Wildland Fire Case Study Development

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Forest Fuels Management Workshop
January 14-16, 2014 – Hinton, AB
Dr. Marty Alexander retired in November 2010 as a Senior Fire Behavior Research Officer with the Canadian Forest Service stationed at the Northern Forestry Centre in Edmonton, Alberta, following 34.5 years of public service. He presently serves as an Adjunct Professor at the University of Alberta. His research and technology transfer efforts have focused on practical applications of wildland fire behavior knowledge, including firefighter safety. He is one of the architects of the Canadian Forest Fire Behavior Prediction System. Marty began his career in wildland fire in the early 70s, serving as a member of the Bighorn inter-regional hotshot crew during the 1972 and 1973 fire seasons. In 2003, Marty received the International Wildland Fire Safety Award and in 2010 was the recipient of the CIF Canadian Forestry Achievement Award. His work over the years has taken him to many parts of the world, including the continental USA and Alaska, Australia, New Zealand, Portugal, Greece, Italy, Fiji, and Turkey, as well as every Canadian province and territory. He has authored over 350 publications, including a recently published book entitled “Fire on Earth: An Introduction” (www.wiley.com/go/scott/fireonearth).

http://www.rr.ualberta.ca/ContactUs/AdjunctProfessors/MartinEAlexander.aspx
Some background information
Making the “Case” for Case Studies
In addition:

- Sat through some 250 Wildland Fire Behaviour Specialist case study presentations during 11 offerings of the course from 1996 to 2012.

- Lecture and presented on the subject at several different venues in the USA, Europe and Canada over the past 10 years.

My latest case study
What is a case study?

A systematic method for looking at events, collecting data, analyzing information, and reporting the results.
Historical Note: The First Wildfire Case Study?

1926 Quartz Creek Fire, Kaniksu National Forest – adjacent to the Priest River Experimental Forest, northern Idaho

Harry T. Gisborne
Pioneer Forest Fire Researcher

Why do we need case studies in the first place?
General Value of Case Studies

“Time and time again case histories have proven their value as training aids and as sources of research data.”

Chandler (1976)
Byram made extensive use of the case study method in his research on blow-up fires.
Empirical and semi-empirical – based fire behavior prediction systems are dependent to some extent on wildfire case study information.
Predictions of Crown Fire Rate of Spread based on Rothermel’s (1991) Model vs. Field Observations
Wildfire case study information forms the basis for a wide variety of approaches to fire training.

- **Sand table exercise**
- **CD-ROM based delivery**
- **Tailgate safety briefing**
- **Traditional classroom lecture**
- **Videos**
“Inquires should be made into all fires as soon as possible after they have been controlled. Even short descriptions of very small fires have a value.

Recording the details of large fires is vital because success in the future depends largely on knowledge gained in the past.”

“Expectations of how a fire should behave are based largely on experience, and to a lesser extent, on fire behaviour guides.”

Burrows (1984)

Case studies also provide a mechanism for formalizing the basis for “experienced judgment”.

Neil D. Burrows
“For what is experienced judgment except opinion based on knowledge required by experience?

If you have fought forest fires in every different fuel type, under all possible different kinds of weather, and if you have remembered exactly what happened in each of these combinations of conditions, your experienced judgment is probably very good.

But if you have not fought all sizes of fires in all kinds of fuel types under all kinds of weather, then your experience does not include knowledge of all the conditions”.

We should be observing/documenting fires and preparing case studies to improve our understanding of wildland fire behaviour and of our fire environments for the safe and effective management of both wildfires and prescribed fires in the future.
What kind of field observations, measurements, and documentation are required for a case study?
Everyone has a photographic memory.
Some just don't have film!
Advanced Wildland Fire Behaviour Course

Unit IV-B: Guidelines for Fire Behaviour Documentation
Supporting Guidance
Stages of Wildfire Observation, Measurement and Documentation

- Detection
- Initial attack
- Later stages of suppression
- After containment
The more important fire behavior characteristics from the practical standpoint of fire suppression are:

- Forward Rate of Spread
- Fire Intensity
- Flame Front Dimensions
- Spotting Pattern (densities & distances)
- Fire Size and Shape
- Rate of Perimeter Increase
- Burn-out Time
Ontario Fire Behavior Information Report Form

### Weather

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<thead>
<tr>
<th>Station</th>
<th>Distance</th>
<th>Direction</th>
</tr>
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<tbody>
<tr>
<td>Onsite: Estimate</td>
<td>Measured</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Station</th>
<th>Onsite</th>
<th>FFMC</th>
<th>DMC</th>
<th>DC</th>
<th>ISI</th>
<th>BUI</th>
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<tr>
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<td></td>
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<tr>
<td>Relative Humidity</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Wind Speed</td>
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<td></td>
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<td></td>
<td></td>
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<td>Wind Direction</td>
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<td>Precipitation</td>
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</table>

