Crown fires in conifer forests of the world: Do you have something to contribute or would you like to know about something?

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Abstract

This paper provides a brief overview and progress report of the U.S. Joint Fire Science Program (JFSP) sponsored project "Crown Fire Behavior Characteristics and Prediction in Conifer Forests: A State-of-Knowledge Synthesis" (JFSP 09-S-03-1). To learn more, visit the project website (http://www.fs.fed.us/wwetac/projects/alexander.html).

Keywords: crown fire initiation, crown fire phenomenology, crown fire potential, crown fire rate of spread, crowning, extreme fire behavior, knowledge gaps, research needs.

1. INTRODUCTION

The current edition of the U.S. National Wildfire Coordinating Group (2011) glossary indicates that extreme fire behavior involves "A level of fire behavior characteristics that ordinarily precludes methods of direct control action. One or more of the following is usually involved: high rate of spread, prolific crowning and/or spotting, presence of fire whirls, strong convection column. Predictability is difficult because such fires often exercise some degree of influence on their environment and behave erratically, sometimes dangerously."

In conifer forests at least, the onset of crowning, the type of crown fire and the associated spread rate and fireline intensity (Figure 1) are integral to extreme fire behavior because they dictate the potential for other related phenomena (e.g., medium- and long-range spotting, the type of convection column development, and various types of fire-induced vortices).

In October 2009, a 3-year project supported by the U.S. Joint Fire Science Program (http://www.firescience.gov/) was initiated that aims to synthesize the currently available information on crown fire behavior in conifer forests in relation to the wildland fire environment – i.e., fuels, weather and topography (Alexander 2011a).

This paper provides an overview of the project as well as a progress report. In addition to the authors of this paper, the project team also includes David L. Peterson, USDA Forest Service, Pacific Northwest Research Station, Pacific Wildland Fire Sciences Laboratory.

*Figure 1. Variations in fire behavior within the jack pine (*Pinus banksiana*) – black spruce (*Picea mariana*) fuel complex found in the International Crown Fire Modelling Experiment study area near Fort Providence, Northwest Territories, Canada (Stocks et al. 2004): surface fire, passive or intermittent crown fire, and active or fully-developed crown fire. Photos by M.G. Cruz.*

2. FOCUS, GEOGRAPHICAL SCOPE AND AUDIENCE

Although the focus of the project is on the coniferous forests of the United States and adjacent areas of Canada, the synthesis is intended to be global in nature (Alexander 2011b) and is intended for multiple audiences including the general public to college students, fire and land managers, and university professors and other researchers.

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.

In addition to summarizing the existing scientific and technical literature on the subject, project team members are also actively seeking assistance from individuals in the form of field observations of crown fires and related experiences as well as still pictures (Figures 2 and 3) and video footage in both natural forest stands and industrial plantations. Information from all regions of the world would be appreciated and is actively sought, including Mexico, South Africa, Australasia, Europe, Central and South America, and Asia.

*Figure 2. Active crowning associated with the major run of the Bilo Road Fire in New South Wales, Australia, on 10 December 2006 as described by Cruz and Plucinski (2007). The stand height of this 15-year-old radiata pine (*Pinus radiata*) fuel complex is ~18 m. Photo by S. Cathcart, National Parks and Wildlife Service of New South Wales.*

3. SOLICITING YOUR INPUT

We are interested in hearing your opinion on the subject of crown fires and any specific questions and/or research needs and knowledge gaps that you would like to see addressed or discussed as part of the crown fire synthesis project (Alexander *et al.* 2010). The Forest Fire Management Group (2007) of Australia for example has done an excellent job of enunciating their concerns regarding the implications of crown fires in softwood plantations. To share your knowledge and ideas with us, join our My Fire Community Neighborhood (http://www.myfirecommunity.net/Neighborhood.aspx?ID=816).

4. ACCOMPLISHMENTS TO-DATE

Several interim publications have now been produced (Alexander and Cruz 2011a, 2011b, 2012a, 2012b; Cruz and Alexander 2012). Several other journal articles have been accepted for publication, and an expanded version of Alexander and Cruz (2011b) will appear in print later in 2012.

Three additional manuscripts have also been accepted for publication:

Albini, F.A., Alexander, M.E., Cruz, M.G. *A mathematical model for predicting the maximum potential spotting distance from a crown fire.* International Journal of Wildland Fire.

Alexander, M.E., Cruz, M.G. *Modelling the impacts of surface and crown fire behaviour on serotinous cone opening in jack pine and lodgepole pine forests.* International Journal of Wildland Fire.

Jenkins, M.J., Page, W.G., Hebertson, E.G., Alexander, M.E. *Fuels and fire behavior dynamics in bark-beetle attacked forests in western North America and implications for fire management. Forest Ecology and Management.*

A "Volume 2" companion to Alexander and Cruz (2011b) for fire behaviour specialists, fire researchers and fire weather meteorologists is scheduled for publication later in 2012. A manuscript entitled "Assessing the Effect of Foliar moisture on the Spread Rate of Crown Fires" and intended for a scientific journal is also currently under review. A software tool in support of the Cruz *et al.* (2003) canopy fuel prediction models has also been developed (Alexander and Cruz 2010); visit http://www.frames.gov/cfis to download a copy.

