Assembling the Landscape Management Puzzle Pieces

A Review of the Work Completed for Landscape Planning
In Alberta for the
Lands Working Group of CEMA

January 18th, 2012

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Quotes

"The accuracy of a forest relative to development as it will emerge in the real forest is entirely dependent on the degree to which the initial conditions, the stand dynamics, and the responses to treatment reflect reality as it will operate in the forest"

GL Baskerville 1998

"Panarchy places great emphasis on the interconnectedness of levels, between the smallest and the largest, and the fastest and the slowest"

The Sustainable Scale Project

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Executive Summary

This review was carried out in order to examine the current state of work carried out by the Sustainable Ecosystems Working Group (SEWG) and other agencies working on landscape topics. The SEWG working group is a part of the Cumulative Environmental Management Association (CEMA) program. Five different areas or categories were identified from this review. The five categories describe all of the completed projects and reports that were reviewed. The categories identified were 1) Accuracy of Data 2) Indicators and Ranges 3) Modeling the System 4) Management Systems and 5) Monitoring. All of the recommendations made pertain to one of these categories.

Each document received a review, a gap discussion from which recommendations were made. All of the individual recommendations from each document were summarized based on the five categories developed. Findings from the review included the following: It was recommended that a new ecological planning base be developed for NE Alberta. This planning base would facilitate landscape planning and would be useful for tying a number of important species and ecological processes to the landscape. This new inventory would eliminate having to coddle together older inventories from a number of independent sources when landscape assessments are completed. Work needs to be done on the selection of the best indicators and for setting trigger levels for these indicators. Several modeling exercises from Alberta were reviewed and each offered a set of unique indicators. Indicators used in each one of these landscape assessments completed need to be evaluated for use as potential indicators in future landscape work. Currently a review is being conducted of the CCFM Criterion & Indicators. The Criterion & Indicators need to be considered as well when indicators are selected. Both fine filter and coarse filter indicators have been suggested. Trigger levels for indicators need to be established based on empirical data (habitat availability, current population levels and species sensitivity to disturbance). Monitoring systems need to measure these indicators and provide feedback into landscape assessments. Additional work needs to be done on evaluating the accuracy of Wildlife Habitat Units (WHU's) and Habitat Suitability Indexes (HSI). Work completed by SEWG on identifying wildlife travel corridors needs to be integrated into landscape planning. Additional work is required to evaluate the use of coarse woody materials to simulate old growth forest attributes (habitats) for many species of birds and small mammals. Modeling initiatives completed in NE Alberta need to be evaluated in order to inform the selection of new modeling systems for future work. Models that have the ability to optimize are suggested for future landscape assessments. CEMA and other organizations have provided a great deal of work that will assist in completing future landscape assessments and management of these landscapes. A conceptual management system needs to be defined so that individual pieces of work that have been completed can be plugged into a management system. A management system would help to identify all of the different management components and steps that are required to assess and management large landscapes. Connections can then be made between different planning and operational levels as well as the flows between these levels. The management system should describe all of the inputs and outputs from each management step within each management component. A management system map or diagram could be developed to

represent the management flows. This would help to ensure that all of the critical management pieces have been accounted for and are in place. All of the work completed by SEWG should then be assigned to the appropriate management component and step. Linkages between these components and steps can then be identified and understood. Currently there are a number of monitoring systems in place in NE Alberta. There needs to be a reconciliation of all of these monitoring systems and wherever possible monitoring systems need to be combined if scales and other environmental factors being measured allow this. Due to regulatory requirements for monitoring or monitoring associated with specific environmental concerns (air and Water) may dictate that some monitoring programs remain separate. An Annual State of the Environment Report was suggested as a way to bring together many of the regional monitoring programs.

1) Introduction

a) Purpose of the review

This work was carried out under the direction of Cumulative Environmental Management Association (CEMA), Lands Working Group (LWG) and was done to identify potential work for future LWG programs. Discussions were held at the November 3rd 2011 Lands Working Group Meeting on the development of a LWG Work Plan. Specifically stated to: "*It should be clearly mapped out as to what CEMA working groups are doing, what other groups or government may be doing and then chart this and evaluate as a gap analysis to assist the LWG to determine what work can or should be done as a part of it's work plan*". The work will be completed by the Work Plan Task group and the results will be presented at the next LWG meeting in January 2012. The Work Plan Task Group is composed of the following volunteers:

Tim Vinge (Government of Alberta)
Amit Saxena (Devon Canada)
Kim Rymer (can be included in the second iteration)
Haneef Main (can be included in the second iteration)

b) Review methodology

In order to complete the gap review several key landscape planning documents were identified and reviewed. Selected documents were either generated by the Sustainable Ecosystem Working Group of CEMA or were from other sources that had a landscape focus. Documents from other organizations included Alberta Environment and OSRIN (Oil Sands Research and Information Network). The review focuses on gaps associated with landscape issues or planning. In completing the review it was quickly noted that all of the landscape planning pieces needed to be considered in concert. The quality of a gap analysis is directly proportional to the effort to review documents from as many organizations as possible. This gap analysis then was based on only a sampling of key documents. The authors recognize that other pertinent documents may exist but due to time constraints were not included as a part of this review. The review did not consider

work completed by any of the other working groups but this would be a consideration for future work. For example the work that the Reclamation Working Group is completing for mined areas would be just as relevant for other disturbed landscapes as well.

A review was carried out of each selected document. Each document (Bibliography) was reviewed for recommendations or for creating an understanding of current programs. Each document provided a slightly different background and slant on landscape planning. Some repeating themes are evident as a part of this review. There was no effort to remove these duplications as the review progressed as these duplications tend to be the common thread throughout the documents and add urgency to completing them the more that they are discussed.

Direct statements that contributed to the potential identification of gaps were pulled out of reviewed documents and summarized in a spreadsheet to allow for organizing statements into similar groupings. The spreadsheet also tracked the name of the document, the date the document was released and the organization that generated the document. Primary and secondary categories were developed so that each selected statement in the spreadsheet was labeled and could be sorted or grouped during the review phase. The summary categories were developed as the reports were reviewed and new subject areas were identified. Categories were assigned at two levels in order to be able to obtain some resolution in the information summary analysis. The primary and secondary categories used in the review were as follows:

Primary Review Categories
Aboriginal
Access Management
Best Management Practices
Consultation
Habitat
Hydrology
Inventories
Landscape Management
Landscapes
Management Frameworks
Modeling
Monitoring
Reclamation
Planning
Policy
Research
Standards

Secondary Review Categories
Aboriginal
Access Management
Approaches
Assessments
Coarse woody debris
Components

Demonstration
Development
Ecological
Evaluation
Examples
Existing
Feedbacks
Footprint
Growth and Yield
Habitat
Hydrology
ILM
Indicators
In situ
Inventories
Issues
Land Classification
Landforms
Landscapes
Linear
Linear Recovery
Linkages
Mechanisms
Monitoring
Objectives
Operations
Patterns
Priorities
Rationalization
Recommendations
Reporting
Research
Results
Review
Riparian
Soils
TEK
Tools
Tradeoffs
Triggers and Thresholds
Values
Vegetation
Watercourse crossings
Wildlife

These categories helped to identify appropriate groupings for the evaluation as well as to develop the potential focus areas and focus summaries for this report. The categories helped to define and organize the context for the material that was reviewed.

A brief summary of each document was provided along with a discussion of the potential gaps associated with the review and recommendations associated with potential gaps. The summaries help to define the current context for the work that has been completed. By understanding the current context based on the existing work then a recommendation can be made on potential future work. A discussion will also be had in this section about the potential gaps that were identified in each document and the recommendations that were made. The authors recognize that some of the gaps that were identified as a part of this review may have already been dealt with by other organizations.

2) Document Review Associated with Work Completed by the Sustainable Ecosystem Working Group of CEMA

The purpose of this section is to provide a preliminary review of the important milestones that SEWG and other organizations have focused on over the past number of years. In understanding something about the past work undertaken by CEMA and other Provincial organizations in this region then this may help to define future areas for focus or gaps associated with completed work. At the end of each document there will be a short discussion of the potential gaps that may be associated with the work. Recommendations were made based on the gap discussion. The document review was done as much as possible in chronological order from the earliest to latest documents.

At the end of the review section a summary will be presented that pulls all of the independent document reviews together.

a) Document Review – CEMA Regional Habitat Evaluation and Mapping for Key Wildlife Species in the Athabasca Oil Sands Region, 2003

The review was carried out to assess the availability of information on wildlife population and wildlife data that was available at the time for use in predictive modeling exercises. It was determined that there was a shortage of information that was available in a standardized habitat inventory format. The project was done to address the need to classify and map wildlife habitat in the region that was at the level that would allow for landscape planning. Habitat was classified for terrestrial and semi-aquatic wildlife species using a combination of ecological information along with traditional knowledge of species/habitat relationships. The information generated from this project would need to be defensible scientifically and useful for application at larger landscape levels. The inventory used for this project was developed from a combination of AVI (Alberta Vegetation Information), Phase 3 inventory data and data from the Alberta Ground Cover Classification (AGCC). Some areas were not covered by the AVI inventory so these gaps had to be filled using other, older inventory data that was available at the time. The AGCC inventory was generated using Landsat TM spectral reflectance data. The Phase 3

inventory was an older Government of Alberta vegetation inventory that pre dated the AVI inventories.

Gap Discussion

Landscape planning is requiring planners to look at larger and larger landscapes. Inventory data that has been developed over the past number of years was developed for individual management areas or developments as a part of the EIA requirements. Each inventory was developed to a different standard and resolution. This makes it very difficult to combine these smaller inventories together into a new inventory. The gap here is that there is no ecological inventory or planning base for NE Alberta for completing accurate habitat evaluations, assessing indicators or for larger scale modeling exercises.

There is no stream order classification for the RSDS study area so habitats associated with streams are not well defined. These stream corridors are important for wildlife travel and for a diverse range of species. They represent ecological focal points or hot spots for species diversity.

The accuracy of the Wildlife Habitat Units (WHU)) in relation to existing populations has not been evaluated. A systematic accuracy assessment of the WHU has not been undertaken. No comparisons have been done between the WHU's that were developed and other existing habitat indexes. If an accurate ecological inventory is completed this may enhance the quality of the WHU's for future landscape assessments.

Recommendations

- That an ecological inventory be developed for North Eastern Alberta that could be considered to be the standard inventory for completing landscape assessments. Existing ecological inventories completed on smaller areas (EIA) could be used to assist in the development of this new landscape ecological inventory. Having such an inventory would facilitate individual resource evaluations as well as larger landscape exercises like LARP. Wildlife habitat assignments and evaluations may be more accurate based an ecological inventory.

- That stream classification will be undertaken for the area located in the RSDS study area and habitat types associated with these stream classifications will be developed.

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- An evaluation of the Wildlife Habitat Units and current populations be conducted in order to ensure that these classifications are an accurate reflection of wildlife populations.

- Field checks of a sample of WHU's needs to be undertaken in order to confirm the accuracy of the WHU's.