<table>
<thead>
<tr>
<th>Cloud Cover</th>
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<th>1-3</th>
<th>3-6</th>
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<table>
<thead>
<tr>
<th>Comments:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Local wind effect on fire:</td>
<td></td>
</tr>
</tbody>
</table>

### Fire Behaviour Observations

<table>
<thead>
<tr>
<th>Time</th>
<th>Estimated time fire began to spread</th>
<th></th>
</tr>
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<tbody>
<tr>
<td>Spread from:</td>
<td>Point source</td>
<td>Line source</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Rate of Spread</th>
<th>Measured</th>
<th>Estimate</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Depth of Burn</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Flame Height</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Scorch Height</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spot Distance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perimeter</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Crownning</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>Triggering Mechanism:</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Comments:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(wind field change, weather, topography...)</td>
<td></td>
</tr>
</tbody>
</table>

### Topography

<table>
<thead>
<tr>
<th>Aspect</th>
<th>N</th>
<th>S</th>
<th>E</th>
<th>W</th>
<th>Slope</th>
<th>Length</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spread Direction:</td>
<td>Up</td>
<td>Down</td>
<td>Angled</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drainage:</td>
<td>Bedrock</td>
<td>Till</td>
<td>Sandy</td>
<td>Clay</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rolling</td>
<td>Ridge</td>
<td>Valley</td>
<td>Basin</td>
<td></td>
<td></td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Comments:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>(location of fire start)</td>
<td></td>
</tr>
</tbody>
</table>
What are the most the important things to observe and record during major fire activity?

• Position of head fire at selected times
• Wind speeds to match the fire spread intervals
• Representative photos (time, location & direction of view relative to fire)

As it turns out these are the most difficult to obtain!
Red Lake 35-61 Fire - Northern Ontario

Fire Progress Map
Fire Environment Observations

Weather
Topography
Fuels
Technological advances in photography, remote sensing and weather monitoring over the years has greatly facilitated matters. However, good representative or site-specific wind readings, for example, are still difficult to obtain.
A wide variety of hand-held anemometers exist

Sims Digital 3-Cup
Height of Lethal Crown Scorching

(Alexander 1998)

Weather Conditions:
31 °C, 12% RH, 10-m
Open Winds 28 km/h, and
37 days since rain

Fuel Type: 19-20 year old
Slash Pine Plantations with
variable stand tending

Head Fire Rate of Spread
during the major run average
22.5 m/min.

Stands with CBD ~ less than
0.13 kg/m³ did not experience
any crowning, although there
was full crown scorch.
The question remains, how will the observations, measurements and documentation be undertaken?

• By a Fire Behaviour Assessment Team dedicated to active, on-site monitoring? *or*

• By a Fire Behavior Assessment Team assigned immediately following a major fire run or following containment? *or*

• By a Fire Behavior Assessment Team that effectively has to “reconstruct” the details long after the event (e.g., in the winter).
How does one go about writing up a case study?
Report Preparation and Documentation

After compiling all the information required to produce a case study report, one must then write it up.

The challenge is to distill the mass of information into a coherent summary.
There is a great deal of variance in size of case study reports.

Hayman Fire Case Study
Russell T. Graham, Technical Editor

~300 pages

Fire Technology Transfer Note
Number - 5
December 1994

Wildfire Behaviour Case Study of the 1986 Awamoa Wetlands Fire

by H.G. Prentice, R.F. Morgan and M.E. Alexander

One might be quick to suspect that there is very little relationship between wetland and wildland fires, yet many natural-plant communities in these ecosystems are exceedingly flammable despite the fact that they may be associated with wild fire climates. A case in point is the human-created wildfire that occurred in wetland associated with the Awamoa Plains (relatively low shrub, some 15 km southwest of Invercargill) on the South Island of New Zealand during the previous summer (1986). The damaged area was totally closed for two days to the public due to the fire's proximity to national parks. The fire's origin was set on or before the 1st of August, and was made worse by a strong northerly wind. The fire was finally contained 4 days later, as the fireplume was blown into the wetland vegetation provides habitat for the endangered Carnivorous. The other potential value-risk were the water lines leading to the nearby Carnivorous NZ Aluminium smelter plant, a disruption in the power supply would have caused a financial calamity.