5. THE FINAL PRODUCTS

It is presently envisioned that the final products of the synthesis will consist of a book patterned after Cheney and Sullivan (2008) and a special issue of *Fire Management Today*. These are not likely to available in print until mid 2013.

*Figure 3. Flame front associated with a crown fire spreading through a young maritime pine (*Pinus pinaster*) stand in the Pampihosa da Serra region of central Portugal on August 18, 2005. The stand height is ~10 m. Photo by M.G. Cruz.*

6. FOR FURTHER INFORMATION

We have created a project website (http://www.fs.fed.us/wwetac/projects/alexander.html). You will find additional information on the project there, including publications and other products produced as part of project activities.

7. ACKNOWLEDGMENT

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8. REFERENCES

Alexander, M.E., 2011a. *A synthesis on crown fires in conifer forests in underway.* Fire Management Today, 71(1), 36.

Alexander, M.E., 2011b. *A global look at crown fires in conifer forests*. Wildfire, 20(2), 9.

Alexander, M.E., Cruz, M.G., 2010. *Introducing the Canopy Fuel Stratum Characteristics Calculator*. In: D.D. Wade and M.L. Robinson (eds.). Proceedings of 3rd Fire Behavior and Fuels Conference, 25-29 October 2010, Spokane, Washington. (CD-ROM) International Association of Wildland Fire, Birmingham, Alabama. 6 p.

Alexander, M.E., Cruz, M.G. 2011a., *What are the safety implications of crown fires?* In: R.L. Fox (ed.). Proceedings of the 11th International Wildland Fire Safety Summit, 4-8 April 2011, Missoula, Montana. International Association of Wildland Fire, Missoula, MT. CD-ROM. 16 p.

Alexander, M.E., Cruz, M.G., 2011b. *Crown fire dynamics in conifer forests.* In: Synthesis of Knowledge of Extreme Fire Behavior: Volume 1 for Fire Managers. pp. 107-142. USDA Forest Service, Pacific Northwest Res. Station, Portland, Oregon. General Technical Report PNW-GTR-854.

Alexander, M.E., Cruz, M.G., 2012a. *Interdependencies between flame length and fireline intensity in predicting crown fire initiation and crown scorch height.* International Journal of Wildland Fire, 21, 95-113.

Alexander, M.E., Cruz, M.G., 2012b. *Graphical aids for visualizing Byram's fireline intensity in relation to flame length and crown scorch height.* Forestry Chronicle, 88, 185-190.

Alexander, M.E., Cruz, M.G., Vaillant, N.M., Peterson, D.L., 2010. *Towards a crown fire synthesis: what would you like to know and what might you be able to contribute?*. In: D.D. Wade and M.L. Robinson (eds.). Proceedings of 3rd Fire Behavior and Fuels Conference, 25-29 October 2010, Spokane, Washington. (CD-ROM) International Association of Wildland Fire, Birmingham, Alabama. 6 p.

Cheney, P., Sullivan, A., 2008. *Grassfires: fuel, weather and fire behaviour.* 2nd edition. CSIRO Publishing, Collingwood, Victoria, Australia. 150 p.

Cruz, M.G., Alexander, M.E., 2012. *Evaluating regression model estimates of canopy fuel stratum characteristics in four crown fire prone fuel types in western North America.* International Journal of Wildland Fire, 21, 168-179.

Cruz, M.G., Alexander, M.E., Wakimoto, R.H., 2003. *Assessing canopy fuel stratum characteristics in crown fire prone fuel types in western North America.* International Journal of Wildland Fire, 12, 39-50.

Cruz, M.G., Plucinski, M.P., 2007. *Billo Road Fire – report on fire behaviour phenomena and suppression activities*. Bushfire Cooperative Research Centre, East Melbourne, Victoria, Australia. Report No. A.07.02. 96 p.

Forest Fire Management Group, 2007. *Softwood plantation fire synopsis.* Primary Industry Ministerial Council, Forestry and Forest Products Committee, Canberra, Australian Capital Territory. 106 p.

National Wildfire Coordinating Group, 2011. *Glossary of wildland fire terminology.* National Fire Equipment System, Boise, Idaho. Publication PMS 205. 185 p. [see also: http://www.nwcg.gov/pms/pubs/glossary/index.htm]

Stocks, B.J., Alexander, M.E., Lanoville, R.A., 2004. *Overview of the International Crown Fire Modelling Experiment (ICFME).* Canadian Journal of Forest Research, 34: 1543-1547.

Alexander, M.E.; Cruz, M.G.; Vaillant, N.M. 2012. Crown fires in conifer forests of the world: Do you have something to contribute or would you like to know about something? Pages 160-165. in D. Spano, V. Bacciu, M. Salis and C. Sirca, eds. Modelling Fire Behaviour and Risk. University of Sassari, Italy.