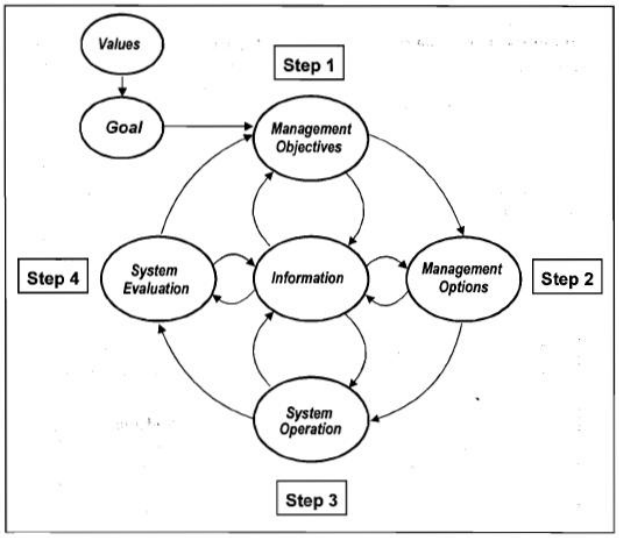
- That a comparison is made between HSI models (Habitat Suitability Index) and WHU be conducted in order to determine the differences between these two approaches.

- That WHU information, terrain and ecological information be used to define current and future wildlife travel corridors.

b) Document Review – CEMA Sustainable Ecosystem Working Group Terms of Reference, 2004

The next document reviewed was the *CEMA Sustainable Ecosystem Working Group Terms of Reference 2004*.The terms of reference focused work on the creation of a Regional Information System (RIS). The membership identified a priority around the development of a management system for achieving ecosystem and landscape stability. In order to accomplish 17 Regional Sustainable Development Strategies were identified based on the original 72 that were identified in the RSDS. The purpose of SEWG work at that time was to recommend a management system to address cumulative effects on ecosystems and landscapes in the Regional Municipality of Wood Buffalo. In other words, the work undertaken by SEWG was to design a management system to ensure ecosystem and landscape sustainability. The model used for this was borrowed from the Clean Air Strategic Alliance (CASA) Model.

Figure 3: Clean Air Strategic Alliance (CASA) Model



A series of goals and indicators were identified through this process. A total of 8 ecosystem landscape components (ELC's) were identified based on: Wildlife and fish, Vegetation, Biodiversity, Soil, Landforms, Watersheds, Cultural & Historical Resources and Renewable Resource Use. A generic set of steps was identified to achieve the desired management system as follows:

> Step 1 - Define stakeholders values and goals to address the 17 issues identified by RSDS and identify the indicators to be used to track performance in meeting

these values and goals. Develop indicators by which performance can be monitored.

Step 2 - Develop models for natural variability, current conditions and future conditions. Assess the Range of Natural Variability.

Step 3 - Identify management units within the Regional Study Area (RSA). SEWG identified eight Landscape Management Areas based on types of development and physiographic differences.

Step 4 – Identify ecological resources and landscape components (ELC's) within the RSA. SEWG identified eight ELC's as listed above. The data sets were assembled in CEMA's Regional Information System (RIS).

Gap Discussion

Recently a report was published called the "*Regional Sustainable Development Strategy for the Athabasca Oil Sands Area (RSDS) Work Plan Progress Analysi*s" by Bruce McGillivray. The report was an evaluation of the work that has been completed by CEMA in order to provide solutions for the areas identified in the original RSDS work. There has been very little followup on how the knowledge that has been generated by CEMA has been used. In many cases the work has been summarized into reports that were submitted to the Government of Alberta and were made available to the CEMA membership through the CEMA web site. There needs to be a followup report on which portions of this knowledge that has been generated by CEMA has been implemented. As well in the report on CEMA's progress with the RSDS issues the author stated that "I *was interested in whether or not the work undertaken by CEMA has been summarized in a Management Framework or Recommendations/Guidelines document which is available to the regulators*".

The above model (CASA) is a good example of a management system. All of the individual work that has been completed by different organizations in Alberta on landscape assessments needs to be organized into a management framework. It will be very important for future landscape management to have a map of all of the current work that has been completed. Much of the work that has been completed by CEMA or other Provincial organizations needs to be organized into a management system. Much of the work that has been done has been to test landscape assessment procedures or to define the modeling components. These need to be documented under the appropriate management step. Landscape assessments form a part of a larger landscape management system. When this is completed then linkages and flows can be determined between all of the individual components and steps.

Recommendations

- The Clean Air Strategic Alliance management system is a good model for a management system. The Terrestrial Ecosystem Management Framework incorporated many of the (CASA) management system components. Through the work completed for the TEMF many of the individual management components were identified. For example the development of inventories for vegetation and wildlife, monitoring strategies, modeling to test scenarios, development of indicators for modeling are all parts of a more comprehensive management system. Each piece of work that has been conducted by SEWG is an important piece of the puzzle. Now that all of these puzzle pieces are on the table they need to be assembled so that the entire management picture or management system can be documented and understood. By assembling all of the management pieces any missing pieces can be identified.

- Bruce McGillivray states in his report "*Regional Sustainable Development Strategy for the Athabasca Oil Sands Area (RSDS) Work Plan Progress Analysis*" that this could be accomplished if each group was to organize their respective libraries into categories. The categories suggested were frameworks, recommendations, guidelines, reviews, proposals and original research. As well executive summaries describing the completed work would assist in creating an understanding of the work that has been completed. A management system diagram showing all of the different components developed by CEMA and how they fit together would be most helpful.

- A followup report on the work or knowledge generated by CEMA to see if it has been implemented. Document the feedbacks from the implemented work so that new best management practices can be developed or updated. Document the barriers to the application of new knowledge. There may be barriers associated with current regulatory requirements or with the feasibility of implementing new knowledge. These barriers need to be identified and understood if new knowledge is to be implemented in an effective way.

c) Document Review - Identify Characterize & Quantify the Types of Landforms and Landscape Patterns Present in the Regional Municipality of Wood Buffalo, 2006

The goal of the project was to assess landform topographical characteristics for the Regional Municipality of Wood Buffalo. The landform characteristics were categorized into simple landforms as well as complex landform assemblages. The procedure involved using a combination of visual assessments and measurement of landforms as well as using an automated computer-based quantification of landforms. The authors suggest that the landform information will also be useful for completing reclamation as well. The authors also suggest that the landform information be combined with other data sets like AVI, wildlife suitability ratings and detailed soil surveys. The information on landform characteristics would enhance these other data sets.

Gap Discussion

The authors have suggested that the landform information would be useful for enhancing other inventories. The landform data would certainly enhance the work completed on Wildlife Habitat Units and for defining important wildlife corridors. The landform data could also be used in the development of an ecological layer for the RSDS area. The information could be combined with Lidar data as well to enhance wet area mapping. Creek classification may be facilitated through this information as well. There are many different inventory layers in CEMA's possession. These layers need to be examined in terms of where they might best contribute to a landscape planning exercise.

Recommendations

- A report needs to be written that describes all of the inventory layers that CEMA has developed. Many of these layers will be useful for future landscape planning exercises. The report should describe the extent of the inventory, how it was developed and the attributes associated with the inventory.
- The landform data would be very useful in facilitating the development of an ecological layer for the RSDS. Other data like LIDAR could be used as well in concert with the landform data to facilitate the development of an ecological layer.
- Work needs to be done to evaluate other data sets like the Wildlife Habitat Units using this landform data. Landform is an important component of wildlife habitat. An evaluation of the WHU's and the landform information would point out important landform features and corridors that are used by wildlife.
- The landform data may be used to develop more detailed creek classification for the RSDS. Creek classification could also be confirmed through the Lidar-Wet are Mapping (WAM) information.

d) Document Review – CEMA Sustainable Ecosystems Working Group Terms of Reference – Final 2008

The main purpose for SEWG at this time was stated as follows: "*Develop a management Framework based on the TRIAD approach to address cumulative effects on terrestrial ecosystems and landscapes in the Regional Municipality of Wood Buffalo including recommendations for regional and sub regional land management strategies*." The management objectives that were developed were based on a combination of social, scientific and traditional ecosystem knowledge (economic, social and environmental considerations). SEWG was to provide recommended management objectives, management response thresholds, and strategies for the government to manage cumulative effects on ecosystems and landscapes at a regional and sub-regional scale. The objectives stated were to 1) Develop a Terrestrial Ecosystem Management Framework (TEMF) which included the development of indicators, trade off analysis,

application of the TRIAD approach, land management strategies and an adaptive monitoring system. 2) Develop recommendations to address the details of key elements of the Framework to enable full interpretation which included protected areas, access management, validation of modeling uncertainties including the Natural Range of Variability (NRV) and the identification of research and knowledge to fill knowledge gaps.

Gap Discussion

No gaps associated with the Terms of Reference.

e) Document Review – SEWG Workplan Facilitation and Modeling Project; Data Inputs and Assumptions 2008

The report documents how the data was assembled for the modeling component in the TEMF. The document provides a term of reference for the modeling and ensured that the process was well documented and transparent. The model selected for the landscape assessment was the ALCES model. The authors state the purpose of modeling as follows "*The ALCES model assists resource managers in identifying strategic-level environmental and industrial problems associated with landscape sustainability and for discovering potential mitigation strategies for managing complicated industrial and ecological landbases*". In order to ensure that the assembled data sets would be available for future modeling all data sets including meta data, and spatial data were archived by the Alberta Sustainable Resource Development. Inventories used for the analysis were 1) Alberta Vegetation Inventory 2) The Alberta Ground Cover Classification Inventory (AGCC) and 3) Phase III Forest Inventory. In the end a new vegetation inventory dataset was developed using a combination of classified LANDSAT images, AVI and Phase III forest inventories.

Fire was accounted for in this modeling exercise through the development of a new product called "*Map Now*" which was compatible with the ALCES model. The program generates a plausible fire pattern representative of the Range of Natural Variability. In-situ components were modeled based on existing programs or planned future projects. Acceptable areas for future In-situ development were identified through parameters that evaluated potential for bitumen production.

Model runs were completed on a range of scenarios. Four scenarios were modeled including 1) Base case 2) Expanded protective areas 3) Access management 4) Innovative approaches. A sensitivity analysis was also conducted to quantify risk associated with bitumen production and reclamation. The results of these model runs are not discussed here but will be discussed as a part of the Terrestrial Ecosystem Management Framework document.

Gap Discussion

The inventory layer that was developed for the modeling exercise was based on a number of older vegetation inventories like AVI (Alberta Vegetation Inventory), Phase 3 Vegetation Inventory and the Alberta Ground Cover Classification Inventory. The other inventories identified were used to fill in gaps in the AVI inventory. All of these same inventory sources were used in the development of the Wildlife Habitat Units. Using a patchwork of older inventory data may introduce inaccuracies into modeling. Already dated inventories will be even older when future modeling exercises are undertaken. Consideration needs to be given to the development of a new ecological inventory or base that could be used for the entire RSDS region.

