project-specific decision-making must conform to plans. Requirements in the *Mackenzie Valley Resource Management Act* illustrate this type of linkage. As a practical matter, implementing a threshold-based approach to cumulative effects management also requires mechanisms to ensure that multiple individual decisions yield results that are consistent with overall limits. This topic is the subject of the following section.

5 Implementing Limits in Practice

As noted above, decisions on land and resource use are typically made on a project-by-project or activity-by-activity basis by decision-makers operating within sector-specific mandates. This decision-making structure lies at the heart of the problem of cumulative environmental effects. While planning provides the key to setting landscape-scale objectives, achieving these objectives in practice requires implementation mechanisms to reconcile individual decisions with cumulative or collective limits.

5.1 Aggregation and integration of individual decisions

The general approach to implementation that has been proposed for threshold-based approaches to cumulative effects management is for the land or resource use in question to continue subject to standard regulatory requirements until a limit is approached or reached.[28] At that point, additional management action is required to reduce impacts in order to stay within the limit. In a tiered threshold approach, different management actions are specified depending on the level that is reached.

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[27] Steven A. Kennett and Monique M. Ross. 1998. "In Search of Public Land Law in Alberta" *Journal of Environmental Law and Practice*, Vol. 8, pp. 151-159; Oswald Dias and Brian Chinery. 1994. "Addressing Cumulative Effects in Alberta: The Role of Integrated Resource Planning" in Alan J. Kennedy, ed., *Cumulative Effects Assessment in Canada: From Concept to Practice* (Calgary: Alberta Association of Professional Biologists), p. 314.

[28] Salmo, p. 11.

While this structure of decision-making is common to descriptions of the threshold-based approach, details on the specific management actions to be taken are often sketchy. What constitutes 'appropriate' management action and how is coordination among many decisions to be achieved? Answering these questions requires decision-makers to address the aggregation problem.

The need to aggregate individual decisions when managing cumulative effects is intuitively obvious. For example, a limit on linear disturbance density must ultimately be implemented through a multitude of individual decisions about roads, seismic lines, pipeline rights-of-way, electric power transmission lines and similar disturbances.

Ideally, the planning process will provide some guidance about how these decisions are to be coordinated or integrated in order to achieve the desired collective outcome. However, broad land-use planning is unlikely to anticipate all of the individual projects and activities that may occur on a landscape. To the extent that limit setting through planning provides objectives and parameters for subsequent decisions, implementation of a plan is less about following through on prescribed actions and more about ensuring that subsequent decisions, taken together, produce landscape-scale results that are consistent with the plan.

More specific guidance may be provided through a planning hierarchy, where detailed planning focuses on smaller geographic areas or specific resources. At this level, it may be easier to prescribe management actions in order to ensure that the total level of activity that results from the individual decisions is within the prescribed limit. Even with this level of planning, however, aggregating individual decisions will often involve more than mechanically implementing a plan.

This challenge might be addressed through improved institutional coordination or integration – perhaps making a single decision-maker responsible for a broader range of land and resource uses. For example, the allocation of resource rights (e.g., forestry and oil and gas rights) might be undertaken by a single land management agency that would be responsible for looking at aggregate expected impacts when considering individual decisions. Similarly, project review processes could be integrated across sectors. Even this degree of integration will not, by itself, fully resolve the aggregation issue; decision-makers must also have mechanisms for making trade-offs.

5.2 Trade-offs in practice

The challenge of aggregating decisions leads, once again, to the practical problem of trade-offs. As collective limits are approached, management actions to maintain activities within these limits will involve either explicit or implicit allocation rules that determine how trade-offs are made. These rules will have important consequences for competing land and resource users. They will also have broader social implications, since they constitute judgments about the allocation of scarce resources among alternative uses. Overall welfare will be increased if these decisions favour higher valued uses over lower valued ones. However, not all allocation rules are well suited to making this type of choice.

Trade-offs within cumulative limits can occur among competing uses over both space and time, depending on the type of limit in question and the activities that it affects.

In a case where two activities contribute to a cumulative effect and the limit is reached, several options may exist. First, one activity may be deemed more important and allowed to proceed, while the other is restricted or prohibited. Second, both activities may be constrained so as to bring the cumulative total within the limit. Finally, the activities themselves may change in significant ways, enabling the desired land and resource uses to occur without violating the collective limit. These alternatives could include low impact technology or sharing infrastructure.

