JFSP
Crown Fire Behavior Synthesis Project

Nicole Vaillant
USDA Forest Service - PNW

Marty Alexander
University of Alberta

Miguel Cruz
CSRIO Bushfire Dynamics & Applications

David Peterson
USDA Forest Service - PNW

As for big fires in the early history of the Forest Service, a young ranger made himself famous by answering the big question on an exam, “What would you do to control a crown fire?” with the one-liner, “Get out of the way and pray like hell for rain.”

Maclean (1992)
In October 2009, a 3-year project supported by the Joint Fire Science Program was initiated that aims to synthesize the currently available information on crown fire behavior in conifer forests (e.g., the onset of crowning, type of crown fire and the associated spread rate and fireline intensity).
Project Team Members

Marty Alexander, University of Alberta, Edmonton, Alberta

Miguel Cruz, CSIRO Bushfire Dynamics & Applications, Canberra, Australia

Nicole Vaillant, USDA Forest Service, Western Wildland Environmental Threat Assessment Center, Sparks, Nevada

Dave Peterson, USDA Forest Service, Pacific Wildland Fire Sciences Laboratory, Seattle, Washington
A critical synthesis on crown fire behavior must rest upon as solid a foundation of knowledge as is possible at this time.

A sufficient body of scientific, peer-reviewed and technical literature of a practical nature does in fact presently exist to be able undertake a synthesis on crown fire behavior.
A SYNTHESIS ON CROWN FIRES IN CONIFER FORESTS IS UNDERWAY

Martin E. Alexander

The Joint Fire Science Program (JFSP) has elected to support a project aimed at synthesising the currently available information on the characteristics and prediction of crown fire behavior in conifer forests (Alexander and others 2010). The project will include such facets of crown fire behavior as the onset of crowning and the type of crown fire (passive, active, independent), and the associated spread rate and flame intensity in relation to the wildland fire environment (i.e., fuels, weather, and topography).

While the focus is on North American forests, the synthesis is intended to be global in nature and is intended for multiple audiences ranging from the general public to college students, fire and land managers, university professors, and researchers.

In addition to summarizing the existing scientific and technical literature on crown fires and related experiences as well as still pictures and video footage.

We are interested in hearing from you, the wildland fire community, as to your opinions on the subject.

JFSP Crown Fire Synthesis Project Members

Dr. Martin E. Alexander, Adjunct Professor, University of Alberta, Department of Renewable Resources and Alberta School of Forest Science and Management, Edmonton, Alberta, Canada (mec@ualberta.ca).

Dr. Nicole M. Vaillant, Fire Ecologist, Forest Service, Pacific Northwest Research Station, Western Wildland Environmental Threat Assessment Center, Sparks, NV (vaillantn@fs.fed.us).

Dr. David L. Peterson, Biological Ecologist, Forest Service, Pacific Northwest Research Station, Western Wildland Environmental Threat Assessment Center, Sparks, NV (petersond@fs.fed.us).

In October 2006, a Synop project supported by the Joint Fire Science Program was initiated that aims to synthesize the currently available information on crown fire behavior in conifer forests.

While the focus is on the coniferous forests of the United States and adjacent areas of Canada, the synthesis is intended to be global in nature and is intended for multiple audiences ranging from the general public to college students, fire and land managers, university professors, and other researchers.

Information from all regions of the world would be appreciated, including Mexico, South America, Australia, Europe, Central and South America, Europe and Asia.

We are interested in hearing from you, the wildland fire community, as to your opinions on the subject.

To keep up to date on the crown fire synthesis project periodically visit our website:


Lastly, we are interested in hearing from you — the “real user” — as to your opinions on the subject of crown fires and any specific questions and/or research needs/research gaps that you would like to see addressed in this crown fire synthesis project.

CROWN FIRES IN CONIFER FORESTS OF THE WORLD: Do you have something to contribute or would like to know about something?

M.G. Cruz, M.E. Alexander, N.M. Vaillant & D.L. Peterson

In October 2006, a Synop project supported by the Joint Fire Science Program was initiated that aims to synthesize the currently available information on crown fire behavior in conifer forests.

While the focus is on the coniferous forests of the United States and adjacent areas of Canada, the synthesis is intended to be global in nature and is intended for multiple audiences ranging from the general public to college students, fire and land managers, university professors, and other researchers.

Information from all regions of the world would be appreciated, including Mexico, South America, Australia, Europe, Central and South America, Europe and Asia.

We are interested in hearing from you, the wildland fire community, as to your opinions on the subject.

To keep up to date on the crown fire synthesis project periodically visit our website:


Lastly, we are interested in hearing from you — the “real user” — as to your opinions on the subject of crown fires and any specific questions and/or research needs/research gaps that you would like to see addressed in this crown fire synthesis project.

Getting the word out
Throughout the process there has been liaison and dialogue with:

Conference calls and a in person meeting. Progress reports and provided documents. E-mails. Reviews by FBSC members.
In addition to summarizing the existing scientific and technical literature on crown fires, project members are also seeking assistance from individuals in the form of field observations of crown fires and related experiences as well as still pictures and video footage.
Finally, we are interested in hearing from you -- the “end user” -- as to your opinions on the subject of crown fires and any specific questions and/or research needs/knowledge gaps that you would like to see addressed in this crown fire synthesis project. For example:

*What fuel-weather combinations are required to produce a propagating crown fire in northern flatwood forests?* – Rodney W. Sando *et al.* (1970)
Another example: In a fire ecology survey of land managers and environmental scientists in western North America conducted in the early 70s, several questions were raised that dealt with aspects of crown fire potential:
Will fire in a thinned stand tend to stay on the ground as opposed to crowning? What are the effects of various spacings? What spacing inhibits spread of [crown] fire?

