



Another Look at the Little Ice Age

Author(s): Yves Bergeron, Mike Flannigan, David W. Schindler

Source: *BioScience*, Vol. 48, No. 11, (Nov., 1998), pp. 884-885

Published by: American Institute of Biological Sciences

Stable URL: <http://www.jstor.org/stable/1313289>

Accessed: 24/07/2008 16:36

---

Your use of the JSTOR archive indicates your acceptance of JSTOR's Terms and Conditions of Use, available at <http://www.jstor.org/page/info/about/policies/terms.jsp>. JSTOR's Terms and Conditions of Use provides, in part, that unless you have obtained prior permission, you may not download an entire issue of a journal or multiple copies of articles, and you may use content in the JSTOR archive only for your personal, non-commercial use.

Please contact the publisher regarding any further use of this work. Publisher contact information may be obtained at <http://www.jstor.org/action/showPublisher?publisherCode=aibs>.

Each copy of any part of a JSTOR transmission must contain the same copyright notice that appears on the screen or printed page of such transmission.

---

JSTOR is a not-for-profit organization founded in 1995 to build trusted digital archives for scholarship. We work with the scholarly community to preserve their work and the materials they rely upon, and to build a common research platform that promotes the discovery and use of these resources. For more information about JSTOR, please contact [support@jstor.org](mailto:support@jstor.org).

## ANOTHER LOOK AT THE LITTLE ICE AGE

In a recent issue of *BioScience*, David Schindler presents an apocalyptic view of the future of boreal forests in his article "A Dim View for Boreal Waters and Landscapes" (*BioScience* 47: 157–164). He suggests that climate warming has resulted in increased forest fire activity and reduced lake levels in Ontario's boreal forest and implies that this scenario is applicable to the North America boreal forest.

However, our own research indicates that there is a large regional variation in the response of fire activity and lake levels to climate warming. Contrary to what is portrayed by Schindler for northwestern Ontario, the warming after the end of the Little Ice Age (c. 1850) in Québec's boreal forest has led to a decrease in forest fire activity (Bergeron and Archambault 1993) and an increase in lake water levels (Bégin and Payette 1988, Tardif and Bergeron 1997).

Schindler argues that climatic warming implies an increase in temperature, which in itself may cause an increase in fire activity as well as increased evapotranspiration and lake level decline. However, increased temperature is often associated with an increase in precipitation that often can more than compensate for the effect of increased temperature on the water balance. Our work strongly suggests that decreased forest fire activity and increased lake levels in Québec's boreal forest are related to a more positive water balance since the post-Little Ice Age warming began.

This interpretation has been confirmed by simulations of the Fire Weather Index (FWI) for a doubling of carbon dioxide scenario using a general circulation model (GCM;

Bergeron and Flannigan 1995). The FWI integrates weather variables that control fire intensity and spread and is inversely related to the water balance. Simulations showed that except for Central Canada, where the FWI might increase significantly, most of the boreal forest would be characterized by a decreased or unchanged maximum or mean FWI. In a recent study (Flannigan et al. in press), we were able to show that historical frequency of forest fires observed in the Canadian boreal forest was indeed what was predicted by the GCMs. Although we tend to agree with Schindler that boreal forests are threatened, we think that the scientific arguments on climatic warming developed in his article do not properly take into account large regional differences in the climate and in the response of the ecosystem to changes in the climate.

YVES BERGERON  
*Groupe de recherche en écologie  
forestière  
Université du Québec à Montréal  
Montréal, Québec H3C 3P8  
Canada*

MIKE FLANNIGAN  
*Canadian Forest Service  
5320 - 122 St  
Edmonton, Alberta T6H 3S5  
Canada*

### References cited

- Bégin Y, Payette S. 1988. Dendroecological evidence of lake-level changes during the last three centuries in subarctic Québec. *Quaternary Research* 30: 210–220.
- Bergeron Y, Archambault S. 1993. Decreasing frequency of forest fires in the southern boreal zone of Québec and its relation to global warming since the end of the 'Little Ice Age.' *The Holocene* 3: 255–259.
- Bergeron Y, Flannigan MD 1995. Predicting the effects of climate change on fire frequency in the southeastern Canadian boreal forest. *Water, Air and Soil Pollution* 82: 437–444.
- Flannigan MD, Bergeron Y, Engelmark O, Wotton BM. In press. Future wildfire in the northern forests: Less than global

warming would suggest? *Journal of Vegetation Science*.

Tardif J, Bergeron Y. 1997. Ice–flood history reconstructed with tree rings from the southern boreal forest limit, western Québec. *The Holocene* 7: 291–300.

**Response:** I am familiar with the fine paleoecological studies of Bergeron and his colleagues and with their conclusions about past climates. They are quite right about past records for climate in the eastern boreal. Indeed, the eastern boreal (Québec and the maritime provinces of Canada) have experienced little of the recent warming and drought seen in central, western, and northwestern areas. In contrast, western and northwestern regions have had more severe climatic warming and greater increases in fire than what I documented for northwestern Ontario. The effects of the recent drought were clearly seen in northern Wisconsin, and well into eastern Ontario. My article could be similarly criticized for other specific regions. For example, the effects of acid rain are important in Québec (Minns et al. 1990, 1992) but will not be seen in western or northwestern boreal regions in the foreseeable future. In brief, not all of the many insults that I described occur in all regions. My point is rather that several stressors do apply to every region, so that I think that the "Dim Future" that I foresee is widespread in the boreal.

