RESEARCH NOTES

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FOREGASTING DEFOLIATION BY SPRUCE BUDWORM IN QUEBEC

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INTRODUCTION

The spruce budworm (*Choristoneura fumiferana*) is one of the most destructive insect pests of North American conifers. Populations of spruce budworm have reached outbreak densities on a more or less regular basis over extensive forested areas for at least the past three centuries. The last outbreak in Quebec started in 1965, ended in the early 1990s, and caused timber losses equivalent to 10 years of harvesting by the forest industry. There is considerable concern that another outbreak is now developing.

The ability to predict the occurrence, duration and severity of defoliation caused by a spruce budworm outbreak would greatly enhance the capability of forest managers to minimize the impact of the insect on forest resources. The patterns of defoliation during the previous outbreak can provide important clues to the expected patterns of the next outbreak.

Figure 1 illustrates the extensive defoliation that occurred during the last spruce budworm outbreak (1965-1994) in Quebec.

DESCRIPTION OF OUTBREAK PATTERNS

A key characteristic of a spruce budworm outbreak in Quebec is the year in which it begins in a given location. The 1965-1994 outbreak started earlier in the southwestern corner of Quebec, and progressively later toward the northeast, with some additional delays to the north and south of this main axis *(Figure 2)*. We estimated this trend in onset of a spruce budworm outbreak in Quebec to predict a so-called "year zero" of the next outbreak *(Figure 3)*.

Additional characteristics of the outbreak can be described by reference to this "year zero" of the outbreak. Thus, it is possible that two locations experienced an identical defoliation sequence during the outbreak, except that the defoliation began in different years. In fact, the defoliation sequence in any location in Quebec can be described by 1 of 25 patterns. The locations of each pattern are illustrated in *Figure 4*; the patterns themselves are shown in *Figure 5*.

PREDICTIONS OF OUTBREAKS

Although we cannot expect the next spruce budworm outbreak to be identical to the one that occurred from 1965 to 1994, there will likely be strong similarities. Defoliation sequences exhibited in the 1965-1994 outbreak can be used to predict defoliation during the next outbreak for any location in Quebec in the following way:

1. Use *Figure 3* to estimate "year zero" for the location.
2. Use *Figure 4* to identify the defoliation pattern number for the location.
3. Choose the appropriate pattern (as identified in step 2) from *Figure 5*. Add "year zero" (from step 1) to the "relative year" scale to obtain the predicted defoliation sequence for the location (e.g. "relative year –2" becomes 1999 ±1 when "year zero" is 2001 ±1, etc.).

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Natural Resources Canada
Canadian Forest Service
Ressources naturelles Canada
Service canadien des forêts
Canada

FIGURE 1

Defoliation levels recorded by aerial survey from 1965-1994.
Colours indicate defoliation levels as follows:

