Ecosystem Based Management Challenges to EBM for Alberta and Saskatchewan Forests

Section C: Intermediate Level Frameworks

fRI Research Healthy Landscapes Program

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Informing Land & Resource Management

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C: Intermediate Level Frameworks

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This section covers topics related to the translation of high level policies into general direction with respect to the specifics of who, where, when, and where natural resources are managed. This is a critical interpretative phase, with many potential implications for EBM. At this level, the topics include regional and sub-regional land use planning, cumulative effects, and integrated land use issues that start to address those part of the forested landscape that are not part of the "working landbase" from a forest management perspective. This level also addresses the ongoing concern of natural resource silos. The three main sub-sections here discuss the EBM challenges and opportunities as they relate to the three main strategic levels of planning used today; land use, sub-regional, and forest management or licence area.

C1 Land Use EBM Planning

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Land use plans are a high-level planning scale that affirms or changes existing land uses, designates new land uses and provides direction to lower planning levels, including management of DFAs with specified allocations or uses. A linked system of plans of increasing detail for outcomes and activities is needed to facilitate EBM (Slocombe 1998). Hierarchical and comprehensive EBM also requires multilevel governance systems that recognize the importance of diversity in land ownership and use. EBM can inform and support land use planning.

As an integrated approach, EBM is comprehensive, place-based, throughout time and space, looking at things from multiple standpoints, and including linkages between society and ecosystems and between different types of ecosystems (Delacámara et al. 2020). EBM strives to bring together all the pieces of the VBA (plus some others unique to EBM) for specific DFAs, with each DFA being unique. Adding up in scale from individual DFAs provides regional, provincial, national, and international contexts. Adding down in scale provides sub-regional and local details and short-term actions. EBM requires a multiscale approach because of the nested, hierarchical nature of complex systems on both the ecological and human use sides (Odum 1982; Chambers et al. 2019).

EBM planning can be defined as the identification of measurable outcomes (targets) for indicators and the activities (actions) needed to achieve them. Hierarchical planning refers to developing plans with targets and actions at two or more scales or levels within an integrated hierarchy from strategic to tactical scales, usually with increasing levels of detail as scales decrease (Weintraub and Cholaky 1991). Hierarchical planning is useful when planning is very complex and involves many aspects and interests (Sessions and Bettinger 2001). Hierarchical planning that includes spatially and temporally explicit

strategic plans is the best option to achieve ecological integrity and human wellbeing objectives over time and space and verify that we are moving towards sustainability (Bourgeois 2008).

A formal management system is needed to define, plan, implement, monitor, and continually improve EBM. A management system is a set of interrelated or interacting elements used to set policies and objectives and to establish the processes that are needed to ensure that policies are followed and objectives are achieved. There are many forms of management systems. The international ISO 14001 *Environmental Management System* (EMS) Standard (International Organization for Standardization 2015) has been adopted as a management system for both the Alberta and Saskatchewan provincial governments and it is also used by most forest companies.

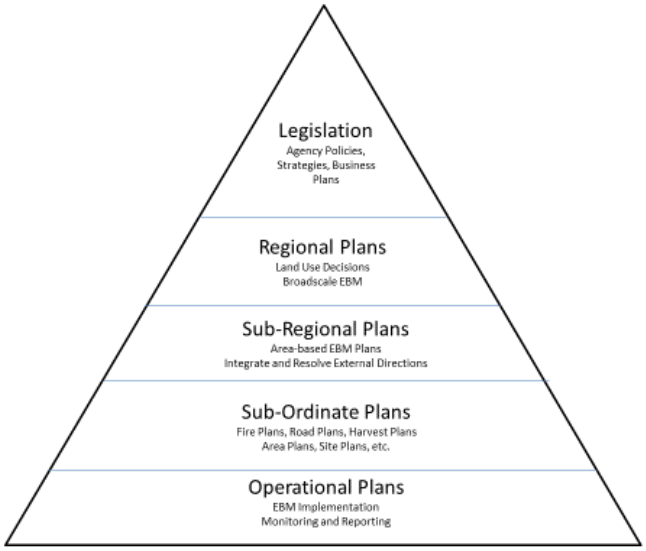

Figure C1. A hierarchical planning diagram modified from Scholte (2009). Regional plans would be government land use plans and related large-scale area-specific plans. Management plans would be sub-regional EBM plans in a non-overlapping and complete layer of DFAs. DFAs could be combinations of smaller units to assemble areas of sufficient size to address EBM at appropriate scales but not get so large that they become unwieldy. Subsidiary plans would flow from or feed into EBM plans. Operational plans would provide further detail for short-term actions (e.g., 5-year Development Plan, one-year Annual Operating Plan, individual actions

In parallel with the CCFM process Alberta and Saskatchewan progressively incorporated SFM and EBM into their commercial forest management frameworks. The Alberta Forest Management Planning Standard (AFMPS) was first released in (Government of Alberta 1998) and revised in 2006 (Government of Alberta 2006). The Saskatchewan Forest Management Planning Standard (SFMPS) was first released in 1995 (Government of Saskatchewan 1995) and revised in 2017 (Government of Saskatchewan 2017). Both provincial standards use the plan-do-check-act continual improvement cycle from the ISO 14001 EMS Standard (International Organization for Standardization 2015) (Figure C2; Scholte 2009)

Management System Process

a) Establishing policy
b) Planning
c) Implementation and operation
d) Checking and corrective action
e) Management review

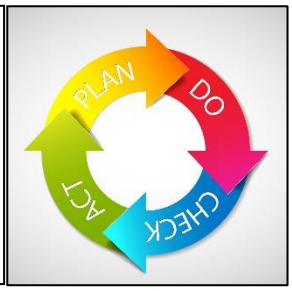

Figure C2. Example Management System Loop

Goals and objectives reflecting individual, organizational, and societal values and philosophies are critical to any planning or management process (Slocombe 1998; Chambers et al. 2019). EMS *Values, Objectives, Indicators, and Targets* (VOITs) as described in CAN/CSA Z809 (Canadian Standards Association 2016) were used in the forest management planning standards for forest management plans for commercial forests in Alberta and Saskatchewan. The EMS continual improvement cycle (Figure C2) is also used in the three main SFM certification standards, and it was used in this report for consistency and comparability.

In Canada the provinces and territories are responsible for land use planning and designations on provincial lands and the federal government is responsible for federal lands. The federal government is responsible for relatively small proportions of total forest area in Alberta and Saskatchewan and does not undertake formal land use planning at large scales in either province. Potential creation of new protected areas under initiatives such as the Canada Target 1 Challenge are a form of federal land use planning in cooperation with the provinces, Indigenous governments, and others.

Provincial governments use land use planning to manage their land and natural resources to achieve economic, environmental, and social goals. As the highest integrated land planning initiative, land use plans are an ideal entry point to a connected hierarchical planning system that is needed to implement EBM and provide directions to lower-level planning scales. EBM principles suggest that land use decisions should start with affirmation of protected area networks, including any changes or additions to existing networks, and other land use categories as required to determine allowed human uses.

Alberta established a new *Land-use Framework* in 2008 and has completed Regional Plans for 2 of 7 regions that closely follow the major watersheds of Alberta. Through the 2009 *Alberta Land Stewardship Act*, approved Regional Plans that become law override other provincial legislation and plans. The ALSA provides the legal basis for the development of regional plans under the Land-use Framework. The Land Use Secretariat (LUS) was established by the ALSA as part of the public service of Alberta but not as part of a government department. The LUS reports to a Stewardship Commissioner and works independently of a department and is subject only to directives issued by the Stewardship Minister, who is responsible for ALSA.

In November 2020 Alberta announced Alberta's Crown Land Vision, which includes "*a clear, understandable system for land use with an integrated approach to managing all Crown lands, sustainable funding and partnerships for recreation, and focusing on outcomes and reducing red tape*" (Government of Alberta 2020a).

The Saskatchewan *Forest Resources Management Act* (Government of Saskatchewan 1996) states the promotion of "sustainable use" as its main purpose. The revised *Forest Resources Management Act and Regulations* (Government of Saskatchewan 1999) contained a commitment to prepare a provincial Forest Accord every 10 years to establish long-term principles, policies, and goals for forest management in the province. The *Forest Resources Management Act* was the initiator of land use plans in Saskatchewan (Rayner and Needham 2009). On a five year cycle, Saskatchewan produces Integrated Forest Land Use Plans that include EBM aspects for each of the province's forest management units (divisions of the provincial crown forest).

Saskatchewan land use planning links environment, community and economy to ensure resources sustainability, integrate environmental, social and economic values, resolve conflicts, build common land use objectives, and ensure openness and inclusiveness. The Saskatchewan land use planning system is not as geographically complete as Alberta's and tends to be done on an as-needed basis. It currently appears to be largely inactive. Land use planning objectives are largely absent in Saskatchewan and there is no framework to guide provincial and regional objectives for land use planning that could identify trade-offs and provide an indication of government objectives (Rayner and Needham 2009). Saskatchewan is in the process of establishing more protected areas through its Representative Areas Network Program.

Governments are understandably reluctant to make major changes to pre-existing land uses and tend to make land use decisions that include the least controversial options. Both of the Land-use Framework Regional Plans approved in Alberta added major new areas to the provincial protected areas network, that had comparatively fewer existing uses that needed to be reconciled as part of the designations. The process attempted to balance ecological representation with minimizing disruptions to existing land uses.

> *"The Alberta Land-Use Framework has been driven by powerful interests within and external to government each fighting for their own interests. The public and especially Indigenous are not well engaged and influential. This is a huge challenge."* (Anonymous SME).

The Alberta and Saskatchewan governments support EBM goals through their policies to maintain healthy ecosystems:

- Alberta Land-Use Framework (2008): "Outcome 2 – Healthy ecosystems and environment. Alberta lands should be managed to ensure healthy ecosystems."

- Saskatchewan State of the Environment (2019): "In order to maintain healthy ecosystems, environmental protection must be balanced with economic growth. Forests are managed to ensure environmental contributions into the future. Natural and human disturbances can change forest landscapes, composition, structure, and habitat diversity. Forest management includes the stability, resilience and rates of biological production in forest ecosystems."

> *"Saskatchewan land use plans started in 1995 and were supposed to be done in five years and then reviewed every five years. Most plans were never completed or signed off, the provincial governments, whether left or right of center, would rather not have plans they have to follow. The land use process is in limbo now."* (Anonymous SME).

CHALLENGES

- Land use decisions are made by the responsible government authority for the lands and waters in question. For forested ecosystems the main authorities are provincial governments for provincial lands and the federal government for federal lands. Federal and provincial authorities overlap where federal legislation (e.g., Fisheries Act, Migratory Birds Convention Act, Species at Risk Act) might apply to or influence provincial lands and provincial land use decisions. Federal and provincial governments manage overlapping authorities through cooperation such as the Species at Risk Accord and environmental impact assessment processes. This process can result in conflicts between governments.
- Land use planning alignment and cooperation between the federal and provincial governments and between provinces across borders is weak.
- Land use allocations are a continually-changing surface that reflect historical and evolving interests of societies. Population growth and increasing needs for land and resource uses lead to competing demands and increased pressures and cumulative effects.
- Both provinces include EBM aspects in their land use planning process and decisions reflect EBM to varying degrees but neither province has specifically embraced EBM or incorporated an EBM implementation framework into their land use planning processes.
- Higher-level land use plans should be informed by EBM principles, particularly for selection and designation of protected areas and reserves, resolution of conflicts between competing uses (e.g., through zoning), and policy direction for ecological management and restoration, and direction to lower-level planning processes. In practice social, economic, and political aspects appear to dominate the process.
- The Alberta Land-use Framework covers the entire province but original timelines to complete regional plans by 2012 were not met and regional plans have not been completed for five of the seven land use regions. The LUF initially was regarded as a policy that could upset economic growth of the resource (especially energy) industry (Budny 2014) and persistent resistance from powerful resource interests has prevented the process from achieving clearer success (Urquhart

2018). The GOA failed to account for the inherent legacy of sectoral policy making and path dependency of prioritizing the interests of the energy resource industry (Budny 2014).

- Saskatchewan's land use planning system covers the entire province in concept but not in application (Rogers 2008). Saskatchewan does not currently have a plan to complete land use plans for the entire province (SME interviews).
- Despite good intentions, provincial land use planning initiatives and associated tasks may be delayed, not completed, or not updated on a timely basis (Thielmann and Tollefson 2009; Land Use Planning Hub 2018). This leaves a hodgepodge of regional outcomes and challenges effective policy coordination and accountability for land use outcomes at the provincial level (Kennett and Schneider 2008; Rayner and Needham 2009).
    - Land use planning is expensive and provincial governments may be unwilling or unable to fund the process.
    - Land use planning takes time, which can result in people losing interest, priorities changing, and new perspectives and knowledge arising during the course of planning.
    - Land use planning is inevitably controversial and influenced by political considerations and cycles (Wilson 1998; Robinson et al. 2001).
    - For political reasons governments are famously averse to making controversial decisions. Everything is viewed through a lens of popular support and electoral benefit. If local people (electors) do not agree with an initiative, politicians are inclined to back away (SME interviews).
    - Land use planning is still focussed on the VBA, which pits values and their advocates against each other instead of engaging them in processes to develop shared outcomes.
    - Much process goes into areas of disagreement and comparatively little goes into areas of agreement.
    - Historic land use planning often consisted of a compilation of separate agency objectives and targets that were not supported by area-based scenario forecasting of future forest conditions to see if all goals could actually be simultaneously achieved on the specified landbase (Brownsey and Rayner 2009; Rayner and Needham 2009). This created an illusion of integration that was often not feasibly achievable and more or less guaranteed that implementation would fail.
    - Because targets were not integrated and often were not quantified in measurable terms, there was no accountability for failing to achieve results.
- For many of the same reasons land use plans are rarely completed on time, land use plans are rarely fully implemented on the ground (Godschalk 2004; Brownsey and Rayner 2009; Rayner and Howlett 2009; Hogl et al. 2016).
- In theory land use plans are "living plans" that are regularly reviewed and updated to maintain currency with events and priorities but this has not been the case in practice.
- The main purpose of land use plans is to consider acceptable human uses and make decisions about the areas where they are allowed. Environmental and ecological considerations factor

into human use decisions but may not be specifically recognized or quantified. Land use plans are also the appropriate process to recognize that not all desired ecological integrity and human wellbeing outcomes are simultaneously possible (Newman 2019).

- Plans may direct creation of new land use units such as protected areas. They do not explicitly direct application of EBM in any land use category; those decisions are considered at lower planning levels. Because of this, land use plans currently miss an opportunity to provide strong EBM direction.
- The land use plans do promote hierarchical planning but do not mandate preparation of area-based long-term plans for a complete coverage of non-overlapping DFAs. This is an important tool to define and implement EBM across connected landscapes.

RECOMMENDATIONS

> *"Land use plans provide opportunities to integrate across all ecological and human values for particular landscapes. If done well they more or less force people to participate, especially if the focus is on outcomes and not activities."* (Anonymous SME).

> *"Changing one thing always changes other things. Land use plans could be used to compare alternatives as packages of all things considered important for a given area. There will still be disagreement over the alternatives, but at least people will be able to see the pros and cons and hopefully understand and support the alternative that wins the day. That's EBM in action."* (Anonymous SME).

- Provincial governments have opportunities to explore and pioneer land use planning innovation by reinventing how land use plans are developed and implemented through EBM. This could start with investment in longer-term planning processes and institutions that are dedicated to the science and practice of planning (Parkins 2011).
- Discussion papers describing how land use planning is currently done in each province and options to use EBM to strengthen the processes would be useful to support societal review and recommendations about how to improve land use planning.
- The Alberta land use planning process has slowed due to a new government and the COVID pandemic. This provides an opportunity to review the Alberta Land-use Framework in relation to building EBM into Regional Plans and Subregional Plans.
- The Saskatchewan land use planning process is also in a slow period. This provides an opportunity to review the Saskatchewan land use plan process to build EBM into future plans.
- Land use plans are excellent opportunities to initiate large-scale EBM. These include questions such as:
    - How much natural forest land will be maintained as forest lands as compared to conversions to other uses (e.g., agriculture, settlements).

    - How much land to be managed as forest lands will be allocated to protected areas, commercial forest areas, non-commercial forest areas, other uses, etc.
    - How will land use plans direct EBM at lower planning levels, especially strategic EBM subregional plans for DFAs.
- Land-use plans that incorporate dynamic adaptations in socio ecological relationships help to advance understanding of both past and future land-use changes and their sustainability and potential effects at multiple scales.
- Where commercial timber logging should and should not occur is one of the most contentious land use decisions, and the challenge strongly influences public involvement in commercial forest planning. Separating decisions about whether or not to allocate lands for commercial forests (land use plans) from decisions about how to use EBM to manage commercial forests (forest management plans) is an opportunity to focus on the key questions at the appropriate level.
- There are opportunities to link strategic land use plans with more detailed DFA-specific EBM subregional plans at lower levels, and use the linkages and synergies to make continual improvements at both planning levels.
- Explore opportunities to increase land use planning alignment and cooperation between the federal and provincial governments and between provinces across boundaries and orders. This could start with identifying EBM aspects that need to be addressed across borders. Typically, these are the larger-scale ecological contexts that transcend administrative boundaries. In some cases, there are also human contexts that need coordination (e.g., Indigenous traditional use areas).

C1.1 Land Use Designations

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Ecological integrity and EBM are frequently cited as a goal for land use decisions, especially in relation to protected areas and private sector developments. Protected areas designations help to achieve societal protected area network goals. These provide high conservation value but limited area, poor connectivity and high rates of anthropogenic disturbance (Ellis et al. 2013) means they must be part of EBM for entire forest landscapes (Table C2).

Table C2. Forest Land Use Designations in Alberta and Saskatchewan.

Forest Land Category	Alberta	Saskatchewan	Federal
Unallocated forest lands	Included in LUF Regional Plans	Included in land use plans	n/a
Area-based tenures	Forest Management Agreement	Forest Management Agreement	n/a
Volume-based tenures	Timber Quota	Term Supply Licence	n/a
Miscellaneous tenures	Timber Permit	Term Supply Licence	n/a
Private lands	Agriculture and forest	Agriculture and forest	n/a
Protected areas	Provincial Parks, Wilderness areas, etc.	Provincial Parks, Representative Areas Network, etc.	National Parks
Indian Reserves, Metis	Metis settlements	Metis settlements	Indian Reserves
Settlements	Communities	Communities	Communities
Infrastructure	Human sites	Human sites	Human sites
Federal lands	n/a	n/a	Military areas

Protected area legal designations by governments may be associated with land use processes (e.g., Alberta Land Use Framework), agency initiatives (e.g. Saskatchewan Representative Areas Network, Canada Target 1 Challenge), or one-off government decisions (e.g. 2018 Alberta Bighorn Country Protected Areas proposal). Development designations help to sustain human wellbeing through economic and social uses of forest lands. Development designations may be associated with government initiatives (e.g., 1999 Saskatchewan forest industry expansion) and private sector development proposals (e.g., Oil Sands Development in both provinces).

Protection and development land use decisions are both controversial because factions of human society differ in their views over the appropriate balance. Ultimately, governments are accountable to citizens for their land use decisions. The process never ends as governments come and go and societal views evolve and change. EBM has great potential to inform land use decisions and provide a common frame of reference that may help to reduce the associated controversies over time.

Where land use designations have been made, land management decisions should be about the best way to manage the designations, not whether the designation was wrong. However, land use decisions, or their absence, are frequently mixed up with land management decisions. Land management processes often include participants that disagreed with the land use decision or want a different decision than the management decision that is being considered. This can overwhelm the voices of participants that are interested in how best to manage according to the existing land use designation.

