Integrated Resource Management in Ecosystems Dominated by High Intensity Fire: Challenges, Tools and Solutions Workshop, **November 8-10, 2000, Edmonton, Alberta**

Fire Behavior *Knowledge* Gaps (& Research Needs) Pertaining to Ecosystem Management

Martin E. (Marty) Alexander, PhD, RPF
Sr. Fire Behavior Research Officer
Canadian Forest Service
Northern Forestry Centre
5320-122 Street
Edmonton, Alberta T6H 3S5
Work Ph: (780) 435-7346; Fax: (780) 435-7359; Home Ph: (780) 417-0244
E-mail: malexand@nrcan.gc.ca

" further major advances in combating wildfire are unlikely to be achieved simply by continued application of the traditional methods. What is required is a more fundamental approach which can be applied at the design stage... *Such an approach requires a detailed understanding of fire behaviour..."* from Drysdale (1985) - Introduction to Fire Dynamics

In preparing this document I've assumed that the reader has as a minimum taken (and passed) the national CIFFC sponsored Advanced Wildland Fire Behavior Course; if one has also taken the Wildland Fire Behavior Specialist Course then all the better!

Although there are many other fire behavior knowledge gaps and research needs that I could list here (e.g., development of models or guidelines for predicting fire vortex generation, plume-dominated or convectively dominated fires and safety zone size/characteristics) here's my "Top 20" list of items pertaining to ecosystem management in no particular order; I considered 20 to be a sufficient number of issues to be addressed and besides it represents the number of players you can have on an NHL game sheet so see if you can think of something that could crack the "roster".

The items listed are largely a reflection of my own opinions and are not based on any survey of fire researchers and fire managers; I am however indebted to comments made by Judi Beck (B.C. Forest Service), Mark Heathcott (Parks Canada) and Rick Lanoville (GNWT Forest Management Division). Bear in mind that my perspective is largely that of someone who has been engaged in outdoor experimental fire behavior research, wildfire case study investigation, and wildfire monitoring/operations as a professional for nearly 25 years, principally in the boreal forest region of Canada but with some experience in Australia, New Zealand and the U.S.

1. Are there changes needed or improvements that can be made in the existing Canadian Forest Fire Behavior Prediction (FBP) System (e.g., foliar moisture content estimation by fuel type, degree of curing function in grassland spread rate models). Can we increase the number of fuel types and fuel characteristics from what is presently recognized in the FBP System? For example, what about shrublands and insect or disease impacted forests (e.g., mountain pine beetle)?

2. What are the changes in flammability with time since last fire in different vegetation types and geographical areas? For example, how soon after a stand-renewing fire can a boreal pine forest in the Yukon support being completely reburned? Is it the same for a boreal pine forest in northeastern Ontario?

3. How much do ground/surface fuels have to be reduced and/or modified in conifer stands to reduce the possibility of crown fire initiation? Can we define the crown fuel bulk density and wind speed thresholds required to sustain continuous crowning so as to specify thinning regimes that limit this characteristic of extreme fire behavior in conifer forests?

4. How much ground/surface fuel should be left on site following timber harvesting to decrease to limit the development of a spreading fire?

5. Are there certain silvicultural practices that result in a significant increase in stand flammability as opposed to lowering it?

6. When is deciduous or hardwood vegetation a deterrent to fire spread and when is it susceptible to high-intensity fire behavior? Conversely, can we identify conifer stands are effectively also firebreaks or fuelbreaks due to their surface fuel characteristics (e.g., lack of appreciable duff or organic layer, "green surface fuel" effect)?

7. How much of the landscape has to be "treated" to a certain standard so as to facilitate fire containment by suppression resources and thereby minimize the potential for conflagrations?

8. What are (or have been) the consequences and resulting impacts, if any, of attempted fire exclusion on the likelihood of major conflagrations in the future? Can we identify those areas that are at high risk of experiencing a catastrophic fire event? In other words, where are we going to have our next Virginia Hills Fire(s)?

9. How can we increase the accuracy and reliability in modelling or extrapolating fire weather elements and the fuel moisture codes of the Canadian Forest Fire Weather Index (FWI) System, especially in mountainous terrain? How can we optimize the location of new, strategically placed weather stations and individual sensors (i.e., for barometric pressure, solar radiation, year-round precipitation and wind speed/direction).