No defoliation

Light to moderate defoliation

Heavy defoliation

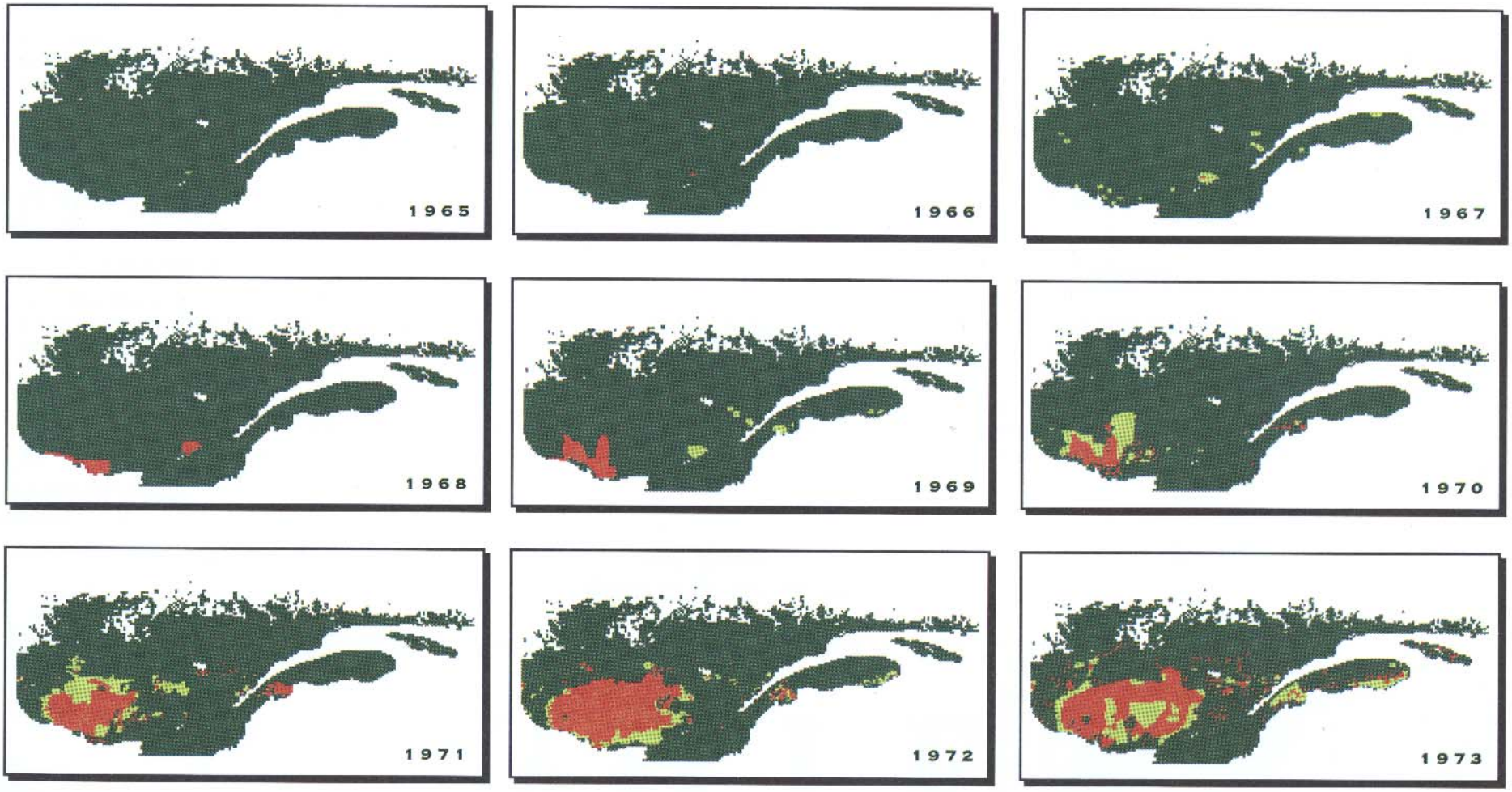


