Introduction

The following is a summary of the Day 2 facilitated discussions as part of the workshop "Forest Management Planning in the Face of Climate Change: Impact and Adaptation in the Acadian Forest" held in Fredericton, May 16, 2007. The summary is based on the notes collected from flip charts and note takers in each of the four facilitated groups.

Facilitated Sessions

Group 1-1 – Question 1 with respect to Growth and Yield of "Natural Stands"

Participants:

Mike Lavigne	Raj Chaini	Dan McKenney	Dominique Blain
Walter Emerich	Jody Jenkins	Chris Norfolk	Mary Myers

What are the expected changes in growth and stand development and succession and how can we forecast these?

What are the expected changes?

- ✓ Stand composition
- ✓ Rate of climate change will make it difficult for species to expand their natural ranges in step with what the climate will allow
- ✓ Difficult to promote species with natural regeneration. Interventions will be required to promote species who's natural range is expanding
- ✓ The natural range of as many as 60 tree species could inhabit the Acadian forest
- ✓ There will be changes in the pattern and periodicity of mortality

What data and knowledge gaps exist?

- ✓ Rate and direction of successional pathways – recruitment data - (knowledge/data)
- ✓ How the changes in climate will influence sites and therefore site classes (knowledge)
- ✓ Spatial soils information (data)
- ✓ Response of stands to partial harvest (knowledge)
- ✓ Response of individual tree species to stress as a result of climate change (knowledge)
- ✓ Impacts of alien pests and diseases (knowledge)
- ✓ Linking of sites data to empirical models – link process models to empirical models (knowledge and data)
- ✓ Future forest composition (knowledge)
- ✓ Growth and yield information from outside the Maritimes (knowledge/data)
- ✓ Components of climate data that is the most relevant to forestry (knowledge)
- ✓ Linking of weather station data to growth and yield and PSP data (data)
- ✓ When will seed sources arrive (rate of migration by tree species vs rate of climate change)? (knowledge)

What are the suggestions for moving forward?

- ✓ Linking data to process models with empirical models within DSS's
- ✓ Require "knowledge transfer" of current state of knowledge and all new information to practitioners
- ✓ Require robust monitoring system to pick-up factors such as mortality, succession, forest health etc. in managed and unmanaged stands
- ✓ Need to understand what responds positively and negatively to climate change - may require plot level, individual tree growth models

Group 1-2 – Question 1 with respect to Growth and Yield of "Managed Stands"

Participants:

Yill Sung Park	Werner Kurz	Ian Taviss	Ivan Downton
John Majors	Pierre Bernier	Robert O'Keefe	Fan-Rui Meng

What are the expected changes in growth and stand development and succession and how can we forecast these?

What are the expected changes?

- ✓ Yield patterns and succession rules
- ✓ Different growth & mortality in managed stands: Require them across the range of expected climate conditions
- ✓ Genetic variability within species will allow for some change

What data and knowledge gaps exist?

- ✓ Don't have empirical data for managed stands (little data for trees over 20 years of age)
- ✓ We have the conceptual framework necessary to predict growth & yield: effects of intensive management, tree improvement, climate change
- ✓ PSP that fully cover the range of climate conditions
- ✓ Relationship between climate and growth: Modify empirical growth models, develop process models
- ✓ Make sure climate change predictions are more related to tree growth especially extremes, magnitude of variations
- ✓ Data from provenance tests across Atlantic region 25-30 years, red black and white spruce and jack pine
- ✓ Total carbon and merchantable volume
- ✓ Carbon budget model is available for use: opportunity to improve inputs, soil carbon pools
- ✓ Better understanding of impact of climate change on tree growth: identify critical drivers, varies by species/site
- ✓ Impact of management activities and climate change
- ✓ Will climate change affect carrying capacity?
- ✓ Intensity of forest management is more akin to what is happening in Scandinavian countries so maybe we need to look there

What are the suggestions for moving forward?

- ✓ What proportion of the sites in our managed forest will respond positively or negatively to climate change?
- ✓ Develop climate and tree growth relationships (dendrochronology).
- ✓ Relationship between tree level radial growth and plot level net volume growth.
- ✓ To what extent do managed forests represent a unique case?
- ✓ Managed stands are density controlled.
- ✓ Need for plot level individual tree growth models ex. Forest vegetation simulator (US Forest Service; IVY model)
- ✓ Look to Scandinavian experience to get a better understanding of managed stands and species and genotype interactions with climate.
- ✓ Compare existing climate to existing PSP's.
- ✓ Model or tool to test species and genotypes for future climate conditions 20+ years.
- ✓ Need for improved soil data.