10. What role can remote sensing technologies play in fire danger monitoring, including the determination of snow-free cover start-up dates, "green-up" dates

(e.g., when do you move from FBP System Fuel Type M-l to M-2 or M-3 to M-4) and degree of curing in grasslands? How do we best determine these on a historical basis?

11. Can we develop a fuel moisture and in-stand wind modelling that would allow us the flexibility to extend the FBP System models to fuel situations different from the benchmark fuel types or to analyze the effects of fuel treatments (e.g., thinning) on altering the microclimatic conditions? What about latitude effects on the Fine Fuel Moisture Code component of the FWI System?

12. Given that forecasting wind speed and direction is the most difficult aspect of predicting fire behavior, particularly in complex terrain, what, if anything, can be done to improve the situation for both planning purposes and near-real time use?

13. What is our collective operational knowledge base in Canada with respect to spotting (e.g., maximum distances, spot fire density, ignition potentials)? Assuming that Albini's theoretical models are adequate for predicting maximum spot fire distance, can we expect our existing Lawson et al. probability of sustained flaming ignition models to be suitable for smouldering or non-flaming firebrands?

14. Do current fire growth model simulations account for spotting and breaching of natural or man-made barriers to fire spread? Is fire acceleration and deceleration incorporated into the fire growth models? If not, does this seriously limit the value of any resulting conclusions? Can we realistically expect to predict fire behavior in mountainous terrain or to predict the post-fire mosaic other than in the most rudimentary manner with fire growth models?

15. Are the existing computer-based tools (e.g., RERAP, PFAS), methods and procedures for projecting the growth potential of long-duration fires both adequate and appropriate?

16. Assuming that our existing models are reasonably adequate for predicting the probability of tree mortality following fire (i.e., as a result of lethal crown scorching) or outright tree death (i.e., flame defoliation as a result of crowning) have we got adequate models for predicting surface fire and ground fire residence times for use in predicting tree bole heating, shrub mortality and soil heating or depth of burn and mineral soil exposure?

17. Can we use the Lawson et al. probability of sustained smouldering ignition models to predict ground or sub-surface fire spread and duration?

18. Presently we are able to model the behavior and impact of two very simplistic cases of free-burning fire behavior: a single ignition point and an established line of fire (with no allowance for any interaction between points and/or lines). But what about more complex ignition or firing patterns that are typically used in prescribed burning which involve junction zone effects?

19. How well do we understand what the linkages are between fire behavior characteristics and fire effects let alone be able to model or predict what the biological response is likely to be following fire? [A peer-review journal article by a prominent Canadian fire ecologist in the academic community would suggest that we have very poor understanding – i.e., we have a difficult time separating theory from reality.]

20. Can or should we put wildfire threat analyses and wildland-urban interlace fire hazard assessments on a probabilistic basis (i.e., 0 to 100 scale) so as to increase their objectivity and thus their utility in fire planning?

Fire researchers are generally reluctant to point out the weaknesses in their products for fear that they won't be accepted. Be honest - point out the warts in your work. You don't want to have to explain why you didn't do this in court!

The dream of someday having a physically based fire behavior model that predict for any situation maybe just that, a dream. Such models may not necessarily a panacea for our problems. We commonly encounter a paradox: Some complain that the models and systems aren't accurate enough while others say they are too complicated. Presumably what is needed is crude but reliable predictive aids and guides.

Fire behavior training is readily available (e.g., national courses, Principles of Fire Behavior and FBP System CD-ROMs). Take advantage of what is available and encourage others to do the same.