FIGURE 1 *(cont'd)*

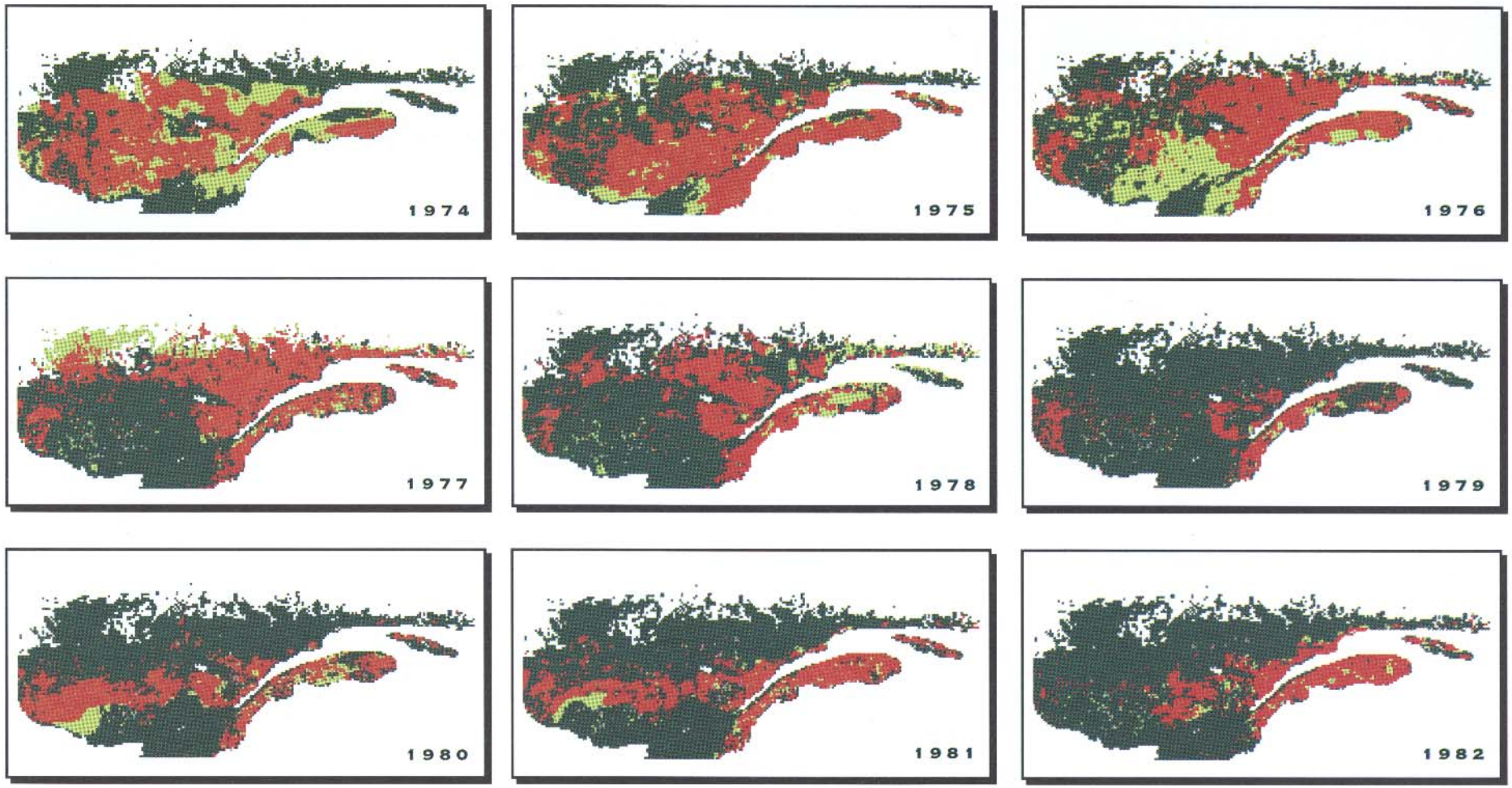


FIGURE 1 *(cont'd)*