Group comments:

Yield patterns and succession needed to incorporate into planning exercise: there are unique issue with managed stands. Different from natural stands: we don't have empirical data for stands on how they are going to grow from this point forward. Very little data for managed stands beyond 20 years of age. Mensurationally: don't grow differently but growing under different densities.

Don't believe growth and mortality are the same in managed and unmanaged stands. Development pattern, growth rates, the range of diameters are important, stand tables and stocking tables. Need these patterns under different climate regimes. We have the infrastructure to get the information we need (i.e. PSP's to get growth and yield information).

Tremendous amount of genetic variability even with genetically modified stock. The information that is missing from our G&Y information is the effect of: intensive management, climate trends, tree improvement (PSP's are primary data source).

Use process models to adjust G&Y under climate change. Use relationships between climate and growth to modify empirical growth models.

We need to look at the extremes of climate change not just the average. Relative variation within a small area vs. year to year. Magnitude of variation is important.

We have the opportunity to extract data from provenance tests — pay attention to the climate variables. Seeds were collected from natural stands and have grown for 20 to 30 years in a garden type plot. There is mortality captured as well. There is a migration lag with those that have been brought into a different climate zone. You can see what was added carbon wise as these sites were totally cleaned before the provenance trials were put in. Equations exist to determine above and below ground biomass. There is a

lot of data that needs to be pulled together that exists in various jurisdictions that could aid in fine tuning these models i.e. soil samples, provenance testing.

What aspect of climate is driving tree growth? Also what the tree stored in its battery the year before affects how is will grow in the following year.

Plantations being established still 60 % black spruce. Except for the reserved stands, then within the next 20 years all of forests in NB will be managed stands. Try to do the right thing on the right piece of ground in context of producing a product. Need to understand succession rules even with plantations. For certain species the harvesting techniques have a greater impact on succession that climate change does.

Species and site specific responses to climate change can be extracted from PSP data. But management adds another variable that compounds it. Is climate change going to change the carrying capacity? There are no error bars on the AAC. What portions of our species and sites going to respond positively or negatively to climate change?

Need to look at tree growth on individual trees (tree level radial growth) as well as plot level net volume growth (mortality) for specific species in specific regions.

Comments during plenary:

Must keep in mind that it is an “operational” forest – information from specific stands can be informative but information should also be collected from a large number of stands over a wide area.

Perhaps look to Scandinavia for guidance – has a small land base.

Look at continuum across reserves and managed forests

Even with out climate change our understanding of interactions with soils and drainage are not well understood even without climate change.

What defines a managed stand?

Drivers in growth will vary by species and site.

Need data for winter months as well – is the unusual events (those every 10 – 20 years) that limit what can grow where. Need to measure in soils and crown in summer and winter. If we have a small number of plots that measure detailed climate data how do we link that to the rest of the network of plot data?

Need to ensure samples are stratified appropriately.

In terms of G&Y do we need to follow other species? What is currently being done?

Would feel better extrapolating to EC network. We need estimates at all locations and stand types. PSP's are measured every 5 years so how do we do it as actual data better than projected mapped data. Fluxnet is trying to capture weather data. You need the estimates at all locations. Data has been withheld from weather stations and then the models have predicted well data from those stands.

Art Groot has another tree based model

In terms of monitoring: one task is choosing genotypes. Do we need start to look at the none traditional species—paradigm shift. For data needs, let's look at what we have already in terms of climate and provenance tests and PSP's. We need to predict species and genotypes for 20 years into the future

Group 2-1 – Question 2 with respect to "Other Disturbances" – "Insect Disturbance, Natural"

Participants:
David Gray Quentin Jackman Jorg Beyler Dave MacLean
Rory Gilsenan Bob Dick Keith Deering

What are the expected changes in disturbance regimes in the Acadian Forest?
What are the expected changes?

- ✓ In general, increase in extreme weather events
- ✓ There will be a change in the balance – some insects will benefit some will not. What we currently see will be different in the future as new species (tree and insect) move into the Acadian forest
- ✓ Blowdown/hurricane will increase and have secondary impact on insects – examples are spruce and bark beetle outbreaks
- ✓ Need to look at the range of disturbances and their effect on insect outbreaks – need to systematically go through outbreaks – fire, wind, ice, insects, diseases
- ✓ The Maritimes is likely to get warmer but precipitation is not likely to be a big problem - fire is not likely to be a factor
- ✓ Minimum temperatures are starting to increase and will affect insect populations
- ✓ Wind events likely be more severe – localized and hurricanes. Juan affected spruce (planted and natural) the most and may impact future management decisions (changing species composition to reduce risk?). What species to plant or manage for? Deep rooted species? Species that do better in warmer temperatures? Consideration must be made for stems lost to wind and those left standing and affected by pests.
- ✓ Salvage problems may arise (collection and processing). Pests may make the window for salvage much shorter (scale dependent)
- ✓ Likely-hood of fire is less in Maritimes. There maybe a slight increase in risk but we have adequate access and suppression capacity. Costs of detection and suppression may increase
- ✓ Increased expectation of more ice events – may impact softwoods
- ✓ All weather events may increase stress in trees