Alberta and Saskatchewan forest lands are administered by the provincial governments (public land, private land) or the federal government (National Parks, military lands, Indian Reserves, other federal lands). The responsible government authority makes land use designations under their respective legislation. Provincial designations include legislated protected areas and forest industry tenures and directions controlling other human uses such as energy, mining, commercial activities, and public use. Land use responsibility tends to remain stable over time but occasionally changes between provincial and federal governments (e.g., creation or expansion of Indian Reserves and National Parks). When provincial designations change or governments restructure the management responsibility may change between government agencies.

Both provinces have relatively small forest areas in private land, so they face minor issues with applying EBM across land ownership categories, which is a prominent factor in other areas such as the USA (Cortner 1996).

The first Alberta land use framework in 1948 divided the province into Green and White Areas. Forest production, wildlife management, and recreation were permitted within the Green Area, and agriculture and settlements were permitted within White Area. Alberta later divided Green Area forest lands into Forest Management Units, which may be allocated to industry through some form of tenure. Unallocated FMUs represent areas that for some reason are not allocated or considered suitable for commercial tenures. They are analogous to the non-commercial forest zone in northern Saskatchewan.

Saskatchewan divided provincial forests into Commercial and Non-commercial Forest Zones. The Commercial Forest Zone is divided into management tenures held by forest companies or managed by the GOS.

In addition to formal legislated land use designations governments use zoning to designate and specify permissible human uses or resource values for specified geographic areas. The 1977 Policy for Resource Management of the Eastern Slopes identified the priority uses of the Alberta Eastern Slopes to be watershed integrity, public recreation and tourism. Resource development was permitted only where compatible, and zones were established to define each land use category. Alberta Public Land Use Zones (PLUZ) are used to manage recreational activities and each PLUZ has specific regulations. Zones used in Saskatchewan include seed zones, fire management zones, hunting zones, etc.

CHALLENGES

> *"EBM is constrained in some Alberta areas by over allocated AAC and little room to resolve wood supply challenges."* (Anonymous SME).

> *"Alberta pursued maximum development for many decades and ignored the environmental consequences. This produced mounting liability and unresolved challenges that can't be solved simply by changing land use designations."* (Anonymous SME).

- Governments historically tend to make land use designations primarily in response to social (e.g., new protected areas) and economic (e.g., forest industry expansion) values and goals. Landuse debates and decisions usually do not use EBM as an organizing concept to frame debates.
- The responsibility to propose and manage designation changes is dependent on the social and political values and goals that drive changes, which gives government agencies changing roles and responsibilities that may not be informed by EBM.
- Land use plans may include zoning directions which are often oriented toward activities instead of outcomes. Directions can be inflexible and function to reduce innovation.
- Zoning by activities risks continuation of the underlying conflicts over which uses will be allowed.
- Government agencies can have roles and responsibilities as both development proponents and environmental stewards. This tension is unavoidable and it challenges trade-off decisions.
- The public good responsibility of designations is usually a political decision that reconciles competition between government agencies and social pressures.

RECOMMENDATIONS

> "Area-based sub-regional plans are a possible way to resolve challenges by creating landscapes that support development as well as other values over space and time." (Anonymous SME).

- Governments are moving toward area-based land use planning which is more effective and efficient than ad hoc single-issue proposals. Government agencies responsible for land use planning have a mandate to reconcile ecological integrity and human wellbeing. This could be extended to incorporate additional measures to implement EBM.
- Land use plans can be used to revisit and affirm or revise historic land use designations.
- Governments can direct completion of area-based subregional EBM plans for DFAs as lower-level plans.
- Zones based on ecological distinctions may be useful for organizing EBM and providing clear and specific management directions. For example, classifying watersheds and watercourse channels using ecological criteria offers the potential to convert the distinctions to zones that recognize the inherent differences in disturbance regimes.
- Zoning has the potential to reduce conflicts between stakeholders by establishing a hierarchical order of uses within each zone (Côté et al. 2010).
- Zones could be useful organizing concepts to support EBM by assigning levels of EBM balance, from zones of higher ecological integrity at one end of a gradient and zones of lower ecological integrity at the other end. Human use intensity would be the opposite over the same gradient. Examples of this type of zoning include the TRIAD concept (Seymour and Hunter 1992) and the

proposed protected, converted and consistent zones in the B.C. Old-growth Panel Report (Gorley and Merkel 2020).

- Zones could help to reduce challenges associated with the NIMBY problem. For example, zones with few resources that are valued socially in locations without sensitive ecological systems could be good locations to schedule large disturbance events, while zones with high levels of environmental or social values could be good locations to schedule smaller events with lower levels of intensity. Such zones could be managed directly by governments, communities, or Indigenous people, or combinations thereof, to add more flexibility and increase engagement and "ownership" of EBM on local scales (Vertinsky and Luckert 2010).
- Zones could be used as lower-level planning units and plans developed for them would help to reduce uncertainty associated with EBM including the long-running generational conflicts between values advocates.

C1.2 Cumulative Effects

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Cumulative effects are changes to environmental, social and economic values caused by the combined effects of past, present and potential future human activities and natural processes. There is an extensive and complex regulatory and policy framework to address cumulative environmental effects in Alberta and Saskatchewan which is administered by both the provincial governments and the federal government. Cumulative effects assessments (CEA) became mandatory for all EIAs required under the 1995 Canadian Environmental Assessment Act.

CEA in Alberta (Government of Alberta 2015) is part of formal environmental impact assessments usually applied to resource development projects subject to the *Environmental Protection and Enhancement Act* (Government of Alberta 2000). Alberta also is working on a *Cumulative Effects Management Framework* which is to be applied through the *Land-use Framework*. This initiative offers the potential to incorporate strategic area-based cumulative effects management into Alberta policy and planning.

Alberta is developing *environmental management frameworks* to manage cumulative effects by establishing outcomes and objectives along with the strategies and actions to achieve them. The frameworks are intended to provide context within which decisions about future activities and management of existing activities should occur. They confirm regional objectives and establish thresholds. They are intended to add to and complement, not replace or duplicate, existing policies, legislation, regulation and management tools.

Saskatchewan does not have a formal process for identifying and managing cumulative impacts. The Cumulative Impacts and Science Branch is currently primarily concerned with climate change.

The GOC approach to address cumulative effects includes 4 components: integrated open science and data platform, regional assessments, strategic assessments, and national environmental frameworks.

Challenges

> *"Cumulative effects are real but largely still a dirty word. The [Alberta] government attitude is everything everywhere fast and no tradeoffs, which maximizes government revenue and cumulative effects at the same time."* (Anonymous SME).

> *"Government uses regulation as a means of control but often doesn't get the response it was looking for, which leads to more regulation and eventually it's not sustainable. Using EBM to identify outcomes and then some level of regulatory reform to achieve them requires a far better level of trust than we have now."* (Anonymous SME).

- Cumulative effects arise from failures in up-front avoidance through governance systems that anticipate potential negative cumulative effects and take steps to prevent occurrences.
- CEA has traditionally been applied mainly to environment impact assessments (EIA). CEA guidance has been largely ignored in actual EIA practice and has largely failed to deliver on the early promises of safeguarding environmental and ecological values that might be compromised by development (Duinker and Greig 2006).
- Current CEA is often hampered by either too technical or too political approaches to decision making that leave large portions of society unsatisfied with the outcomes. Attempts to apply a more pragmatic approach and increase societal support are challenged by the difficulties in achieving more democratic decision making (Parkins 2011).
- Regional CEA tends to be not well-integrated into governance structures, and when it is mentioned or actioned it is typically done as a response to "after the fact" occurrences. For example, Alberta environmental management frameworks set limits for individual cumulative effects outcomes such as air particulate levels, with triggers at a lower level to flag potential challenges. But it is only after a trigger or limit is exceeded that an analysis and possible corrective action is done. The horses have left the barn.
- Thresholds (limits, triggers, targets) are usually set in isolated processes and the science to support them is often limited, which means thresholds are often set arbitrarily (Duinker and Greig 2006). Also, they are usually set without clear understandings of effects on other aspects of ecological integrity and human wellbeing. This can lead to unresolvable contradictions between thresholds, or between environmental thresholds and human wellbeing. It also prevents opportunities for innovation through imagination and consideration of different alternatives.
- Cumulative effects monitoring programs are often short-lived initiatives or disconnected from land use planning and regulatory decision making (Cronmiller and Noble 2018).

Recommendations

> *"Present EBM to the energy sector as a way to manage change and address cumulative effects. If we can arrive at higher-level plans and use those to direct cascades of lower-level plans we may be able to replace lower-level regulation and reduce the regulatory burden. EBM has to be packaged to appeal to the specific interests of those being asked to buy in"* (Anonymous SME).

- Explore opportunities to address CEA challenges by building institutions for cumulative effects assessment, and move away from short-term project-focussed CEA toward strategic integrated assessment and resolution over the long term (Parkins 2011).
- Strategic environmental assessment (SEA) is a widely-used process for policies, plans and programs that could be used to evaluate current structures and instruments, future options, and the institutional environments needed to enable the development and implementation of successful strategic initiatives (Noble and Nwanekezie 2017).
- EBM implemented at regional and subregional scales provides an opportunity to replace the currently reactive CEA practice with a proactive planning-based approach that includes explicit creation of alternative development scenarios and analysis of potential cumulative effects associated with each one (Greig et al. 2004).
- Operationalizing the concept of regional CEA through land use plans led by governments provides opportunity to consider the potential cumulative effects of all human activities and other stressors (invasive species, climate change, species at risk, etc.) and design plans to avoid, minimize, and mitigate both current and anticipated future cumulative effects (Kennett 1999; Duinker and Greig 2006).
- Educational tools such as the Alberta tomorrow simulator could be used to increase public understanding of land use and EBM.

C1.3 Environmental Impact Assessment

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Project based environmental impact assessment began across Canada in the 1970s (Beanlands and Duinker 1983) and has continued to evolve (Doelle and Sinclair 2019). Project based assessments have been criticized for their limited and ad hoc nature, focus on process, and lack of integration into larger policy, planning and development systems decision making (Spahlinger 2018; Noble et al. 2019).

In Alberta most EIAs are reviewed and led by Alberta Environment and Parks under the authority of the Alberta Environmental Protection and Enhancement Act, *Environmental Assessment (Mandatory and Exempted Activities) Regulation*, and *Environmental Assessment Regulation* (Government of Alberta 2000). The Alberta Energy Regulator is responsible for EIAs associated with energy projects.

In Saskatchewan the *Environmental Assessment Act* (Government of Saskatchewan 2000) requires development proponents to conduct an Environmental Impact Assessment, which includes cumulative

environmental effects. The Saskatchewan *Cumulative Impacts and Science Branch* is responsible for broader cumulative effects.

At the federal level, project assessments required by the *Impact Assessment Act* (Government of Canada 2019a) consider potential environmental, health, social and economic impacts of proposed projects, including benefits.

The federal and provincial governments have cooperation agreements first signed in 1999 to avoid duplication and ensure that environmental assessments are conducted as efficiently and effectively as possible. In addition, the *Canadian Council of Ministers of the Environment* (CCME) maintains a *Cumulative Effects Working Group* that is identifying key elements of an effective cumulative effects monitoring regime and developing CCME guidance for standardized indicators of cumulative effects and measurements of ecosystem health.

In addition to comprehensive and project-based assessments, individual cumulative effects are considered in most regulatory, policy, and planning instruments. An example is The Cabinet Directive on the Environmental Assessment of Policy, Plan and Program Proposals (Government of Canada 2010). The instruments are usually narrowly focussed around specific values and may miss bigger-picture aspects and challenges.

Challenges

Regulatory EIA requirements have become so costly, burdened with red tape, and subject to political influence that they discourage or prevent projects that may be in the public interest (SME interviews).

- Environmental impact assessments are the responsibility of development proponents and are geographically centered on development proposals. This is inefficient (expensive, narrow mandate, process-oriented, time-limited, information-limited, EIAs can overlap, etc.) and the one-at-a-time process does not encompass temporal cumulative effects.
- Existing management is often focused on activities and ignores or inadequately manages cumulative effects outcomes. For example, planning and approving roads on an as-needed basis does not manage the cumulative effects of roads and associated human uses on ecological integrity outcomes.
- Regulatory EIA requirements have become so costly, burdened with red tape, and subject to political influence that they discourage or prevent projects that may be in the public interest.
- In the case of “multi-aspect” environmental problems, the Tinbergen Rule suggests a combination of several instruments, because a first-best optimum cannot be reached with any one single instrument such as EIA (Tinbergen 1952; OECD 2007).

Recommendations

A complete system of land use plans based on EBM with quantitative targets for environmental indicators could eliminate the need for traditional regulatory EIA. (SME interviews).

- As a comprehensive management approach, EBM is designed to identify and manage cumulative effects at landscape and regional scales. Area-based management plans such as Forest Management Plans and Park Management Plans are the closest current instruments to consider cumulative effects for DFAs.
- Incorporation of area-based cumulative effects assessment into land-use plans and DFA EBM plans could provide a comprehensive framework that
    - Uses cumulative effects assessment for historic, current, and forecasted future disturbances and conditions to effectively manage area-based cumulative effects
    - Provide background and context for new projects, which would simplify and streamline project-based environmental impact assessment. Projects could assess the effects of their project against existing regional targets and regulators could use the assessment to decide if the project is acceptable. Accepted projects would be incorporated into the next revision of regional EBM plans.
- As an initial step, a concept document that describes how land use plans and subregional EBM plans could be used to manage cumulative effects and EIA would be an opportunity.

C1.4 Integrated Land Management

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An EBM objective is to minimize the surface footprint of human uses because there are no natural analogues for roads, railways, pipelines, transmission lines, seismic lines, wellsites, facilities, settlements, and other human surface infrastructure. Coordination of human activities to manage surface infrastructure to minimize environmental impacts and maximize efficiency is called integrated land management (ILM) in Alberta. Saskatchewan does not use the same term but has similar processes with the same basic objectives, to minimize the footprint needed and mitigate the ecological effects. ILM is particularly important where different users share surface lands and develop their infrastructure using different criteria and processes. The energy sector and the forest sector overlap over large proportions of Alberta forests and the western portion of Saskatchewan commercial forests, which makes ILM an important EBM aspect in both provinces.

Challenges

"Alberta and some parts of Saskatchewan have extensive areas with significant legacy footprint including linear corridors and two-pass harvest checkerboards. How to restore these is a challenge." (Anonymous SME).

"EBM establishes the need to do ILM, so improved ILM makes sense because it's done for a higher purpose. Going from saying ILM needs to be done to actually doing it is a big challenge because of the legacy of doing things the old way and the low levels of trust between key players." (Anonymous SME).

"People are all over the place with levels of EBM understanding. For example, a company is going back to an older area that had access and are obligated to reclaim the roads when they are done. Local Indigenous communities have been using the roads for 25 years and want to continue. The government plan says reclaim them. Gridlock. It will be interesting to see where it goes." (Anonymous SME).

- In areas with multiple developers of surface infrastructure the cumulative effects of development are a challenge to manage (Schneider et al. 2003).
    - Multiple companies, tenures, timelines.
    - Competitive, fractured, rules driven.
    - One development (e.g., a road) at a time. Local mitigation, Follow the rules.
    - Few limits to quantity and rate.
    - No way to directly address cumulative effects.
    - Inefficient, ineffective, and frustrating.
- While there is some shared infrastructure such as roads, different human users have their own infrastructure needs and challenges to make infrastructure work for them.
- The division of regulatory responsibilities and processes makes it hard to coordinate development to share and minimize total footprint. The forest and energy sectors submit infrastructure plans and proposals to different regulators and must comply with different requirements.
- In Alberta a referral process is used to inform forest companies of energy development proposals and provides an opportunity for the two sectors to coordinate. This process helps to coordinate between the two sectors at the level of individual or small group proposals, but it misses big picture opportunities.
- The referral process occurs after energy companies have already invested in planning and surveying, making it more difficult to make beneficial adjustments.
- Companies have limited resources available for coordination and those tend to be allocated toward the interests of individual companies rather than common objectives to minimize and mitigate infrastructure.
- Government requirements intended to coordinate and minimize infrastructure are incomplete and, in some cases, have unintended consequences. For example, Alberta direction to energy companies to use existing corridors for roads and pipelines is beneficial when forest company roads already exist. When the only existing corridors are seismic lines, energy sector roads that follow them are often not the best access routes. This could mean unnecessary watercourse and wetland crossings, steep road grades that could have been avoided, and road grades and locations not usable for forest companies. This creates later challenges for both sectors and

leads to duplication of road infrastructure, costly realignments, redundant roads, unnecessary environment and ecological impacts, etc.

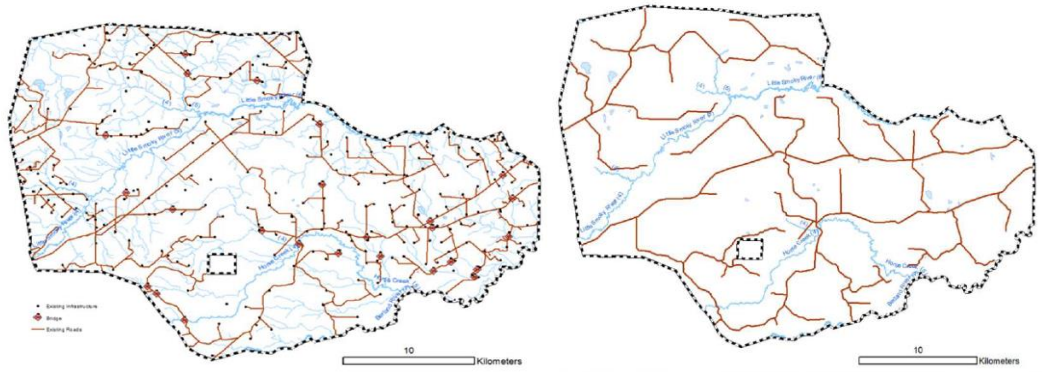
- Each user sector is further divided into individual companies with different objectives. This is especially prominent in the energy sector, where multiple companies may have the rights to develop different subsurface zones beneath the same surface area. Competition between companies makes cooperation difficult and results in each company pursuing development of their own infrastructure. This leads to duplication and redundancy.
- In Alberta the provincial government sells energy development leases through competitive auction. Companies that buy development rights must commence within specified time periods or the government can cancel their rights and put them up for auction again. This process maximizes government revenue and encourages timely development (companies can't 'sit on' development leases), but it can also cause companies to proceed with inappropriate initial development to maintain their development rights. This reduces opportunities for coordination and minimization of infrastructure.
- Regulatory agencies also have difficulty with internal referral processes, which may cause delays in approvals and increased costs for both government and developers.
- ILM is overwhelmingly oriented to development activities instead of development outcomes. Both activities and outcomes are needed to successfully manage cumulative effects. Governments have responded by developing thresholds which in theory limit cumulative effects. However, thresholds are usually developed in isolation for single or narrow groups of values or activities. This can lead to inefficiency and gridlock when developers and government agencies attempt to simultaneously apply multiple disconnected requirements and processes.
- Provincial governments have been slow to move away from activity-based development planning and approvals supported by ILM requirements towards a plan-based ILM approach.
- When initiatives have been proposed and piloted the process has been slow and hampered by governments inability to shift nimbly from the existing system towards a plan-based approach.

- In some cases, thresholds are developed as outcomes without processes to achieve them (Little Smoky Regional Access Management Plan; Thorp and FMLF 2019).

Box C1. Access Management Plans

Roads, trails, and other linear corridors are typically built on an as-needed basis and tend to persist on landscapes whether or not they are in use. The issue is especially important where multiple users build access and where access built for one purpose gets used for others (e.g., seismic lines used for motorized access).

Regional Access Management Plans are a tool to rationalize existing access networks and plan for future access needs. The pilot area example below shows 507 km of existing roads (left side) that can be reduced by 42% to 293 km over time (right side) and still meet all existing and expected future permanent road and resource access needs (Thorp and FLMF 2019).