The major run of the fire took place under moderate cool ambient temperatures (12°C), relatively high humidities (75-82%), and nearby overcast skies, but exceeding strong surface winds (45-50 km/h) (Table 1) occurred as a result of an anticyclone to the west of New Zealand and an intense low-pressure system southeast of the country (Fig. 3). The 1 pm NZST upper-air sounding at Invercargill revealed a region of dry air above 400 m MSL, but also a "jet point" or wind maximum at 2200 m MSL, although the shape and angle of the fire's smoke column was not particularly that of a classic wind-driven conflagration.

1 This Fire Technology Transfer Note (FTTN) is based largely on a poster paper entitled "Wildfire Behaviour in a New Zealand Wetland: A Case Study" as presented at the 19th Tall Timbers Fire Ecology Conference - JUNE 21-24, 1993 - MANAGEMENT PERSPECTIVES that was held from 3-6 November 1993 in Tallahassee, Florida. The text of this FTTN constitutes the abstract for the poster paper that will appear in the conference proceedings to be published early in 1995 by the Tall Timbers Research Station, Tallahassee, Florida. The copious assistance of L.G. Perry of the New Zealand Forest Research Institute in the preparation of this wildfire behavior case study is gratefully acknowledged.

2 Department of Conservation, Southland Conservation, Invercargill, New Zealand.

3 Canadian Forest Service, Northern Forestry Centre, Edmonton, Alberta.
Suggested Outline for Preparing a Case Study Report Used in the Wildland Fire Behaviour Specialist Course*

• Introduction
• Chronology & Development
• Details of Fire Environment
• Analysis of Fire Behavior
• Conclusion

Might possibly add an appendix or two.
Suggested Outline for Preparing a Wildland Fire Behavior Case Study Report

These guidelines are based in part on those originally prepared by M.E. Alexander for use in three advanced fire behavior courses sponsored by the National Rural Fire Authority in New Zealand in 1992–93. The guidelines were subsequently used in six wildland fire behavior specialist courses sponsored by the Canadian Interagency Forest Fire Centre in Hinton, Alberta, in 1996–2001.

1. Introduction: Significance of the fire, including regional map with fire location.

2. Fire Chronology and Development: Cause; time of origin and/or detection; initial attack action; forward spread and perimeter growth; fire characteristics, such as spotting distances and crowning.

3. Details of the Fire Environment:
   - Topography—Review major features; include topographic map and photos, if pertinent.
   - Fuels—Describe the principal fuel type(s); include a vegetation cover type map and any photos, if possible.
   - Fire Weather—Describe prefire weather as appropriate; summarize synoptic weather features and include surface map; present daily fire weather observations; present fire danger ratings, including drought indexes, and append monthly fire weather record form; present hourly weather observations, if relevant; denote location of weather station(s) on regional map or fire progress map and comment on the relevance of the readings to the fire area, including notes about the station’s instrumentation.

4. Analysis of Fire Behavior: For example, discuss the fire’s behavior in relation to the characteristics of the fire environment and the success/failure of the suppression operations.

5. Concluding Remarks: For example, what did you learn about predicting fire behavior and fire behavior documentation from this assignment?

*Detailed work on fuel characteristics (e.g., amounts by fuel complex strata, moisture content of live fuels) will depend on the situation and the specific need. Generalizations are often satisfactory for most purposes.

**It is a good idea to cultivate a long-term relationship with your local fire weather meteorologist/forecaster and seek their assistance as a cooperator.
Example of a 1-(or 2-) pager:
Cranbrook #6-1985 Fire, B.C.

From McAlpine, Stocks, Van Wagner, Alexander and Lynham (1990)
Some Tips
(from Alexander and Thomas 2003)

Motivation – take a professional attitude

Your Standard is Too High – keep it simple

Organization – be prepared

Information Overload – decide on which model you are looking to evaluate and what the input requirements are

“Peer Review” – by colleagues and researchers
Publication Mediums

Popular Journal Article (e.g., *Fire Management Today*)

Research Agency Report (e.g., USDA Forest Service Research Station)

Operational Agency Report (e.g., USDA Forest Service Region)

Science Journal (e.g., *International Journal of Wildland Fire*)
Canadian Examples

2009 Fuel Management Success Stories

Glenrosa-West Kelowna Fire K50739 303.3 ha 2009

Fire Chronology & Behaviour

Saturday July 18 2009, at 14:44 a fire was reported up on a hillside near Gorman Brothers Sawmill in Glenrosa.