- ✓ Nova Scotia on hurricane track – increased risk even if area haven't been impacted yet, it is still in the track

What data and knowledge gaps exist?

- ✓ Increase risk of loosing plantations to hurricane, wind and pest events – what can we modify in management planning processes (tomorrow) to manage risk?
- ✓ More thunderstorms – better lightning detection
- ✓ Increase contribution of insects in predictions (probabilities) of insects becoming a problem (gaming scenarios)
- ✓ Look at probability distribution
- ✓ What are potential rewards (may be different in cases where we are managing risk)/loss of opportunities/risk adversity of management activities
- ✓ Frequency distribution – regional probability maps of various weather events – useful for forest managers. Historical patters of weather
- ✓ Can we plant for ice?

Some insects we can make predictions for but need more information on:
Spruce budworm – longer outbreaks but less severe

Gypsy moth – controlled by length of summers: good probability of increase in severity

Spruce beetle – more deadwood then increase; devastating events would provide good habitat for increases

Balsam woolly adelgid – if mixing stands to hedge bets against insects, we will see increases in this insect

Hemlock looper – unknown why in the NL but not known why there and not here. Highlight this as dynamics not well known. How susceptible is it to c.c.? Hits mostly managed stands. Hemlock becoming more a part of our managed stands.

Tussock moth – Starting to see again. Minor issue as compared to others.

Parasites – not enough info to know how players will react to c.c. Increased temperature, increased fecundity of pests and parasite – we don't know enough

Pale wing grey – first time it has shown up, was never a problem. It is an early sign of this insect moving into the region

Balsam saw fly – becoming a huge problem in managed stands in NL. Anticipate more outbreaks

Forest tent caterpillar – more site related; outbreak in Ontario that was more severe than expected – should be studied

Dieback – water and freezing related; could be more prevalent if winters become more extreme

Beech bark disease – spreading northward

Exotics – larger scale disturbances and planning, planting other species, we would be more subject to exotics. How is cc going to affect BSLB?

Emerald ash borer – don't know a lot about climatic conditions required for spread.

Mountain pine beetle – spread will slow – characteristics of Pj range – spread has bee affected by weather and forest management practices

Need to think about what environment in which they will establish themselves. Future climate change – new insects move in.

Balsam fir – many insects – disaster species – it regenerates easily but is susceptible to many insect species

Mixing stands may mitigate risk in some but increase risk to others.

What are the suggestions for moving forward?

- Need a workshop to assess, on a pest by pest basis, the risk due to climate change.
- Need to identify probabilities/like the plant hardiness map for insects
- Laws and policy limit our ability to adapt and manage. Institutional changes maybe needed.

Group 2-2 – Question 2 with respect to "Other Disturbances" – "Managed"

Participants:

Kevin Porter	Eric Neilson	Greg Adams	David Carmicheal
Roger Cox	Martin Girardin	Tom Ng	Thom Erdle

What are the expected changes in disturbance regimes in the Acadian Forest?
What are the expected changes?

- ✓ Disturbance regimes affect G&Y
- ✓ with CC can expect more change in disturbance (frequency; severity)
- ✓ types of disturbance (all can be inciting factors in tree decline and causing asynchrony for plant development)
  - Fire
  - Wind
  - Decline in forest health (mortality)
  - Drought
  - Disease
  - Frost events (late, early)
  - Freeze/thaw
  - Ice damage (i.e. freezing rain instead of snow)

Pollutants (e.g. acid fog)
Insidious change within plant

Any of these conditions can set preconditions in the forest for any of the others to occur.