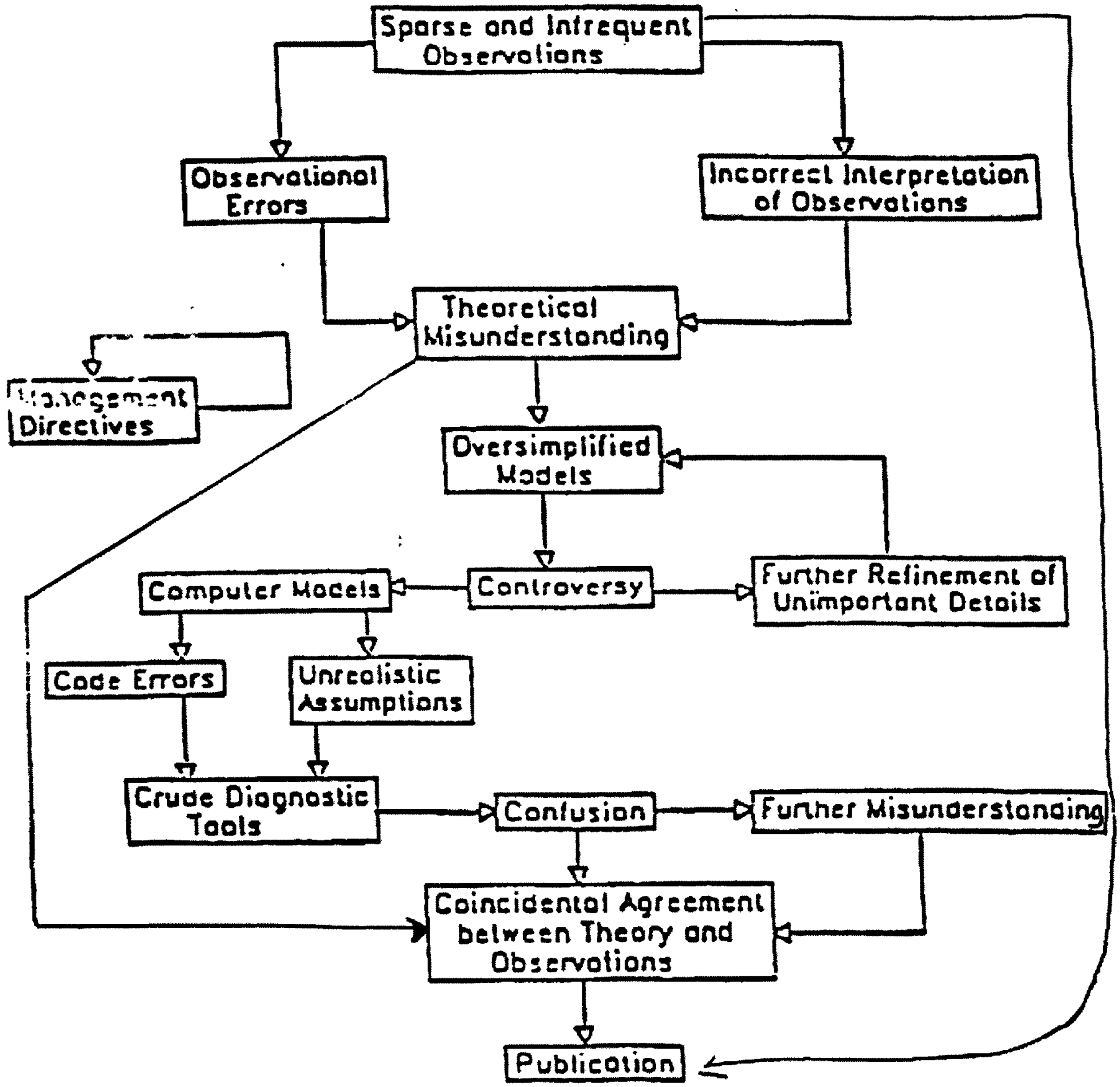
Gotta burn to learn! Seek solutions based on field experimentation. Support research efforts like the International Crown Fire Modelling Experiment both financially and with provision of people to participate.

The appointment of at least one permanent, full-time fire behavior specialist within your organization is a must (minimum). Fire management organizations should consider the establishment of a fire behavior documentation unit for the purpose of formally supplementing new fire behavior knowledge generated by fire research; some issues are simply going to require local solutions/answers (e.g., threshold conditions for reburning). There's enough knowledge gaps to go around and don't expect fire research to solve them all.

Be somewhat cautious of any new fire behavior information/product generated by either fire managers or fire researchers (see attached flow chart "The Course of Fire Behavior Prediction Science?"); those of you who have been through the Wildland Fire Behavior Specialist Course will appreciate this kind of decision trap. Recognize that it is human nature, especially amongst managers with pressure to solve real-world problems, to be looking for "silver bullets". Study and analyze - do you own homework!