Recommendations

- This recommendation is the same as was made in the section describing the development of the Wildlife Habitat Units in that a new ecological inventory or planning base needs to be developed for the RSDS area. This new layer would be available for landscape planning, modeling or for use by companies for future industrial expansions. The inventory should be developed based on providing solutions for current landscape issues, accommodate selected indicators, TEK and aboriginal values and future modeling requirements.
- Modeling that was carried out under the Terrestrial Ecosystem Management Framework (ALCES) needs to be examined. The examination should include inputs and outputs and modeling procedures in order to determine modeling effectiveness. A report should be written summarizing what the modeling constraints were associated with the ALCES model and what future models will have to do to improve on this. What new inventories will be required to facilitate future modeling? Do we have the right indicators and can they be easily modeled? How hard will it be to determine the NRV associated with these indicators? Will future modeling exercises be a turnkey process or will there continue to be problems associated with assembling all of the required inventory data.
- Considering all of the above discussion on modeling identify a new model or suite of models that will allow turn key landscape assessments.
- Work needs to be done to confirm assumptions associated with the success of assisted and natural regeneration on disturbed sites. Previous modeling exercises have had to use assumptions about the success of natural and assisted revegetation. Based on the varied number of ecosites that a linear feature crosses and the levels of the initial disturbances these assumptions would be quite broad.
- There is a need to develop a disturbance and recovery model that would predict recovery trajectories based on initial disturbance, age of the disturbance and the ecosite that has been disturbed.

f) Document Review – Terrestrial Ecosystem Management Framework for the Regional Municipality of Wood Buffalo June 2008

Modeling examined the four scenarios listed above along with a land management approach called the TRIAD approach. The TRIAD approach partitions areas into management zones. Each zone has specific management levels that are defined. Indicators were selected from a list of potential options using a suite of defined criteria. Indicators for the TEMF analysis included woodland caribou, native fish, fisher, black bear, moose, old growth birds and area of old forests. For wildlife species the level of habitat was used except for caribou which was assessed at the population level. For fish an index of native fish integrity was used. Models were driven by bitumen production forecasts to the year 2030 based on bitumen production rates of 4 million barrels per day. These production levels were translated into footprint metrics based on information provided by industry. Timber harvesting was also modeled as part of the industrial landbase. A fire model was developed that would be compatible with the selected modeling approach.

Gap Discussion

Several areas were identified in the report that requires additional work. Many of these items were categorized as modeling uncertainties. Modeling uncertainties need to be dealt with before future modeling exercises are undertaken. The report identified the following priorities to improve knowledge and information, and to respond to a number of uncertainties that were identified during the development of the framework:

Recommendations

- Complete comprehensive and consistent inventories of vegetation and footprint for the entire region.
- Refine models for NRV for environmental indicators based on empirical indicators.
- Develop population models for key wildlife species including woodland caribou, moose, black bear, fisher and old forest birds.
- Consider altering the bird species comprising the old forest bird index. The index used in the assessment included species that are more generalists.
- Validate habitat effectiveness models, including responses of indicators to human disturbances and management actions.
- Validate modeling assumptions related to projected industrial development including footprint size, duration and reclamation for both surface and in situ operations.
- Develop new spatial models to predict indicator response more accurately.
- Periodically revise models and update modeling studies as additional monitoring and scientific data and TEK become available.
- Continue with the linear inventory for the Footprint Management Pilot. This linear footprint inventory should be completed for the larger RSDS area in order to assist future landscape assessments.

These recommendations are important. Future modeling should be tested against this list to ensure that new modeling strategies have overcome these constraints.

Monitoring was also discussed as a part of the TEMF. The document suggested that the monitoring system should be designed to:

- Measure achievement of management objectives and enable management responses to be triggered;
- Enable validation of modeling assumptions; and
- Track the implementation of the framework.

Data management and reporting were identified as being critical for the monitoring component. The Alberta Biodiversity Monitoring Program was identified as the potential monitoring program of choice for the TEMF.

It was suggested that for response triggers that population-level objectives and related management response thresholds and monitoring approaches be developed for woodland caribou, black bear and moose. Special consideration should be given to old growth specialist birds or interior species of birds.

g) Document Review – In Situ Oil Sands Footprint Monitoring Project Alberta Government of Alberta - Environment 2008

The program used the developed protocol to identify, monitor and map the cumulative land footprint associated with in situ activities for the selected area between 1980 and 2007. Periodic updates were completed on the inventory after 2007. The stated purpose of the program was to "*Develop a management system that describes processes and linkages for conducting landscape assessments."* The management system should include the following components:

- Risk assessments that identify significant aspects associated with landscape features.
- Landscape health indicators that can be used for completing landscape assessments.
- Accurate and timely inventories.
- Coarse and fine filter indicators that are linked to monitoring programs.
- Trigger points for coarse filter and fine filter indicators.
- Different management options based on the level of the indicators.
- A management system that describes all of the management steps.

Land mosaics are described by the authors in the following way:

"*Land is a mosaic or pattern comprised of three basic units; patches, corridors and the matrix. These three elements may be natural or human in origin. The matrix is the dominant background ecosystem or land use mosaic. Within the matrix patches and corridors are reasonably uniform areas of linear features that differ from their surroundings. The matrix and the type and arrangement of patches and corridors in that*

matrix determine the suitability of the landscape mosaic for different species and human activities."

The definition is useful in that it helps frame a complex landscape system in terms that land managers can understand. Evaluation of landscapes needs to examine this mosaic and then tie this mosaic to the species that inhabit this landscape.

Gap Discussions

The program objectives look somewhat similar to the objectives that were identified within the Terrestrial Ecosystem Management Framework. The report discusses potential best indicators and trigger levels. The indicators that were used were somewhat different than the indicators used in the TEMF assessment. In This study the assessments that were completed were based on two types of indicators; 1) Disturbance indicators which included landuse footprint, corridor density, riparian footprint and core area within forest stands. 2) Reclamation indicators which included certified footprint, restored footprint and inactive footprint. The authors do call for the development of a management system that will incorporate all of the steps used to complete this assessment. The suggestion for the development of a management system for describing landscape assessments and the components associated with landscape assessments has been a common theme through much of the reviewed documents.

The difference between this assessment and the TEMF assessment has to do with scale and the indicators that were selected. This assessment examined the impact of in situ development while the TEMF examined a much larger landscape and a range of management scenarios. In these analyses scale is important as different species and ecological process function at many different scales. In this study issues associated with incomplete inventories and lack of reclamation information were identified as barriers to completing landscape assessments. Information on reclamation status for sites was not available. This creates a problem for making vegetation recovery predictions in models. As a result of not having good information on reclamation status broad general assumptions are used in modeling. This type of input into modeling can create the potential for large inaccuracies. In the forest industry, reclamation records are kept on all harvested areas so when modeling is undertaken accurate forecasts can be made on future vegetation trajectories. Problems with inaccurate inventories associated with disturbances and lack of information on reclaimed sites will be a continuing problem for completing landscape assessments no matter what the scale of the assessment.

The document also brings to light the lack of information on the effects of different types and densities of linear disturbances on a range of species and ecological processes. The authors state that linear features create a unique site level environment that are associated with moisture, light, ecosites traversed by the lines, nutrients, temperature, wind and edge effects. Research is required to understand these unique site level characteristics in relation to site recovery.

Recommendations

Several recommendations were made based on this report on landscape assessments and monitoring as follows:

- Lack of a consistent, attributed, geo referenced and up to date land use and reclamation data (spatial).
- Lack of spatially explicit record of well lease footprints.
- Implement consistent cross ministry as built reporting of landuse footprints including geo-referenced data on feature location, type, size, and age and activity status according to prescribed status.
- Improve and expand existing ASRD base feature update system to include all anthropogenic surface disturbances (well sites, small oil and gas facilities, borrow pits) thus consolidating the land use footprint mapping within the base features mapping process; and increase the update frequency in the areas of intensive resource development.
- Require reclamation objectives and vegetation status to be included as attributes in digital land base data for all land uses as part of the conservation and reclamation reporting. Conservation and reclamation should be digital and geo-referenced.
- Identify the Range of Natural Variability for a number of indicator values associated with Forest Inventory attributes (Stand age, Stand size and stand structure). A range of coarse and fine filter indicators is needed.
- Need research to examine the impact of linear features in terms of line edges, width of lines, slope and aspect of lines, disturbance levels on lines, density of lines and ecosites traversed by lines.
- Research is required that examines the best practices associated with linear restoration and access management. The research needs to confirm the effectiveness of these tools. This will be important for future linear restoration efforts.
- New prescriptive systems or procedures should be developed for restoring linear features.
- Work needs to be done to develop a disturbance and recovery model for linear features. The model could use ecosite information, site disturbance information to predict when and how seismic lines will revegetate. These disturbance and recovery models could inform larger landscape modeling exercises.
- Look at relationships between corridor density and species occurrence, habitat effectiveness or population persistence (upland and lowland systems).

h) Document Review – GOA's Proposed Future Work by SEWG to assist with the NE Regional Plan, 2008

This was a summary document that was developed by SEWG (Peter Koning) to establish future work priorities. The document explores how the work that has been completed by SEWG could be integrated into the proposed regional planning process. The purpose of the document was to examine the past efforts of SEWG and clarify the role going forward. In order to define future work the document used the TEMF recommendations

(43 recommendations) and the priorities identified in the Northwest Regional Planning Element Teams and the Northwest Regional Plan.

Gap Discussions

Many of the priorities identified in this document represent the pieces of a management. All of these individual pieces need to act in concert in order to be effective in completing landscape assessments. The recommendations made here all fit very well with a landscape planning exercise and therefore fit within the planning process discussed in LARP. Once again there is discussion about the development of indicators and trigger systems. Peter Koning stresses that the selected indicators will need to be in concert with selected modeling approaches and monitoring systems. New models will be required that will be able to provide assessments based on spatial and temporal considerations. Potential new models should be evaluated and recommendations made on the best system for future assessments. The Natural Range of Variability (NRV) is discussed in terms of followup work to confirm fine and coarse filter indicators and their associated ranges. Linear densities are discussed as well. More work is required to truly understand the impact of lineal features on species and ecological processes. This recommendation was also made as a part of the in situ footprint monitoring project carried out by Alberta Environment and the TEMF project. The document discusses the need for new reclamation and restoration strategies that consider TEK. Most of current knowledge in reclamation is associated with more of the commercial tree species. Additional work is required on the non commercial species. Natural disturbances will continue to shape the landscape and must be factored into landscape evaluations.

Recommendations

The following recommendations were made:

- Further work to the proposed conceptual trigger system, including temporal aspects such as the length of time before an indicator is assigned a red or yellow condition
- The impact of natural disturbances (fires).
- The accountability for and frequency of modeling, and the parallel considerations for the related monitoring and modeling system design particularly related to spatial and temporal resolution and potential implementation at the sub-regional scales.
- Look at how different types of footprints are accounted for.
- Look at the scales or resolution for looking at indicators. Should be done in conjunction with new spatial modeling tools.
- Examine the science, utility and application of linear footprint density thresholds as a means of managing industrial footprint.
- Conduct a review of natural resource monitoring systems and certification systems and report on best practices that could be adopted in the NE region to report on wildlife habitat, fish and wildlife populations subject to feasibility; vegetation composition, age class distribution and pattern; human and natural disturbances; and resource extraction and use.