5.3 Permanent or long-lasting impact sources

The difficulty of keeping cumulative impacts within regulatory limits is likely to increase when there is an accumulation over time of permanent or long-lasting sources of impacts. These sources may take the form of land and resource uses that require ongoing resource inputs or that produce discharges or emissions. As more and more of these uses are approved within a given area, limits will be approached and there will be less and less scope to accommodate new activities. For example, the accumulation of extractive water uses along a river may eventually make it impossible to make any new allocations without significant consequences for aquatic ecosystems and, eventually, other users. Many rivers in southern Alberta are already at this stage. Without mechanisms to reallocate water use among existing users, the accumulation of approved uses will eventually choke off further development that requires water as a resource input.

Long-lasting disturbances exhibit the same characteristic; they tend to accumulate over time, contributing to the cumulative impacts. Seismic lines may be used only briefly for geophysical exploration, but can persist on the landscape for decades. Other types of linear disturbances, such as transportation corridors, are essentially permanent. In some cases, the impacts continue long after the disturbance in question has ceased to have any economic or other value – as is the case with seismic lines or access roads to abandoned well sites. In other instances, ongoing impacts may be the result of uses of the disturbance that have little or no relationship to the original reason for creating it. Use of seismic lines and forestry roads for public access are an illustration of this phenomenon. If cumulative impacts are to be managed through regulatory limits on total area of disturbance or linear disturbance density, the accumulation of these disturbances over time is a significant problem.

The problem may be mitigated in some circumstances by reducing the impacts from individual disturbances – thereby allowing more activity to occur within cumulative limits. For example, the shift from six metre to three metre seismic lines reduces the total area cleared. Improved construction of stream crossings can reduce the total disruption of aquatic habitat caused by hanging culverts. Best management practices can therefore buy some time in the face of relentless pressure for incremental development. If the intensity of development continues to increase, however, reducing individual impacts may not be enough to keep cumulative effects within regulatory limits.

Long-lasting sources of impacts therefore accentuate the problem of trade-offs for threshold-based approaches to cumulative effects management. Where reducing individual impacts is not an adequate solution, explicit or implicit choices between existing and new impact sources are unavoidable if regulatory limits are to be respected. Decision rules or other mechanisms will be needed to make these choices.

5.4 Regulatory responses to allocation issues

As regulatory limits on cumulative effects are approached, allocating space within these limits among different land and resource uses involves explicit or implicit choices among competing applications for new activities and among existing impact sources and proposed new ones. Regulatory responses range from simple and rigid allocation rules to complex and flexible packages of management options.

The most straight-forward allocation rule is the one used for traditional water licences in much of western North America: first in time, first in right. Uses are simply approved up to the point where regulatory (or natural) limits are reached, at which point allocation ceases or 'junior' rights essentially lose value. Where it is impossible to satisfy all users, allocation is based on chronology with rights issued first having priority. In the traditional model, each rights holder can use its full entitlement before subsequent users can withdraw any water.

Use of this model would involve approving land and resource uses until the regulatory limit is reached and then stopping. This simple decision rule raises a host of problems, most obviously because of its rigidity and the fact that it fails to accommodate the shift from low value to high value land and resource uses. As a result, the 'first in time' rule for water rights may be modified by other allocation rules and flexibility mechanisms, such as requirements for conservation measures in times of drought and provisions for transferring water rights.

There are many possibilities for flexible management responses as land and resource uses approach regulatory limits. Implementation of threshold-based cumulative effects management should therefore include opportunities for regulators, project proponents and existing impact sources to find creative means of facilitating development without exceeding limits. An illustration of this approach is found in the November 2005 draft of the Dehcho Land Use Plan, which states that developers have the following options once cumulative effects thresholds have been reached:[29]

- Employ technologies or mitigation methods that do not lead to an increase in cumulative effects. This may include re-using existing disturbed areas or employing Minimal Impact Seismic, or to a lesser extent, Low Impact Seismic … whenever possible to ensure new disturbance does not trigger a land use permit application used to assess cumulative effects;
- With the approval of Regulatory Authorities, reclaim other lands of similar ecological value, equivalent to the amount of land to be disturbed by their proposal such that the threshold would not be exceeded by the proposed development;
- Submit better data and studies demonstrating that the overall level of disturbance, including the proposed development is below the thresholds; or

[29] *Respect for the Land: The Dehcho Land Use Plan*, Prepared by the Dehcho Land Use Planning Committee, Revised Draft Plan – November 2005, p. 30.

- Apply to the Committee for an exception to the thresholds when extenuating circumstances exist.