Predictability of factors (some/not others)
Can fit some to G&Y curves and can respond to; others not
Planning can help mitigate some

What can we respond to?
Risk reduction/mitigation

Disturbance	Priority	Frequency	Severity	Extent	Predictability	Response Potential	Risk Mitigation Potential
Fire	M	Need more information (could go up or down)	Function of conditions Seasonal variation will be driver Driven by moisture – can be periodic severity	Also driven by moisture conditions	low	high	moderate
Decline		increase	increase	increase	low	Medium	low
Wind		increase	increase	increase	low	high	high – stand management, hgt/diameter; landscape planning (topo considerations)
Drought	H	increase	increase	increase	Moderate – better with improved site information	low	High – right species on the right sites
Disease		Increase and decrease	Increase and decrease – new diseases	increase	Low for specifics; Mod-high for generalities	Moderate – silvicultural operations	Cross over with response
Frost		fewer	Variable/uncertain	M – in terms of species wrt soils characteristics; changes of spp wrt frost hardiness	? soils info	Impacts of new arrivals - succession	
Ice		increase	increase	increase	low	high	Mod Spp selection
Freeze/thaw		increase	increase	increase	moderate		
Human disturbance							
Flooding							

What data and knowledge gaps exist?

Several factors, and measures to be taken, can be better addressed through improved understanding of soils and moisture regime.

Better information on soils and landforms.

Continued modeling and simulations to improve predictability of each disturbance to help prioritize. Also to model and assess effects of INTERACTIONS of disturbances

Merge various data sources and use them together to predict conditions.

Use info from this list and simulations to create DSS to improve prediction and risk analysis

Consider meteorological variables in maps
- Insulation
- Elevation…

When considering meteorological data, include winter.

Relate climate to landscape and elevation

Influences of temperature

What other independent variables do we need to consider to predict, respond to and mitigate effects of CC? Precursors to impacts from insects…

What are the suggestions for moving forward?

No specific comments.

Plenary and Group Discussion:

Resultant conditions from potential hurricanes – e.g. flooding and effects on soils and local physiographic conditions

Secondary and tertiary effects of various disturbance regimes and responses

What is management implication?
- Strategic mgt planning
- Givens in plans
- Reflected in yields – level of risk willing to accept
- We don't incorporate levels of impacts directly, only indirectly

Large number of primary and secondary disturbance types
- Plants maladapted so increase in susceptibility
- Pathway projections are far away

High level (strategic level) likely pathways need to be considered to hash out trajectories

Generic disturbances to consider these high-level possible pathways

How much do you model? When are we satisfied? *Interactions* are critical. Habitat is critical in initiating, promoting and supporting natural disturbances.

Do succession modeling with multiple disciplinary experts for the region.

Become much less sophisticated in the "first pass" to capture characteristics of the forest and susceptibility.

Simplicity in addressing BIG questions is important to moving forward and gaining understanding among experts.

Are we managing the manageable forests for Carbon?

Add flooding to list…

Afternoon Session:
Group 3-1 – Question 3 with respect to "Management Strategies"

Participants:

Mike Lavigne	Rory Gilsenan	Greg Adams	Mary Myers
John Majors	Dan McKenney	Jorg Beyler	Thom Erdle

What management response strategies are required to respond to the expected changes due to climate change?

- Need to continue to carry out the practices we are currently using (over the short-term) and add tools to address the challenges of climate change (over the long-term) – climate change is just another uncertainty we must take into account
- May need to look at shorter rotation species for some sites to reduce risk of disturbance
- Mixedwood stands maybe a good way to hedge bets
- Pests such as adelgid and budworm may reduce balsam fir (certainly it is less desirable as a market commodity)
- In Nova Scotia on private woodlots the species distribution is as follows: 1) fir 2) white birch 3) red maple 4) white pine 5) red spruce. The choices depend on markets
- Flexibility is of the most value – need to incorporate flexibility as an objective in management planning

What uncertainties prevent choice of forest management options?

- No static site variables
- Selection of species genotypes will change
- Introduction of new pest and diseases
- Markets

- Carbon – budgets – markets
- Nature of uncertainty needs to be examined. Reduce what you can – can predict some.
- Knowledge of impacts of harvest on carbon
- Bioenergy?

What information/input is required to incorporate climate change into management planning?

- Risk assessment needs to be carried out and then communicated that risk effectively so that effective strategies can be implemented. We need to adopt explicitly, some of the management responses - need to be convinced (the public as well) a specific strategy is a good idea
- Need to have planned responses ready to go so that they can be implemented quickly. Some will be pro-active and some reactive.
- Carbon will be a forest product – how will that change what we do now?

To what extent can each input be met with available data or is additional data and/or expertise required?

- More information on carbon and carbon storage

What are suggestions for the way forward?

- Management strategies must have exit points where you can "get off" onto another path based on economic, ecological or social reasons

Group Discussion:

No additional comments.