- The TRIAD management approach is discussed as a potential management framework.
- Adopting evolving methodologies to expedite aggressive phased reclamation of existing linear corridors and mine sites, and hence reducing reclamation lag time and increase reclamation success.
- Establishing specific measurable objectives for achievement of social and economic goals.
- Traditional Land Use Studies which can include maps of the different aspects of traditional land use like harvest areas for wildlife, fish and plants, cultural sites, historic sites. SEWG take on a project and immediately develop and put out an RFP to culminate work already done in the Region on "Aboriginal Traditional Land Use" potentially in combination with some community oral survey and information gathering.
- CEMA has no monitoring mandate but could suggest paths forward as a deliverable. SEWG could describe the current situation in terms of 1) How monitoring is done. 2) Researching and evaluating current practices and from there suggest how the process could/might be improved is valid. 3) Companies might find this practice very useful for reporting. Might lead to a program of industry self reporting (ISO 14001).
- Assessment of current modeling techniques. What have been the experiences associated with different modeling techniques? What were the major constraints associated with models and what needs to be done to eliminate these constraints? What are the future components required for completing landscape assessments and are they available?
- Aboriginal values need to be identified and tied to specific inventory parameters. The incorporation of aboriginal values into landscape assessments will allow the management of these values to be demonstratable and transparent. Inventories of aboriginal cultural sites are now in the process of being developed. Other current areas that are important for hunting and gathering have been identified as well. Many of these features that are tied to different ecosites and will change over time as the forest ages or changes due to disturbance. Associations will need to be developed between these aboriginal values and inventories (Vegetation types, landform types and other inventory identifiers). These other values need to be modeled over time as their abundance and location will change with the passage of time. There is a need to not just map where existing aboriginal cultural sites are located but to understand the land and ecological components that are tied to these values so that they can be assessed over time on a changing landscape.
- An evaluation of fen subtle drainage systems associated with fen drainages needs to be undertaken especially now that Lidar data and wet area mapping data (WAM) are available to assist in this evaluation. Fen blockages need to be identified and resolved. (Serious hydrological issue).

i) Document Review - Sustainable Ecosystem Working Group Presentation General Meeting 2008

The GOA tabled an information draft work plan for SEWG at the September 16th 2008 meeting. The recommendations from the TEMF were evaluated and topics that require

further work were identified that would be of value to the NE planning process. Options were discussed by industry at the OSDG meeting and by the SEWG Steering committee. Priority areas were identified and a draft work plan was proposed. Criteria were developed to help focus the work. The focus for the work would be on areas that would benefit the NE Regional Planning, would support the outcomes associated with the NE Regional Plan and would make good use of CEMA's multi stakeholder forum.

The following focus areas were suggested:

- Proposed conceptual trigger system, examine the utility of linear footprint density thresholds and using the quarter township metric for evaluation of indicators.
- Discusses the collaborative culvert inspection program (FRI).
- Discusses revisiting the NRV as it relates to modeling and monitoring.
- Focus on validating in situ footprint assumptions.
- Collect information on in situ operations on actual footprint size and duration including correlations to actual production.

Gap Discussion

The majority of these items have already been highlighted in other documents but bear repeating here. Many of the reviewed documents have identified the work required associated with evaluating the appropriate indicators, trigger levels, time associated with trigger level responses and with the NRV associated with different key species. Some work has been done through the TEMF to suggest and test some of these triggers but additional work will be required. Indicators and trigger levels will be important for completing future landscape assessments for LARP and other landscape evaluations that may be carried out.

The presentation starts to identify some of the information needs around in situ programs. In situ footprints will play a large role in defining future landscapes in NE Alberta. There is a need for better information on in situ developments. This was identified as well in the in situ footprint analysis carried out by the Environment called "*In Situ Footprint Monitoring Projec*t" in 2008. The information that was generated from this work by Alberta Environment should be incorporated into larger landscape assessment process as well as it represents another approach. There is very limited information associated with the impacts of increased lineal densities on many wildlife species and other ecological processes (hydrology). Research will need to be conducted in order to be able to understand the potential positive or negative impacts of lineal densities on a range of species and processes. Research needs to be conducted on the impacts that in situ development has as well. Currently we are not able to speak to the impacts of these lineal disturbances.

Recommendations

- That work on trigger levels and the NRV associated with a range of fine and coarse filter indicators be continued. These may be determined through an evaluation of

current landscape disturbance levels and populations that are associated with these disturbances.

- Work that was carried out by Alberta Environment on in situ footprints be included in future landscape assessment process.
- An evaluation of all landscape assessments that have been undertaken with recommendations for completing future landscape assessments and planning.
- Research is conducted on key species that associates lineal densities and population levels.
- Research is conducted on in situ disturbances in order to understand the impacts of in situ developments on a range of species and ecological processes.

j) Document Review - Management Scenario Combination Modeling (Supplement to the Terrestrial Ecosystem Management Framework)

The work was undertaken to help improve the understanding of the analysis used in the Terrestrial Ecosystem Management Framework forecasted indicator responses to the current application of management strategies. Four management strategies were assessed in the report (Combinations of Access management, protected areas and innovation) as follows:

- Access management + Protected Areas:
- Access Management + Innovative Approaches;
- Innovative Approaches + Protected Areas;
- Innovative Approaches + Protected Areas + Access Management

Indicators used in the evaluation included Black Bear, Moose, Fisher, Old Forest Birds, Index of Native Fish Integrity, Caribou and Area of Old Forest. Different bitumen production rates and thus disturbance rates were also examined as a part of the study. The document shows the impacts of the management scenarios on the selected indicator species. Each indicator species has an identified RNV associated with it. Future levels are predicted through modeling and comparisons are made to the assumed NRV.

The modeling that was undertaken had some specific limitations. These limitations were associated with the prediction of future conditions and flows on defined landscapes. The models do not possess the predictive insight to be able to identify how future landscapes will evolve. Differences associated with the inputs could produce very different results. The model was not able to evaluate the possibility of using different levels of strategies over time or on different portions of the landscape. Additional work on the models would allow for multiplicative relationships to be examined.

Gap Discussions

Many of the points that are brought up on the model limitations should be considered for future modeling exercises. Since this modeling was done new models may be available that will overcome these limitations. An evaluation needs to be completed on existing

modeling exercises that have been completed and as well on new potential modeling systems. Recommendations need to be made for the best models for completing future assessments. All modeling systems have positive and negative attributes associated with them. In many cases expectations for future modeling results may not be met if this evaluation of these systems is not undertaken. An evaluation should include required inputs into the model, optimization capabilities, and outputs. How difficult is the model to run, as well?

Recommendations

- That an evaluation is done of all modeling completed by CEMA and other organizations (OSRIN, Alberta Environment) in the Province of Alberta so that desirable attributes can be defined for future model selection.
- An optimization approach be considered for examining future landscape options.
- An evaluation of existing and future inventories be carried out and documented. Recommendations for the development of a future regional planning inventory be made (ecological).
- More work is required on selected indicators and trigger levels.
- More work on connecting the NRV of species with current populations and landscape configurations that they are currently dependent on.
- Ensuring that monitoring programs provide information on indicator species that is sufficient for modeling and for evaluating trigger levels.

k) Document Review – Wildlife Movement and Habitat Connectivity Monitoring Guidelines for the Rural Municipality of Wood Buffalo

The report examines wildlife corridors in the Rural Municipality of Wood Buffalo (RMWB) in order to develop connectivity criteria/guidelines into assessment of wildlife habitat quality. The report details the specific habitat, migration and dispersal requirements which are related to connectivity of key indicator species. Connectivity requirements are related to available habitats and cover a range of scales. The document provides a review and synthesis of available information on wildlife movement and connectivity requirements in the RMWB for several indicator species.

Gap Discussion

Wildlife corridors are often referred to as dispersal corridors. These corridors are linear in nature and facilitate the movement of wildlife species from one habitat type to another. These corridors are important for reducing the effects of habitat fragmentation and for providing for the recolonization of different habitats. These corridors also facilitate the movement of genetic materials between different populations. This movement may be extremely important in systems that are stressed due to development or due to climate warming. This is especially important where certain species have been locally extirpated. Low numbers of individuals put the local population at some risk for continuance. Wildlife corridors occur at many different scales on the landscape. These scales are associated with the mobility of individual species and the distribution of adequate habitat

types. The authors state that the biggest problem or gap associated with corridors is as follows: "*Planning for wildlife connectivity in the RMWB is limited due to our understanding of species-specific connectivity criteria in the region. Current monitoring is focused on improving this but past research and environmental assessments have focused more on wildlife habitat use."*

The importance of old growth forests, riparian systems and the levels of snags and coarse woody materials associated with older forests was discussed. All of these landscape components are important habitat for a number of species. In the future habitat combinations will need to be considered and the distance that species travel in these habitat associations will be an important spatial consideration for habitat. For many species more localized habitat types are important like snags and other dead wood. In recognition of the importance of these materials new best management practices need to be developed that allow coarse woody materials to be used in site restoration as well as for use in the restoration of seismic lines. Creating additional habitat types using woody materials in developed areas may help to ensure that species that are dependent on these habitats remain viable in these local populations.

Recommendations

- Information on wildlife travel corridors needs to be identified spatially. If the locations of these corridors are known then these areas can be considered during development. A spatial layer needs to be developed with these travel corridors identified by species. For other species requiring a range of habitats and have movements between habitats a spatial analysis is required to ensure that combinations of habitats are spatially realistic and exist. This could be developed as an additional inventory layer.
- Best management practices are identified for providing habitats using woody materials that are similar to those found in older forests. Research would be required to confirm that these habitats are functional.

l) Oil Sands Mining Reclamation Challenge Dialogue Report OSRIN 2008

This report represents a summary of a dialogue (workshop) that was carried out between OSRIN and it's stakeholders during the first two months of 2010. Stakeholders were either directly involved with or directly affected by oil sands reclamation. Based on the feedback to the Challenge Paper the results were synthesized to create a systems view of the oil sands reclamation process. Three challenges were identified 1) Challenges associated with the rationale and application of equivalent land capability. 2) End land use selection and 3) How to respond to the expectations of the public on reclamation. Several approaches were examined to develop a reclamation systems map. Eleven recommendations were made based on the ideas generated from the Challenge Dialogue process.

Reclamation of mined areas represents a complicated business as indicated by this report. Reclamation really forms a part of a larger management system but often only the individual pieces of the management system are understood. The authors called the reclamation system "*a system within systems*". Feedback from the workshop indicated that there was a lack of a systems perspective associated with reclamation. Feedback loops have not been well established. The term "*reclamation system*" was intended to include all of the elements involved in planning, managing, conducting and measuring/monitoring reclamation. Other industries like forestry use similar definitions to define their management systems that are associated with forest management. In forestry reforestation is only a part of a larger defined forest management system. Other considerations for a reclamation system include policy considerations, regulatory considerations, operational reclamation considerations, and others. All of these factors need to be considered in concert. Appropriate feedbacks need to be established between the individual management components and the over arching management system. Why do regeneration surveys and what other management components do they inform?