Access management planning depends on clear land use objectives. In this case the access network was planned assuming full access to forest and energy resources was to be provided.

- Once built, considerable proportions of infrastructure tend to remain on the landscape because:
    - It is required for ongoing land uses that were the reason for development, or will be needed for future uses.
    - It is being used by others (e.g., public access for recreation, trapping access, Indigenous access, etc.) who may be resistant to reclamation.
    - There are no requirements for reclamation (e.g., seismic lines).
    - Reclamation requirements are triggered by completion of need, not by a period of inactivity. Fees to maintain inactive dispositions are low enough that owners can easily pay them to maintain future opportunities and avoid incurring reclamation costs and potential costs to reacquire authorizations.
    - Reclamation requirements are not enforced.
    - Unauthorized construction is not managed by governments.
    - New unauthorized access gets established over reclaimed areas after the original holder has discharged their requirements.

- Accountable infrastructure holders that are responsible for reclamation disappear through insolvency and other processes, leaving governments with the legacy infrastructure problems.

- The Alberta orphan well program was established in 2002 to close wells, facilities and pipelines that do not have a solvent and responsible owner. In recent years funding provided by an orphan well levy paid by energy producers has not kept pace with the number of sites needing treatment (Orphan Well Association 2019).

Recommendations

> *"There are multiple overlapping land uses with associated linear corridors that have no natural analogue. EBM says to minimize corridors. Owners/users have to work together and with government. Develop integrated plans and use them for future approvals with a process for adjustments when needed. Geothermal is an example of a new activity that might need a different surface footprint and be a reason to make adjustments to access plans."* (Anonymous SME).

> *"Tough times for the energy sector actually provide an opportunity for EBM such as access plans. When times are good the energy sector doesn't focus on costs, just speed. Only now do they look at access management as a valuable cost-saving exercise that also helps with sector reputation, so it makes sense."* (Anonymous SME).

> *"EBM actions that can be done now include reclamation of all footprint within cutblocks as part of reforestation. This includes roads, seismic lines, pipelines (plant trees), etc. Include as part of regional access planning using a cooperative approach and best technology. Do these as part of caribou range plans to start, fish species at risk at the watershed level, grizzly bear, etc. Eventually extend access plans to the whole province."* (Anonymous SME).

- ILM is an initiative that requires governments, industry sectors, and individual companies to work together. There are examples where this is being explored. The Foothills Landscape Management Forum has been working on access planning initiatives since 2005 (Box C1). In 1999 the Al-Pac Integrated Landscape Management Program started and to work with other land users to meet their needs while evaluating environmental risks and applying conservation strategies. More emphasis on developing relationships and partnerships will further ILM.
- Government commitment and leadership toward ILM is evolving as government agencies recognize the benefits of partnerships and planning-based approaches. There are opportunities to expand and enhance these initiatives.
- Area-based access management plans (Box C1) are a promising opportunity to address issues with existing access and related infrastructure and to plan for future roads and related infrastructure in ways that maximize coordination, take advantage of technological advances, and create adaptive processes to administer and amend access plans.

- Adopting a *life cycle approach* (Box C2) for all surface infrastructures is a promising way to manage individual features from planning to reclamation.

Box C2. Life Cycle Approach to Manage Human Infrastructure

An approach to planning for the full life cycle (planned, construction, built and in use, inactive, deactivated, reclamation, reclaimed, restored) of roads and other human infrastructure. All features are planned, ideally in advance, as permanent or temporary depending on the expected duration of intended use. Temporary roads needed to support temporary activities (e.g. cutblock, wellsite) are scheduled for reclamation when no longer needed. Temporary features can exist for many decades. Permanent features are expected to be in place indefinitely. Planning includes defining triggers that shift a feature into a new life cycle phase. The life cycle approach is integral to regional access planning where there are multiple human uses with associated infrastructure.

- Plans to manage access infrastructure provide opportunities to expand to include access use. This has the potential to address challenges associated with secondary users and multi-level issues including user conflicts such as motorized versus non-motorized uses.

C2 Subregional EBM Planning

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A central tenet of EBM is that ecological integrity is associated with place and time for relevant ecological units. Place recognizes the unique ecological characteristics of an area which change in relation to ecological and geographic scale. Time recognizes that natural ecosystems are dynamic and change over time in response to variable disturbances and other processes, creating ever-shifting ecological conditions and biological consequences that can be used to define ecological integrity. Human wellbeing is also linked to place and time. As it is for ecological aspects, each forest area has a unique combination of human presence and uses that change over time.

EBM is based on horizontal and vertical policy coordination and integration that needs cooperative agreements and collective action to balance ecological integrity and human wellbeing. EBM planning is the process of understanding historic and current conditions and natural disturbance regimes, the history of human uses, and assessing possible future forest disturbances, conditions, and consequences from both natural processes and human uses. Planning usually involves making choices between potential scenarios to identify alternatives and uncertainties and selecting one scenario as a path forward (Delacámara et al. 2020).

Directed by Regional Land Use Plans, area-based subregional EBM plans (EBM plans) could provide an integration process to bring together all ecological values and all human uses and collectively discuss possibilities of imaginable future forests and uses. EBM plans help to clarify and imagine how to resolve wicked problems and build adaptive future capacity. Forward-looking analysis and planning raise

awareness and focus societal attention to the consequences of choices and actions of individuals and societies (Boyd et al. 2015).

The distinction between regional and subregional whole landscape planning is a management choice. Computer capacity continues to increase, enabling larger spatial datasets and modelling. Alberta could in theory transform their Land-use Regional Plans into spatial land use EBM plans with both land use decisions and landscape forecasts and indicator targets. However, it may be better to keep decisions about land use designations separate from decisions about landscape targets within designated areas.

Saskatchewan does not currently have an equivalent to the Alberta LUF regional plans but could use a mosaic of subregional plans to implement EBM using only 1 planning scale.

Alberta, Saskatchewan, and the GOC use variations of subregional plans, but they fall short of the ideal for comprehensive EBM plans. Both provinces produce FMPs for commercial forest DFAs and management plans for protected areas. Parks Canada produces management plans for National Parks and provincial agencies produce management plans for provincial protected areas.

An ideal complete EBM planning framework for Alberta and Saskatchewan would include some form of EBM applied to all forest lands, and all their ecosystems, regardless of which level of government (federal or provincial) has ultimate management authority and which organization(s) are designated as land and resource managers or users, and for DFA managers to cooperate across borders where there are cross-border aspects that should be integrated.

EBM plans should be prepared by designated managers, which may be governments or collaborations and partnerships of interested responsible and accountable parties. EBM plans are approved by the accountable government(s).

CHALLENGES

> *"A potential barrier to area-based plans is that they complicate the process and lengthen the process. The single-value process is faster and easier but doesn't always resolve challenges. Moving to area-based plans would require massive change and that would be a challenge. It would be hard to overcome the tendency to maximize "my values". Cost and stakeholder burnout and disengagement are also issues."* (Anonymous SME).

> *"Governments will often not approve changes without sufficient proof that it works first. In many cases the proof could take decades so things don't move. This attitude contributes to EBM being so hard to implement with regulators. Even if it makes sense to change on the surface or conceptually to move in that direction, it is an extremely hard challenge to overcome without trust that it is being done for the right reason."* (Anonymous SME).

> "National Park Management Plans have always been 5–10-year documents that focus on the short term. They are fairly inward-facing to avoid elaborate consultation, which garners a lot of interest and is very time-consuming and expensive. Every little thing is under scrutiny. Parks Canada management is still more acutely than most people realize at the behest of the political winds." (Anonymous SME).

- There is currently no systematic system of designated DFAs endorsed by governments specifically as EBM planning units. Until that occurs managers who wish to engage in EBM planning will need to define DFAs themselves in a bottom-up process.
- In contrast to the mix of area-based and value-based planning in general use, EBM is concerned with achieving ecological integrity for DFAs and the focus of management shifts to entire ecosystems and all human uses (Andison 2020). To do this, EBM plans must integrate all of the VBA considerations and directions for each DFA to develop 1 area-based EBM plan for each DFA.
- There are currently no area-based planning processes that meet the aspirational criteria for EBM plans. FMPs prepared for commercial forest DFAs come close in many ways but they are missing key aspects such as a whole landscape approach and inclusion of all human uses. Management plans for protected areas also come close but they do not incorporate long-term outcomes and activities.
- Hierarchical area-based planning is an incomplete framework in both provinces. It largely covers commercial forest tenures and protected areas but not non-commercial forests.
- Long-term EBM plans with forecasts of future forest conditions are routine for commercial forests but not for other forest DFAs. Introducing them for those DFAs is a tremendous challenge with many hurdles to overcome.
    - Policy changes to mandate EBM plans or to change existing management plans to EBM plans.
    - Acquiring digital inventories and forest estate models needed to run scenarios and output predicted results.
    - Gathering all legal requirements and information about all values associated with the DFA, including ecological values and human uses.
    - Identifying interested parties and providing opportunities for them to participate in the planning process.
    - Defining ecological and human use indicators for both activities and outcomes.
    - Comparing scenarios against NRV and setting targets from the chosen scenario.
    - Setting the management actions (from the chosen scenario) with specifications for location and time period.
    - Addressing uncertainties and missing information.
    - Identifying knowledge needs and setting up an adaptive management system based on monitoring and experimentation.
    - Setting up a communication and reporting process.
    - Setting up a formal plan review and revision at a specified time interval.
- Neither province currently requires long-term area-based plans based on scenario forecasts for any other resource use than timber. Most large commercial forest tenures require the holder to complete a detailed long-term FMP at least every 10 years. The FMPs determine a long-term sustainable AAC subject to regulatory compliance and government approval of plans to mitigate

effects of timber management on other values. FMPs do not currently fulfil the aspirations of comprehensive EBM planning.

- Historic land use decisions and their consequences strongly influence current landscapes and decisions about what is possible and desirable for the future. Establishing direction is easier when there are fewer pre-existing considerations that must be respected or changed.
- Many human activities are not linked, or are indirectly linked, to area-based planning. For example, road planning is usually done on a road-by-road or small-area (e.g., forest logging compartment) basis, not as part of larger area-based road plans.
- Plans developed for resource values may have aspects that are linked to ecological conditions that are not linked to area-based EBM plans. For example, road density targets in the Alberta Grizzly Bear Recovery Plan (Government of Alberta 2016) are not linked to plans or processes to achieve them.
- Resource plans or requirements for specific values may be linked to ecological conditions through requirements that constrain possible activities and affect opportunities to achieve EBM. For example, maintaining riparian vegetation to provide shade for streams is intended to keep water cool but may not be needed if shade is not an important factor in local water temperatures.
- Understanding the external requirements that may constrain EBM innovation for a DFA and finding ways to incorporate them or get approval for variances or alternatives that conserve or protect the associated values with approval from the relevant government authority.
- Where forest companies do long term forest management planning, they are required to account for existing human uses but do not control or forecast rates and effects of future human uses. How to consider and accommodate other human uses in EBM is a challenge.
- Management plans may be absent or out-of-date.
- FMPs are revised every 10 years in Alberta and Saskatchewan. Many have recently been revised, so it will be several years before additional EBM considerations can be incorporated.
- It will take many years before EBM plans can be completed for all areas where no long-term planning is currently done. The process would need to start with a review of existing planning frameworks by governments and DFA managers and commitments to move in the direction of long-term EBM planning.

RECOMMENDATIONS

> *"Sub-regional EBM plans are a good way to define and implement EBM. Caribou range plans a good example of those, and they have to address multiple values to be successful. We need a catalyst such as caribou to provide a spark to get going."* (Anonymous SME).

- EBM implementation would be significantly aided by creating a series of long-term, comprehensive, and quantitative EBM plans that define EBM outcomes and activities for each DFA and shift from individual, value-based management plans to comprehensive plans for DFAs. An EBM plan is similar in many ways to a forest management plan that is prepared for commercial forest DFAs, with augmentations. It is more inclusive and comprehensive because EBM is applied in forests with diverse ecosystems and multiple human users with forest interests that must be recognized and addressed.
- There is an opportunity to identify and fill existing gaps in management plan coverage and quality.
- Existing planning processes could be revised to transform them into EBM plans.
- In areas where there is little human activity and alteration these management plans could be simplified versions of the more detailed plans prepared for commercial tenure areas. For example, the Alberta Land Use Framework Regional Plans could be used to plan and implement basic EBM on non-tenured forest lands.
- Some existing DFAs (e.g., protected area management plans) have management plans but they are not long-term, not based on quantitative scenario forecasts, and they don't incorporate VOITs.
- Area-based long-term Forest Management Plans prepared by industry or provincial governments are the current state-of-the-art for management plans that define and implement EBM. There are many opportunities to improve FMPs. These include using a whole landscape approach, partnerships, adapting external requirements to achieve them through EBM.
- Holders of area-based commercial forest tenures are the only non-government organizations that prepare strategic FMPs.
- Industry FMPs specifically exclude the passive landbase and have no responsibility or authority to consider non-timber values and aspects other than compliance with government directions.
- Industry FMPs must consider past and current disturbances and land uses in their preparation but do not forecast future conditions for non-timber considerations.
- FMPs prepared for commercial forest DFAs already have many of the framework components needed for them to be EBM plans. Augmentations needed to take them to the EBM level include:
    - Adding, possibly through partnership or contract, the missing pieces including management of non-timber values and human uses, consideration and incorporation of the passive landbase, including ecological contexts, and inclusion of aspects under government authority that are currently excluded from FMP processes.
    - Redefining roles and responsibilities to respect existing arrangements and build new relationships that resolve missing and fuzzy elements such as how provincial governments overcome the tensions created by government as regulator and government as planner.

- For areas with existing FMPs, there are likely opportunities to improve the supporting EBM framework so it is ready when the FMP revision cycle arrives. This includes implementation of EBM activities that don't require an FMP revision.
- For non-commercial forest DFAs with low levels of human use and disturbance regimes (especially wildfires) that are close to natural levels EBM plans could be simplified to a basic analysis of the most important aspects (e.g. caribou habitat) which means they could be produced faster and for less cost.

C2.1 EBM Planning Management

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EBM encompasses all areas in DFAs, and all the different ecosystems that occur and interact (Grumbine 1994). EBM also envisions one organization that has assigned responsibility to prepare EBM plans for DFAs working on the principle that there should be just one comprehensive whole landscape EBM plan for each DFA.

Once Defined Forest Areas have been designated by the responsible federal or provincial government, EBM for each DFA must be defined and implemented. Creating comprehensive EBM plans with integrated targets for all ecological and human use indicators is a key step in the process. Irrespective of the type of DFA and associated ownership, tenures, etc., governments have overall authority and responsibility to ensure environmental protection and ecological integrity (Vertinsky and Luckert 2010), and to coordinate and manage human wellbeing.

Each DFA needs an overall manager with defined responsibilities and authorities to prepare the EBM plan for the DFA. The designated manager does not need to be a single organization. In most cases some form of partnership or other working arrangement between multiple organizations will be needed to ensure that the manager has the responsibility, capability, and authority to comprehensively plan EBM for a specific DFA.

When a government agency is not the manager responsible for preparing management plans responsibility is usually held by one or more companies that hold tenure for some form of industrial development. Planning requirements vary by industry and at minimum require plans to develop the specific resource while complying with requirements to avoid, minimize, and mitigate effects on other values, especially environmental and ecological values. Planning and compliance requirements can be limited to a specific location or activity (e.g., an energy sector wellsite) or expand to include very large areas (e.g., a large commercial forest FMA).

Challenges

> *"FMAs/FMPs are obligated to plan, harvest, and grow timber. This limits the licensee legal obligation and is a potential barrier to doing more for EBM (the government can't ask, and companies have no requirement or incentive)."* (Anonymous SME).

- The forests of Alberta and Saskatchewan are largely divided into administrative DFAs and government responsibilities and authorities are largely divided among federal and provincial agencies. The net result is that most DFAs (except protected areas) are not managed by a single accountable agency.
- In the absence of integrated EBM plans the divided responsibility and authority for most DFAs means that different agencies and organizations must cooperate to be effective. Cooperation is often not done, or not done well enough. This leads to different actors pursuing different objectives for different resources, ecosystems, or human activities on the same landbase, which is inefficient and often ineffective. The divided oversight governance model must be overcome to fully implement EBM.
- Many DFAs already have managers that are responsible for at least some EBM aspects. However, few of these managers have responsibility and authority over all EBM aspects and there are few incentives or requirements to work with others to fill gaps and establish a complete framework.
- Planning requirements differ significantly by industrial sector and disposition type operating on the same landbase. Forest companies holding FMAs must complete long term strategic plans every 10 years to demonstrate sustainability of timber cuts over the long-term. Energy and mining companies must complete plans related to short-term development needs, except where development is more intense and long-term such as oil sands developments or mines. Sectors are not obliged to co-plan developments, although they are expected to practice ILM in relation to some activities that are common to sectors such as roads.
- The size and complexity of management is increasing. More and more ecological values are being recognized. The number of actors that operate on each DFA differs depending on the specific combination of resource values and human uses that are present. In DFAs with a lot going on there can be a dozen or more federal, provincial, municipal, and Indigenous actors involved just on the governance side, and equal numbers or more of authorized human users and public interests. Actor sectors are divided as well between, for example, different companies or municipalities. Individual actors are frequently further divided internally and the mix of divisions is subject to periodic change as actors reorganize and influential individuals come and go.
- On provincial lands there is a long-standing division among agencies that manage different ecosystems. One division is between agencies that manage water and aquatic ecosystems and associated human activities, and agencies that manage terrestrial ecosystems and associated human activities. Terrestrial ecosystems are further divided among actors that are involved with the active landbase in commercial forests (including forest companies) and the passive landbase.
- Another challenge is the development of regulatory requirements and plans that manage only some of the ecosystems and human uses. Directions for ecosystems and associated resource

values are usually introduced as constraints to the activities that may affect them. This makes it difficult to plan for all ecosystems and human uses concurrently to ensure effective EBM.

- Regardless of who the designated manager is, authority for EBM always rests with either a provincial government or the federal government, with some aspects shared between federal and provincial levels. Within each government there are usually several agencies with authority over one or more EBM aspects.
- Distinctions between responsibility and authority are complex and often unclear, particularly where governments serve as both responsible planners and approval authorities.

RECOMMENDATIONS

> *"To do better* [FMPs that implement EBM] *would mean bringing in other players and finding ways to work together. The Land-Use Framework is a possible platform to do that. Uncertainty about how to start something different would be a challenge."* (Anonymous SME).

- Many DFAs (protected areas, commercial forest tenures) have a manager that prepares area-based management plans that could be transitioned to comprehensive EBM plans.
- Perhaps the best opportunity for recognition and resolution of EBM on DFAs is for all actors and interested parties to participate in a single process that recognizes and balances all ecological and other values and all human uses and interests. The resulting plan defines EBM for each DFA including future forests and provides direction to all actors that can be implemented cooperatively or independently with improved efficiency and effectiveness. The end result would be a complete network of designated land managers who are responsible for preparing and administering EBM plans for a non-overlapping mosaic of defined forest areas.
- There is an opportunity to update the current systems used to identify and designate organizations with responsibility to prepare EBM plans for DFAs. For most DFAs a lead manager will be apparent by building on existing manager responsibilities and authorities. The opportunity is to build on existing arrangements to include all relevant parties needed to ensure all EBM elements are incorporated for each DFA.
    - Existing government agencies for protected areas.
    - Government agencies for non-commercial forests and commercial forests with government management plan responsibility.
    - Commercial forest licensees with FMP responsibilities. The FMP process is the only large-area private sector planning process that has the potential to be modified to meet the ideals of a comprehensive EBM plan.
- Improved cooperation between actors would help to resolve limitations of the divided governance structure. This is a perennial challenge that is very difficult to do but still important to undertake.