Group 3-2 – Question 3 with respect to "Management Strategies"

Participants:

Yill Sung Park	Pierre Bernier	Jody Jenkins	Keith Deering
Roger Cox	Dominique Blain	Bob Dick	Fan-Rui Meng

What management response strategies are required to respond to the expected changes due to climate change?

- Need risk management strategy in light of climate change—this needs to be regionalized. i.e. Insects may or may not increase due to climate change.
- Disturbance may become more erratic. What are you most vulnerable to right now in the uncertainty of climate change?
- What is your management objective/value and your tolerance for risk? This needs to be done upfront. Industry and government have difference response—hands on vs. policy. As and example, there are regulations that prevent the movement of provenance trials outside of certain zones.
- We should try to formulate a management strategy.
- CFS take over the long term research that you don't necessarily see immediate results from. We can do damage by taking short term research to influence/make policies. You can take the issues/strategies that have been

researched for a long time and put into management planning but we need to be careful about making policy on short term research with preliminary results.

- We should learn to spatialize risks. What species is most at risk and where. Then we can spatialize pests over an area. Then what do we have in genetic reserves. Has what we know about risks i.e. the SBW DSS been incorporated into management planning? Is there the desire to put these risks into management planning?
- NB does management planning every 5 years. Major blowdown was not forecasted but happened and it blew down an entire year's worth of AAC in one night. How that is dealt with is to salvage and update your inventory therefore your management plan.
- Two categories like catastrophic and insect and disease and climate change that can be incorporated into management planning. When there is a long term sustained effect then our monitoring plots can give information that can be included into plans.
- How flexible is our solution for dealing with risk? Give yourself options.
- What are the costs to mitigating the risks? The less certain the risk is the less apt people are to incorporate that mitigating factor into your management planning. You want to make sure of your science before hand. If it costs more to implement that you get back then you will not tend to use it. Expensive and uncertain will not tend to be used.
- The places where we are most likely to see climate change are places where we have already chosen not to manage at all (NFLD). We have to make sure that our policies and decisions do not box us in for future flexibility in management planning. Even choosing not to manage can box us in for future decisions.
- Introduction of exotics can be a contentious issue.
- What are the links to forest products and management strategy and climate change?

What uncertainties prevent choice of forest management options?

- Uncertainty in the land tenure system.
- Markets introduce uncertainty.
- Salvage and other wood from private lands.
- Big shift in what worked and how things were 50 years before may be very different in light of CC.
- Carbon credits can be a driver in management planning.
- Policy uncertainty in things like Carbon credits.

What information/input is required to incorporate climate change into management planning?

- Determine what knowledge can be used in management strategies.
- Where are the gaps for continuing research
- Need to link risk to value chain

To what extent can each input be met with available data or is additional data and/or expertise required?

- Current forestry based on historic forest growth not future growth
- Look to other jurisdictions for possible solutions

What are suggestions for the way forward?

- Group of experts to try and predict future risk impacts
- Greater uncertainty calls for greater diversity
- Structured framework for risk assessment and good feedback mechanism. Needs to be done at sectoral and regional level.
- Look to other jurisdictions for solutions as to what they have done and what worked and did not work and why.
- Build consensus in scientific community as to what needs to be done.
- Communication and outreach is important in educating people. Dispel the myths. Having a way to support our decisions. Our scientific outputs need to fit into management needs.
- Research community needs to boil all of it down to be able to fit into management strategy for a specific region or jurisdiction.

Group Discussion:

- Revisit natural disturbance regime as a management strategy. Revisit the ones we have, climate change may be the death knell of this – does climate change negate the concept.
- How climate change will influence forests but also globally; role in global carbon cycle, mitigation , bioenergy, have to address many issues that have to be incorporation into management plans
- Implication is we are trying to restore ecology to normal conditions: even though "normal" is changing
- Scientists didn't know what natural regime is, if we maintain it, we must be doing something sustainable (maintain a natural portfolio of disturbance)
- Does it still make sense to use the portfolio natural disturbance regimes as a focal point of discussions when moving under climate change?
- Society's responsibility to determine the natural regime? Landowners?

Group 4-1 – Question 4 with respect to "Planning Tools"

Participants:

David Gray	Eric Neilson	Ian Taviss	Ivan Downton
Raj Chaini	Martin Girardin	Tom Ng	Dave MacLean

What changes are required to forest planning tools to cope with climate change impacts?

How do we predict changes in ecosystems? Response/recovery...