Gap Discussion

The report indicated a lack of definitions for defining a functional boreal ecosystem and landscape. The authors go on to say that this definition could include visual, biophysical and spatial attributes, ecosystem functions and indicative successional trajectories. In this case these definitions are required so that reclaimed mined landscapes can be compared to natural landscapes for determination of success associated with reclamation. Similar definitions should be developed for defining new vegetation trajectories on disturbed lands outside of the mined areas. Definitions then, should be developed that define what a functioning landscape should contain (i.e. functioning riparian, certain key habitat types, habitat combinations and associations, some level of average patch size, some realistic level of lineal densities, some level of habitats and travel corridors, natural vegetation trajectories, ratio of wetland and upland complexes in fens and bogs). This same recommendation was made in the Alberta Environment Report which evaluated in situ footprints (In situ Footprint Monitoring Project, 2008). Defining what a functioning landscape should contain (coarse or fine filter levels) will help to define appropriate indicators and trigger levels.

The development of a management system was useful in this case for organizing all of the individual reclamation pieces and determining where they fit into larger scale management systems. Management systems help to organize the individual management pieces but also help to define management flows. Each step requires a series of inputs from potentially many different sources and at the same time provides outputs that will be usable by other steps in the process. Landscape planning is equally or more complicated and requires inputs from many sources. These sources may exist but may not be used because they are either not known or were not done in a fashion that can contribute to the process. This often occurs because the piece was developed in isolation or not catalogued.

Recommendations

- Develop definitions around what attributes a functioning landscape contains (i.e. average patch size, age class and species distributions etc.) These may be helpful in the identification of the triggers that are selected.
- Development of a management framework that describes all of the different steps, inputs and outputs for each step for landscape planning. The management system will be composed of a number of smaller management systems like reclamation.
- Build a complete inventory of all of the work that has been completed and plug these individual pieces that have been completed into the developed management system so that linkages can be developed between them.
- Define what reclamation success looks like on seismic and other disturbances. Currently standards have been developed for upstream oil and gas sites. Measurement protocols have been developed within RWG for mined areas. These are measurement protocols but have not been formalized by the Government of Alberta into reclamation standards for the mines. What constitutes acceptable regeneration of linear features? Success needs to be defined for these kinds of disturbances and sites.

m) Document Review – Review of the Four Major Environmental Effects Monitoring Programs in the Oil Sands Region, 2010 OSRIN

The purpose of the study was to engage the four main environmental effects monitoring programs and reporting organizations currently operating in the oil sands area to document their programs. The four programs evaluated were as follows:

- Regional Aquatics Monitoring Program (RAMP) which focuses on water quality and is operated by the Oil Sands Development Group (OSDG).
- Wood Buffalo Environmental Association (WBEA) which focuses on air monitoring.
- Alberta Biodiversity Monitoring Program which provides information on the state of Albert's biodiversity.
- Cumulative Environmental Management Association. CEMA is a management association that studies cumulative environmental effects of industrial development.
- In addition some companies measure various physical, chemical and biological parameters.

The report indicates the following shortcomings with the current monitoring systems and makes recommendations to correct the deficiencies as follows:

"*Stakeholders including the monitoring program staff themselves, lack a detailed understanding of the full suite of monitoring activities taking place in the oil sands area. In moving forward a more integrated approach would benefit both the existing environmental effects monitoring programs and the ability to speak authoritatively about the oil sands ecosystem effects as a whole*"

Gap Discussion

Each monitoring program was developed based on managing specific issues and scales associated with the values being monitored. Managing requires monitoring. In some cases existing monitoring programs may need to be stand alone programs because of regulatory requirements or because of the required scale of the monitoring. Other programs that are similar may be rolled together or into existing monitoring programs like the Alberta Bio Monitoring Program. An assessment needs to be done that specifically evaluates the existing programs in terms of the regulatory requirement for monitoring, how the monitoring is reported, what other areas could monitoring programs inform and how monitoring programs might be made more efficient.

Recommendations

- That an evaluation be carried out of all monitoring programs and a report be provided of what is being monitored specifically, what the measurement protocols are, what is driving the need for monitoring, scale that the monitoring is being conducted at and how the monitoring program is similar or different compared to other current programs.
- A link needs to be made between current monitoring programs and the Criterion and Indicators that are being considered as well as to the indicators that have been selected for modeling.
- Monitoring needs to be timely and effective. Meaningful indicators need to be identified for monitoring. These indicators need to cross as many disturbance types as possible.

n) Oil Sands Terrestrial Modeling for Disturbance and Reclamation Phase 1 OSRIN 2010

The overall objective of the project was to develop a framework that could be used to evaluate the risk associated with disturbances (natural and anthropogenic) on ecosystem processes, products and services and on habitat suitability for terrestrial species in Alberta's Lower Athabasca Region on mined areas. The evaluation included an assessment of natural disturbances due to insect outbreaks, fire and wind events as well as other industrial and agricultural disturbances. Conservation and reclamation activities are factored in as well. Part I and II of this evaluation only examined these components on mined areas. Part I and II examine the impacts that climate change may have on vegetation trajectories as well. Phase III of this project is projected to examine the larger landscape. This evaluation will be more of a coarse filter examination than was conducted in Phase I and II. Phase III proposes to use the FORECAST model in order to evaluate a more spatial representation of disturbances and landscapes. FORECAST will be used as well to generate a spatial representation of forest stands associated with disturbances. An evaluation of risk will be completed in relation to climate warming and wildfire events. The evaluation considers the potential impacts of climate change on vegetation trajectories.

Gap Discussion

Knowledge from Phase I and Phase II were focused on mine reclamation efforts. Phase III will focus on a regional level analysis covering the Lower Athabasca Region. Work being proposed for Phase III needs to be integrated along with other regional assessments into a report that combines all of the learning's from all of the landscape evaluations completed in Alberta. The strength in combining all of the landscape evaluations is the different approaches that were taken. The approaches differ so comparing and contrasting them will be valuable for future evaluations.

Recommendations

- All of the landscape analysis that has been completed through these evaluations have used very different approaches. Several landscape evaluations have been completed in Alberta to date by CEMA (SEWG-TEMF), OSRIN and GOA-Environment in similar areas of the Province. An analysis needs to be completed of the procedures used, the models involved and the outputs for each modeling exercise. This would be useful for informing future landscape assessments (LARP).

o) Correspondence from the Government of Alberta on CEMA Potential Involvement in LARP 2011

The exchange of information was undertaken in order to determine how CEMA could help to support the LARP process. The Government of Alberta stated that it values the multi stakeholder character of CEMA. CEMA offered to develop environmental outcomes and management frameworks. Other areas suggested by CEMA to the GOA included access management plans, tools developed for monitoring, best technology research, establishment of critical thresholds, development of management plans and the evaluation and auditing of regional planning policies.

The GOA responded with some priorities for CEMA including using new data to recommend targets and thresholds for forest condition, helping to achieve forest growth standards and maintain soil productivity. Investigate the opportunities associated with wet area mapping for assisting in future management

Gap Discussion

Wet area mapping has not been completed for large areas of NE Alberta. Once completed wet area mapping could be useful as an inventory layer for defining the location of future exploration and developments, prescribing appropriate reclamation strategies, updating hydrological layers, defining wildlife habitat types and for the development of a new ecological planning base. Having the wet area mapping information along with a new ecological planning base would satisfy a number of areas that were suggested as being gaps.

Recommendations

- That wet area mapping be completed on the remainder of NE Alberta and that this information be used to facilitate the development of a number of planning opportunities in the region including but not limited to the development of a new ecological planning base.
- CEMA should continue work on defining the best process for the development of recommended targets and thresholds.

p) A Review of Linear Footprint Management Approaches , Tools and Strategies, 2011

The objective of the report was to prepare a document that summarizes a number of linear footprint management tools, approaches and strategies that could be applied for access management in the RMWB. Ideas would be generated through a workshop on access management strategies. The other objective was to encourage workshop participants to engage in a dialogue on footprint management planning. The report that was produced provided a summary of the results from the key CEMA and other relevant documents along with the results from the dialogue from the workshop. The report categorizes footprint management into several categories including:

- Process;
- Access Management Planning;
- Information and Analysis;
- Zoning;
- Fiscal Instruments;
- Communications and Education; and
- Management Frameworks

The removal of linear features or the management of footprint may be one of the most effective tools for maintaining healthy ecosystems. Rollback and other woody material applications have been identified as effective tools for accomplishing footprint management goals.

Gap Discussion

The document identifies gaps associated with the calibration of the habitat suitability approach with a number of wildlife species. In terms of species, additional work is required which can calibrate the habitat suitability approach for fisher with actual fisher abundance data. Other gaps were suggested for linking bird species and populations to forest seral stages. A smaller subset of birds should be selected that are known to be true old forest species. Concerns were also expressed in regard to the impact of lineal densities on bird species. Several specific gaps were defined for wildlife as follows:

- An assessment of the utility of lambda equation approach;
- Individual herd management requirements;

- Incomplete forest cover inventory across the region;
- A multi species predator dynamics model involving woodland caribou, wolves and moose;
- The actual spatial distribution of populations;
- The lack of defined critical wildlife movement corridors;
- Examine the science, utility and application of linear footprint thresholds

Concerns were also expressed about the assumptions used in the TEMF on seismic line recovery times. These assumptions need to be evaluated in terms of seismic line recovery times and trajectories based on ecosite and other site level information. Assumptions on these line recoveries can have a big impact on modeling results. Information is required for both natural and assisted recoveries of these features.

Densities of linear features have a big impact on landscape assessments. Measurements like edge density have been shown to be good measures of linear feature impacts on ecological components. Through the modeling completed in the TEMF linear densities were shown to be a major contributor to six of the seven management objective indicators that triggered a management response. The authors stated that "*The construction of linear features poses the greatest risk to indicator performance and that slower reclamation exacerbates the negative effect".* Comments were also made on the impacts of linear densities in the work completed by Alberta Environment on in situ footprint monitoring.

Similar recommendations are made in this document as to how future monitoring should be completed. The TEMF recommended that the Alberta Bio Monitoring Institute sampling grid should be used as the basis for the development of a new sampling network.

Suggestions were made for the prioritization of reclamation on lineal and other disturbance features. Criteria were suggested for making these evaluations around forest intactness and ecosystem recovery. Several questions were raised about how sure we are about reclamation and restoration effectiveness on these disturbed sites. Questions were also raised about what constitutes success for reclamation and restoration on these types of features.

A gap was identified associated with lack of an inventory for watercourse crossings in NE Alberta. Additional stream fragmentation is predicted as new roads and crossings are developed. A suggested 30% increase is predicted in crossing issues (hung culverts).

Recommendations

- Need to develop rollback and coarse wood application strategies. Research needs to be completed to establish the effectiveness of wood applications for deterring wildlife and human use of the lines as well as for encouraging revegetation of the lines.
- Adopt a stream crossing inventory program that is similar to the one being used in the Foothills of Alberta. The program was developed by the Foothills Research Institute.

- Habitat suitability indexes and other measures of habitat use need to be confirmed with empirical data. This work needs to be completed for a range of species.
- Vegetation inventories are fragmented and weak. A new inventory (ecological) needs to be completed for NE Alberta based on ecological classification.
- Information on disturbances and recovery of these disturbances is weak. Research needs to be done to establish a link between disturbances and recovery. A range of information including ecological, wet area mapping and existing inventories could be used to develop this relationship.
- Research needs to be conducted on establishing the best assisted and natural recovery strategies for disturbed sites (seismic lines, pipelines, and well sites).
- Develop a list of tools for completing assessments of linear features that will facilitate the prioritization of these features for restoration.
- Research needs to be done to confirm the effectiveness of Innovative Pipeline Systems that have been developed that minimize impacts of pipeline instillations. It seems prudent to be minimizing disturbances up front.

q) Cumulative Environmental Management Association Issues Workshop for Setting Priorities for 2012

The CEMA Board requested the four Board Caucuses to provide their recommendations for project priorities for investment during 2012 based on issues identified by each caucus. The following priorities were identified:

Priority #1 – **Reporting**
Develop the content for an annual State of the Environment Report. Annual state of the environment reporting will be important to all stakeholders and the public. A template will be developed to incorporate all of the information collected by CEMA and CEMA members.