These mechanisms show that options for providing 'room' for new development within cumulative limits often involve both project proponents and regulators. Where reclamation is required, land owners and existing land and resource users may also be involved. It is also obvious from these examples that the implementation of flexibility mechanisms itself raises a series of policy, planning and regulatory issues that should be addressed when considering a threshold-based approach to cumulative effects management.

5.5 Cap-and-trade allowance systems

A cap-and-trade allowance system is an alternative to regulatory decision-making for determining which land and resource uses should be undertaken when a specified activity (e.g., emission, discharge, water withdrawal, land disturbance, etc.) is subject to a cumulative limit. Under this system, transferable allowances to undertake the activity in question would be allocated among users. The maximum number of allowances corresponds to the regulatory limit. Actual and potential land users are then free to trade allowances, thereby allowing market forces to determine which activities are entitled to proceed.

This economic incentive mechanism has been used in a variety of contexts, including transferable air emission rights and transferable fishing quotas. Weber and Adamowicz have proposed a system of "tradable land-use rights" (TLRs) for managing terrestrial cumulative effects.[30] Under this system, rights to disturb surface lands would be allocated to firms up to the cumulative limit. Trading among holders of TLRs would reallocate surface activity to highest value uses, enabling conservation objectives to be met at minimal costs. Rights could also be purchased by new entrants, allowing flexibility to accommodate new land and resource uses by retiring old ones.

Weber and Adamowicz argue that the ability of the market mechanism to "integrate land-use decisions in order to maximize the economic benefits of development" is central to the rationale for TLRs.[31] It is also the point of contrast with traditional 'command and control' approaches to regulating land use. They state that the market mechanism "eliminates the inefficiencies caused by evaluating projects on a case-by-case basis" and that "the opportunity costs of habitat protection can be inferred by permit prices, reducing the demand on government to obtain and verify information about the relative economic value of candidate ecological reserves."[32] Furthermore, they argue that TLRs "increase incentives for intersectoral coordination and the use of low-impact technologies" because they allow land users to capture financial benefits from spatial coordination to minimize total land disturbance.[33] Finally, the higher scarcity value for

[30] Marian Weber and Wiktor Adamowicz. 2002. "Tradable Land-Use Rights for Cumulative Environmental Effects Management" *Canadian Public Policy*, Vol. 28, No. 4, pp. 581-595.
[31] Weber and Adamowicz, pp. 586-7.
[32] Weber and Adamowicz, p. 587.
[33] Weber and Adamowicz, p. 587.

certain TLRs (e.g., for disturbance of old growth forest) "will encourage the substitution of activities away from scarce habitat types."[34]

Cap-and-trade systems, such as the TLR model, provide an opportunity to use market incentives to address some of the difficult aggregation, integration and allocation issues raised by threshold-based approaches to cumulative effects management. However, these systems have their own limitations and areas of complexity. Tradable allowances must be relatively homogeneous commodities in order for the market to work effectively. This condition may be easy to meet for standardized air emissions or water withdrawals, but is more challenging when dealing with terrestrial disturbances. Where issues such as the spatial distribution and specific type of land and resource use are important, cap-and-trade markets may need to incorporate regulatory intervention or restrictive trading rules of various types. A cap-and-trade system that applies to the flow of inputs (e.g., annual creation of linear disturbances) may also have to be adjusted or supplemented in order to deal with the accumulation of a stock of long-lasting disturbances on the landscape.

Incentive mechanisms embodied in cap-and-trade systems provide a promising means of supplementing conventional regulatory decisions-making, but will require further elaboration and adaptation to handle the full range of land and resource uses that could be subject to threshold-based cumulative effects management. In practice, incentive mechanisms will likely complement, rather than completely replace, more conventional regulatory tools.

6 Conclusion

The discussion of threshold-based approaches to cumulative effects management rightly begins with the science of environmental and social thresholds. Science is essential to understanding the relationships between human activities and environmental and social change. The incorporation of science-based thresholds into decisions on land and resource use is, however, a multi-faceted task that will require considerable effort from all interested parties – public and private sector decision-makers, stakeholder groups, and society as a whole. This paper has argued that this task requires attention to limits, trade-offs and specific decision-making processes. It has also highlighted the need to confront a series of issues relating to the acceptance of limits in principle, the establishment of limits through planning, and the implementation of limits in practice. Other workshop presentations on the application of thresholds in specific contexts may provide an opportunity to test the usefulness of this analysis in closing the gap between theory and practice.

[34] Weber and Adamowicz, p. 583.

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