- Individual growth tree models are what is needed but transferability of model is not there yet
- Calibrate for specific sites/regions empirical model
- User changed/sensitive scenarios
- Climate change scenarios linked to management objectives linked to G&Y…can we make the connections? (climate change models linked to stand level models)
- Need linkages in planning tools for timber, biomass, or carbon
- How do we move research models to operational use?
- Current models work well but don't understand site characteristics and tree growth
- Priority - Improve predictability of planning tools

To what extent can each input be met with available data or is additional data and/or expertise required?

- We will not have empirical data (don't have it on managed stands, how can we get these for climate change
- Many people are working on this – data is everywhere – need group to gather and work collaboratively on this – currently there is no one making linkages – willingness to share data is a challenge
- Data maybe limited in terms of ability to predict future climates
- Stand table prediction model does not allow for density modification/climate variability
- Tool that is flexible and data is evolving
- Fundamental – tree growth X climate change
- Need a better understanding of basics of soil composition
- Process models are calibrated on short term data – need longer term prediction ability (50-100 years)

What are suggestions for the way forward?

- Data library for sharing data is evolving, include US climate shifting south to north and get their data models involved
- Forest estate models (Woodstok) are standard - improve foundation that feed it and add carbon budget model to it (done)
- Need a better understanding of yield curves and succession rules
- Basic planning framework will not change – managers will continue to use empirical based yield tools and connect to carbon budget – need to improve predictability of models
- Inputs in Woodstok – programs that provide inputs need more flexibility (incorporate projections/possibilities for climate change
- Need a well calibrated/flexible process based model that responds to climate variables

- Assign risk coefficients to stand types
- Rather spend money on data to provide a better understanding of the effects
- Understand the current situation more precisely by collecting data and predicting using a process model and climate change variables

Plenary:

- More linkages between models
- Use Woodstok to link climate change into scenarios (CBM DLL is imbedded into Woodstok)
- No collaboration – may be a generalization – FLUXNET – collaborating process models (BC and QC) CBM projections and process models
- What is needed to make them operational? What is the hurdle? Unclear what is needed; or what choice and differences are between process models.
- Depends on how far you want to go. Examples in some regions that are further ahead . We don't need 10-15 years to get them – We can and should begin working on using empirical models to incorporate climate variability
- Wide variety of process models that are very well developed, ready for application; not a 10 year process. We have to accept a new way of doing things.
- Need global impact: hard to do
- Need to do research into climate change issues across North America
- Models don't connect to broader socio-economic outputs/inputs
- Measure tradeoffs from a social point of view (timber, carbon, bio-energy)
- Growth yield, management outputs and climate change
- Assign risk coefficients for risk assessment
- Develop risk maps
- Need process model approach - start work on it
- While we can't model the world, we have to consider the most dominant impacts interactively (eg. Fire and insects) in Woodstok/Stanley
- Changes in forest habitat, changes in probability of disturbances feed in disturbance scenarios based on something realistic

Group 4-2 – Question 4 with respect to "Planning Tools"

Participants:

Kevin Porter	Walter Emerich	Robert O'Keefe	Quentin Jackman
Werner Kurz	Chris Norfolk	David Carmicheal	

What changes are required to forest planning tools to cope with climate change impacts?

How do we predict changes in ecosystems? Response/recovery...

What does the DSS **need** to know to distinguish/respond? (need to know vs wish list) to our query(ies) about impacts?

Build a model (DSS) that will respond to the variables you want to know about
Outcome that is a result of information lacking in model is more important than an outcome that suggests a certain action that might be incorrect management planning?

DSS needs to address scales of time and space

2 types of DSS support
Models for forecasting
Monitoring systems that allow us to identify and react quickly to unpredictable events

Where are events going to happen (i.e. mortality)
In some cases at individual tree level (satellite…)

What are planning "tools"?

Tools	
Protection	
Growth	
Woodstock – harvest, outbreak, salvage modeling	
Growth rates and succession changes with CC	
Need to incorporate impacts related to disturbances - Multiple pathways Stochastic Probabilistic terms	
Systems perspective of models to integrate questions of "shifts" under CC Probability distributions Plan landscape accordingly Develop likely strategies/scenarios – operations then based on strategy with highest probability of success in getting to desired forest condition	

Educate strategic choices through understanding general choices.

"Sailing in a current" (strategic)
How do we navigate the current to get to where we want to go, all things considered, without going off track?

What changes should we be making to how or what we collect for inventory?
What do we measure?

What information/input is required to incorporate climate change into management planning?

Is current approach of aspatial – strata level – modeling working best for us?

- Redefine strata will be necessary – based on how they will grow (respond to CC).
- Process models will be necessary
- Site and soil become far more important.
- Drought limiting sites will become key in stratification (forest types will change).
- Need to fill recruitment and succession data gap to accurately forecast.