Priority # 2 – **Air Quality Concerns**
Air Quality includes the issue of odour and odour management. Develop a best practices guide to deal with air quality issues.

Priority # 3 – **Groundwater**
Identify gaps associated with groundwater management.

Priority # 4 - Water Quality
Identify gaps in surface groundwater management.

Priority # 5 - Oil Sands Reclamation (wetlands)
Reclamation of wetland areas.

Priority # 6 – **Lineal Disturbance**
Linear Disturbance Project related to restoration of lineal features.

Priority # - 7 Biodiversity Frameworks
The development of a management system for defining a biodiversity framework. Currently being led by SRD.

Priority # 8 - Fish and Wildlife
SRD is the lead agency.

Gap Discussion

A State of the Environment report will need to consider information from all of the current monitoring programs. In many cases information is already published on web sites and in other report formats. Having all of this in one report for the region would allow comparisons to be made between the different monitoring approaches. What are different programs measuring and what did they find?

Implementing the Foothills Research Institute Stream Crossing program would satisfy Priority # 4. Wet area mapping may also be useful in making this assessment.

As pointed out in many of the reviewed documents lineal densities and their effect on wildlife species and ecological processes needs examination. The current Footprint Management Project will develop the planning protocols required for managing access and restoring seismic line disturbances. Disturbance and recovery models need to be developed as well to help model these disturbances over time.

Recommendations

- That the State of The Environment Report be generated from published monitoring information. The framework for this report still needs to be developed and may eventually contain information on Criterion & Indicators as well as other selected indicators. The report could talk to monitoring in relation to trigger levels as well. Information from landscape assessments could also be reported in this document.
- That the Foothills Watercourse Program be examined and considered for NE Alberta.
- Examine the effect that lineal densities have on wildlife species and ecological processes.
- That Wet Area Mapping be used to assist in the evaluation of drainage systems and for the classification of all streams in NE Alberta.
- That fen blockage issues be examined and a report be generated showing the extent of these blockages.

r) Regional Sustainable Development Strategy for the Athabasca Oil Sands Area (RSDS) Work Plan Progress Analysis, 2011

The report represents an assessment of the status of the issues that were assigned to CEMA as a result of the Regional Sustainable Development Strategy (RSDS) document. A total of 72 issues were identified in the original RSDS work. The 72 issues were

grouped into a total of 14 themes based on similarities in the issues. At this time a stakeholder group called the Cumulative Environmental Management Association (CEMA) was formed. The partnership included industry, non governmental organizations, Alberta Environment and Sustainable Resource Development. This group was assigned 37 of the issues to address. Priority issue areas included:

- Biodiversity
- Cultural and historical resources
- Fish habitat
- Ground Level Ozone
- Landscape Diversity
- Reclamation
- Surface water quality
- Trace metals
- Wildlife habitat

Gap Discussion

The work that has been done by CEMA was examined in this report against the original 37 issues. The work was also examined to see if the work undertaken by CEMA had been summarized in a Management Framework or Recommendations/Guidelines document. The reviewer suggested that additional work is required on monitoring before sufficient information will be available to make informed decisions. It was also suggested that all of the work completed by CEMA should be organized into categories and libraries within their respective areas. The following categories were suggested for organizing the work: frameworks, recommendations, guidelines, reviews, proposals, original research (published and unpublished) theses and dissertations.

Following are some specific comments from the review by Issue number:

Issue Number 64

The issue relates to the slow return of reclaimed habitats to pre disturbance conditions. Many of the revegetated sites will take 60-100 years for vegetation to reach mature states. There are many species (predator and cavity nesting species) which require elements of mature and climax forests in the form of decay structures (dead or dying trees, fallen or rotten logs) as well as complex forest floor structures (debris, moist-micro environments, cover diversity). These will be difficult to ensure in new young stands. This is an important point especially because of the manner in which woody materials are currently being handled on developed sites. In many cases these materials are being removed in order to meet the current regulatory requirements. The importance of these materials is well established in the scientific literature for maintaining forest ecological processes. Woody materials need to be retained on developed sites so that newly reestablished vegetation has coarse wood attributes. Research is needed to confirm new best management practices for the application of coarse woody materials.

Issue Number 63

Currently models are used to examine various scenarios of development. Thresholds are proposed for indicators that are 10% below the NRV. Once these limits are exceeded management actions are initiated to address the causes of the low level. Difficulties associated with this method are:

- Difficulties in having good data
- Difficulties in establishing the NRV.
- Establishment of trigger points
- Indicator monitoring
- Type of correct management response

It was well established in the TEMF that monitoring is currently insufficient to track these changes.

Linkages need to be made between indicators used for landscape assessments and monitoring programs. Are we monitoring the right indicators? New methods of assessing the NRV need to be developed that can make the link between current populations and habitat combinations. The Alberta Bio monitoring Program may be a useful tool for establishing population levels in relation to habitats for some species. Establishing the trigger levels and NRV will take time so some way of determining the start point for these is required. Should trigger levels be coarse filter (area of old growth, level of fragmentation or fine filter (old growth bird numbers) or both? These need to be finalized and incorporated into inventories and monitoring systems.

Issue Number 49

The latest gap analysis related to in situ resource extraction has not been published yet. The report discusses knowledge and practices for reclaiming disturbances associated with in situ and conventional oil and gas exploration on wetlands. Similar work needs to be conducted for upland systems as well. Depending on the ecosite and the level of the initial disturbance recovery of some upland sites can be as difficult or more difficult as wetlands. Because of the lineal nature of seismic lines they create a unique challenge for the reestablishment of vegetation. The majority of the CEMA, RWG work has been on the reestablishment of vegetation on mined systems. Similar work is required to examine the best restoration techniques that can be used on linear and other severely disturbed forest systems.

Recommendations

- It was also suggested that all of the work completed by CEMA should be organized into categories within their respective libraries. The following categories were suggested for organizing the work as follows: frameworks, recommendations, guidelines, reviews, proposals, original research (published and unpublished) theses and dissertations.

- Based on the work that has been completed by CEMA that a Management System and all of its components be described. All of the individual component work can then be assigned to the management system structure. Management flows can then be determined and additional gaps can be identified in data and processes. Linkages can be established between planning levels or between different assessment procedures (Inventory, modeling).
- Some type of process be defined that ties existing populations to habitat complexes. Establish a mechanism for determining the NRV associated with wildlife species. In order to complete this work habitat suitability evaluation work will need to be reviewed and a good inventory base (ecological) will be required
- Insure that monitoring systems reflect indicators (fine and coarse filter) and feedback from indicators.
- Develop a process or strategy to use the best science or modeling to set trigger levels.
- Strategies need to be developed for using coarse woody materials to maintain old forest attributes in younger stands.
- Develop new restoration strategies for linear features and put research in place to confirm the effectiveness of these strategies.

s) Advice to the Government of Alberta Regarding a Vision for the Lower Athabasca Region Lower Athabasca regional Advisory Council 2010

To enhance the depth of local input the Government of Alberta established the Regional Advisory Council (RAC) for the Lower Athabasca Region in December 2008. The RAC was composed of members that had a cross section of expertise and experience in the area. The RAC provided advice based on local insights and perspectives on future land use activities and challenges that were associated with the Lower Athabasca Region. RAC was asked to provide advice on the following areas:

On Future Resource Development

Examine growth under low, medium and high growth scenarios based on a continuum of peak bitumen production levels of up to six million barrels per day.

Land Conservation Objectives

Assessing lands in the region that could contribute to an overall land conservation target of 20 percent or more with regard to established key criteria.

Regional Air and Water Thresholds

Examining various development scenarios with reference to established air and water thresholds for the region, and identifying options for satisfying these thresholds.

Human Development Considerations

Considering options for community development, physical and social infrastructure needs, recreation and tourism development, population growth and labour needs, and impacts to local communities as well as aboriginal communities.

The committee was to also to identify key social, economic and environmental factors that needed to be considered. As well, other land uses, land use trends and potential landuse conflicts associated with development were to be identified. Aboriginal traditional knowledge or ATK was to be identified and integrated into the assessment.

Gap Discussions

The document states that the development of future management frameworks will require the following considerations:

- Appropriate consultation with stakeholders
- Utilization of aboriginal traditional knowledge and involvement of aboriginal knowledge holders early on in the process.
- Effective and timely communication during development that supports transparency once the framework is in place.
- Creation of clearly defined thresholds and precautionary triggers. The thresholds and triggers need to be developed in a way that allows proactive actions.
- Appropriate congruency with national standards (for example, Canadian Council of Ministers of the Environment).
- Recognition of, and the planning for, the impacts of climate change and variability on air quality.
- Clarity in terms of consequences for non-compliance with the management framework.

The Landuse Framework was used to provide guidance for many of the identified outcomes, objectives and strategies. The following represent some of these and are summarized by the stated outcome and objective statements in the Landuse Framework. The section describing **Outcome 4** of the Landuse Framework is particularly relevant to a landscape management discussion.

Outcome 4 states that land users have a responsibility to sustain and conserve ecosystems. Several strategies are suggested for achieving the stated objective. Some of the strategies that may be relevant to SEWG work are summarized as follows:

- Minimize motorized access and linear footprints.
- Use aboriginal traditional knowledge to enhance and understand cumulative effects.
- Develop an integrated reclamation land management plan.

- Work with a range of organizations to (Industry, aboriginal, multi stakeholders) to coordinate reclamation.
- Manage the developed landscape to facilitate the movement of native species, communities and ecological integrity.
- Use the natural disturbance template or approach for managing the landscape.
- Enhance current research and monitoring of fish and wildlife populations.
- Recover endangered species.
- With industry as a partner, commit to ongoing research of ecosystems and biodiversity to enhance, assess and update knowledge.
- Maintain game populations in support of aboriginal traditional use and recreational hunting.
- Develop all-season trail systems in accordance with Athabasca Recreation Corridors and Trails Designation Program guidelines.
- Identify, monitor, review and report on indicators, targets and thresholds that are established.

Recommendations

Strategies can be grouped into a few key areas:

Managing the Landscape

Access management is suggested as a strategy as well as maintaining important corridors in developed landscapes for the movement of wildlife, humans and ecological components. A natural disturbance template was suggested for the management of complicated landscapes. Reclamation of landscapes is suggested as an important component of landscape planning. The following recommendations are made in regard to managing landscapes:

- There needs to be work done on the development of new strategies for managing access and for restoring linear features.
- Additional work done on using a natural disturbance template for defining and managing landscapes. Natural landscapes have been shaped by these disturbances and species numbers and movements as well as ecological processes are adapted to it.
- Important corridors for a number of species need to be identified and managed. Inventory layers need to be developed which indicate important travel corridors for use in landscape assessments and planning.
- Develop ways to incorporate traditional knowledge into landscape management and modeling efforts.