COMMERCIAL FORESTS

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Commercial forest tenures have limited scope that reflects the rights granted by the respective province and the form of tenure. Alberta and Saskatchewan Forest Management Agreements are area-based and confer the rights to establish, grow, harvest, and remove timber (Government of Alberta 2006) subject to government approval of required plans including a Forest Management Plan (FMP) prepared by the main licensee(s) and accommodating and reconciling the interests of any other forest companies operating in the FMA. FMA-holders are prohibited from restricting access or constraining the right of the respective province to manage other resources or allocate lands for other industrial uses. They are also required to manage to reduce impacts on other resource values and users and comply with directions from higher-level plans and legislation.

Box C3. Potential Options to Transition FMPs to EBM Plans.

Voluntary Action *– Licensee adopts a whole landscape approach and presents results and discussion for voluntary EBM aspects outside of their responsibility and authority.*

Partnership *– Could take many forms including public-private-partnership or other arrangements. Ideally the partnership would have full responsibility and authority for all aspects of EBM, and the partnership would represent all actors with legal interests including Indigenous, municipalities, energy sector, etc.*

Contract *– Government and/or licensee contracts EBM planning to a 3rd party, including consultants or other organization(s). This could also include government giving a licensee a contract to include in scope aspects that are not normally their responsibility.*

Government *– Government leads EBM planning and augments FMP process within their authority to make it comprehensive.*

Volume-based licensees have similar but fewer rights and responsibilities. The provincial government usually prepares the FMP which sets the AAC level and directs SHSs.

CHALLENGES

"There's tension between the government role as regulator versus planner, the emphasis has differed in the past. Government in democracy has to lead and do both where necessary for success. That has not been done well to date because government is divided within itself about who should lead and have the final say." (Anonymous SME).

- The public land model divides roles and responsibilities between government and forest companies. No single organization has a mandate to implement EBM for DFAs.
- The only private sector planning process that has the potential to be modified to meet the needs of a comprehensive EBM plan is the FMP process.
- Other government agencies act independently to promote development (e.g., energy sector, tourism) or ecological integrity (e.g., fish habitat protection, species at risk). This can bring them

into conflict with the agencies administering the forest companies and commercial forest tenures. It also leads to considerations for other resource development or protections being imposed on forest management as constraints.

- Most commercial forest allocations were made in the past when EBM was not a consideration.

RECOMMENDATIONS

> *"The FMP process is the best land management process in Alberta and needs to get the recognition it deserves."* (Anonymous SME).

- There is an opportunity to prepare a policy options document that lists pros and cons of potential approaches to modify FMP processes (Box C3).
    - Government agency participation in FMPs to fill in the EBM gaps not already included in industry FMPs.
    - Government takeover of the FMP process with the role of forest companies reduced to determining sustainable timber cut levels on the active landbase.
    - Government contracts the licensees to transition FMPs to EBM plans.
    - Government contracts preparation of EBM plans to private sector or other organizations that have the capacity and interest. For example, the Alberta Delegated Administration Organization authority system could be used to set up an organization charged with completing subregional EBM plans.
    - Government establishes direction and authority for EBM plans and participation by others.
- Exploring a partnership between forest companies and governments and others as interested through a pilot project is an opportunity.
- Build on the provincial DFA agency mandates to include responsibility to define and implement EBM for each DFA.
- Explore opportunities to establish partnerships between government agencies and forest companies to define roles and responsibilities toward comprehensive EBM for DFAs.
- Alternatively, forest companies could become responsible for assessing and accounting for non-company human uses in their forest management plan, through a contract or other arrangement. For example, forest companies, with funding and participation from the energy sector and provincial government, could forecast and account for (as much as is known or can be reasonably forecasted) energy sector development and include it in assessments of EBM indicators. Or energy companies could provide the information to the forest company process. There is potential to improve considerably on the forecasting of future activities, assessment of EBM outcomes, and selection of improved EBM plans.

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PROTECTED AREAS

Roles and responsibilities for protected areas are straightforward as they are usually managed by a single government agency. However, protected area management is influenced by external legislation and by embedded human uses that may be managed by different government agencies. Examples include transportation corridors, municipalities, private land or leases, and sometimes industrial activities, which occur in some provincial protected areas.

CHALLENGES

> *"*[Alberta] *Protected area managers are not following EBM either. It's tough to penetrate the culture. Often higher-level leadership is supportive but rank and file are opposed, they got into the business with an ideology and a certain education and it's hard to overcome that. More open minds are needed."* (Anonymous SME).

> "Funding for protected areas management planning is always a challenge, other priorities seem to dominate. Management plans are often out of date or outright not there at all." (Anonymous SME).

> *"Alberta Parks talks a little about the need for disturbance to maintain ecological health but their culture is oriented toward protection and visitor use. It's a big challenge to overcome that mindset."* (Anonymous SME).

> *"Saskatchewan produced an EBM plan for Meadow Lake Provincial Park, which was good. It's a small park with a lot of human use, and they got a lot of pushbacks about logging and fire in the park to keep disturbance going. They need to do a better job upfront to communicate benefits and get people on board in advance."* (Anonymous SME).

- The responsible agency has to interact with other government agencies and non-government organizations and activities. These may not be considering EBM as part of their mandate, making cooperation more challenging.
- Many protected area managers have challenges related to defining and achieving a balance between ecological integrity and human wellbeing (Canadian Parks and Wilderness Society 2020; Kalynka 2020). For example, the balance between ecological integrity of a park versus visitor uses and embedded infrastructure such as transportation corridors and communities, especially for protected areas with high levels of visitors.
- Some external requirements override local manager responsibility and authority. For example, protected area managers must comply with the *Fisheries Act* and the critical habitat provisions of the *Species at Risk Act*. The requirements may influence and possibly conflict with protected area manager options in relation to EBM.
- Protected area managers have mostly not adopted the use of long-term management plans with quantitative forecasts of future forest conditions. Moving in that direction will be a challenge, but it is the only reasonable alternative to define ecological integrity for future forests over the long term.

RECOMMENDATIONS

"Parks Canada is migrating to use the Open Standards for Conservation, which is a systems approach that is aligned in some ways with EBM but doesn't use the same language. There may be opportunities for discussions to look at common elements." (Anonymous SME).

"Saskatchewan is working on a second EBM plan, this time for Cypress Hills Provincial Park. They are on the right path but it will take time to get there." (Anonymous SME).

- Protected area managers have clear roles and responsibilities and some are actively pursuing EBM. There is opportunity to build on their initiatives to better incorporate aspects such as partnerships and long-term scenario planning.
- Smaller protected areas could partner with EBM plans for larger contiguous areas to address challenges and opportunities associated with spatial scales and reduce planning costs.
- A concept paper that describes how protected areas are currently managed, gaps compared to EBM ideals, and alternatives for transitioning to EBM.

Unallocated and Non-Commercial Forest Lands

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Forest lands that are not protected or allocated to commercial tenures may have a variety of human uses (energy and mining development, Indigenous traditional use, trapping, recreation, etc.) that are managed by the responsible government agencies. The same or other agencies are responsible for management of individual aspects (e.g., fire, fish and wildlife, wetlands, etc.). The provincial forest management agencies usually don't prepare forest management plans for unallocated lands, so they are managed informally without comprehensive EBM plans.

Challenges

"The biggest challenges in non-commercial forests relate to poor engagement with Indigenous peoples, fire management, and caribou. Where there's no industrial uses EBM should be co-developed and delivered by Indigenous and other governments. Doing that is hard." (Anonymous SME).

- Non-commercial forests currently have no area-based management plans and there are no designated manager(s) responsible to prepare plans.
- Unallocated and non-commercial forest lands are rarely managed by a single government agency, and government oversight depends on what human uses are, or might be, applicable to specific DFAs. This means that there generally is no assigned manager to plan and implement EBM.
- Government agencies pursue their own roles and responsibilities independent of EBM considerations, and these may or may not be compatible.
- Because EBM is not planned it is usually not managed, and there are no EBM targets to achieve.

- Indigenous peoples are by far the highest proportion of populations in the non-commercial forest zone. EBM in these areas is challenged by the imperatives to engage Indigenous governments to lead or co-manage implementation.

RECOMMENDATIONS

> *"I think the answer is less about Indigenous people advocating for a policy of full fire suppression everywhere, but rather ensuring that Indigenous people have a powerful say in how fires are managed more generally, which includes what values are protected, how and by whom."* (Anonymous SME).

> *"There are options for fire in the passive landbase and non-commercial forests, prescribed burns and managed wildfire. Indigenous peoples are interested in cultural burning but are constrained by liability and needing to get permission, and they still want their values protected. There should be opportunities to design desired future forests and work out how does fire play a role."* (Anonymous SME).

- Governments can confirm or assign agencies to take lead responsibility for EBM. Lead agencies can start by engaging other government agencies and others who have activities or interests in each DFA.
- Three-way discussions between Indigenous, federal, and provincial governments about EBM challenges and opportunities.
- Depending on the levels of human use, EBM plans for non-commercial forests could be relatively straightforward exercises of Indigenous-led "traditional land management" combined with "letting nature take its course with appropriate adjustments near human values", and monitoring of outcomes.

OTHER FOREST LANDS

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Private lands, Indian Reserves, military lands, and other similar forest lands are not the focus of this report. In general, they are not managed with EBM in mind. There should be many opportunities for managers of these lands to build EBM into their activities and to partner or align with neighbours who are pursuing EBM.

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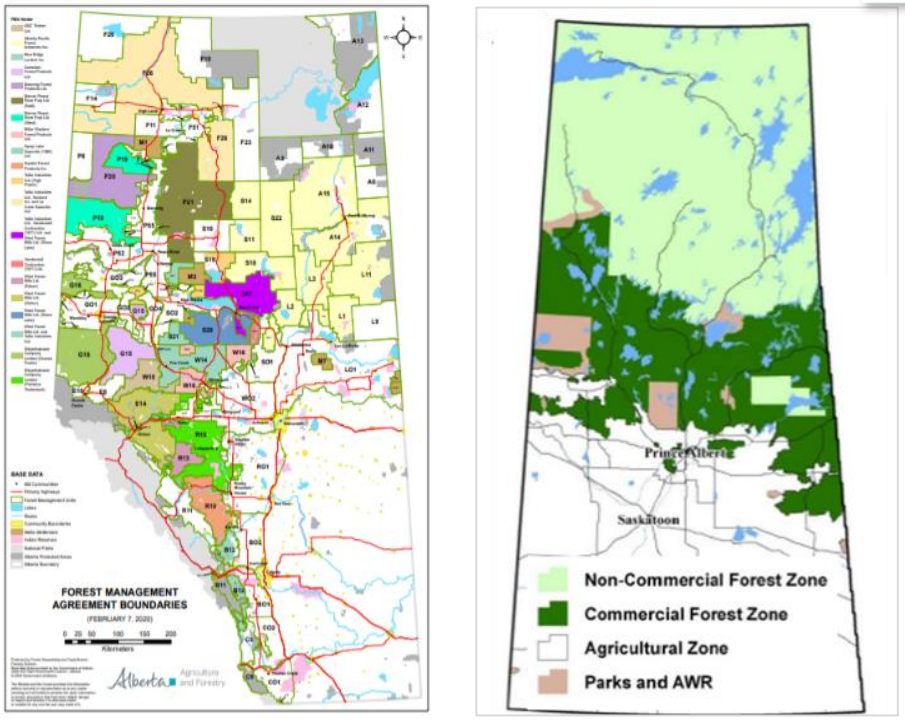

Figure C3. Alberta Forest Management Agreement boundaries (left panel) and Saskatchewan forest zones (right panel).

Management Unit Boundaries

Area-based management is critical to the delivery of EBM (Bourgeois 2008; DeFries and Nagendra 2017). A complete network of non-overlapping area-based management units (DFAs) is the best way to confirm roles and responsibilities and implement EBM defined through a long-term management planning process.

Alberta divided the Green Area (includes most Alberta forest lands) into Forest Management Units (Figure C3). About 74% of the total gross FMU area was allocated to commercial forests for which Forest Management Plans are prepared by either the forest industry tenure-holder or the GOA. The original Forest Management Units were used to define tenure allocations and adjustments occur from time to time. Non-allocated FMUs may not have sufficient economically accessible timber resources to support commercial use. Alberta forest lands not allocated to FMUs include provincial and federal protected

areas and the Cold Lake Air Weapons Range (FMU L9), which is leased to the federal government. There are small areas in communities, private lands, Indian Reserves, and other categories.

Saskatchewan divided the provincial forested area into commercial (34%) and non-commercial (64%) forest zones (Figure C3). The commercial forest zone is allocated to three types of forest management industrial tenure and divided on that basis into units similar to the Alberta system. Saskatchewan

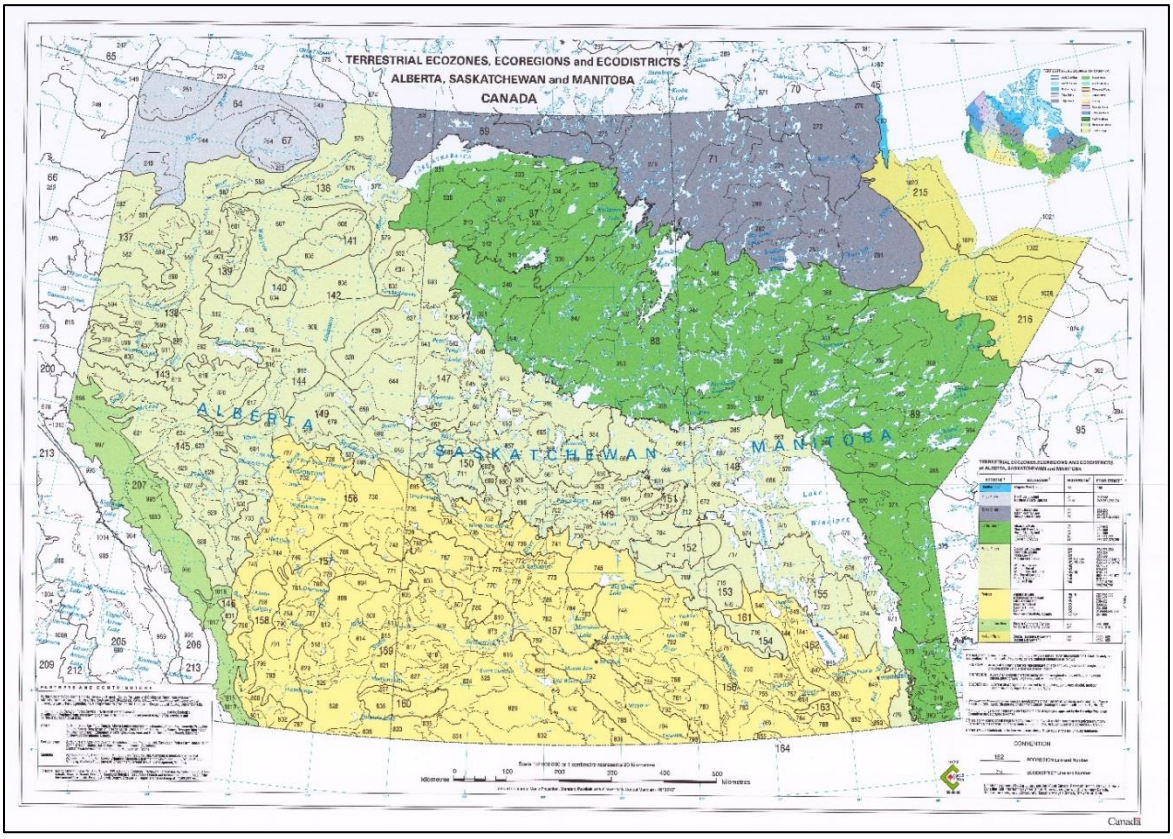

Figure C4. Terrestrial Ecozones, Ecoregions, and Ecodistricts of Canada for the prairie provinces. Source. The Alberta Natural Regions closely approximate the Canada Ecoregions.

commercial zone forest lands not allocated to industry include provincial and federal protected areas and the Saskatchewan portion of the Cold Lake Air Weapons Range. The non-commercial forest zone in northern Saskatchewan is not divided into subunits.

EBM calls for using ecological boundaries rather than administrative or political boundaries. Large-scale revision of existing management unit boundaries to align with ecological units is impractical. However, DFA boundaries do change from time to time, and it would be helpful to consider ecological unit boundaries when changes are being considered. Revising administrative boundaries to follow ecological boundaries may be useful in some situations. This is not a workable solution for most DFA boundaries because administrative units are useful for societal organization and understanding and they reflect established human society such as the locations of communities and supporting infrastructure. Redefining management unit boundaries using ecological boundaries may not be a better basis for EBM

(Slocombe 1998) and the best approach is likely to retain administrative units and reconcile the appropriate ecological contexts through cooperative practices (Figure C4).

CHALLENGES

> "Lack of cooperation and collaboration between land users and between provinces is a big issue. Regional priorities are so different." (Anonymous SME).

> *"We have to make some of the administrative lines go away so we can place things in proper context. For caribou in Saskatchewan the government is looking at the central region right now and not considering the others on either side. Management has to break it up into manageable units but still pay attention to the ecological context."* (Anonymous SME).

- The current land use planning policy frameworks in Alberta and Saskatchewan do not call for non-overlapping DFAs as a basis for EBM planning.
- Existing DFAs in both provinces that could be used for EBM planning were determined primarily using administrative instead of ecological boundaries. This means that managers must work together to define EBM for relevant ecological units.
- Some existing management units are too small (e.g., small protected areas) to use as DFA units for EBM because they are too small to encompass EBM at larger scales. Small units include small protected areas, private land areas, municipalities, Indian Reserves, Métis Settlements, etc. The collective area of small units is a small proportion of total forest area.
- The non-commercial forest zone in northern Saskatchewan is very large, which enables large landscape scale considerations but may be too large to administer in one management unit. Subdivision into smaller units may be needed.
- DFA Managers lack incentives and authority to consider other jurisdictions and neighbours both within and bordering their own DFAs. Working with others across administrative boundaries to encompass relevant ecological units is generally not required by governments, so there are few reasons to invest the resources that would be needed.
- Working across political and national boundaries requires trans-provincial and international initiative and cooperation (Johnston 2006).
- There are relatively few examples of purposeful and successful cooperation and collaboration to address trans-boundary EBM.

RECOMMENDATIONS

> *"The provincial government has to take the lead to define the ecological contexts they want used and then to ensure indicators and targets get measured and set for those. It's not overly hard to do, just requires thought and direction. The devil will be in the details."* (Anonymous SME).

"Using common datasets that transcend borders is an achievement. That means we are able to look at issues at scale and forms the basis for future discussions and success in working together." (Anonymous SME).

- Both provinces are already largely covered by administratively-defined DFAs that are categorized in this report into protected areas, commercial forest tenures, non-commercial forest lands, and other. Non-overlapping area-based management units are the norm for commercial forests, protected areas and other land use categories in Alberta and Saskatchewan. This is a robust system to use as a possible geographic basis for EBM plans:
    - Alberta uses a series of Forest Management Units which cover the forested Green Area. Minor forest areas in the White Area are not included in FMUs.
    - Saskatchewan includes a similar series of management units in the Commercial Forest Zone. The very large Non-commercial Forest Zone north of the Commercial Forest Zone (roughly, north of the Churchill River) is not subdivided into smaller units.
    - Protected areas could also be used as DFAs, especially for larger contiguous areas such as National Parks and some of the bigger provincial protected areas.
- Government leadership to define EBM DFAs for which EBM plans. This could include a complete network of non-overlapping DFAs that provides areas of sufficient size to consider most of the spatial aspects of EBM. Smaller and isolated units could be assigned to coordinate with or join planning processes for adjacent larger units. Very large units could be subdivided to more manageable sizes.
- Government leadership to establish the direction and framework to implement and monitor EBM using ecological units at varying scales.
    - The ecological units and scales to use (e.g., ecoregions, ecodistricts, watersheds, species distributions).
    - The indicators to use and which ones to highlight for consideration in internal and external overlap contexts (e.g., ecoregions: forest type and age quantity and patch size; watersheds: annual water yield, peak flows; species distributions: habitat by categories).
    - Summaries of current conditions especially for ecological indicators, in ecological unit and regional contexts. These summaries would both inform land use plan decisions and directions to lower-level planning.
    - Establish requirements to work with others across boundaries where there are EBM aspects that can't be addressed within DFAs. For example, species at risk such as woodland caribou.
- Government action to roll up EBM defined at smaller scales into larger units. For example, the regional landscape assessments completed for the Alberta Land-use Framework could be recompiled for Natural Regions and Subregions, larger watersheds, and species at risk distributions.