Need more than one modeling approach.

- What are plant stressors? What do vegetation shifts predict? Use this to guide modeling.
- Need to include growth curves AND events in modeling
- Replace growth curves with process model
- How do we deal with all stochastic events? What is the domain of possibilities and probability that any one will happen?
- How do we deal with dynamic change of disturbance events? Long term/short term.

Simulation vs optimization
We have a suite of tools to move us forward.
We need to incorporate CC
We address domain of outcomes through probabilistic models knowing uncertainties are associated.

To what extent can each input be met with available data or is additional data and/or expertise required?

What are suggestions for the way forward?

Need to change current method of "the past will predict the future".

Not necessarily evenflow AAC – requires change in policy
Need to address institutional constraints that we have on our systems as we deal with CC.
Look beyond optimization models ("Optimization models give you the perfect answer to the wrong question.")

Final Discussion and Plenary:

- We are currently working with optimization (a deterministic future) models (stochastic events need to be incorporated). We need to aim towards a desired future forest and incorporate disturbances into planning.
- We are not trying to achieve harvesting schedule but a future desired future forest condition.
- Optimization runs ignore disturbances
- Importance of figuring out succession. Disturbance impacts directly on succession theory (eg. Frost) important in how forest renews itself

- We need to know how to respond to new disturbances (not really succession)
- Ideas about more spatial information in determining recruitment
- Cohort selection different disturbance / differences what was affected in the stand – varies according to forest
- Everything raised as important needs to be evaluated – it's the way we intervene that has a greater influence on recruitment than climate change (hypothesis). All has to be evaluated for importance.
- Monitoring is of the utmost importance – landscape and our actions – to manage for change

Appendix A

Agendas and Workshop Outlines

Forest Management Planning in the Face of Climate Change: Impact and Adaptation in the Acadian Forest

May 15 & 16, 2007

Workshop Objectives:

1. To explore opportunities to determine short and long-term impacts of climate change on the Acadian Forest.
2. To identify decision support needs and information gaps that prevent forest managers from preparing for and responding to the impacts of climate change.

Purpose:

Climate change is expected to affect future forest dynamics in many ways. Forest management planning based on observations of past forest dynamics could result in failures to meet sustainability objectives and result in future timber supply problems. The purpose of this workshop is to (1) summarize the current understanding of the key impacts of climate change on the Acadian Forest and (2) identify strategies and information requirements to support and enhance forest management planning tools and their ability to incorporate climate change impacts in the planning process.

The workshop will prioritize the questions that have to be addressed in terms of vulnerability assessment and identification of opportunities in the following areas that directly affect the information in forest management planning tools:

1. Changes to Forest Dynamics and Growth Rates:

- How do climate change and variability affect annual growth and mortality rates?
- Status of process models for the Acadian Forest
- Link physical environment to impact on growth and yield
- Data availability and opportunities for model development
- Regeneration and Succession - Natural and Managed
- Species selection in anticipation of future change
- Responses to forest management treatments

2. Natural Disturbance Regimes:

- Changes in disturbance regimes (fire, insect, invasive species, wind-throw)
- Change in probability of events occurring and severity of events
- DSS models describing probability of outcomes

3. Long-Term Ecosystem Change:

- Species selection
- Tree improvement opportunities
- How will native tree species respond to climate change?
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4. Management Response Strategies:

- What adaptation strategies are available?
- What changes are required to forest planning tools to cope with climate change impacts?
- What uncertainties prevent choice of forest management options?

Workshop Format:

This will be a two day workshop with a combination of presentations for day one for knowledge transfer and facilitated discussions on day two to prioritize the main requirements and topics for future research efforts aimed at supporting forest management planning in the face of climate change..

Participants:

Day one of the workshop will be open to the public as a science forum (Agenda attached). Participation on Day Two will be by invitation only to ensure a balanced representation of expertise on the topics of discussion while keeping the group size manageable.

Timing:

Workshop is scheduled for May 15 & 16, 2007 in Fredericton, N.B.