Monitoring the Landscape

Indicators, thresholds and targets are discussed as being an important component of a successful landscape planning process. The following recommendations are made with regard to monitoring.

- Selected indicators need to be in concert with modeling. Fine filter and coarse filter indicators should be considered. Thought needs to be given as to how these indicators will be measured and how often they will be measured.
- There needs to be a reconciliation of all of the current monitoring programs. Some may need to stand alone while others may need to be combined.
- Thresholds need to be developed for a range of fine and coarse filter indicators.
- The NRV needs to be determined for a number of species and ecological components.

Researching the Landscape

Traditional aboriginal knowledge is important and will play a role in both the setting of management objectives and for assessing the health of ecosystems. Good traditional knowledge is really good ecological knowledge and should be integrated where possible. Several strategies call for research on wildlife populations and ecosystem function. The following recommendations are made with regard to research:

- Research needs to be conducted on the impacts of linear densities on a range of wildlife species and ecosystem processes.
- Research on how effective habitat suitability estimates are for wildlife species.
- Work needs to be done to define new reclamation and restoration techniques that can be used on linear disturbances. New techniques need to be confirmed through research.
- Research on the ecosites containing important traditional species (medicinal plants and foods). Research on the best way of restoring these species on disturbed sites.
- Research from other existing landscape research projects like the Ecosystem Management Emulating Natural Disturbance (EMEND) be reviewed and knowledge be transferred to NE Alberta for use on this landscape.

3) Summary Discussion of Gap Areas from the Document Reviews

This portion of this report will focus on a summarization of all of the individual gap areas from the reviewed reports. Many of the reports that were reviewed identified potential gap areas and suggestions for additional work. These gaps represent potential work for the Lands Working Group or may point in a direction for further investigation. The Gap's that were found are associated with any organization that is involved with landscape planning, not just CEMA. In terms of the review of the landscape planning documents five different gap categories were identified as follows: 1) Data accuracy 2) Indicators and ranges 3) Modeling the system 4) Management systems and 5) Monitoring complex systems. All of the identified gaps fall into one of these categories.

As a part of this process, a few journal articles were reviewed that pertain to integrated land use planning and the management of complex landscapes. These documents will be used to set the context for this summary section. Many of the issues that are brought forward in these documents tend to be common across all planning fronts regardless of the scale of the planning. There are many commonalities in terms of the challenges that were identified in these articles that were common to what was determined in this gap analysis.

The first paper reviewed is called *Squaring the Circle? Combining Models, Indicators, Experts and End-Users in Integrated Land Use Management Support Tools (Furst et al, 2010).* The paper discusses issues and constraints associated with landscape planning. The second paper reviewed was written by Baskerville in 1998 called *What Constitutes Best Forest Management*. The paper discusses forest management planning but many of Baskerville's comments are appropriate for land management planning as well.

The most important areas that were identified by Furst et al were associated with the following planning areas: harmonizing and integrating data sets, selecting appropriate indicators, finding appropriate models for different scales and integrating indicators and data into modeling systems that allow easy participation and that are flexible enough to accommodate changes, when they occur. In terms of the gap analysis these all sound very familiar. Many of the problems that were identified by Furst et al were associated with higher levels of complexity in landscapes. The authors also talk about the dynamic nature of environmental parameters (climate) and how these parameters will affect the reliability of future forecasts. Not accounting for these dynamic changes adds risk to future landscape predictions. The authors also discuss the complexity that excessive numbers and types of indicators add to the process. Some important questions need to be asked about indicators: Do we have the right indicators and are the selected indicators in sync with the models that will be used to assess these indicators? Do we have the right indicators at the right scales to assess landscape health? What are the sensitivities associated with the indicators? Are the indicators apart of or can be inferred from a larger inventory? Some indicators may be much less resilient than others in that small disturbances may cause large shifts. Other indicators may be more resilient to change. How many coarse filter and fine filter indicators need to be selected?

There is also a discussion about decision support systems or models and their effectiveness. New modeling systems that use multi criteria analysis (MCA) or optimization are suggested as new technologies for completing landscape assessments (Furst et al, 2010). Baskerville calls these approaches Algorithm Search Systems. In these systems the landscape manager defines a set of landscape dynamics and responses to interventions and a computer rule (algorithm) uses these to systematically generate an array of forecasts. The forecasts are then compared to the managers specified goals and constraints and the best solution is then identified (Baskerville, 1998). In other words the landscape is optimized. The majority of the modeling that has been completed to date (Terrestrial Ecosystem Management Framework) would be classed as heuristic by Baskerville. The modeling represents a more linear approach to modeling. Selected

attributes are modeled into the future and then decisions are made on the predicted result in terms of goodness or badness. Baskerville defines Heuristic modeling as the simulation and review of a relatively small number of possible futures. Baskerville states that this is considered to be a heuristic approach because the manager learns about the system responses and what constitutes good management through conducting the searches.

Many areas that were identified by Furst et al and Baskerville are very relevant to this gap review. It would seem that these planning issues are universal and have been around for quite some time in landscape planning exercises. The following section represents a summary discussion of the gaps identified in the document review in relation to the planning issues identified in the published papers on the subject.

a) Discontinuity of Information and Data Accuracy

Discussion

Using fragmented or dated inventories makes landscape planning difficult. This is not anyone's fault; it is just the current reality that we face. Development has occurred at such a fast pace that inventories of disturbances have not kept up. Inventories like AVI (Alberta Vegetation Inventory) are costly and depending on the size of the landscape can take several years to complete. This creates an inventory lag in relation to current planning questions. At the same time we are now asking more complicated questions about current and future landscape options. Our landscape challenges and questions are now being associated with very large landscapes. We tend to loose the ability to answer these large scale questions as base level inventories on similar scales are not readily available or out of date. At best all that can be done by managers is to coddle together a patchwork of older inventories to try and address these landscape questions. The problem with this approach is that the inventories that are used are quite different. These inventories were developed to meet a range of accuracy standards, were developed at different scales and resolutions. This creates problems for the resultant data set and for the management interpretations developed from these inventories. Inventories need to be specific to the intended management. These inventories are then used to make some very long term landscape projections and for developing relationships between mapped and site level ecological components. For example, wildlife habitat suitability indexes have been developed and applied based on this approach. There may be questions about the validity of the results. Some of the reviewed documents suggested that additional work was required in the determination of habitat suitability models and wildlife habitat units.

Assumptions are also made in modeling about how fast disturbed areas regenerate themselves. In many cases areas may regenerate more quickly or may not regenerate themselves for many years (60+). The recovery of these disturbed areas is based on the level of the initial disturbance and the ecosite that was disturbed. Using broad assumptions about recovery times can affect modeling outcomes. The impacts of linear features was highlighted in the Terrestrial Ecosystem Management Framework and in the in situ footprint monitoring program carried out by Alberta Environment.

Poor information in terms of inventories and assumptions on recovery times can lead to incorrect results and interpretation of results during the modeling phase. Reconstructing a patchwork of data based on incomplete inventories can increase costs associated with these reconstruction exercises. These reconstruction exercises seem to occur over and over again as different parties undertake modeling exercises.

The following recommendations are made based on the review of the documents associated with inventory and data considerations:

Summary Recommendations to Improve Data Discontinuity and Accuracy

- **That an ecological inventory be developed for North eastern Alberta that could be considered to be the standard inventory for completing landscape assessments and planning. Existing ecological inventories completed by industry on lease areas and work completed by SEWG on defining landscape features and complexes could be used to facilitate the develop of this ecological base. Wet area mapping will also assist in the development of the ecological inventory. Having such an inventory would facilitate individual resource evaluations as well as landscape planning exercises like LARP. The information would be available to all land users as well. Broader generalized inventories being discussed in the Province are not sufficient for this in depth landscape planning.**

- **Based on this new inventory that a suite of indicators (fine and coarse) be identified and incorporated into regional monitoring systems.**

- **That an investigation be carried out on all existing inventories currently available for NE Alberta and that a report be written on the content of these inventories and the data parameters tied to these inventories. CEMA has many of these layers from past work (TEMF). All of this information on older inventories would be useful for informing the development of a new inventory or planning base.**

- **That stream classification is undertaken for the area located in the RSDS study area. Wildlife habitats associated with these stream classes (riparian habitats) are identified and mapped. The landform definition work completed by SEWG and wet area mapping would be useful for accomplishing this**

- **When the new inventory is completed that wildlife corridors be identified spatially and be available as a future layer for completing landscape evaluations.**

- **That the work that CEMA SEWG did on defining habitat suitability be reexamined in terms of this new ecological inventory. How do the previously determined wildlife habitat units line up with the new ecological base?**

- **That a disturbance and recovery model be developed for seismic lines and other disturbances. These models could contribute directly to other landscape modeling efforts. Recovery of disturbed systems and accuracy around these predictions will be very important for defining future landscapes. Currently models are using assumptions about recovery times.**

- **TEK needs to be matched to ecological parameters so that this important knowledge and aboriginal values can be included and assessed. For example certain ecosites may contain important aboriginal medicinal plants or berries. These will change over time as the landscape changes. We need to ensure that they remain on the landscape and that this can be demonstrated.**

- **That inventories on disturbed areas associated with disturbances be improved. Currently CEMA SEWG is conducting an inventory for seismic lines for the Footprint Management Plan development. These inventories should be completed for larger areas. New technologies (Lidar) may be useful for updating these disturbance inventories in a more automated fashion.**

- **When a new ecological base is developed, that there be an evaluation of WHU's (Wildlife Habitat Units) and current populations. Field checks could be used to confirm this.**

- **Investigate the natural range of variability associated with a number of key species based on the new ecological inventory.**

- **Improve and expand existing ASRD base feature update system to include all anthropogenic surface dispositions (well sites, small oil and gas facilities, borrow pits) thus consolidating the landuse footprint mapping within the base features mapping process; and increase the update frequency in the areas of intensive resource development (Alberta Environment Recommendation).**

b) Establishment of Indicators and Ranges Associated with Indicators

Discussion

Furst et al discusses some of the complexities associated with the selection of indicators. In order to support management decisions representative indicators must be selected and must be scalable to larger landscapes. Issues were identified by Furst et al about which indicators would be the most relevant in light of changing environmental conditions. Some modeling exercises have been undertaken in Alberta and have used selected indicators that are quite different. Under the Terrestrial Ecosystem Management

Framework indicators selected included individual species like woodland caribou, native fish, fisher, black bear, moose, old growth birds and area of old growth forests. Some fine filter species along with some coarse filter forest attributes. In modeling completed by Alberta Environment on in situ footprints disturbance indicators were chosen which included corridor density, riparian footprint and core area within forest stands as well as reclamation indicators. Reclamation indicators included restored footprint and inactive footprint. It would seem that in both cases (TEMF and Alberta Environment) important indicators were identified and were used to assess landscape condition. Other documents discussed the use of the natural range of variability associated with these indicators. In several cases there were recommendations to refine the models for NRV based on empirical information. Some fine tuning was suggested on bird species used as indicators. Species selected should be changed from the more generalist bird species that were used to the bird species comprised of old forest birds. As we can see the discussions continue about what the best indicators might be.