That being said, I am somewhat doubtful that increased precipitation may offset the effect of warming on evaporation. Much of the boreal, including Québec, has little water storage capacity because the soils are shallow. A few weeks of warm, dry weather can create extreme fire weather, even under conditions of higher average precipitation. Even the rather slight warming of the 1970s and 1980s greatly increased annual evaporation and decreased

streamflow (Schindler et al. 1996, Schindler 1997). Some climate models predict significant declines in soil moisture under a doubled carbon dioxide scenario for Quebec, although projections are not as extreme as for the central boreal (Manabe and Wetherald 1986).

As Norrman Yan has pointed out to me in a personal letter about my article, I also omitted reference to one insult that is important in eastern boreal waters, invasions of non-native species. Zebra mussels and the cladoceran *Bythotrephes* are altering the communities of boreal freshwaters, and a host of insect pests are known to predispose boreal forests to fire. These factors could not be accounted for in paleoecological studies and may therefore cause future climatic scenarios for the boreal to be greater than those predicted from models verified with paleoecological data. In summary, we must not focus too narrowly on any other single stressor in a given region: It is the "multiple whammy" that humans

are applying to the boreal that is causing its rapid demise worldwide.

DAVID W. SCHINDLER  
*Department of Biological Sciences*  
*University of Alberta*  
*Edmonton, Alberta T6G 2E9*  
*Canada*

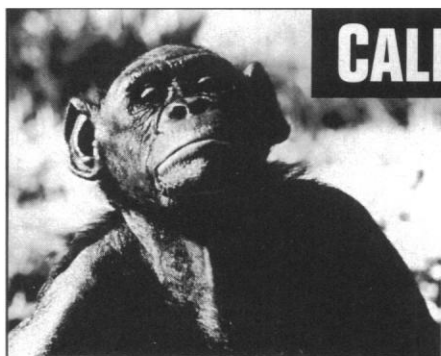
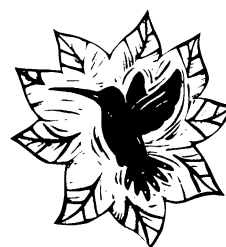
#### References cited

- Manabe S, Wetherald RT. 1986. Reduction in summer soil wetness induced by an increase in atmospheric carbon dioxide. *Science* 232: 626-628.
- Minns CK, Moore JE, Schindler DW, Jones ML. 1990. Assessing the potential extent of danger to inland lakes in eastern Canada due to acidic deposition. III. Predicted impacts on species richness in seven groups of aquatic biota. *Canadian Journal of Fisheries and Aquatic Science* 47: 821-830.
- Minns CK, Moore JE, Schindler DW, Campbell PGC, Dillon PJ, Underwood JK, Whelpdale DM. 1992. Expected Reduction in Damage to Canadian Lakes Under Legislated and Proposed Decreases in Sulphur Dioxide Emissions. Canadian Global Change Program. Ottawa (Canada): Royal Society of Canada. Technical Report Series no. 92-1.

Schindler DW. 1997. Widespread effects of climatic warming on freshwater ecosystems. *Hydrologic Processes* 11: 1043-1067.

Schindler DW, Bayley SE, Parker BR, Beaty KG, Cruikshank DR, Fee EJ, Schindler EU, Stainton MP. 1996. The effects of climatic warming on the properties of boreal lakes and streams at the Experimental Lakes Area, Northwestern Ontario. *Limnology and Oceanography* 41: 1004-1017.

**Correction:** In the article by Wayne M. Getz ("An Introspection on the Art of Modeling in Population Biology," *BioScience* 48: 540-552), the first two equations on page 547 have typesetting errors: A prime symbol was erroneously added to their denominators.



Art from *Bonobo*

## CALIFORNIA SCIENCE

### Ecology

A Pocket Guide  
**Ernest Callenbach**

With this lively guide to the essentials of ecology, Ernest Callenbach, author of the classic *Ecotopia*, provides a pocket-sized introduction to the wonderful complexity of life on Earth—and our part in it.

"This book confirms our love for and respect for scientific insight as a major way of knowing." —Lynn Margulis,

coauthor of *Microcosmos*

\$9.95 paper, illustrated

At bookstores or order 1-800-822-6657  
[www.ucpress.edu](http://www.ucpress.edu)

### Kea, Bird of Paradox

The Evolution and Behavior of a New Zealand Parrot

Judy Diamond and Alan B. Bond

The kea, a New Zealand parrot, is considered by some a playful comic and by others a vicious killer. Its true character is a mystery that biologists have debated for more than a century. This comprehensive account of the kea's contradictory nature casts new light on the origins of behavioral flexibility and the problem of species survival in human environments.

\$29.95 cloth, illustrated

### Dolphin Societies

Discoveries and Puzzles

Karen Pryor and Kenneth S. Norris, Editors

*New in paperback*—"The book offers a tantalizing cross-section of adaptations with the dolphin world."—*Science*

\$22.00 paper, illustrated

### Plant Life in the World's Mediterranean Climates

California, Chile, South Africa, Australia, and the Mediterranean Basin

Peter R. Dallman

Preface by Robert Ornduff

"Many people will enjoy this book: students and instructors in geography, ecology, climatology, and plant biology have a superb text." —Michael Barbour, author of *California's Changing Landscapes*  
*Published in collaboration with the California Native Plant Society*, \$50.00 cloth, \$29.95 paper, color & b/w illustrations

### Bonobo

The Forgotten Ape

Frans de Waal

Photographs Frans Lanting

*New in paperback*—"Bonobo is a delightful romp in the world of another species and a pleasant consciousness-raising session about our closest evolutionary relatives."—*The Sciences*

\$24.95 paper, color & b/w illustrations

**University of California Press**