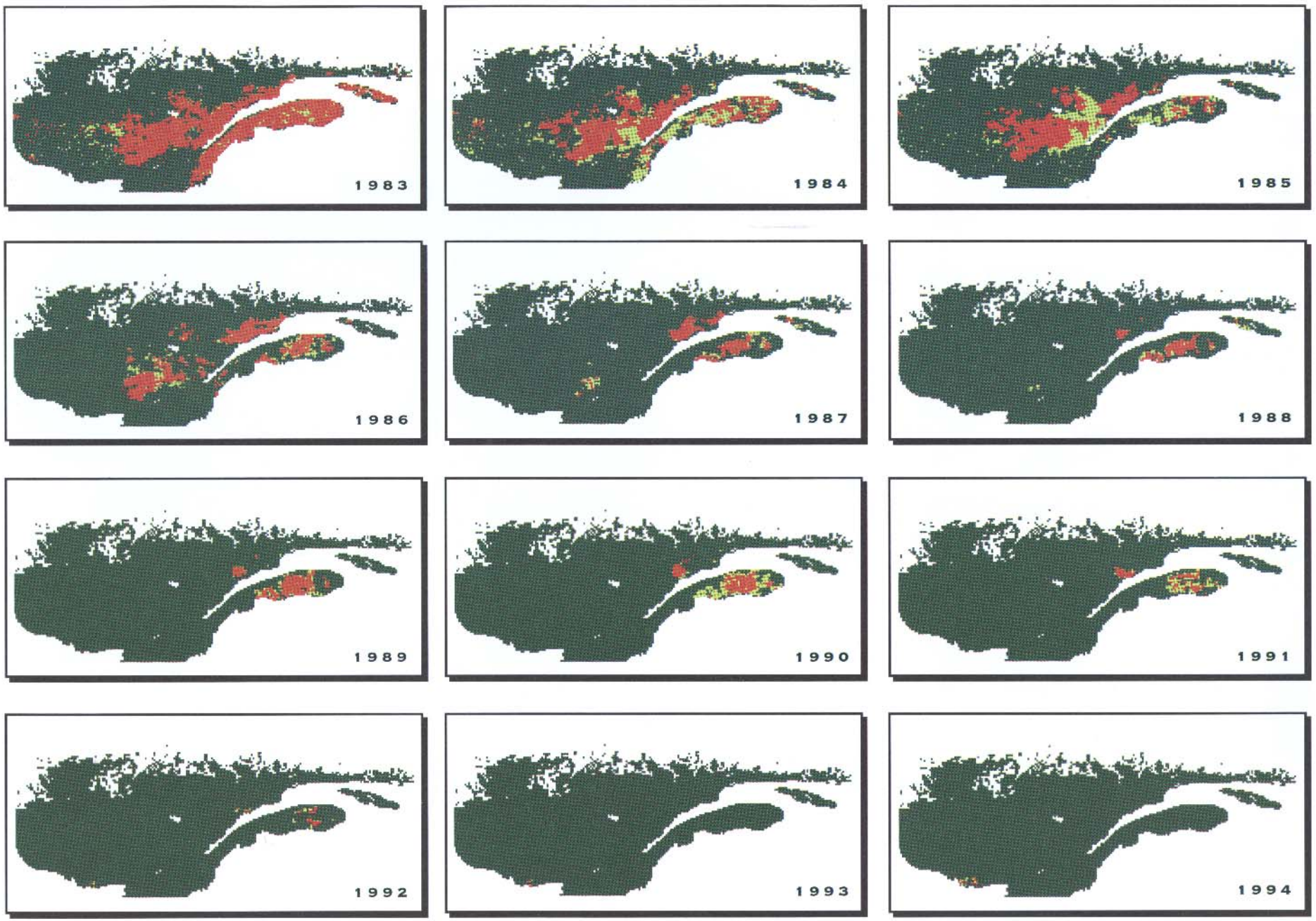
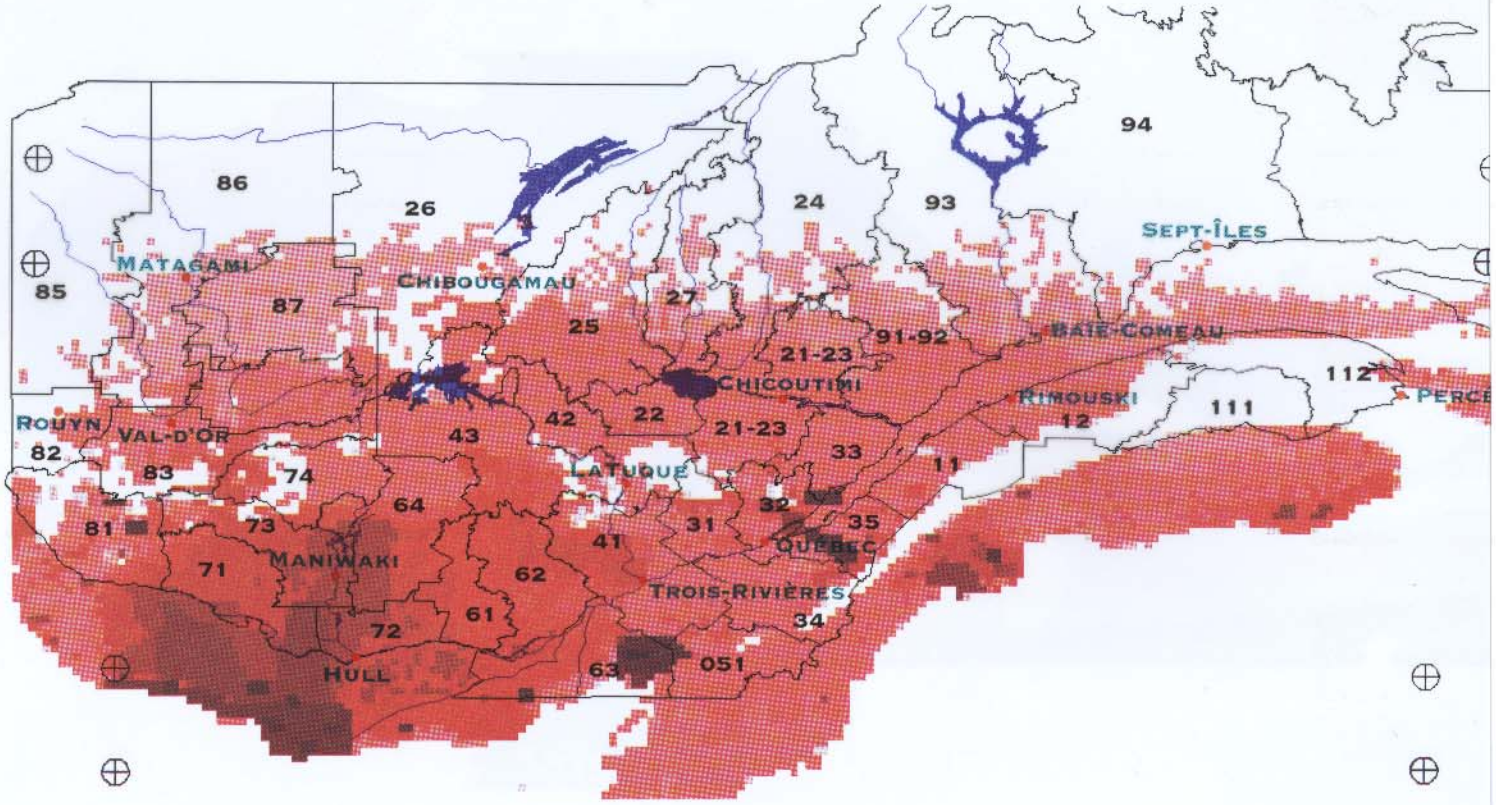