By 14:53 the fire was reported to have reached 4 hectares and was exhibiting rank 4 fire behaviour. Within 10 minutes the fire was reported to be Rank 6 in heavy C7 fuel type, and was an interface fire, as houses and a sawmill were in danger. By 15:35 there was a report of 1 house being consumed, and by 15:43, 2 homes were affected and homes were being evacuated.

At 19:00 the fire was reported to have reached Glenrosa Road to the north east, with minor spotting across that road. The fire had also reached the Gorman Brothers Mill and some of the decked timber had become involved. Fifteen minutes later the fire had jumped highway 97 to the east and was exhibiting rank 4 fire behaviour, at an approximate size of 70 hectares. It was headed towards homes, a sewage treatment plant and the Gellatly Heritage Regional Park. An hour later the fire was reported to have traveled 1.3 km, this equates to a rate of spread of 21 meters per minute. The east flank was near the marina and water treatment facility which is adjacent to Gellatly Heritage Regional Park. Several structures were threatened at this time.

Weather

Weather data was collected from the most representative Forest Service weather station which was FINTRY (located North of Glenrosa on Okanagan Lake with the same aspect and terrain as the fire site). The last precipitation prior to the fire was recorded on July 10th measuring 3.6 mm however the following day the temperature rose up to 29.1 and the FFMC went back up into the 90's for the next week.

Chisholm Dogrib Fire Research Initiative

Quicknote # 3

October 2003 By: Ember Research Services Ltd

Aspen stands stop fires, don’t they?

Introduction

Recent spring wildfires in Alberta seem to be challenging the wisdom that deciduous forest types like aspen make good firebreaks for community fire protection and for reducing fire risk to commercial forests at a landscape scale.

What is going on that the 2001 Chisholm Fire and 2002 House River Fire can grow so large (over 100 000 hectares and 250 000 ha, respectively) when lots of aspen stands were present to act as firebreaks? Do aspen stands actually “crown”?

Chisholm Fire Study

Foothills Model Forest supported a study of fire behaviour in aspen stands of different fire histories and fuel loads on the 2001 Chisholm fire, in order to help community protection planners and forest managers to understand better the effectiveness and limitations of aspen as a firebreak under severe spring burning conditions.

The study included the re-measurement of re-burned fire behaviour research plots from the 1970s and the evaluation of the re-burn of a 1968 wildfire, in which the Chisholm Fire stopped.

What we found

Estimated fire intensities on re-burned aspen research plots from the 1970s exceeded 200 000 kW/m, while intensities in aspen stands that regenerated after the 1968 Vega wildfire were only 10% of that, because fuel consumption estimates were much lower on the Vega Fire re-burn.

For more information on this Quicknote, please contact: Bruce Lawson, Ember Research Services Ltd. (260) 478-2656, or visit www.fmtna.ab.ca
Welcome to the Fire Behaviour Knowledge Base Web Site. The FBKB is a joint project of the Ontario Ministry of Natural Resources, the Canadian Forest Service and the University of Toronto.

The FBKB is a searchable database of wildland fire behaviour observations. The purpose is to allow fire behaviour analysts to describe a fuel complex, search through the observation database and review field fire behavior observations from similar fuel situations.

Users can also record their own observations of fire behaviour (fuels, weather, and resulting fire behavior) building their own private database, and then submit that back to us and we will then include it in the master database. In that way the master database continually grows and users can continually download updated versions, allowing access to the current state of the knowledge for fire behaviour prediction.
Operational prescribed fires can also be used as opportunities to observe and document free-burning fire behaviour.
ICFME Treated/Untreated Plot - June 14, 2000

At end of Treated half (note "prune line")

At end of Untreated half

Fire in progress
Take-home Messages

• Seek to learn more about the case study method.
• Consider how you might best considering doing a case study in your position.
• Encourage your colleagues and co-workers to consider doing a case study.
• Make it a personal goal to try and complete a case study every year.
• Recognize that regardless of what field of wildland fire you are in, that the understanding of wildland fire behavior is key to safe and effectiveness control or use of planned or accidental fires.
Thank you for your attention! Questions? Comments?

mea2@telus.net
Postscripts
Summary Comments

If wildfires are expected to be used to judge the effectiveness of fuel treatments in the future, then the effort that goes into developing a case study will need to be considerably more rigorous than has been the situation to date in Canada.

There will be the need to have specific fire behaviour assessment teams to undertake the bulk of the work (i.e., by active, on-site monitoring or assigned immediately following a major fire run/containment).

Fire management organizations should expect to expend considerable in documenting pre-fire fuel conditions and degree of fuel consumption.
Suggested Readings on Wildland Fire Case Studies*


*For Fire Management Today articles go to: http://www.fs.fed.us/fire/fmt/