Discussions and concerns were brought up in several documents about the impact of lineal densities on many wildlife species. These impacts are not well understood and research needs to be done confirming these relationships between wildlife species and line densities. The work carried out by Alberta Environment on in situ footprint monitoring suggest research be conducted to examine the impact of linear features in terms of line edges, width of lines, slope and aspect of lines, disturbance levels on lines and density of lines. The impacts of linear features represent a very complicated challenge for relating these disturbances to wildlife and landscape impacts. Suggestions have been made and rightly so that newer exploration lines are much narrower and therefore very different (less impact) from older, wider seismic lines. Based on the limited width of these lines this may be correct but some research may be prudent to confirm that this is so. The lines may be narrower but the densities of the lines have increased for oil sands exploration. The University of Alberta, Department of Renewable Resources has proposed a study that would follow the impact of an in situ project on a range of species from exploration through to production. The research would be set up with controls and would follow the developed landscape over time. This would be an excellent way to assess these disturbances on a range of species.

Several documents talk about the importance of aboriginal knowledge and values. Indicators need to be included that can be used to assess how these aboriginal values are changing over time as the forest is disturbed by anthropogenic and natural disturbances.

When the best fine and coarse filter indicators are selected work needs to be done to determine the appropriate trigger levels for these indicators. Monitoring will play a large role in defining these potential trigger points. The trigger points need to be set based on the species current population levels, current habitat availability and sensitivity to disturbances.

If a new ecological base inventory were developed coarse filter triggers could be associated with different combinations of vegetation seral stage and site types (wet vs. dry).

Summary Recommendations to Improve Indicators and the Ranges

- **That an evaluation be carried out on indicators that have already been selected through the TEMF and other modeling that has been done by Alberta Environment and that a final suite of indicators be proposed for NE Alberta. This work needs to be done in concert with work now being considered by the Reclamation Working Group on Criterion & Indicators for the oil sands mined area. Some indicators may be used to evaluate ecosystem process or function (topsoil replacement) while others may be more species specific or more landscape indicators (forest structure). All of these selected indicators should be as similar as possible across all disturbance types.**

- **Studies are conducted on the relationship between linear type (width, aspect, and slope), linear densities and their impacts on wildlife species.**

- **That research is implemented to examine the impact of in situ disturbances on a range of species. The research should follow the in situ program from exploration through to production.**

- **Work is done to ensure that trigger levels are set for selected indicator species and that monitoring is in sync with the selected triggers. Modeling should be done to examine the sensitivities of different species to disturbances and thus help to determine the appropriate trigger levels.**

- **That landform work completed by SEWG be used to evaluate Wildlife Habitat Units.**

c) Modeling the System

Discussion

Baskerville discusses three types of approaches typically used in modeling approaches in the context of best management approaches. In relation to the accuracy of forecasts Baskerville states the following "*The accuracy of a forecast relative to development as it will emerge in the real forest is entirely dependent on the degree to which the internal conditions, the vegetation dynamics and the responses to the treatment reflect reality as it will operate in the forest".* Baskerville reflects in this paper on three types of modeling approaches for managing complex systems. The three approaches are 1) The prescriptive approach, 2) The heuristic approach and 3) The algorithm approach.

The prescriptive approach is the simplest. This approach focuses on the goodness of the tools and not on what the outcomes of the tools are (Baskerville, 1998). The treatments

are already known so there is no need for searching for the best solution. Baskerville describes "*best*" associated with this approach as having faith in the person or agency who prescribes the treatment. The heuristic approach involves modeling and reviewing a relatively small number of potential solutions. The modelers or managers tend to learn about the system as the modeling is completed. The best solution is selected from a relatively small set of possible solutions based on the learning that has occurred. The third approach that Baskerville discusses is the algorithm approach. In these systems the landscape manager defines a set of desirable landscape dynamics and responses to interventions and a computer rule (algorithm) uses these to systematically generate an array of forecasts, compares these to the managers specified goals and constraints and identifies the best solution (Baskerville 1998). In other words the landscape is optimized. Furst et al call these kinds of modeling systems MCA or multi criteria analysis or more commonly referred to as optimization. These kinds of papers point the way for future modeling programs and considerations.

- Modeling Undertaken in Alberta

The Terrestrial Ecosystem Management Framework used the ALCES model. Four different scenarios were modeled along with a land management scheme called the Triad approach. Each management zone in the triad had specific development levels associated with the triad. A fire model was also developed for this assessment. The report made the following recommendations before additional modeling exercises are undertaken:

- Complete comprehensive and consistent inventories of vegetation and footprint for the entire region
- Refine models for NRV for environmental indicators based on empirical indicators.
- Develop population models for key wildlife species including woodland caribou, moose, black bear, fisher and old forest birds.
- Consider altering the bird species comprising the old forest bird index. The index used in the assessment included species that are more generalists.
- Validate the habitat effectiveness models, including responses of indicators to human disturbances and management actions.
- Validate modeling assumptions related to projected industrial development including footprint size, duration and reclamation for both surface and in situ operations.
- Develop new spatial models to predict indicator response more accurately.
- Periodically revise models and update studies as additional monitoring and scientific data and TEK become available.
- Continue with the linear inventory and Footprint Management Pilot.

Modeling work was also undertaken by Alberta Environment which investigated the impacts of in situ footprints. The stated purpose was to "*Develop a management system that describes processes and linkages for conducting landscape assessments*". The Oil Sands Research and Information Network completed modeling on mines areas using the FORECAST model. Climate change was examined in relation to future wildlife habitats resulting from landform redevelopment and reclamation of these new landforms. All of

these modeling efforts represent a wealth of information for informing future modeling efforts.

Summary Recommendations for Modeling

- **All of the landscape analysis that has been completed in Alberta used very different approaches. Several landscape evaluations have been completed by CEMA (SEWG-TEMF), OSRIN and GOA-Environment in similar areas of the Province. At this time all of the procedures undertaken and results from these assessments are independent. An analysis of the procedures used to do the analysis, the models involved and the inputs and outputs for each modeling exercise would be useful for informing future landscape assessments. An evaluation needs to be done on each modeling exercise undertaken and a report summarizing the results needs to be completed. This work would be used to inform future landscape modeling exercises for LARP.**

- **An evaluation is undertaken of newer models and approaches that are available and a report be written that recommends the best attributes of a future modeling system. Comparisons can be made back to previous modeling exercises.**

- **That the recommendation for a new base level ecological inventory be completed in order to facilitate future modeling efforts.**

d) Monitoring Landscapes and Landscape Processes

The Oil Sands Research and Information Network completed a review of existing environmental effects monitoring programs currently in place in the oil sands area. Each monitoring program was identified to be associated with specific scales and with specific environmental or ecological parameters or concerns. The authors stated the following "*Stakeholders including the monitoring program staff themselves, lack a detailed understanding of the full suite of monitoring activities taking place in the oil sands area. In moving forward a more integrated approach would benefit both the existing environmental effects monitoring programs and the ability to speak authoritatively about the oil sands ecosystem effects as a whole"*

Summary of Recommendations for Monitoring

- **That an evaluation is carried out of all monitoring programs and a summary be provided of what is being monitored, what the measurement protocols are, what is driving the monitoring, scale of the monitoring program and how the monitoring may be similar or different than other existing programs.**

- **Thought be given to the Criterion & Indicators when a new comprehensive monitoring program is developed.**

- **Monitoring is in concert with selected indicators used in landscape assessments**.

e) Management Systems

Management systems have been a priority of the SEWG group as evidenced by the work completed on the Terrestrial Ecosystem Management Framework. The membership identified a priority around the development of a management system for achieving ecosystem and landscape stability. The Clean Air Strategic Alliance (CASA) model was selected as a template for the management system. Work needs to be done to further define or describe the management system. The Oil Sands Research and Information Network workshop and report called the Oil Sands Mining Reclamation Challenge Dialogue Report talk about reclamation being a "*systems within a system".* Feedback from the workshop indicated that there was a lack of a systems perspective associated with reclamation.

There is a concept now being discussed in ecological circles called **Panarchy.** Panarchy is specifically defined in a website located at www.sustainablescale.org called The Sustainable Scale Project as "*A conceptual framework to account for the dual, and seemingly contradictory, characteristics of all complex systems, stability and change. It is the study of how economic growth and human development depend on ecosystems and institutions, and how they interact. It is an integrative framework, bringing together ecological, economic and social models of change and stability, to account for the complex interactions among both these different areas, and different scale levels*". The article states that often regional management efforts are linear in nature, targeting the maintenance of certain variables only. Ecosystems tend to be regulated by interactions between fast and slow variables that are non linear in that processes and reorganize resources across levels and ecosystems. These systems have not one but several equilibriums. Management systems must take these dynamic ecosystem features into account and be flexible. Panarchy places a great emphasis on the interconnectedness of levels from the very smallest to the largest, from the slowest to the fastest. The concepts of panarchy need to be built into new management system considerations. Small cycles and large cycles need to be considered in as a part of a future management system. The management system needs to be able to demonstrate all of the specific steps, feedbacks between management levels and all of the required inputs and outputs required to help to understand these large systems and the small systems. There has currently been a great deal of good work on a number of the pieces or components of landscape assessments and management. It is time to bring all of the individual management pieces or resources that have been developed into a clearly defined management framework. A management system diagram and associated flows need to be developed. All of the individual pieces that have been developed can then be plugged into the management system. Clear connections can be made between existing work and between planning levels. Every component and step will be informed by the appropriate other components and steps. Flows of information across management networks can be understood. Once the management system is known efficiencies can be built into the system. A management diagram would help to define and organize all of the current work, would indicate flows, would indicate gaps and would provide a framework for future management. We have all

of the landscape puzzle pieces; it is time to assemble them to see what the picture looks like.

Summary of Recommendations on Management Systems

- **The Clean Air Strategic Alliance management system is a good model for a management system. The Terrestrial Ecosystem Management Framework incorporated many of the management system components. In systems development flows are important as the flows describe all of the individual management components and how information and resources move between them. For example the work that SEWG has done on the development of inventories associated with vegetation and wildlife, monitoring, modeling to test landscape management approaches, suggestions of indicators for modeling all are parts of a more comprehensive management system. Each one of these components is informed from information produced by preceding steps and in turn will inform other management steps once they are completed. Each piece of work that has been conducted by CEMA is an important piece of the management puzzle. Now that we have all of the CEMA and other puzzle pieces on the table they need to be assembled so that the entire management picture or management system can be demonstrated and understood. By assembling all of the pieces any missing pieces could be identified and efficiencies can be developed in future management systems.**

- **Organize work that has been completed in CEMA. Bruce McGilllivray stated this in his report "*Regional Sustainable Development Strategy for the Athabasca Oil Sands Area (RSDS) Work Plan Progress Analysis*" by saying that this could be accomplished by each group. Each group should organize their respective libraries into categories. The categories suggested were frameworks, recommendations, guidelines, reviews, proposals and original research.**

- **Develop executive summaries describing the completed work would assist in creating an understanding of the work that has been completed.**

- **Develop a management systems diagram showing all of the different components developed by CEMA and how they fit together would be most helpful (flows, inputs and outputs).**

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