- Provinces make changes to management unit boundaries and designations from time to time, typically in conjunction with land use planning. This provides a process and an opportunity to make boundary adjustments that could help with EBM implementation.
- Provinces have an opportunity to use their management units as a basis for provincial EBM policies and planning if they work out processes for representing ecological units through their system of DFAs.
- DFA managers have the opportunity to cooperate and collaborate by combining DFAs into units that are appropriate for EBM and meet the needs of managers. For example, DFA managers of smaller protected areas within or bordering larger units such as commercial forest tenure areas could participate with EBM planning for the larger area to address larger-scale aspects while concurrently managing aspects specific to the smaller DFA. This would assist with implementing comprehensive EBM at appropriate geographic scales and ecological contexts.

C2.3 Whole Landscape Approach

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Successful EBM implementation over large regional areas depends on a system of non-overlapping, area-based, DFAs that covers whole regions. Each DFA would use a whole landscape approach, which means EBM would encompass and include all areas (all ecosystems: forested, non-forested, aquatic, etc.) and all human uses within each DFA, with integration between and among subregional EBM plans to scale up and down according to needs.

To paraphrase Indigenous phrasing, the key concept to a whole landscape approach is that there is only one land. Taking care of the land takes care of the people. There are multiple human activities that shape the land. Everything about the land is tied to everything else (Figure C5; Fraser et al. 2006). For example, human activities in upland ecosystems also affect aquatic ecosystems.

Challenges

> *"Disturbance in the passive landbase is an issue. Fire suppression and exclusion of logging creates a big fire risk, the passive landbase is where a lot of fires start. FMA wildfire management plans are not well linked to FMPs, there's room to improve."* (Anonymous SME).

> *"Traditionally, forest managers just ignored the passive landbase. Some companies are now tracking it and presenting information about whole landscapes, but that's it, because they have no responsibility or authority to manage the passive landbase."* (Anonymous SME).

- The management process for DFAs managed by single government agencies is relatively straight-forward where there is a designated government agency with overall responsibility for management (e.g., Parks Canada for National Parks, Saskatchewan Parks Division for Provincial Parks). These agencies take a whole landscape approach because they are responsible for all areas (ecosystems) within their boundaries but they must work with others where human uses

such as transportation corridors, private leases, private land, and municipalities are managed or partially managed by other agencies.

- For other areas the provinces have the option to do comprehensive area-based whole landscape EBM plans but, with the exception of larger protected areas, they are not currently engaged in formal EBM planning. The challenge is to build on existing programs to better incorporate EBM.
    - Alberta uses subregional plans under the Land-use Framework but these are mostly related to specific values and issues and those that are area-based are not comprehensive because they do not address all values and all uses.
    - Saskatchewan does not have a provincial-scale regional land use plan framework but has completed a number of whole landscapes Integrated Land Use Plans. The most recent 2012 Misinipiy and Nisbet plans embraced EBM.

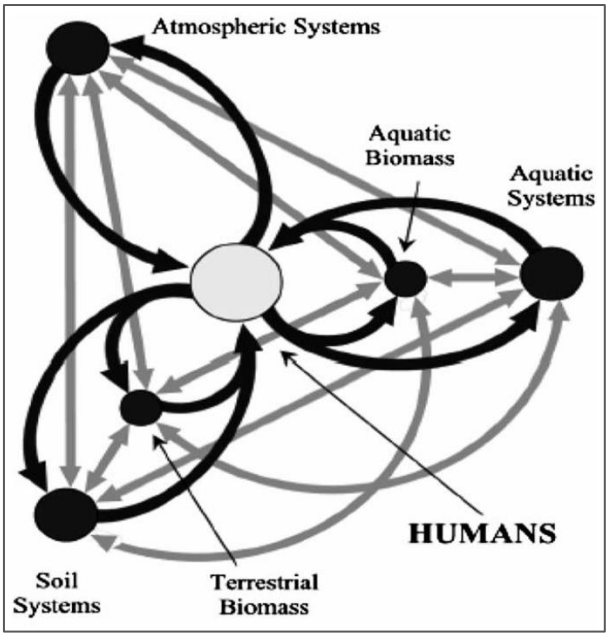

Figure C5. Schematic representations of environmental pathways for understanding and defining environmental factors that affect social or political planning jurisdictions (from Fraser et al. 2006).

Recommendations

- Ideally, a mosaic of area-based non-overlapping long-term EBM plans using a whole landscape approach that covers all forested lands in Alberta and Saskatchewan and links with similar plans in neighbouring provinces and territories.
- Both provinces have area-based administration systems that could be used as DFAs for EBM planning. Provincial and federal governments could refine their systems to ensure that all areas are included in DFAs to assemble whole landscapes. Both provinces have many existing management units (especially commercial forest tenures and protected areas) that could be used in an EBM DFA system and some of these have existing planning processes that could be expanded to be EBM plans.
- At the subregional scale EBM is typically implemented for defined forest areas with a specified land use (e.g., a protected area or an FMA area). Many of these existing administrative units have been used as DFAs for which the closest current analogues to EBM plans are prepared: FMPs for commercial forest tenures and Park Management Plans for National Parks and some provincial protected areas. There is an opportunity to build on current DFA units and plans towards transitioning them to EBM plans for whole landscape DFAs.
- Planning for whole landscapes could be aided by assigning whole landscape government oversight responsibility to an agency or group of agencies who would be charged with ensuring

integrated EBM plans are prepared for each DFA. In Alberta this could be the already-existing Land Use Secretariat, which was set up to support the LUF.

- Smaller units could be aligned with larger DFAs to address larger-scale EBM. The opportunity is to develop processes to include smaller designated land units in larger DFAs to meet the whole landscape objective without affecting the autonomy of the smaller land unit owners or managers. This could include their direct voluntary participation or something as simple as estimates of scenarios that the small unit managers might be expected to apply. These could come from published plans (e.g., a mine reclamation plan) or other sources.

> *"Apply EBM to maintain age class structure and use ecological boundaries to assess. With current trajectories, in commercial forests old forest distribution is going to end up mainly in the passive landbase and in protected areas there will be more old forest than expected from NRV. Distribution can be uneven (very little on active landbase but lots in passive and protected areas) if that's the choice. Looking at the right scale will be the first step in deciding what to do."* (Anonymous SME).

> *"Increase passive landbase disturbance in commercial forests by granting permission and finding ways to make it economic. Steep slopes, forested wetlands, and riparian areas all provide opportunities for careful logging to introduce disturbance while still protecting other values. Innovation could include log/burn combinations."* (Anonymous SME).

C2.4 Planning Integration

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How should society define EBM in integrated ways that build on the strengths of current governance and improve on the weaknesses? The best opportunity is through information-sharing, consideration, and discussion of management alternatives for DFAs which culminates in EBM plans that integrate all ecological integrity and human wellbeing considerations that are applicable to each DFA, with an eye to coordinating up and down in scale with other areas both administrative and ecological.

Challenges

> *"The land use planning group* [in the Alberta government] *has only been in place for a little over a decade and has made some progress despite challenges. It will take time for this to work. There's still much internal strife about who should lead planning and getting everyone else actively and constructively engaged."* (Anonymous SME).

> *"Short-term thinking on the political side constrains strategic thinking and cooperative planning. Politicians and public servants are very averse to risk and very defensive of their turf."* (Anonymous SME).

- The biggest challenge to subregional EBM planning is overcoming resistance coming from established political governance-client arrangements that lead to policy failures and other sub-optimal outcomes in policy reform efforts that attempt to replace sector-specific plans with more integrated area-based frameworks (Rayner and Howlett 2009).
- Lead agencies are responsible for portions of areas and other agencies are responsible for specific areas or resource values. This complex divided governance and management model means that government agencies and their clients must cooperate to deliver EBM for most DFAs. This is a cumbersome and difficult process that does not work well in practice. Government agencies have their own mandates and tend to focus on those in isolation, which leads to conflicting policy direction and makes it difficult to apply EBM to individual DFAs and build integrated EBM plans for whole landscapes that cover all forest areas. As a consequence, there are few whole landscape plans outside of larger protected areas.
- The situation is even more complex when governments allocate resources or human uses to others through some form of land or resource tenure. For commercial forests, both provinces follow the Public Land Model (Government of Alberta 2010), which allocates timber or the right to harvest timber to forest companies in return for investments and other benefits such as jobs and taxes. Allocations are broadly either area-based (all timber from a specified area over time) or volume-based (specific logging volume from a specified area over time). Provinces retain overall land ownership and the rights to allocate other uses, remove lands from tenure agreements, and manage for non-timber resources. Long-term forest management plans are required for tenured lands. In both provinces, holders of FMAs are required to prepare the plans. In Alberta the Ministry of Agriculture and Forests prepares FMPs for FMUs not held under FMA such as the E8 Forest Management Plan. In Saskatchewan the Ministry of Environment prepares plans for some units including the Island Forests FMP. FMPs have the potential to be revised to whole landscape plans but this would require alternative arrangements to the Public Land Model that include processes to involve the applicable agencies and clients, and the public, in EBM planning.

RECOMMENDATIONS

> *"EBM offers a contemporary opportunity to uplift traditional concepts in applied management. EBM represents a more holistic broader approach that could blend pre-existing traditional concepts in management as parts of an all-encompassing strategy (sustainability, integration, yield of goods/services, etc.). Multiple resources on the landscape represent some of the singular value-interests that could be accommodated by an ecosystem-based approach."* (Anonymous SME).

"Entry points are the political platform commitments of the government; those tend to drive the public service. Things do improve over time but it's a very messy process that requires patience and persistence." (Anonymous SME).

"External requirements are usually one-size-fits-all and constrain EBM opportunities at regional planning scales. An innovative and adaptive approach probably has better chances of success. Something like 'do this or convince us [government regulators] *that you have something better' as an alternative to 'do this, end of discussion'. And make it clear that alternatives are encouraged."* (Anonymous SME).

- EBM plans offer a direct pathway to institutionalize planning integration. For each DFA, complete one EBM plan that sets targets for all ecosystems (whole landscapes) and integrates all human uses and management to achieve the targets.
- A feed-in process which consists of all existing requirements and plans that apply to each DFA, and a feed-out process that consists of all ecological and human wellbeing targets fed back to the separate feed-in processes, which would be used to update them and direct their implementation (Box C4).

Box C4. Example Feed-in and Feed-out Process for Species at Risk Habitat

Feed-in: Critical habitat definitions, information, and requirements from all species recovery plans that overlap the DFA.

EBM Process: analysis of current and projected future habitat for each species. Exploration of innovation opportunities. Back and forth discussions with regulator responsible for species plans. Reconciliation of habitat requirements between species and against all other ecological and human wellbeing values. Set DFA-specific habitat targets for each species at risk. Set general ecological conditions within NRV to prevent further species from becoming at risk due to habitat degradation.

Feed-out: DFA-specific habitat targets feed out for compilation and merger with targets from other relevant DFAs to cover the entire distribution of each species at risk. Update recovery plans with new critical habitat forecasts and targets. Adjust any related actions such as population management accordingly and implement both for DFA and externally as required.

The process could iterate and expand as EBM plans are completed for the entire distribution of each species at risk. This would bring the habitat protection and management aspects of recovery strategies to the forest, which makes them more relevant and simultaneously compares them to other values and uses and balances overall outcomes. The additional benefit is to provide an in-place system of ecosystem (habitat) management including targets that can be referenced during preparation of future species at risk recovery plans.

C2.5 Inclusive

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A critical part of EBM planning is to involve all individuals and organizations that have an interest in the DFA for which a plan is being developed (Slocombe 1993; Mårald et al. 2017). When an EBM plan is being prepared for a DFA the DFA planning managers who are responsible for preparing the plan should identify all interested parties and provide opportunities to participate. The goal is to communicate widely that an EBM plan is being done and acquire and include input from all who want to participate in a way that builds cooperation, partnership, and consensus throughout the planning process and ongoing during EBM plan implementation.

Including all who have an interest in EBM for a DFA is a critical step because it is the only way to identify all of the applicable values and seek to build consensus on what EBM is for a specific DFA. Section 6.4 Partnerships has more information about societal engagement in EBM.

CHALLENGES

> "How are we going to sell to the public that EBM will do a better job and save us [society] *money? And what is EBM anyway? It's not cookie-cutter, it varies from place to place, and only people can decide what it is for any place. Which means we need better processes than those we use now to get people involved."* (Anonymous SME).

> *"Public hearings tend to attract and empower well-organized interest groups that may not represent the broad perspective of the community or even those who would be the most directly impacted by a decision."* (MacPhail and Bowles. 2021).

- It is a challenge to establish social capacity building to support exchange of knowledge and communication towards building common ground related to EBM and forests (Mårald et al. 2017).
- Societal agreements or forest social contracts are built on social trust and relational commitments between involved actors to achieve EBM objectives and targets (Mårald et al. 2017). These are difficult to establish and maintain, particularly where past experiences and issues related to trust are brought forward to new initiatives.
- Methods to balance trade-offs in decision making among and between ecological and human wellbeing indicators (MacPhail and Bowles 2021).
- EBM emphasizes ecological contexts, which means DFA managers must expand their engagement with external neighbours who manage DFAs that overlap with common ecological areas for those aspects that transcend DFA boundaries and should be resolved across ecological units (Section 2.8: Spatial Scales and Ecological Context).
- It will be challenging to better engage internal users and interests that traditionally
    - Have not been involved with forest management planning (energy sector, municipalities, etc.).

- Have been narrowly involved for specific values and interests (trappers, OHV users, etc.).
- Have been poorly involved because higher-level issues have not been resolved (low involvement of Indigenous people because of treaty issues or Indigenous rights issues at higher levels of government-to-government engagement, etc.).
- Have not been involved due to lack of awareness, no sense of urgency, lack of resources, etc.

RECOMMENDATIONS

> *"Indigenous peoples have been sidelined far too long. Treaty 8 First Nations are demanding a stronger voice in industrial management. Courts have been siding with Indigenous peoples, the future will be changing and EBM could help with the transition. Possibly start with co-management with Indigenous for wildlife such as moose and deer harvest, then extend to other aspects."* (Anonymous SME).

> *"Processes always take more time and resources than are expected or available. Maybe we need to move away from one-off input to specific processes like an FMP or a development towards an 'always-open' system of information, planning, performance reporting, and input."* (Anonymous SME).

> *"Inclusion has to include respect, and respect has to include a sincere response to input. People will feel included if they feel their effort is respected, even if it isn't always accepted."* (Anonymous SME).

- On a common interest basis, DFA managers can voluntarily seek input and participation from DFA users that have not traditionally been involved in long term management planning.
  - External neighbours including DFA managers that have overlapping geography with larger ecological contexts (e.g., all DFA managers that overlap with portions of an ecological region)
  - Internal stakeholders and interested parties that have not traditionally been involved in long term management planning (e.g., energy sector in large areas of Alberta and Saskatchewan forests).
  - Etc.
- There are significant opportunities with the development of improved information and communication technologies (e.g., social media) to expand traditional engagement processes in ways that provide improved opportunities, more effective communications, and tools to explore the predicted outcomes of proposed management alternatives and actions.
- Where identified interested parties are unable to participate or choose not to participate the DFA managers should recognize their interests to the best of their ability and consider them in the same way that direct input is considered.
- Because EBM is a social initiative, developing good engagement and communication processes to support EBM planning will build a foundation for ongoing involvement of all interested

parties in implementation, monitoring, reporting of outcomes, and revisions to foster continual improvement.

- The list of values (with measurable indicators) to be integrated for each EBM plan should be made by the designated manager after a consultation process that is inclusive, open, and transparent.

C2.6 Comprehensive

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EBM strives to overcome some of the shortcomings of the VBA governance model by shifting the management focus (Andison 2020) from single values and divided oversight to a more comprehensive (holistic) view that incorporates, and integrated all relevant ecological integrity and human wellbeing aspects for individual DFAs. Management focus must include all of the activities and outcomes selected to represent EBM for each DFA. Recognizing multiple functions and benefits and finding the balance between different policy domains is a key advantage of EBM (Delacámara et al. 2020).

After DFAs have been designated, managers have been specified, and ecological contexts have been identified, the next step in EBM is to prepare a long-term EBM plan for each DFA. An EBM plan contains VOITs and the activities specified to achieve the targets. Each EBM plan must be comprehensive, which means all aspects are included, and a set of comprehensive indicators and targets have to be based on a credible forecast of expected future outcomes in response to specified management actions.

Challenges

> *"We can't succeed with people separately doing their own thing on the same landbase, messing that up leads to the chaos we have now. Somehow, we have to shift to better coordination and cooperation, it's the only way it can work."* (Anonymous SME).

- Integrating multiple levels of governance for multiple ecological and human wellbeing values is a major challenge for any management approach.
- In the current governance system, planning, targets, and requirements are usually set externally and then applied locally. In practice this is very hard to do and results in many unresolved aspects.

Recommendations

> "Cumulative effects benefits of EBM are a hard sell to the energy sector. Is there any way for the energy sector to get marketplace recognition for doing EBM? There could be possible opportunities through forest management certification, ESG initiatives, and external recognition for actions." (Anonymous SME).

- Area-based EBM planning that brings all values and all human uses together in one comprehensive process is a promising way to comprehensively integrate management. In a planning hierarchy area-based EBM plans would be one of the strategic planning levels, where direction flows into the process from external sources (ecological values, land use plans, legislation, management plans, resource values and uses, etc.). Direction from completed EBM plans flows to lower-level plans and back to the external sources.

C2.7 Long Term

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Long-term planning at landscape and ecologically-relevant scales is a necessary component of EBM and should result in improved environmental and social conditions over the long term (CIT 2004). Planning should consider time horizons that reflect ecological processes such as lifespans of the longest-lived tree species (Newman 2019) and natural disturbance cycles (fire return intervals, hydrological cycles such as 100-year and 200-year floods, insect cycles, drought, etc.).

Challenges

> *"I'm frustrated with maximum short-term profit people that are not willing to look at cost-savings associated with EBM over the long-term. The same goes for other short-term focus people. They want to cherry-pick only what they like. They aren't being open-minded and have us and them attitudes. How can we get these people to think strategically?"* (Anonymous SME).

- Sustainability requires a long-term vision but most economic and political decision-making traditionally focuses on the short-term (Coast Information Team 2004). This is insufficient to provide for ecological integrity over the long-term over extensive areas (Dodds 1994; Chambers et al. 2019). Ensuring appropriate consideration of VOITs across the planning horizon is a challenge.
- Humans tend to take relatively short-term views on forest management and de-emphasize long-term aspects and issues. Most direct conflicts usually have short-term horizons (e.g., current habitat versus long-term habitat).
- Most areas held under tenure by forest companies have long-term planning led by either forest companies or provincial governments, but not for all aspects. Most non-commercial forests, protected areas, etc. do not have comprehensive long-term plans that use ecological VOITs and scenario analyses. Extending long-term planning to the entire forest landbase is a challenge.
- Where required, management plans may be out of date or not completed (e.g., provincial protected areas).