Remember that fire behavior prediction will always be both an art and a science. So temper your actions accordingly and don't rely strictly on the results of model outputs for definitive solutions (see attached article "A Modelers Day in Court"). You can have the best model in the world but if you have got a knowledgeable and trained user who can properly use it, what's the point?

The Course of Fire Behavior Prediction Science?



Source of original: some bulletin board in Australia, ca 1990

M.E.A.

MY CHANCE

A Modeler's Day in Court

"Misuse of poor models."

By John J. Garland

Scene: Courtroom of a district judge, a learned jurist especially noted for his natural-resource decisions. A resource professional who is in mid-career stands before the bench.

Judge: I have read the complaints against you. How do you plead? Guilty or not guilty?

Resource Professional (RP): I don't understand what I'm doing here. I was just doing my job!

Judge: You are charged with seven offenses:

- Inappropriately using "models" for your natural-resource decision-making.
- Using these models outside the range of data for which the model was built.
- Using models that have not been validated or thoroughly tested for consistency.
- Failing to identify the assumptions upon which the models were dependent.
- Building your own "model" by picking and choosing relationships out of thin air or based on very little research.
- Overextending the results of these model outputs by making decisions about thousands of acres with models that oversimplify the relationships among natural variation, time, and space.
- Impressing your colleagues with these models to the point where they believe anything you do with a computer must be correct. You misrepresented your intelligence just by speaking computerese. How do you plead?

RP: I'm not guilty. Some of the models I used weren't even mine. They were recommended to me and I didn't understand how they worked. Researchers should have validated those models before they made them available. Besides, it's a matter of policy at my organization to use models. They came from higher up. And about the one I put together I didn't have the time to really do it right. I used the best information available. For the rest, I asked the specialists for their opinions. I was just doing what everybody in the organization was doing.

John J. Garland is timber harvesting Extension specialist in the forest engineering department of Oregon State University, Corvallis.

Judge: These reasons are not sufficient for dismissing the charges. There is substantial evidence against you. Not only did you extend the model decisions to thousands of acres at large financial expense and with adverse effects on the resources, you also never checked to see how these models worked in practice. Instead of getting your boots muddy, you buried your head in the computer and came up with reports, statistics, and graphs to impress supervisors and colleagues. The enormous time spent on dubious models kept you and your organization from decisions incorporating on-site conditions. Misuse of poor models actually prevented better models from being developed.

RP: Nobody ever told me I was doing anything wrong. I did have some questions and concerns, but I had to get the job done.

Judge: That is the essence of the professionalism statutes. [Will it come to regulation of professionalism?] The appropriate use of models and computer technology must be blended with a human system of resource management. Perhaps you should consider a common-sense approach to resource management that includes the following list:

- Identify land-management goals and objectives.
- Determine the compatibility of forest operations and associated best management practices with land-management goals. Resolve conflicts of facts and values in advance of operations.
- Construct a contract for a sale or for services that reflects best management practices.
- Provide training to land managers and contract administrators so their expectations are aligned with actual, reasonable results. Identify potential areas of difficulty for heightened awareness and enforcement actions.
- Train contractors and operators to the level of the "machine operator" in how best management practices are developed and executed.
- Develop an enforcement system with adequate contractual clout and sufficient supervision. Seek ways to reinforce positive actions by contractors with appropriate rewards.
- Develop a system to monitor land management based on important and adequate measurement, not a pseudo-scientific, computer-based approach.
- Provide for auditing of operations and periodic monitoring without advance warning by outside experts.
- Review and revise policies, procedures, and contracts as needed using the best scientific information available.

RP: There seems to be plenty of opportunity for using high technology in that approach.

Judge: Indeed! Good, professional resource management requires that kind of blend. Now in the matter before me....

(The verdict is still pending, but the resource professional is buying a new pair of boots.)

1988. Journal of Forestry 86(4): inside back page/cover.

Alexander, M.E. 2000. Fire behavior knowledge gaps (& research needs) pertaining to ecosystem management. Invited paper presented at the Workshop on Integrated Resource Management in Ecosystems Dominated by High Intensity Fire: Challenges, Tools and Solutions (Nov. 8-10, 2000, Edmonton, AB). 6 p.