How many tons/acre of fuel are required to support a crown fire in ponderosa pine and in mixed conifer forest in the Southwest?

What stand and crown density is required to carry a fire in standing pinon-juniper stands?
Over 6,000 invitations sent out to join the Neighborhood.
Independent Crown Fire

“The crown phase will ... No longer depend in any way on the surface phase and can run ahead on its own.” – Van Wagner (1977)

• Is this possible, have you seen it?
• Long term or short term phenomena?
• Crowning over snow or rock slide

Adapted from Brown and Davis (1973)
The possibility exists for a stand to support an active crown fire that would otherwise not initiate a crown fire (Scott and Reinhardt 2001).

- Relatively high CBH and CBD where CI < TI.
- More extreme conditions (of wind and fuel moisture) are required to initiate crown fire than to maintain active crown fire.
What causes crown fires to stop?

• Major change in fuel type,
• Wind changes (speed or direction),
• Moisture differential,
• Combination,
• Other factors ??
Topical Issue #4

Spot Fire Distances

> 2 miles from Active Crown Fires

Spot fire
Open Discussion

#1 Independent Crown Fire

#2 Conditional Crown Fire

#3 Crown Fire Cessation

#4 Spot Fire Distances
> 2 miles from Active Crown Fires
Interim Products:
Review of “Crown Fire” Content in ‘S’ Fire Behavior Courses (190, 290, 390 & 490)

Introduction to Wildland Fire Behavior
S-190

Intermediate Wildland Fire Behavior
S-290

Introduction to Wildland Fire Behavior Calculations
S-390

S-490
Advanced Wildland Fire Behavior Calculations
Instructor Guide
SEPTEMBER 2000

Instructor Guide
MONTH 2002

DRAFT
NFES 0000

NFES 2900

NFES 2930

NFES 001770

Instructor Guide
AUGUST 2010
Cruz, Alexander and Wakimoto (2003)
Canopy Fuel Stratum Characteristics Calculator
Version 1.0 - February 2010

Inputs:
Step 1: Select Unit System
   SI
Step 2: Select Fuel Type
   Ponderosa pine
Step 3: Input Stand Basal Area (m²/ha)
   25
Step 4: Input Average Stand Height (m)
   15
Step 5: Input Stand Density (trees/ha)
   1000

Outputs:
Canopy Base Height (m)
   7.3
Canopy Fuel Load (kg/m²)
   0.95
Canopy Bulk Density (kg/m³)
   0.29
Interim Products (cont.)

Volume II chapter on crown fires has been completed and reviewed
Interim Products (cont.): Peer-reviewed publications

• Cruz MG & Alexander ME. 2012. Evaluating regression model estimates of canopy fuel stratum characteristics in four crown fire-prone fuel types in western North America. Int. J. Wildland Fire - available online

• Alexander ME & Cruz MG. 2012. Interdependencies between flame length and fireline intensity in predicting crown fire initiation and crown scorch height. Int. J. Wildland Fire - available online

• Albini FA, Alexander ME & Cruz MG. In press. A mathematical model for predicting the maximum potential spotting distance from a crown fire. Int. J. Wildland Fire - accepted, not available yet

• Alexander ME & Cruz MG. In press. Modelling the impacts of surface and crown fire behavior on serotinous cone opening in jack pine and lodgepole pine forests. Int. J. Wildland Fire - accepted, not available yet

• Alexander ME & Cruz MG. Assessing the effect of foliar moisture on the spread rate of crown fires. Submitted to the Int. J. Wildland Fire, Jan. 2012
Evaluating regression model estimates of canopy fuel stratum characteristics in four crown fire-prone fuel types in western North America.

Evaluation of the Cruz et al. 2003 regression equations to predict CBH, CBD & CFL from stand characteristics.

Comparison to original data treated and independent PP data set.

Observed vs. expected CBD for 16 PP stands in the Black Hills, SD.
Interdependencies between flame length and fireline intensity in predicting crown fire initiation and crown scorch height.

State-of-knowledge review of the assumptions and limitations associated with

• fireline intensity,
• flame length,
• char height, and
• crown scorch height relationships.

Comparison of FI – FL relationships for various models and fuel types
A mathematical model for predicting the maximum potential spotting distance from a crown fire.

Model inputs
- Flame height above canopy
- Windspeed at top of canopy
- Firebrand size

Spotting distances for different fuel types under specific conditions
Modelling the impacts of surface and crown fire behavior on serotinous cone opening in jack pine and lodgepole pine forests.

Rate of spread, fuel consumption and fireline intensity can be used to define thresholds for opening serotinous cones and release of seed in JP & LP.

Fireline intensity class

I – low intensity surface fire, no crown scorch, no cone opening
II – mod intensity surface fire, part to full crown scorch, no cone opening
III – high intensity surface fire, full crown scorch, cone opening via convective & radiative heating
IV – crown fire, defoliation of crown, cone opening & charring via flame contact
Assessing the effect of foliar moisture on the spread rate of crown fires.

Relative effects of moisture on rate of spread for a) normal and b) extreme range of moisture
End Products

- Book (including a multi-media DVD featuring video imagery and other supporting documentation) pattern after “Grassfires”
  - Text to be completed fall of 2012.
  - Publication of book not likely until late 2013.
  - Patterned after Australian grass fire behavior book.
End Products (cont.)

- Special issue of *Fire Management Today* that will summarize the content of the book.

Looking at early 2013 for publication.
Crown Fire Behavior Synthesis
Project website