Recommendations

"I'm frustrated with maximum short-term profit people that are not willing to look at cost-savings associated with EBM over the long-term. The same goes for other short-term focus people. They want to cherry-pick only what they like. They aren't being open-minded and have us and them attitudes. How can we get these people to think strategically?" (Anonymous SME).

- In Alberta and Saskatchewan forest tree growth rates and lifespan suggest a planning horizon of at least 200 years at landscape scales is appropriate to capture natural cycles of disturbance and recovery and their associated patterns. The provincial forest management planning standards require a planning horizon of 200 years (Government of Alberta 2006; Government of Saskatchewan 2017).
- Extend long-term EBM planning to all forest DFAs in Alberta and Saskatchewan. An interim step would be to characterize current landscapes and do a simple status quo forecast to identify likely future trajectories if current management were to continue.

C2.8 Spatial Scales and Ecological Contexts

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Management must occur across multiple ecological, political, administrative, and generational boundaries and interests (Cortner et al. 1998). Natural forests have complex biodiversity and ecological processes interacting with the environment and each other through internal and external ecological processes and interactions that help maintain the entire system (Noss 1987). Because EBM aims to maintain ecological integrity by scaling patterns in time and space (Urban et al. 1987) it must be implemented at multiple spatial scales that are best judged to represent the interrelated and interacting elements, functions, and processes of ecosystems (Turner 1989; Levin 1992).

Humans recognize ecosystem patches and boundaries based on limited but increasing understanding of natural patterns and ecological processes, but there is much we do not know and the patterns we recognize and manage are most assuredly not relevant for all aspects of ecological integrity. Comprehensive EBM at multiple scales increases chances of success (Table C3).

Table C3. Examples of ecological spatial scales compared to administrative spatial scales.

Ecosystems	Watersheds	Species	Administrative Units
Ecoprovince	Large watersheds	Species distributions	DFA
Ecoregion (AB: Natural Region)	Intermediate watersheds	Designatable Units	Sustained yield units
Ecodistrict (AB: Natural Subregion; SK: Landscape Area)	Landscape watersheds	Regional species populations	Municipalities
Landscapes	Local watersheds	Local species populations	Operating areas
Ecosystems	Water bodies	Habitat areas	Logging plan areas
Ecosites	Stream reach	Habitat patch	Cutblocks

The largest ecological spatial scales should be regional geographic areas that encompass the distributions of wide-ranging animals such as migrating ungulates and top-level predators that use resources over millions of ha or more (Poiani et al. 2000). Alberta and Saskatchewan species in these categories include woodland caribou, grizzly bear, and mountain lion. For individual DFAs these may be subdivided into smaller overlapping units such as species Designatable Units (Committee on the Status of Endangered Wildlife in Canada 2018) or local populations (Government of Canada 2019b).

Ecological units overlap management units and each other. A DFA might include portions of several ecoregions or their subdivisions, watersheds at multiple scales, and individual species distributions.

Most existing land use areas were defined with administrative boundaries instead of ecological boundaries (Figure C6; Forcorp Solutions Inc. 2012), so EBM must be placed in context for larger ecological units that overlap DFAs.

Managers must consider and comply with context and direction from legislation and higher-level plans. This may partially address larger-scale ecological considerations (e.g. caribou range plans that overlap commercial forest areas).

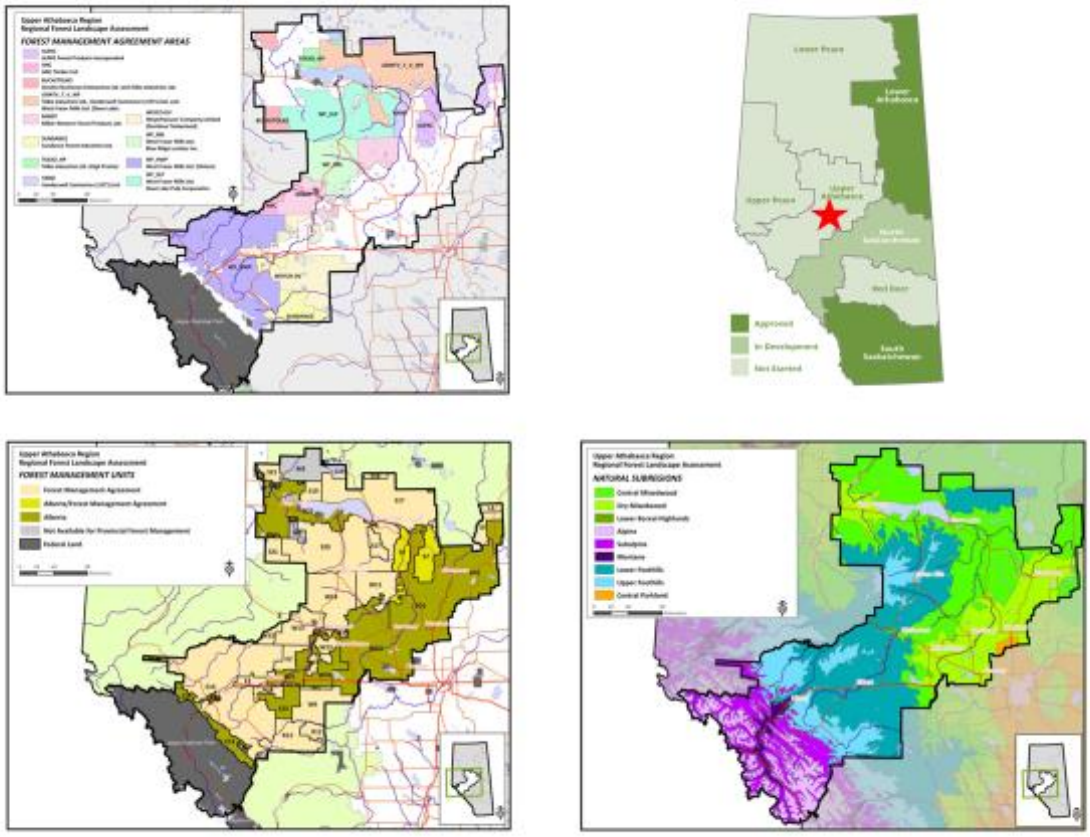

Figure C6. Alberta Land-Use Framework Regions (upper right) and an example subdivision for Forest Management Agreement areas (upper left), Forest Management Units (lower left), and Natural Subregions (lower right) for the Upper Athabasca Region. (Forcorp Solutions Inc. 2012).

At smaller scales ecological units are divided into nesting scales that reflect elements and processes that function at different scales, including rates and frequencies of natural processes like wildfire, and produce patterns reflecting the processes (Urban et al. 1987; Eng 1998). This distinction is important for characterizing NRV because the spatial scale for an indicator must reflect the potential for variation that is less than a 0-100% range to be useful.

Spatial scales must also be selected, or recompiled, to fit within administrative units such as DFA boundaries, administrative areas, operating areas, road networks, and other human constructs. Depending somewhat on area size, additional ecological scales (smaller ecological units, individual disturbance events, etc.) are selected.

Ecological integrity is best measured for ecological units at multiple scales over ecologically-defined time horizons (De Leo and Levin 1997; Parrish et al. 2003; Tierney et al. 2009). Most management unit area (DFA) boundaries in Alberta and Saskatchewan were administratively-defined and some subunits are not contiguous. The largest relevant ecological areas (ecoregions and subregions, larger watersheds, species distributions) usually overlap management unit boundaries and sometimes provincial borders. Management unit boundaries typically reflect social and economic values as well as ecological conditions, so it's not surprising that most do not closely match ecological boundaries. This makes it more challenging to work toward coordinated and comprehensive EBM for entire ecological units (Figure C7).

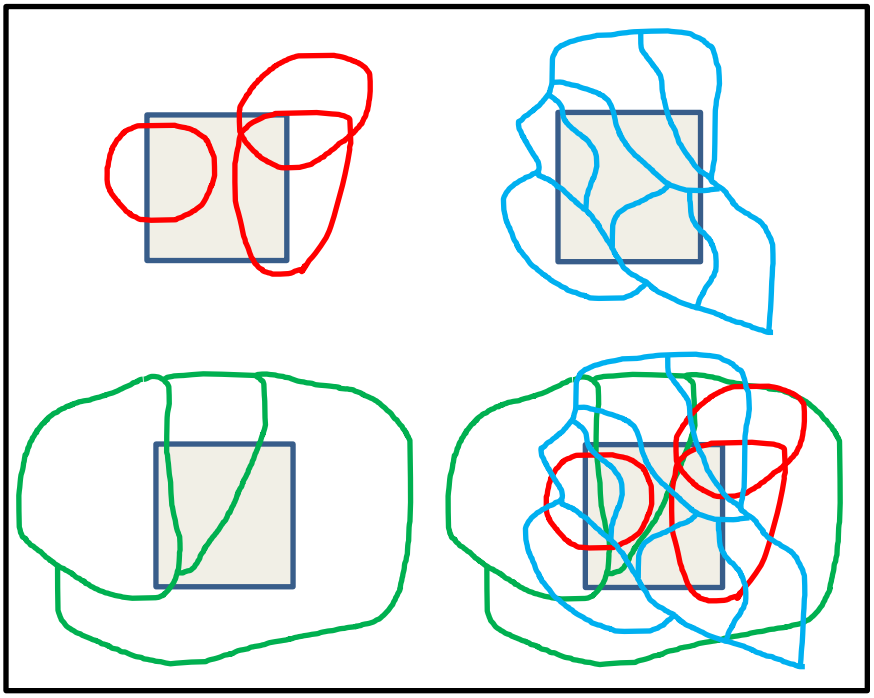

Figure C7. Diagram of hypothetical spatial examples of external ecological contexts for a Defined Forest Area (shaded square), showing species distributions (red), watersheds (blue), and Ecoregions (green).

Most management planning in Alberta and Saskatchewan forests occurs within administrative boundaries at most scales. In some instances, the administrative boundaries broadly reflect ecological boundaries:

- Logging units and cutblock boundaries may follow 'soft' natural ecological forest age boundaries between merchantable and immature forests.
- Logging units and cutblock boundaries often correspond to 'hard' ecological boundaries between merchantable forests and non-forests such as watercourses and lakes, wetlands, grasslands, shrublands, etc. Administrative considerations or requirements may modify these boundaries (protected areas next to water, cutblock boundary where merchantable timber ends instead of where wetland begins, etc.). Administrative boundaries such as roads and management unit boundaries are also frequently used.
- Environmental, economic and safety considerations influence where boundaries are placed in relation to landforms and terrain (e.g., logging boundaries associated with steep slopes may be placed in relation to erosion risk, availability and costs of logging equipment, and safety).

CHALLENGES

"EBM is tough to scale up, it works for small examples but it's harder to do when going to bigger areas with more values and more conflict between winners and losers. The scale of winning and losing with the current system is even larger but people don't realize that." (Anonymous SME).

"There is only so much we can do to manage ecologically. Forest fires can be hundreds of thousands of ha, harvest events can be up to about 30,000 ha, which is equivalent to a smaller fire. Practically we can't do much more, and there is also public resistance to larger events." (Anonymous SME).

- Ecological classifications and inventories are needed to support use of ecological boundaries.
- EBM can be applied across a spectrum of geographic scales from smaller (e.g., a single tree) to larger (e.g., forest ecoregions). Within management units EBM should be applied at a series of nested ecological scales from larger to smaller and vice versa. The scales should reflect natural patterns and ecological processes inherent to the management unit. Some FMPs use several scales to set VOITs, but the process is arbitrary, uneven and incomplete. Extending the concept of ecologically-relevant geographic scales within and between all DFAs would be a challenge.
- As EBM is a developing process, there are many different spatial scales in use. Some are required by governments and others were selected by managers.
- Addressing EBM at relevant ecological scales is a significant challenge. Ecological areas (ecoregions and subregions, watersheds, species distributions, etc.) usually overlap tenure boundaries (Figure C7). To address the largest relevant ecological scales managers must work with others beyond tenure and other administrative boundaries at larger spatial and temporal scales than usually managed.
- Tenure areas and other landuse units are largely administrative units and may not be contiguous.
- Management must encompass historic, existing, and prospective future ecological conditions and futures, and the associated human uses and interests.
- EBM aspects and legal requirements may not be appropriate at some scales.
- Target-setting priority for overlapping scales may be unclear.
- Forest logging planning has traditionally been done for operating areas or compartments, with individual cutblocks within. These are roughly equivalent to the components of natural disturbance events such as wildfires (Andison 2003, 2013). Administration has traditionally been at the scale of individual cutblocks or subareas within cutblocks. Moving administration to the disturbance event scale while respecting legal requirements is a challenge.
- There is no formal process that requires EBM for appropriate ecological units, instead there is a patchwork of single-purpose legislation, policy, and practice that provides incomplete and inconsistent direction or advice.

- Choosing appropriate ecological units to provide EBM context, direction, and evaluation ultimately reflects social choices, which means they may not match up when crossing administrative borders.
- There is no consensus package of appropriate ecological units to use. This leads to variation in the ecological units selected by managers and makes regional cooperation more difficult. An example is the recent *Bull Trout (Salvelinus confluentus), Saskatchewan-Nelson Rivers: recovery strategy, 2020 (proposed)* (Government of Canada 2020a). The GOA and Parks Canada used different watershed definitions and different ways to classify and rank them. Although they are now cooperating, the two agencies missed an early opportunity to cooperate by using the same definitions for a species distribution that transcends provincial and federal DFA borders.
- Most existing legislation and land use initiatives are based on specific values and don't provide useful ecological context and direction.
- At worst external requirements and directions with some form of ecological context conflict with EBM implementation on DFAs. For example, habitat requirements in most species at risk plans (e.g., Boreal Caribou; Government of Canada 2019b) were developed for a single species and did not consider EBM aspects of habitat over time. They also tend to take a one-size-fits-all approach which does not consider ecological variation, and they are not integrated into whole landscape EBM planning. In most cases they act as constraints to EBM management in DFAs. Having one dominant value superior to all others is not consistent with EBM thinking.
- In many cases higher-level plans have not been developed and those that exist (e.g. Alberta Land use Framework Regional Plans) were not developed using an EBM approach. At present they provide little help to DFA managers seeking direction about addressing ecological context for their areas.
- Governments encourage park managers (e.g., Government of Canada 2018) and forest companies (e.g., Government of Alberta 2006) to consider ecological contexts beyond their DFA borders but there are few requirements and incentives to do so.
- It is common for DFA managers to place their DFA in appropriate ecological contexts in descriptive format, and sometimes in quantitative terms including proportions and maps. Some DFA managers have recognized external ecological contexts but most just noted the context and did not take steps to quantify the contexts and relationships and work with others to coordinate, cooperate, or collaborate their plans for individual DFAs into assessments and plans for larger ecological units.
- There are some examples of regional cooperation at larger ecological unit scales, but these are the exception rather than the norm.
- On their own initiative managers may not wish to cooperate on issues of common interest for various reasons including costs, lack of institutional working arrangements, and competition between commercial DFA managers.

- Selection of appropriate ecological units is at present an ad hoc process that reflects legal requirements, established contexts and interests, the interests of regulators and managers, and willingness to establish and support institutional relationships.

RECOMMENDATIONS

Government leadership is needed to define the ecological contexts and scales to be used for planning and reporting of ecological integrity aspects for selected ecological units at the provincial scale, between federal and provincial land units, between provinces and territories, and between nations. (SME interviews).

"Harvest planning and accounting scales should focus on the landscape level instead of the cutblock level. Disturbance event is a good scale to use." (Anonymous SME).

- Research and government leadership to develop a suggested definition and hierarchy of spatial scales would assist DFA managers with selecting appropriate ecological scales and enable rollup of information for DFAs into larger scale contexts. Include administrative scales from province to land use regions to DFAs to management sub-units to activity patches such as cutblocks.
- Government leadership is needed to define the ecological contexts and scales to be used for planning and reporting of ecological integrity aspects for selected ecological units at the provincial scale, between federal and provincial land units, between provinces and territories, and between nations.
- It may be useful to start with three basic scales: region (e.g., ecoregion/ecodistrict, larger watersheds, species population distribution), landscape (smaller units nested within regions), and patch (uniform conditions distinguishable from surroundings). Disturbance events are a special scale that is useful to manage disturbances (Andison et al. 2009).
- Referencing and incorporating relevant ecological scales beyond administratively-defined DFA boundaries is a significant challenge that is resolvable through government leadership and cooperation between DFA managers.

- Governments already recognize and use ecological units in parts of their management frameworks. For example, Saskatchewan reports forest type and age for ecozones and ecoregions (Box C5; Government of Saskatchewan 2019), Alberta prepared regional landscape assessments for Land Use Regions based on major watersheds (Figure C6; Forcorp Solutions Inc. 2012) and Parks Canada produces State of Park reports for National Parks (Government of Canada 2016; e.g., Government of Alberta 2020b).

Box C5. Ecological Units in Alberta

Some initiatives provide potentially useful ecological contexts. For example, the Government of Alberta designated independent non-profit Watershed Planning and Advisory Councils, which "…report on watershed health, and facilitate collaborative planning, education, and stewardship." (Government of Alberta, 2020b). The councils prepare Integrated Watershed Management Plans as advice to governments and agencies that have policy and regulatory decision-making authority for land and resource management. The GOA may choose to incorporate advice into Water Management Plans, which are authorized by the Water Act and become requirements for aspects such as establishment of minimum in-stream flows, conditions on diversions, and strategies for the protection of the aquatic environment (Government of Alberta, 2020b).

Alberta DFA managers seeking external context on watersheds can engage with WPACs and reference Integrated Watershed Management Plans.

- DFA managers can take the initiative to voluntarily work with their neighbours to plan and report on EBM for ecological contexts, and reference their status and plans in their respective DFA plans.
- Governments identify the aspects or criteria for selecting aspects that direct or influence external context activities for DFA managers to assess external ecological contexts and identify the aspects that would benefit from a regional approach.
- There is an opportunity for a discussion paper and comparison of options for addressing ecological contexts in EBM plans, including which aspects would most benefit from cooperation and partnership across boundaries (some form of joint or simultaneous planning) and others where simply compiling information as assessing it could be sufficient. Examples:
    - Regional cooperation to manage a species at risk, see the bull trout recovery strategy for an example (Government of Canada 2020b).
    - Build upwards from DFAs, or direct downward from higher-level plans. For example, if each DFA has a plan for old forest they could be complied upwards for ecoregions and assessed to see what ecoregion-scale old forest is. There could be feedback back down to DFAs if there are challenges or opportunities.
- EBM should reference relevant ecological units and administrative units to portray and discuss different values that are applicable to each DFA. For example, use watersheds for water values and aquatic biodiversity, ecoregions for ecological units, species distributions for species management, and administrative units for human interests including land use categories and

specific use considerations such as traditional use areas for Indigenous communities and determination of Annual Allowable Cut for forest companies.

- DFA managers can voluntarily improve their characterizations of trans-boundary ecological units and provide at least a narrative of potential issues and how they see EBM on their DFA contributing to ecological integrity for larger ecological units.
- DFA managers can voluntarily seek to work with others (Figure C7) who have responsibilities for larger ecological units to achieve EBM at scales that they have only partial responsibility for.
- DFA managers should use and expand existing units and ensure they are operational, flexible, and relevant.
- Monitor management unit definitions and consider alternatives where they would be useful to evaluate specific questions.
- Cross-reference ecological and administrative units to effectively represent both ecological integrity and human wellbeing aspects of EBM.

C2.9 Existing Requirements

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Most planning exercises are constrained by a very large body of existing situations and requirements that must be considered. Planners must comply with all legal requirements including those that constrain or hinder, support, or are neutral to, EBM. Substantial numbers of existing requirements may conflict with possible EBM alternatives.