FIGURE 2

The year of onset of the 1965-1994 spruce budworm outbreak in Quebec (as determined by aerial survey). The outbreak tended to start earlier in the southwestern corner of the province, and progressively later toward the northeast, with some additional delays to the north and south of this main axis. 1 pixel = approx. 58 km².



Cette carte des unités de gestion vous permet de localiser les régions qui vous in

This map of management units can be used to locate areas

Utiliser ce signet pour identifier correctement les couleurs des patrons de défoliation de la figure 4.

Use this strip with Figure 4 to correctly identify the defoliation pattern colours.

FIGURE 3

"Year zero": the expected first year that spruce budworm defoliation will be aerially detected in Quebec during the next outbreak.

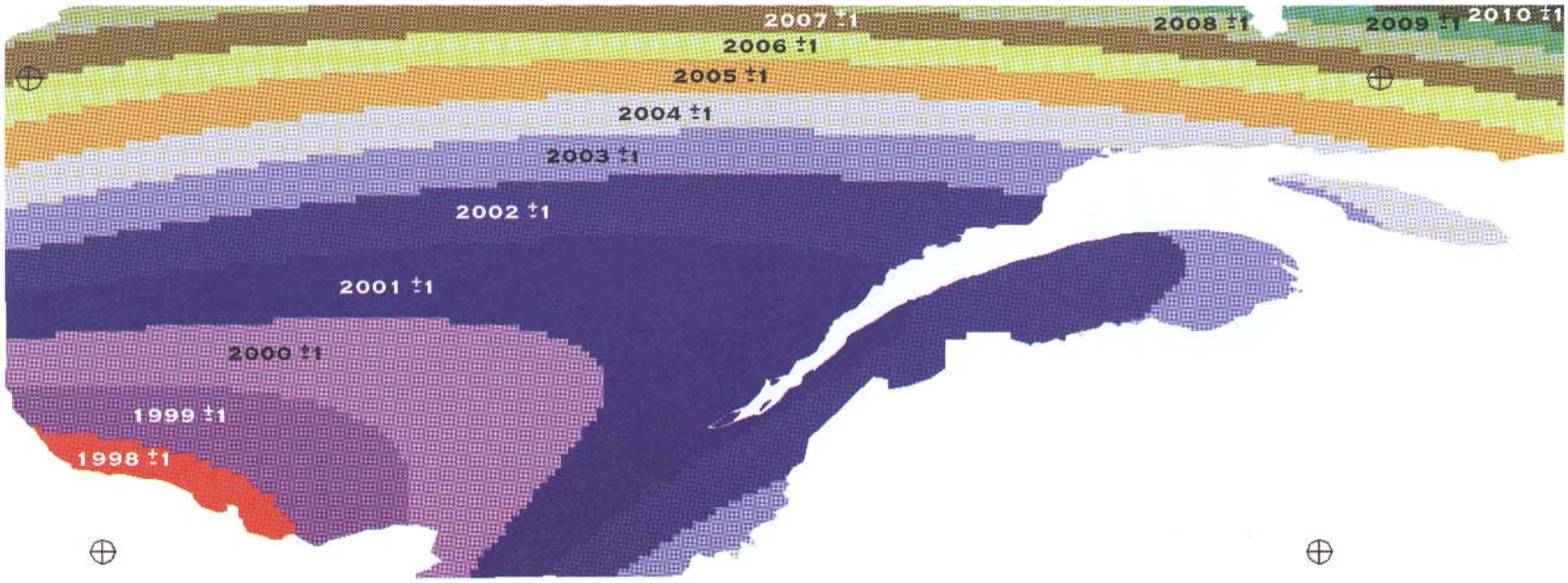
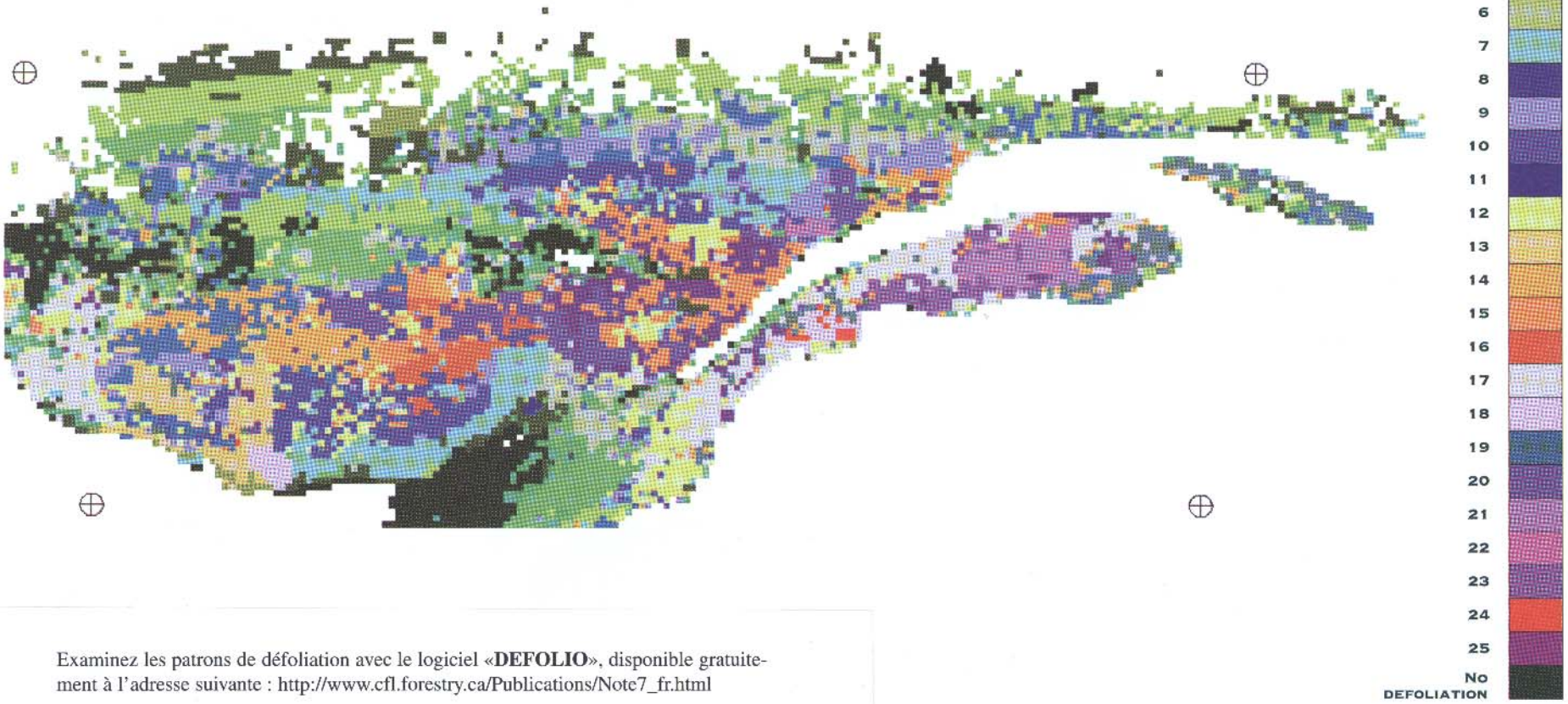


FIGURE 4

The locations and identification numbers of the defoliation patterns caused by spruce budworm in Quebec. All locations with the same colour are expected to experience a similar defoliation sequence, differing only in first year of defoliation. Defoliation patterns are shown in Figure 5. 1 pixel = approx. 58 km².