Forest Management Planning in the Face of Climate Change:
Impact and Adaptation in the Acadian Forest
Hugh John Fleming Forestry Centre
K.C. Irving Theater
May 15 , 2007
Agenda

8:30 am	Introduction and Welcome - Dr. John E. Richards, Director General, CFS-AFC
8:45 am	Workshop Purpose and Objectives - Moderator, Derek MacFarlane, CFS-AFC
9:00 am	Overview of Climate Change and Impacts on Forests - Dr. Werner Kurz, CFS-PFC
9:45 am	Economics of Climate Change & Carbon Credits - Dr. Raj Chaini, CFS-AFC
10:15 am	Refreshment Break
10:45 am	Changes to Forest Growth Rates/Forest Dynamics and Process Modeling Dr. Mike Lavigne, CFS-AFC and Dr. Pierre Bernier, CFS-LFC
11:30 am	Question Period
11:45	Lunch (On your own)
1:00 pm	Plant Hardiness and Climate Patterns in Eastern Canada - Dr. Dan McKenney, CFS - GLFC
1:30pm	Natural Disturbance Regimes Under Climate Change Conditions - Dr. David Gray, CFS-AFC
2:00 pm	What Can Forest Managers Do to Help Ensure Resilient Forests In a Changing Future? - Greg Adams, J.D. Irving Ltd.
2:30 pm	Strategies and Information Requirements To Support Forest Management Planning Tools As A Result of Climate Change - Jorg Beyler, DNR Nova Scotia
3:00 pm	Refreshment Break
3:30 pm	Panel Discussion: Forest Management Considerations, Information Needs and Desired Decision Support Tools Capabilities - Dean Toole, CFS-AFC, Moderator

Day Two
Facilitated Workshop
Wandlyn Inn
958 Prospect Street, Fredericton
May 16, 2007
Questions for Facilitated Discussions

Facilitated workshop form to answer the following questions:

1. What are the expected changes in growth and stand development and succession and how can we forecast these?

2. What are the expected changes in disturbance regimes in the Acadian Forest?

3. What management response strategies are required to respond to the expected changes due to climate change? What uncertainties prevent choice of forest management options?

4. What changes are required to forest planning tools to cope with climate change impacts?

Sub-Questions: Each of the facilitated working groups will be asked to consider the following sub-questions in responding to the questions posed above:

A. What information/input is required to incorporate climate change into management planning?
B. To what extent can each input be met with available data or is additional data and/or expertise required?
C. What are suggestions for the way forward?

Process:
Participants will be divided into four break out groups for the facilitated discussions. Each question will be assigned to two groups with one group focusing on managed forests and the other focused on natural forests.

Output: A summary report will be produced from the day's discussions.

Note: It is important that all participants attend Day 1 of the workshop and take note of the information presented as this information will be necessary for the discussions on Day 2.

Day Two
Facilitated Workshop
Wandlyn Inn
958 Prospect Street, Fredericton
May 16, 2007
Agenda

8:30 am	Introduction, Welcome and Description of Process for the Day - Joe Thompson, Lead Facilitator
9:00 am	Setting the Stage - Ian Taviss, J.D. Irving Ltd.
9:15 am	Facilitated Group Discussions of Questions 1 & 2
10:15 am	Refreshment Break
10:35 am	Plenary Presentations and Discussion of Questions 1 & 2
11:30 am	Facilitated Group Discussions of Questions 3 & 4
12:30 pm	Lunch
1:20 pm	Plenary Presentations and Discussion of Questions 3 & 4
2:20 pm	Plenary Discussion of the Way Forward
3:00 pm	Wrap Up

Forest Management Planning in the Face of Climate Change:
Impact and Adaptation in the Acadian Forest
Draft

Participants List

CFS - National

Werner Kurz - PFC
Eric Neilson - PFC
Dan McKenney - GLFC
Pierre Bernier - LFC
Martin Girardin - LFC
Rory Gilsenan - Ottawa
Dominique Blain - Ottawa

CFS - AFC

David Gray
Mike Lavigne
Roger Cox
Kevin Porter
Raj Chaini
Yill Sung Park
John Majors

Collaborators

Greg Adams - JDI
Ian Taviss - JDI
Walter Emerich - JDI
Quentin Jackman - Bowater
Jody Jenkins - Acadian Timber
Chris Norfolk - N.B. DNR
Bob Dick - N.B. DNR
Tom Ng, N.B. DNR
Jorg Beyler - N.S. DNR
Robert O'Keefe - N.S. DNR
Mary Myers -PEI DEEF
David Carmicheal - PEI DEEF
Thom Erdle - N.B. Task Force
Dave MacLean - UNB
Fan-Rui Meng - UNB
Keith Deering -Nfld. Forest Service
Ivan Downton - Nfld Forest Service

Facilitators

Joe Thompson - Lead
Bruce Pendrel (Derek MacFarlane)
Bill Anderson
Nairn Hay
Dean Toole

Recorders

Joanne MacDonald
Kathy Beaton
Chris Pitt
Jeanne Moore