As an overarching approach to maintaining ecological integrity, EBM must be inclusive of other conservation strategies by recognizing the ecological aspects they apply to and ensuring the chosen EBM plan has considered and integrated them.

Habitat fragmentation refers to changes in habitat configuration that result from the breaking apart of habitat, independent of habitat loss (Fahrig 2003). Policies and requirements to reduce habitat fragmentation arise from concerns about human-caused habitat changes that have negative effects on biodiversity and typically ignore positive effects. The concept is hugely controversial (Fletcher et al. 2018; e.g., Fahrig et al. 2019). Patch size, shape, and configuration are aspects associated with fragmentation. These metrics have NRV and are often included as EBM indicators.

Old interior forest is a fragmentation indicator that is thought to be important for species associated with interior habitat distant from edges with younger forest or open areas (Chen et al. 1993; Chalfoun et al. 2002). As an aspect of patch size interior forest is linked to both habitat configuration and habitat amount.

Induced Edges are a fragmentation indicator that result from disturbances (e.g., fire or logging) and development of human infrastructure (roads and other corridors, buildings, etc.). Induced edges change physical and biological elements of the ecosystems to either side including microclimatic effects and

shifts in community composition (Kremsater and Bunnell 1999). Edges are a part of patch size and shape, and the architecture of anthropogenic edges compared to natural edges is also an aspect of EBM.

Connectivity (Taylor and Carroll 2003) refers to e*cological corridors* that facilitate species movements, particularly for extensively human-altered landscapes (e.g. urban areas), bottlenecks (e.g. narrow valleys 'blocked' by settlements), and partial or complete challenges (e.g. major highway corridors). Undesirable ecological effects may also be associated with corridors, such as invasive non-native plants spreading along roads. Corridors in forest management are sometimes required by governments to facilitate movements across or through recently disturbed (logged) landscapes. Riparian strips bordering waterbodies, disturbance event remnants in corridors or islands (stepping stones), and forest strips retained for aesthetic values are examples of landscape corridors. Natural connectivity NRV can be characterized and compared to future variation.

Critical habitat is defined in the *Species at Risk Act* as "*the habitat that is necessary for the survival or recovery of listed extirpated, endangered, or threatened species, and that is identified as critical habitat in a recovery strategy or action plan*" (Government of Canada 2002). Critical habitat differs for each species and is usually defined in terms of habitat variables that are more detailed than the ecosystem level. Critical habitat is an NRV indicator and this can be compared to critical habitat targets.

Riparian protection requirements refer to protected strips of land (buffers) bordering aquatic ecosystems in both provinces. Riparian disturbances and ecological conditions can both be characterized for NRV and compared to provincial and federal requirements.

CHALLENGES

> *"Governments tend to have a whole bunch of cookbook managers focussed on single issues, and these people are unwilling or unable to look at alternatives or deviate from following the rules. This is very frustrating for those who think things could be better if we did things differently."* (Anonymous SME).

> *"Governments exist to regulate. So much regulation has built up that often the original reason for the requirement has been lost. Effectiveness monitoring is poor. Doing things and assuming a good result is not a winning strategy"* (Anonymous SME).

- Existing requirements constrain the space in which EBM can be envisioned and implemented.
- Most existing requirements were developed by governments over many years and are narrowly focussed on specific values, aspects, and activities.
- Requirements and approval processes often differ by sector
- The long-term trend has been toward increasing the total load of requirements as:
    - New values are recognized and requirements are added to address them.
    - Additional requirements are added for previously-recognized values because the values were judged to be not sufficiently protected, or because the social importance of the values has increased.

- Government levels (e.g., federal and provincial) and agencies (e.g., provincial ministries) tend to operate independently and focus on specific values and human activities (see Section 6.2.1.2.1 on silos).
- Governments rarely review their entire portfolio of requirements in an effort to streamline and reduce red tape and produce better outcomes. Instead, they are more likely to "add to the pile" or engage in one-off initiatives to reduce red tape in an attempt to increase efficiency and competitiveness such as the current Alberta Cutting Red Tape process.
- Existing situations may also be challenging.
    - Ecological conditions could be toward the low or high end, or outside of NRV, in ways that challenge continuation of existing or development of new management options and human uses.
    - Existing human uses may make it difficult to make desired changes, or may slow them.
- Fine filter constraints for wildlife habitat can be a challenge to EBM implementation, especially when compliance would lead to indicators outside of NRV or constrain EBM innovation opportunities.

RECOMMENDATIONS

> *"To make changes government should not dictate, instead partner with those who know how to get it right. Government often brings in rules intended to get a certain result but the law of unintended consequences often leads to different outcomes. Government needs to be humbler and work with others to define what they want and then put in place measures to get it."* (Anonymous SME).

- The best way to remove requirements that constrain or hinder EBM and to add requirements and processes that support EBM is through government leadership to regularly review and revise their policy and legal requirements frameworks. This would be a mammoth undertaking because there are many applicable Acts, Regulations, policies, guidelines, directions, and processes at multiple levels of government.
- With some notable exceptions, many existing requirements include provisions that permit alternative proposals, subject to government approval for variance from standard requirements. These provisions could be used by DFA managers to propose EBM alternatives to existing requirements, but only if governments encourage alternative proposals and are prepared to approve them if they are judged to be equivalent to or better than standard requirements.
- To increase learning and reduce risks, approved alternatives could be implemented with an adaptive management approach that starts with research, demonstration, and operational trials that are closely monitored and evaluated before widespread routine implementation.
- There is opportunity for NRV to be used to inform issues of size, shape, dispersion, amount, fragmentation, interior forest, edge effects, connectivity, etc.
- Characterize NRV for existing strategies using the same criteria that define them and place requirements in NRV context as part of EBM.

C2.10 Scenario Planning

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Scenario planning (Schoemaker 1995; Beach 2021) is development and evaluation of multiple scenarios of potential management actions and outcomes using forecasting supported by data and computerized forest estate models. Scenario suggestions can come from multiple sources, including government requirements, company preferences, and participation of interested parties in the planning process.

Scenario planning enables envisioning and comparison of multiple potential stories of what the future might be given different combinations of forecasted natural events and human activities (Diaz-Balteiro and Romero 2008). Scenarios are not deterministic predictions but they are useful for imagining and forecasting likely results based on current knowledge and understanding and the assumptions that must be made where knowledge is incomplete. They describe images of the future that challenge current assumptions and broaden perspectives (Duinker and Greig 2007). They help to increase understanding and support comparisons of different management alternatives, including testing the sensitivity of forecasts to changes in management activities. EBM is supported by scenarios that assess ecological conditions, track them over time, and project changes under alternative scenarios (Cushman and McGarigal 2019).

Once a scenario is selected as a plan to be implemented, it also serves as an anticipated hypothesis of the future that can be compared to what actually happens to gain new knowledge and understanding and use it to improve the next round of scenario building and forecasting.

Prepared for commercial forests, Forest Management Plans (FMPs) are based on computer modelling (forest estate models) of future forest conditions in response to potential management scenarios over a 200-year planning horizon. Scenario forecasts are requirements for long-term FMPs for commercial forests, and the Alberta and Saskatchewan provincial governments have standard scenarios that must be forecasted and evaluated (Government of Alberta 2006, 2017; Government of Saskatchewan 2017). Managers typically devise and run multiple scenarios that explore the implications of management alternatives, which are then compared and revised to eventually arrive at a preferred management scenario that is submitted for government approval.

Scenario planning requires digital forest inventories and computer models which virtually track and “grow” (age) each stand (patch) in the inventory over time in response to disturbance scenarios and age-based ecological succession. The models are constrained to patches available to cut (the active net landbase once trees reach a certain age or merchantable volume), plus external constraints. The models also grow inventory that isn’t scheduled for logging and can apply successional transition rules for stands when the original cohort of (usually) trees dies of old age. There are many other models that can be used to characterize indicators and forecast future conditions (Mladenoff and Baker 1999; Cushman and McGarigal 2019). Spatially explicit models inform management planning processes and help managers envision and set targets for ecological integrity and human wellbeing indicators (Chambers et al. 2019).

Commercial forest FMPs are organized around logging as the main disturbance agent, but models can include any kind of disturbance. Critical to the interests of forest companies, one of the main outputs is a sustainable annual allowable cut (AAC) and a spatial harvest schedule for stands to be logged by time intervals.

The models also output predicted ecological conditions, including spatial "snapshots" of landscape conditions at any point in the planning horizon for each modelled scenario. The outputs represent possible "future forests" and managers compare them and make adjustments until a final scenario that best represents all management objectives is selected and submitted for government approval.

Each forecast must consider all targets as part of a dynamic interchange, where changing one target may have consequential changes to other targets. For example, increasing old forest will reduce young forest.

CHALLENGES

> *"Plain language, non-technical definitions, easy-to-observe visual evidence, and irrefutable proof of benefits are needed. Traditional attempts to demonstrate benefits or concepts by "modeled" or hypothetical, probabilistic scenario-based visualizations will not serve us well. Nor will traditional communication of science and data as the realm of "experts". These tools are overly complicated to lay people, and too dependent on trained interpretation or on the many assumptions in their inputs and design. Continuing to rely on them in our communications will arguably set an atmosphere of uncertainty, confusion and distrust which could lead to loss of social contract to continue down a path of otherwise promising experimental ecological-based management approaches."* (Anonymous SME).

- Quantitative spatial assessment and projection of future changes is needed to assess current conditions and to assist choice among alternative management scenarios based on expected impacts on future ecological conditions (Cushman and McGarigal 2019). Because comprehensive EBM plans do not yet exist, scenario planning is not being used to develop them. FMPs are the closest approximation.
- The degree to which natural patterns are used in planning depends on whether or not forest estate models are used to develop long-term management plans and the relative priority for ecological integrity possible considering the type of landuse allowed in a given forest area.
- Protected area plans place a high priority on ecological integrity but usually don't use scenario planning and forest estate models to explore management options and set targets for future forest conditions.
- FMPs use forest estate models and place a high priority on ecological integrity to the limits of government requirements and company responsibilities (e.g. they don't plan for the passive landbase and can only minimize the impacts of linear corridors).
- Like all predictions of potential future conditions, scenario planning relies on data and assumptions that have inherent uncertainty. Another source of uncertainty is the inevitable occurrence of unplanned events (e.g., black swan events such as large forest fires, floods, the

mountain pine beetle outbreak, and the COVID-19 pandemic), and how those influence planned outcomes. Uncertainties are partially addressed through sensitivity analysis, which estimates the acceptable levels of change that would necessitate planning, and regular re-planning that accounts for actual versus planned events and provides opportunity to review and revise scenarios.

- The FMP process is as close as there is currently to integrate EBM planning although it doesn't include the future actions of others such as oil and gas. Having lots of indicators is good because it allows inspection of outcomes from multiple perspectives. Having lots of externally-imposed targets is bad because it reduces flexibility and hampers innovation.
- FMP scenario plans do not forecast human uses other than logging.
- FMP scenario plans classify the passive landbase and model age-related changes but do not account for or propose any kind of disturbance for the passive landbase.
- The most advanced FMPs use age-based transition assumptions to account for passive landbase ecological succession triggered by tree cohort lifespans. This practice is voluntary and has not been used by all who prepare FMPs.
- Management plans prepared for DFAs with land use designations other than those for which FMPs are prepared do not use scenario analysis, or if they do the analysis is not transparently available.
- Large forest areas (e.g., non-commercial forests, some protected areas) are not covered by formal management plans.
- Digital forest inventories needed to support scenario planning are not available for some forest areas.
- Development of ecological data, models, and computer processing capability has created questions about model complexity, data quality and availability, and model acceptance by policy makers (Fulford et al. 2020).
- Informal scenario planning is widely used to consider future management options, but it may not be linked to quantitative forecasts based on known and hypothesized cause and effect relationships, and it may not consider ecologically relevant time horizons of 200+ years.
- Formal scenario planning is generally not used for DFAs other than commercial forest DFAs.
- Formal scenario planning for commercial forest DFAs is still mainly oriented toward timber production, with EBM considerations as constraints.
- Legal and process requirements constrain scenario planning because planners must include all requirements in whatever scenarios they wish to consider. This limits the decision space and innovation opportunities.
- Scenario planning for commercial forest DFAs is incomplete because it does not consider the passive landbase and human activities that are not forest company responsibility (e.g. energy sector).

RECOMMENDATIONS

"The FMP process could be improved with public release of resource information gathered at the start of the plan, then ask for input into possible scenarios, then present results of scenarios modelled, along with the preferred scenario, and finally review of the draft FMP." (Anonymous SME).

- A discussion/feasibility analysis on options to extend future forest scenario modelling to all forest DFAs and use the modelling to explore and select long-term EBM plans.
- Scenario planning is a very powerful tool to examine and compare management options that could be implemented and to inform choices of the "best" scenario (Peterson et al. 2003). Scenario planning represents the current state-of-the art for EBM planning and there may be opportunities to use it for plans that don't currently use it such as protected area management plans.
- Simulation models are powerful tools for forecasting and evaluating the potential outcomes of innovations (Mozelewski and Scheller 2021).
    - Information about potential risks and benefits of actions and their trade-offs.
    - Alternative management innovations to achieve improved outcomes and reduce costs compared to current practices.
    - Inform the decision-making process prior to implementation and support innovation choices.
- Spatially explicit approaches that model information on ecological and human wellbeing indicators and changes in response to disturbances provide the foundation for EBM to achieve resilience (Chambers 1999).
- Comparisons of multiple scenarios helps to improve understanding of pathways and consequences of choices over time. Comparison also shows that more than one management pathway can likely achieve management goals and informs choices (Murray and Marmorek 2003)Rapid advances in availability of ecological data and computer processing capability have opened the door to more detailed scenario analysis (Fulford et al. 2020). This makes it possible to explore multiple scenarios relatively quickly and inexpensively.
- Natural range of variability, current landscape conditions, and desired future conditions (as set by land managers under social policy) can be compared to clarify EBM.
- The models can "solve" for anything. In the past (and still for most commercial forests) they are usually set to maximize Annual Allowable Cut considering all the constraints applied for other values. Some companies set the models to achieve multiple targets at the same time or consecutively (age class within NRV, then maximum AAC, vice versa, etc.). This flexibility can be used to develop multiple scenarios that test different assumptions and priorities and explore the predicted consequences of management actions.
- A British Columbia pilot study used alternative forest management scenarios presented using realistic 3D landscape visualisations and used stakeholder group priorities to support expert-based scenario evaluations. There was general agreement between experts and stakeholder

groups on scenario preferences. The process appeared to be an effective use of decision-support tools in conflict-prone areas (Sheppard and Meitner 2005).

- It's possible to change priority for which indicator or target "drives the modelling bus" and to ask other questions. For example, it would be fairly easy to specify the rates of disturbance needed to keep the passive landbase within NRV and use those to design a prescribed fire plan for the passive landbase. This hasn't been done because it's not a company responsibility and governments generally have not been interested. This is an example of opportunity to overcome divided responsibilities and improve integration through cooperation.
- Expand the scope of scenario planning to include comprehensive EBM scenarios – consider all values, all forest ecosystems, all human uses, etc. Compare EBM scenarios to more traditional scenarios, and whether or not existing requirements support EBM or alternatives could be proposed that improve EBM. Look for scenarios that best reconcile ecological integrity with human wellbeing.
- Extend formal scenario planning using quantitative long-term forecasts to EBM planning for DFAs where it is not currently used.

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Forecasting Tools

Preparing a long-term EBM plan using scenario analysis requires digital inventories of natural ecological features and human sites and activities. Most inventories are now stored as layers in a Geographic Information System. Each layer consists of polygons classified according to the data model for the inventory. Forest estate models apply changes over time according to management scenarios or natural ecological succession. The models keep track of each polygon and changes in the GIS layers and can output spatial snapshots of future forest conditions and flows of resources (annual water yield, species at risk habitat, seral stage amounts, timber cut volume, etc.). Managers usually develop multiple scenarios of possible future actions and use the models to create virtual future forests that are then compared to each other before a choice of scenario is made and becomes the basis for the EBM plan for a DFA. Review and comparison of the scenarios should involve all interested parties to try to arrive at a consensus on what EBM will be for a DFA.

Forest estate models are a top-down approach to exploring management strategies. They require specific information about scenarios before they can be modelled and assessed.

- Spatial features and attributes, stored in a GIS. Features typically include polygons and lines showing environmental, ecological, and anthropogenic aspects.
- Ecosystem (forest type) polygons with various attributes including age (time since disturbance).
- Age-linked yield tables for all aspects of management interest (timber volume, habitat, carbon storage, etc.).
- Assumptions about expected responses where data-based predictions are not available.
- Extensions to other parameters such as carbon sequestration, water flow, sensitivity analysis, risk assessment, and social impacts.

Two basic types of forest estate models manipulate large data sets and some of the available models can handle most details that managers wish to examine. Simulation models achieve pre-determined levels of outputs for timber, non-timber resources, and other indicators of management interest. Mathematical programming models attempt to optimize multiple targets using mathematical functions. Examples of forest estate models are Woodstock™/Stanley™ (Walters 1993), FORPLAN (Kent et al. 1991), ALCES (Carlson et al. 2014), and Patchworks™ (Moore and Tink 2008).

Challenges

> *"National Parks has undertaken heavy adoption of GIS systems and data in the last decade or so, and has the tools to do future modelling, but doesn't do that now even though they should be doing it. Doing such an exercise would require doing something now on some issues before it was too late and managers don't have the horsepower and traction to do much."* (Anonymous SME).

- GIS is now widely used by forest managers. Forest estate models are widely available but currently are used mainly for commercial forest DFAs. Managers of other forest DFAs will need to obtain models or hire consultants to provide modelling capability.
- All models are approximations and have considerable uncertainty and risk. Model outputs must be used to inform management and interested parties should not accept or use them as accurate predictions of future conditions.
- Contemporary forest management usually intends maximum sustainable yield of wood, which encompasses inherent productive capability and is constrained by consideration of other values. Restructuring of models and software to accommodate other scenarios would require some work.
- Models need descriptions of indicators that can be derived from available inventories and forecasted. For commercial forests many indicators are already required and built into FMPs. The challenge is to review existing indicators to identify gaps, and recommend additions or changes to complete a comprehensive set.

Recommendations

> *"An EBM strength is that it intuitively feels like the right thing to do. In practice EBM is a challenge to implement. There are conflicting values, and people want to talk about values, which is very hard to do. EBM can help to show what we share in common, reduce differences to a smaller space. Illuminate commonalities. The low-hanging-fruit is to identify common values. Find these and build on them."* (Anonymous SME).

- Forest management planning typically uses sophisticated computer models to forecast future forest conditions and outputs of woodcut levels, plus other indicators such as habitat, water regimes, and carbon cycles. Almost all values that can be objectively described can be forecast, and many models can be set up to produce and compare alternative scenarios with different indicators "driving the bus".

- GIS and forest estate model capabilities are continually improving. They are widely available and can be used by increasing numbers of people with appropriate technical training.
- Models are useful because they can quickly evaluate multiple management scenarios and provide estimates of uncertainty. Scenario outputs including maps and various EBM indicators are very useful information to support discussions about which scenario to choose.
- A research project to identify indicators in use and the information that supports them would help to organize the diverse sets of indicators and identify opportunities for improvement. It will take some time and discussion to identify the most relevant indicators, acquire inventory and incorporate forecast into computer models, especially for DFAs where scenario modelling is not currently being used.
- DFA managers can add voluntary indicators that they see as useful to their planning processes.

C2.11 Values, Objectives, Indicators, and Targets

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Like all good policy, EBM is based on evidence, including scientific knowledge and traditional knowledge. Technical EBM aspects relate to availability of ecological data, choices about which to include in management plans, and issues such as how to set and display targets to incorporate variation. As more VOITs and better data get incorporated into EBM plans these aspects are evolving rapidly. Challenges relate to identifying what is possible, making appropriate choices, and working to improve technical capabilities.