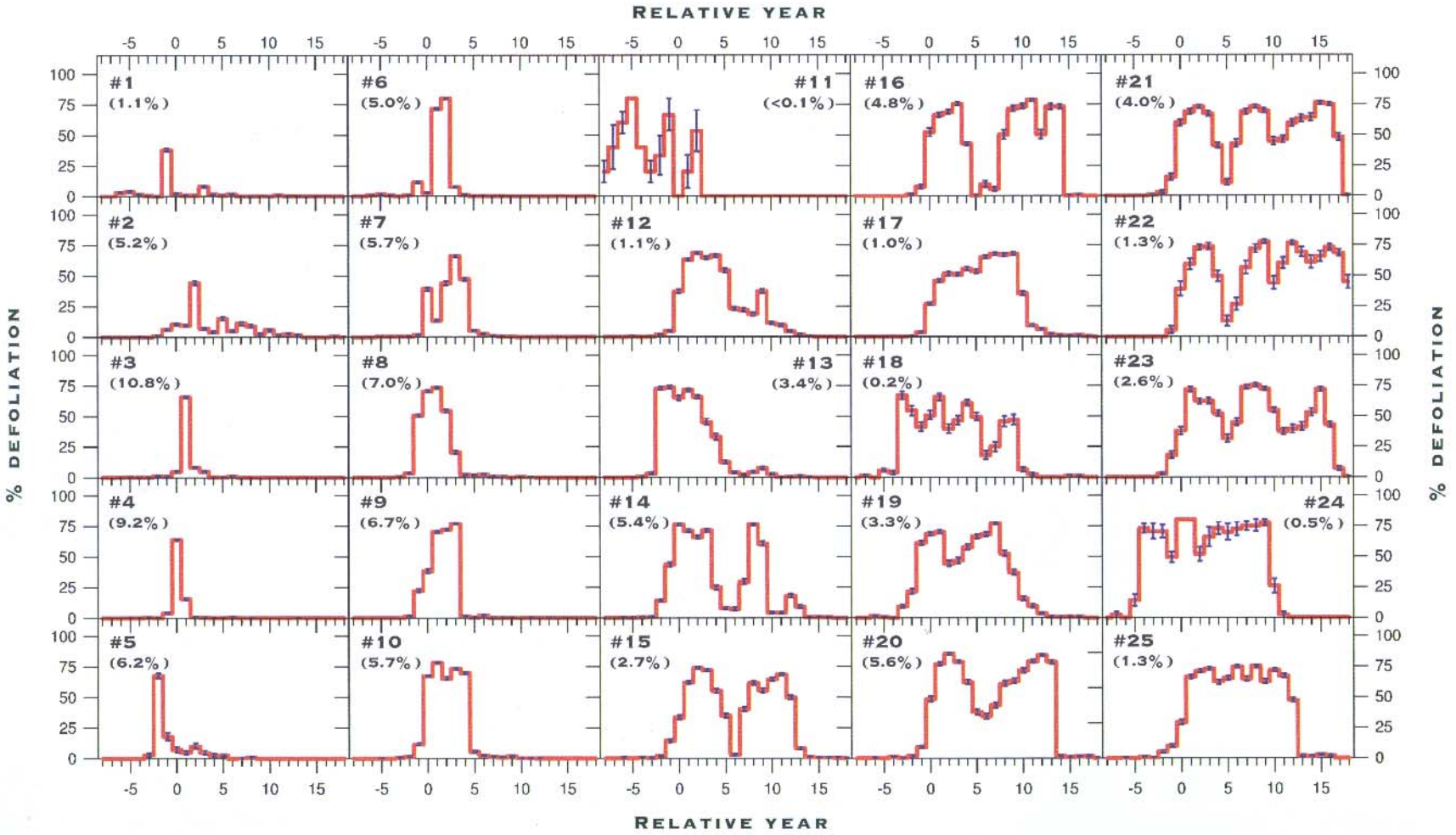


Examinez les patrons de défoliation avec le logiciel «**DEFOLIO**», disponible gratuitement à l'adresse suivante : http://www.cfl.forestry.ca/Publications/Note7_fr.html

*Examine the predicted defoliation patterns with a free copy of the computer software "**DEFOLIO**", available at: http://www.cfl.forestry.ca/Publications/Note7_ang.html*

FIGURE 5

The expected defoliation sequence (mean ± standard error of the mean estimate) in each of the 25 patterns. Numbers in parentheses indicate the percent of forest land in Quebec represented by each pattern.



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