Like all forms of management, EBM is a socially-defined process (Cortner et al. 1998). One of the maxims of management is attributed to Peter Drucker: "*What gets measured gets managed*.". VOITs are widely used to define indicators (measurements) and targets that are related to values and objectives (Box C6). EBM values are those related to the joint goals of ecological integrity and human wellbeing. Once DFAs and responsible managers have been designated, the next step in EBM planning is to identify all of the values applicable to a DFA, and whether or not there are any existing objectives, indicators, and targets for the values.

Box C6. Values, Objectives, Indicators, and Targets (VOITs)

Value	*A principle, aspect, or quality that is considered important, beneficial, or desirable.*
Objective	*A broad statement describing a desired future state or condition of a value.*
Indicator	*A variable that measures or describes the state or condition of a value.*
Target	*A specific statement describing a desired future state or condition of an indicator. Targets should be clearly defined, time-limited, and quantified.*

Information

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Information applicable to each DFA and its relevant ecological contexts is needed to understand current conditions and forecast future forest conditions in response to natural ecological processes and human activities. DFA managers are responsible for information assembly, including assembling or acquiring existing information and collecting new information.

CHALLENGES

> *"There's never enough information, there's too much information. Few trust the information they have. Now we have 'alternative facts' and 'fake news' and plenty of spin, misinformation, and outright lies. It's too much. The problem is getting worse."* (Anonymous SME).

- Planning in all its existing forms relies on a large and constantly growing trove of information. In the digital age information is usually geographically referenced and stored in a GIS. Digital inventories are well-developed for commercial forest areas, especially where forest companies must provide them as part of the terms of their tenure agreement. Comparable inventories are uncommon for other forest areas including protected areas and non-commercial forests. In particular, information on vegetation cover type and age is needed to implement EBM.
- Inventories are expensive and must be initially limited to a set that can be completed with available funding. The challenge is to begin where you are and identify the core inventories needed to implement EBM and ensure they are funded over time.
- Acquiring and integrating the best scientific and traditional knowledge about a region, plus summaries of knowledge gaps and how they were reconciled in planning and will be further addressed in implementation.
- Forest estate models use data-derived information to update virtual information as time passes in virtual future forest forecasts. For example, growth and yield curves are used to predict changes in merchantable tree volume as forest stands grow. Ecological change curves are needed for additional successional pathways including natural development of young stands after natural disturbance and transitions to younger stands related to end-of-life for the oldest trees in stands and small-scale gap dynamic processes that initiate younger stands (Cumming et al. 2000).
- Some information is proprietary and may not be available for use in EBM planning, or available only for a fee. Making existing information available is a significant challenge.
- Most forest information databases suffer from variations in data standards, accuracy, age, and accessibility.
- Responsibilities for collecting information may not be clear.
- Information that is supposed to be collected may not be collected, or it may be out of date or backlogged.
- Collecting new information is expensive. Inventory is often hampered by underfunding or uneven funding.

- Acquiring and using local traditional ecological knowledge from Indigenous and non-Indigenous people. There are challenges related to communities collecting and summarizing their information, which is usually provided by elders, and making the information available to support EBM planning.
- Information needs to be interpreted and presented in a range of ways to support EBM.
- Interpreting, integrating, communicating, and using information from Indigenous traditional ecological knowledge and science-based quantitative knowledge is a challenge.
- Making information available to interested parties in ways that are understandable and transparent is a challenge.
- Retention of historic information when updates are done. For example, new forest cover inventories usually re-estimate forest age for inventory polygons and may simply overwrite previous estimates. The challenge is to build on exiting knowledge while retaining historic information to compare expected and actual results and inform the adaptive management process.

RECOMMENDATIONS

> *"Planning is expensive and currently very inefficient and ad hoc. There should be opportunities to having other participants (e.g., government, energy sector) contributing to costs of planning, including making information available and sharing in the costs of information acquisition."* (Anonymous SME).

- To support EBM the first task is to describe ecosystem dimensions and interpret them for their significance, history and relationships (Slocombe 1998). The second task is to describe all historic, existing, and prospective future human uses. There is usually an existing knowledge base to organize and build on, so the opportunity is to take advantage of this and use it as the base for initial EBM planning.
- Most management plans don't use all the information that is available (Slocombe 1998). There are good opportunities to build a core set of information, derived mainly from existing databases that can be presented as a consensus core set of EBM information. Where data is missing or equivalencies are questionable, work to fill gaps and resolve inconsistencies.
- It is not necessary to wait until complete or comprehensive information is available. EBM can proceed with available knowledge, with gaps identified and filled through future inventories, and new knowledge gained through adaptive management (Box C7).
- There are opportunities to review allocation of available inventory funding and redeploying it to be more efficient, which will likely be more successful than acquiring new inventory funding.
- Data-sharing agreements are useful ways to share information for specified purposes while respecting data ownership and value.
- Focus information research and understanding on what could make a difference to EBM.

- Availability of data is uneven so managers must use what is available (e.g., age class to represent seral stages instead of actual ecosystem composition structure, and functions). Limitations to data and interpretations must be recognized.
- Where detailed spatial inventories are not available approximations may be developed by using association between digital inventory layers and finer-scale information. For example, estimates of dead wood from sample plots can be extrapolated to forest stands in a digital stand-cover inventory.
- NRV information such as forest age class NRV characterization for Alberta and Saskatchewan are widely available through initiatives such as LandWeb. These characterizations could be used to determine NRV of other aspects of interest such as forest types, watersheds, natural regions/ecoregions, fire threat, etc.
- Ecosite-scale mapping exists for some areas (e.g., Beckingham et al. 1999; Murphy and Luckert 2002), and there may be opportunities to extend coverages through
- Advances in remote sensing such as satellite imagery (White et al. 2016; e.g., Hanan and Anchang 2020) and LiDAR (Wallace et al. 2012) offer cost-effective ways to acquire information that may be more cost-effective than or impossible using traditional methods.
- Taking advantage of new and innovative ways to collect and disseminate information (e.g., citizen science initiatives such as eBird).
- Making information available to interested parties is facilitated by digital advances and social media opportunities.
- Where feasible making information available for free or reasonable costs.

Box C7. EBM Information Checklist

Ecological Information	*Human Use Information*
Ecological units	*Historic human uses by category*
Watersheds and hydrographic features	*Historic sites and probability mapping*
Landforms and digital elevation models	*Current human uses by category*
Vegetation/ecosystem mapping	*Existing human infrastructure by category*
Natural disturbance regimes by category	*Cultural and Indigenous sites and uses*
Disturbance history and current age classes	*Commercial forest areas (active landbase)*
Species distributions	*Energy resources and surface allocations*
Ecosites	*Mining*
Soils	*Other commercial uses by category*
NRV for ecological indicators	*Trapping and guiding*
Environmental sites	*Commercial recreation*
Non-native invasive species	*Recreation by category*
Traditional ecological knowledge	*Agriculture and livestock grazing*
Ecological change (yield) projections	*Archeological sites*
Paleontological sites	

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VALUES

A value is a characteristic, component, or quality considered by an interested party to be important in relation to an SFM element or other locally identified element. Value definitions include a desired end-state, service, product, or outcome (Robinson et al. 2001). Ecological values are present in all forests and they form the basis for ecological integrity.

Values are important foundations for both the current VBA and to EBM. The main difference is that VBA identifies values and manages them separately using command-and-control methods, whereas EBM identifies values and integrates them for DFAs. Another difference between traditional descriptions of ecological values and EBM is the emphasis on characterizing ecological values in terms of natural patterns and NRV and managing values to maintain variation.

All forest values are social values because they are defined by humans and they have importance to humans, and values change over time as new knowledge emerges and societal views (Robinson et al. 2001; Dietz et al. 2005). Human interest values pertain to both ecological values and to human wellbeing values. Human wellbeing values vary in type and intensity across forest regions, and some are related to non-forest activities such as extraction of underground hydrocarbon and mineral resources. Managers of non-renewable extractive activities are primarily concerned with economically producing their products while minimizing ecological integrity impacts. Managers of renewable extractive activities have a greater self-interest in maintaining ecological integrity because that allows them to sustain their activity over long periods of time. Social disagreements over the relative importance of competing values are at the heart of all forest management controversies.

CHALLENGES

> "Flexibility to implement EBM is constrained by past history of maximizing all values as much as possible. Government of Alberta business plans for years said to maximize everything. Of course, that is not possible to do, and now Alberta is living with the need to try to maintain the unsustainable status quo." (Anonymous SME).

- The words used to describe management system components (values, objectives, indicators, targets) are not universally understood to have the same meanings. These differences can lead to miscommunications which can challenge efforts to implement EBM.
- Value knowledge is variable across forest landscapes and tends to be highest in areas with the highest levels of human use.
- The values associated with Indigenous Traditional Ecological Knowledge and Traditional Uses are not well-documented for large areas and existing information may not be available to DFA managers.
- Existing indicators and data may not fully reflect linkages between environmental change and human wellbeing, particularly to assess social equity (Breslow et al. 2017).
- In many cases values occurrences must be provisional or estimated due to lack of inventory information. Examples include occurrence and distribution of obscure and poorly-known species

such as the yellow rail (Hedley et al. 2020), historic and archaeological sites, locations of natural springs and fish movement barriers, etc.

- The NRV of some ecological values has not been characterized.
- Among many options, choosing which values to use for EBM VOITs is a challenge.

Recommendations

> *"EBM still has to include considerations and requirements for other values in EBM, and these constrain what can be done. There's opportunity to change those from constraints to shared and integrated outcomes over the long term."* (Anonymous SME).

- Many forest values are well-known and lists of values are available or could be easily compiled for all Alberta and Saskatchewan forest DFAs. The process of value identification continues as new ecological knowledge is developed and economic and acceptable human activities and uses change over time. A research project to assemble values lists and information that could be used to characterize them with appropriate indicators could provide a valuable contribution to inform EBM in Alberta and Saskatchewan.
- The best way to identify wellbeing values is to engage the people whose wellbeing is to be assessed (Breslow et al. 2017).
- At the strategic planning level for DFAs it is not necessary to have complete information about all values that are present, or may be present, so long as there are processes to identify and locate them at lower planning levels. For example, procedures to identify and protect natural springs and cultural sites during field-level planning.
- Values can be linked to other information and used to develop EBM plans. For example, historical resources probability mapping (Noble et al. 2019) can be used to prioritize search effort.
- Build on the growing knowledge base about which VOITs are useful at the strategic EBM planning level, and others that may be more appropriate at lower planning levels.

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Objectives

Objectives are broad statements describing a desired future state or condition of a value. Objectives usually consist of normative statements about direction related to values and objectives factor in to setting targets. Strongly held objectives are typical for strongly held values.

Challenges

> *"EBM should be different things in different areas, which have different combinations of values and human uses. The objectives should reflect those. There's too much emphasis on one-size-fits-all."* (Anonymous SME).

- EBM is based on setting targets for indicators selected to represent values, and objectives are useful to inform the choice of targets. People often hold strong opinions about objectives for activities. The challenge is to engage participants in first setting objectives and targets for outcomes, and second for activities intended to achieve the outcomes targets.

RECOMMENDATIONS

> *"I like the idea of EBM plans for all values and all users as an improvement over FMPs. These should include incorporation of caribou range plans, watershed plans for fish species at risk, ILM for surface footprint, etc."* (Anonymous SME).

- Many objectives are already in use in forest management. A research initiative to assemble lists of existing objectives and placing them in context (outcome or activity) would help to inform the process of setting EBM objectives.
- Preparation of guidance documents describing how to develop EBM plans with descriptions of VOITs and the process to achieve them would help to address issues about terminology and process.

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INDICATORS

Indicators are variables that measures or describes the state or condition of a value and are used as the basis for setting targets that represent objectives. In short, indicators are the glue that holds the VOIT system together. See Section F for challenges and recommendations related to individual EBM indicators.

CHALLENGES

> *"An EBM indicator set has to be practical. Getting into too much detail can be a problem – caribou critical habitat as an example. A coarse filter approach is best, keeps it simple and meets most needs. Even when we adopt EBM practices, we tend to get too prescriptive. It's better to work with what we have and focus on variation, with some places less and others more."* (Anonymous SME).

- Current forest management includes use of many indicators. Indicator lists and the way they are measured tend to differ among managers, government agencies, land use designations, resource types, and jurisdictions. In short, many actors are using indicators but going their own way to define and use them.
- EBM plans require measurable indicators that can be forecasted in response to change scenarios. The challenge is to define a comprehensive and concise indicator set that can be used or recalibrated between EBM plans to support scaling up or down for other planning levels. For example, seral stage (age class) is a widely used EBM indicator but different actors define the number of stages and the age categories differently.

RECOMMENDATIONS

> *"How to reach the next generation? Perhaps a video game that a kid in school could play with, select management prescriptions, include 5 or 10 canned scenarios. This could also be used as a tool for participants in a management planning process. Show key indicators and how those change over time in concert with others. You could select for more moose, but they got shot because the roads got left open, then you have to close the roads, etc. The principles are transferable and can be used to help people learn, even those with non-technical backgrounds."* (Anonymous SME).

- The CCFM Criteria and Indicators (Canadian Council of Forest Ministers 2008) are a useful reference in starting to develop indicators to represent values.
- A research project to look at the indicators in use today that could be useful for EBM planning, assess pros and cons, review options, and make recommendations for a standard indicator set for EBM in Alberta and Saskatchewan.
- Where different definitions are used for indicators, the opportunity is to keep the underlying information that supports the definitions so that it can be recompiled into different categories for comparison or research.

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TARGETS

Targets are specific statements describing a desired future state or condition of an indicator. Targets should be clearly defined and expressed in measurable terms, and they should include aspect of spatial scale and time, either a selected date for non-recurring targets or a time period for recurring targets. Targets are one of the four principal components of the VOIT system used to implement EBM.

EBM is based on measurable activities humans take to achieve measurable outcomes (targets) related to ecological integrity and human wellbeing. Effective management requires clear statements of expected outcomes and the activities to be taken to achieve them (Box C8). Completing an activity is also an outcome, but generally outcomes are the end results of activities. Performance assessment involves setting indicators and targets for both activities and outcomes. Managers interested in achieving outcomes must measure both the outcomes and the actions taken to achieve them to understand the reasons for success or failure and use the results for continual improvement of the management system. Failure to achieve an outcome could be because the activity was not completed, because the activity was completed and did not achieve the outcome, because some external factor had an influence, etc.

Box C8. Activities and Outcomes Example for a Commercial Forest DFA

Outcome (target) – Proportion of old forest stays within NRV and varies between x-y % over 200-year period.

Activity (target) – Manage disturbances rate (e.g., fire and harvest) to achieve outcome over time.

Performance assessment applies to both activities and outcomes. Managers need to know if the proposed actions were taken and if they were successful in achieving the expected outcomes.

Managers need to know why they did or did not get the expected outcomes to make adjustments to improve the next management cycle iteration.

Two target aspects are particularly important for EBM. First, targets should be set for appropriate ecological units in addition to targets set for administrative units. Second, targets set for EBM indicators that are subject to NRV should acknowledge and address variation.

Ideally ecological EBM targets would be defined for the largest relevant ecological units after considering the inherent ecological characteristics and their NRV, plus land use decisions about the relative priority of ecological integrity versus human uses. In reality targets at the largest scales and land use decisions are driven by administrative units and societal demands as represented by government allocations. For example, Alberta LUF Regional Plans are roughly based on major watersheds (ecological) but make land-use decisions that are influenced primarily by existing uses and political considerations (administrative). Saskatchewan does not have a provincial land use framework but does have sub-regional plans that are similar.

Incorporating variation into targets for indicators that have NRV is an important EBM aspect. Many existing target statements do not address variation or imply but do not state variation. The management systems applied to forested areas of Saskatchewan and Alberta contain many targets derived from legislation, policies, traditional practices, and planning initiatives.

CHALLENGES

> *"We've got to reduce arguing so much about specific practices and shift to arguing more about the outcomes of applying the practices. Once we settle on the outcomes, we can circle back to how to get them. That sounds easy but it's very hard to do."* (Anonymous SME).

- The number of forest management targets in use is very large, growing, and increasingly complex. This is a challenge to managers:
    - Keeping track of all applicable targets.
    - Incorporating target compliance and implementation into management systems and plans.
    - Time needed to ensure all targets are considered and addressed.
    - Increasing costs to address requirements.
    - Parsimony to develop an efficient and minimal set of targets.
- The portfolio of targets includes a gradient from fixed legal requirements to recommended but optional guidance to voluntary.
- There are relatively few targets directly related to EBM.
- Required targets limit the options managers have to define and implement EBM.

- Most existing targets are related to specific resource values and were developed externally to area-based EBM planning processes. This leads to implementation conflicts between targets for different values and can result in partial or full planning and implementation gridlock.
- There are more activity targets than outcome targets and many activities do not have corresponding outcome targets. This limits manager choices and does not ensure that outcomes are achieved.
- Many targets, particularly those related to activities, are detailed and prescriptive. This tends to reduce variation, increase implementation costs, and limit innovation.
- Standardization of targets intended to facilitate administration and enable comparisons across categories creates 'one size fits all' challenges that don't work well with variation in processes, ecosystems, and human interests and uses.
- Forest management in Alberta and Saskatchewan currently contains a diverse and jumbled array of activities and outcomes that differ considerably between forest areas depending on the management authority, land use designation, and mix of human uses.
- Many DFAs have multiple human uses that are managed by different organizations according to their own mandates and interests.
- Many activities have no stated outcomes or do not have direct links to measured outcomes. For example, an Alberta review of industrial practices related to caribou conservation revealed many activities (practices) that had no stated or discernible outcome (Bentham 2007) and others that had stated outcomes that were not measured. Some monitoring programs have the reverse situation. They report on outcomes but not on activities, or they report on both activities and outcomes but they are not linked.
- Many existing activities and outcomes were developed externally through processes that considered only specific values and then were introduced as requirements or guidelines into management planning frameworks. This process does not consider other values and removes innovation opportunity. It also can lead to management gridlock, where it simply is not possible to apply all required activities and/or achieve all required outcomes, or the only feasible options are uneconomic or socially unacceptable scenarios.
- In most cases, alternatives to legal requirements may be approved through variances or incorporation into approved higher-level plans. Governments have generally been reluctant to approve alternatives. There are potentially many reasons for the unwillingness to try alternatives
    - Perceived risks
    - Inertia
    - Resistance to change (not broken, don't fix)
    - Costs
    - Social understanding and acceptance or support.

RECOMMENDATIONS

"EBM means different things to different people. Start with understanding of multiple values especially ecological, involve all in defining EBM for areas. Maintain ecological processes and conditions over time. Disturbance is vital to do this, creating and maintaining a shifting ecological mosaic over time." (Anonymous SME).

"Set large landscape-level targets that differ by areas. Start with what we want to achieve." Envision EBM as a spectrum, how far along do we want to be? What's the right balance? (Anonymous SME).

- There are many good examples of linked activities and outcomes. Contemporary commercial forest management in both Alberta and Saskatchewan has many linked activities and outcomes directly related to EBM indicators. For example, after logging forest companies must initiate reforestation treatments (activity) and then are required to do surveys to measure reforestation outcomes (establishment and free-to-grow). The VOIT process used in both provincial forest management planning standards is a robust management system.
- The existing emphasis on single-purpose activities and outcomes and disconnected input processes is unlikely to change in the short term because that would require major revision of legislation, policy, and practice, and other significant challenges. There may be opportunities to change some aspects and these should be explored.

Many requirements have provisions for alternatives which may be approved through variances or incorporation into approved higher-level plans. Implementation would depend on willingness of approval authorities to use the flexibility provisions.

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